JUNE 1991

The Institute of Petroleum

PETROLEUM REVIEW

Kuwait

IP President Basil Butler takes a look and assesses the problems

Alternative fuels

Automotive fuels for the future by WE Betts

Leak detection

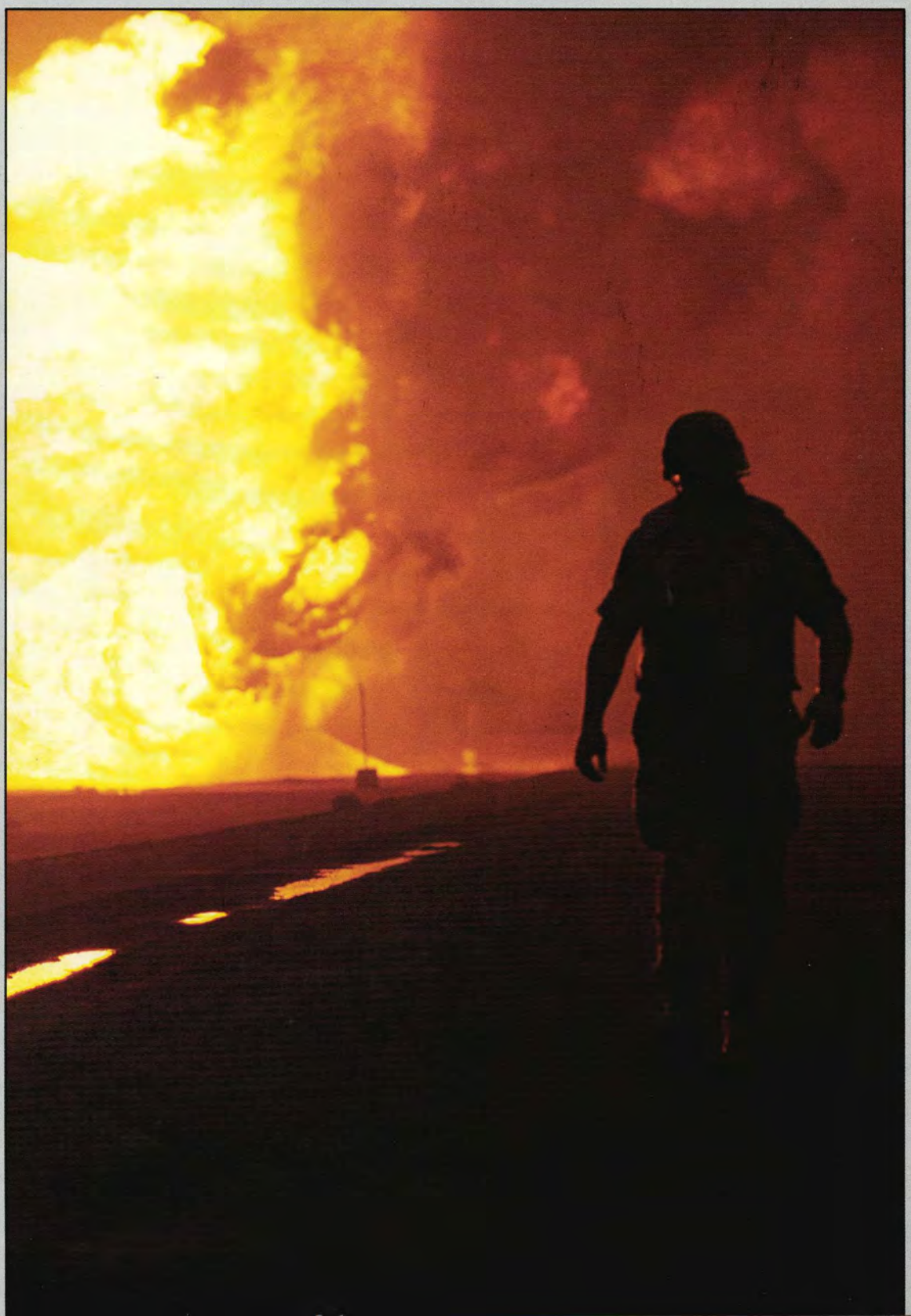
Details of the underground protection system which is being installed at Mobil's UK outlets

Information technology

Systems integration for refinery planning and scheduling by John Holmes

Europe

Laurens Knegt outlines the proposed European Energy Charter



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Cover photograph of Kuwaiti oil well fire. Photograph courtesy of Ben Gibson/Katz.

. . . news in brief

13 April

Texaco has announced a possible western extension of the giant Lapworth/Kilda gas accumulation in the UK North Sea.

Nigeria has announced an increase of 2.5 billion barrels in its oil reserves following successful exploration drilling last year.

16 April

The US subsidiary of British-Borneo Petroleum, the UK gas and exploration company, has successfully bid for stakes in six Gulf of Mexico leases.

Deutsche Shell is heading a consortium to build a pipeline from western to eastern Germany for refined petroleum products and chemical feedstocks.

Elf Aquitaine has discovered oil and gas 50 kilometres off Brunei Darussalam.

BP has put Tex/Con Oil and Gas, a wholly owned Texas-based subsidiary, up for sale. Tex/Con holds all BP's onshore natural gas interests in the United States, excluding Alaska.

Iraq's largest oil refinery at Baiji has started production again after the Gulf War, according to Baghdad.

Conoco and Norsk Hydro in partnership with Finnish firms — Imatran, Voima, Metra Engineering and Neste Oil have revealed plans to develop a giant gas field in the Soviet Barents Sea at a cost of up to $20 billion.

17 April

The investment cost of a second Thai petrochemical complex (NPC-2) has increased by more than 50 percent to $3 billion as a result of the Gulf War.

According to the Peruvian Mines and Energy Minister, Fernando Sanchez Albavera, Peru expects to sign oil contracts worth $500m this year with foreign investors.

18 April

Brazil's Petrobras oil monopoly plans to raise $350 million abroad in floating rate bonds to help finance its exploration and refining programmes.

British Petroleum has reached an agreement to sell around 30 percent of its available gas from the first part of the Brae field production to British Gas.

Belgium's Petrofina is to become the operator of four oil prospects in Eastern Siberia under new agreements signed with the Soviet authorities.

19 April

In February 1991, oil imports to Germany dropped by 17.7 percent to 6.5 million tonnes.

Chevron has awarded contracts worth more than £11 million for work on the Ninian field facilities and the Alba field development in the UK North Sea.

20 April

During the first quarter of this year, the North Sea produced hydrocarbons at a record rate of 3,960,000 barrels per day of oil and liquids — with Norwegian production running slightly ahead of that from the UK Continental Shelf.

The number of seismic land crews and marine vessels searching for oil and gas in the United States has fallen to the lowest level since 1974 — the year records started.

Gaz de France, the French state gas distributor, is to appeal to the government in an attempt to halt an amendment to a law that would threaten its monopoly.

Norway's Labour cabinet have approved plans for Statoil's Kr10.2 billion Europipe gas line which will run from the riser platform on Statpipe to the Emden terminal in Germany.

22 April

The House of Commons select committee on energy has accepted a proposal from UKOOA that operators provide funds to cover any civil liability arising from abandonment and decommissioning.

23 April

US major Chevron added more than 100m barrels to its UK reserves in 1990, in what the company described as a vintage year for exploration.

Vietnam has set up a shipping company to export its crude oil and natural gas and also to import fuels into the country.

27 April

A Polish/US mining joint venture has begun extracting methane gas in southern Poland in a project intended to make the country fully sufficient in gas supplies by 1996.

29 April

Trinidad and Tobago is discussing plans to merge two state-owned oil companies — Trinopec and Tintoc — with Trinmar, a company one third owned by Texaco.

30 April

Work has begun on laying a 60 mile pipeline for Shell Chemicals UK from Grangemouth to Moffat in Dumfriesshire.

2 May

Colin Moynihan, the UK energy minister, has announced a new £12m programme which is designed to boost the country's position in hydrocarbon research.

Denmark, The Netherlands and Italy are to spend £7.2bn on oil and gas developments over the next six years, according to a survey by Scottish Enterprise.

3 May

The PowerGen-Conoco joint venture gas company Kinetica has begun supplying gas to its first customers some six months earlier than forecast.

7 May

Mobil North Sea plans to invest a further £300m in extending its gas-processing facilities at the St Fergus gas terminal, if planning permission is given.

8 May

Eight international oil companies have reached an agreement to co-operate on the future appraisal of the Clair field in the waters west of Shetland.

9 May

US oil company Kerr-McGee is to acquire Sonat Exploration's oil and gas properties in the Powder River Basin of Wyoming for $65.6m.

Indonesia and South Korea have signed a new long-term LNG contract for 2.3m tonnes per year beginning in 1994.

Norwegian oil and gas drilling company Aker is to acquire US engineering company Omega Marine.

Royal Dutch Shell has injected $74m of new capital into its subsidiary in Chile, where it is investing in forestry and mining.

10 May

Conoco and Elf are to increase their holdings in the Clair discovery in the United Kingdom through the acquisition of interests in block 206/8.

11 May

UK independent Hardy Oil and Gas have made their fourth Gulf of Mexico gas field discovery in nine months.

BP has signed a 50/50 joint venture agreement with the Turkish oil company TPAO to explore the deep waters of the Turkish Black Sea.

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Joint venture buys out Oxy

A joint venture between Elf Aquitaine and Enterprise Oil is to buy Occidental Petroleum Corporation's North Sea assets for $1.35 billion.

Elf Enterprise Petroleum, the new company, will now become a leading player in the North Sea, having estimated reserves of 300 million barrels of oil; production is expected to peak at 100,000 barrels a day by 1995.

The reserves from Occidental include 36.5 percent of the Piper, Saltire, Scapa and Chanter fields, and 23.4 percent of the Claymore field. It also owns a 36.5 percent interest in the Flotta terminal and pipeline on the Orkneys.

Ownership of Elf Enterprise Petroleum will be split two-thirds to Elf and a third to Enterprise. The agreement between the two companies involves the transfer of part of Enterprise's Nelson oilfield to the joint company. In return, Elf's stake in Enterprise will be reduced from 25 percent to 10 percent.

Elf has said it will retain its stake in Enterprise as an investment but has promised to consult its British partner if it decides to sell.

The deal consolidates Elf Aquitaine's expansion into the United Kingdom, following the recent clearance by the Monopolies and Mergers Commission of its purchase of Amoco's UK petrol stations and refinery.

Oxy are selling their assets because, in the wake of the death of Armand Hammer, there has been a reorganisation of its core assets and the sale is a way of reducing the parent company's debt of $3 billion.

Amerada Hess has been awarded the Association for Business Sponsorship of the Arts, Scottish Award for Best New Work for their sponsorship of Scottish Opera's production of Judith Weir's new opera *The Vanishing Bridegroom*. Pictured here is Richard Hardman, Director of Amerada Hess Limited, being presented with the award by the renowned Scottish percussionist, Evelyn Glennie.

Queen's export awards

Several oil industry companies were among the 118 winners of the prestigious Queen's Awards for Export Achievement this year.

In the upstream sector, the four companies recognised for their export sales achievements were: Rotherham-based Cutting & Wear Resistant Developments Ltd for its bit-hardening techniques and drilling tools 'DIY' repair kits, Great Yarmouth-based underwater vehicle operator HMB Subwork Ltd, for its support of the offshore oil industry, Aberdeen-based Racal Survey (UK) Ltd, for its offshore positioning and survey services, and Gwynedd-based Robertson Geologging Ltd, for its computer-controlled geophysical borehole logging systems.

Downstream, and in related areas, two other companies, both UK subsidiaries of American firms, were honoured; London-based Bechtel, part of the Californian engineering and construction group and East Midlands-based Fisher Controls Process Instrumentation, part of the US firm Monsanto Inc.

US discovery

Shell Oil Company has announced a potentially significant discovery in the Gulf of Mexico deepwater frontier. The discovery occurred in a water depth of approximately 3,100 feet on Shell's Mars prospect, located about 130 miles southeast of New Orleans. BP Exploration has a 33 percent working interest in the discovery as part of a joint venture agreement.

The discovery well on Mississippi Canyon Block 763 found oil-bearing zones at depths between 14,500 feet and 18,100 feet. These zones have a combined thickness of approximately 440 net feet of oil-bearing sand.

Shell said further engineering studies are necessary and additional wells may be required before total discovered oil volumes at Mars can be reasonably estimated.

A number of development options are being considered including tension leg platforms, floating and subsea production systems and compliant towers. Production could commence within five years.

Brae gas sales

BP Exploration has announced that it is to sell 55 billion cubic feet of gas from its share of the Brae fields to British Gas.

First delivery to British Gas will be in 1994, when the gas comes on stream to St Fergus, under a 15 year supply contract.

Rempstone field

Colin Moynihan, Energy Minister, has given the go-ahead for the development of Pentex Oil Limited's new onshore oilfield at Rempstone.

The Rempstone field was discovered in 1985 and is located some 10 miles south west of Nottingham.

The first phase of production was scheduled to start in May 1991 at an initial rate of 80 barrels a day, building up to a plateau rate of 350 barrels a day by 1992.

Norwegian gas

Statoil has signed a 15-year deal with National Power to supply 2.2 billion cubic metres of Norwegian gas a year to fuel gas-fired power stations in the United Kingdom.

The deal, estimated to be worth £150 million a year, is a breakthrough for Statoil who previously only sold gas to British Gas.

Licence changes

John Wakeham, Energy Secretary, introduced new changes to onshore licensing regulations last month.

The principal changes are: a new licence which will permit a licensee to extend a seismic survey up to one kilometre into an adjacent unlicensed area, permission to carry out a first long-term test (up to a maximum 90 days) under an exploration licence and less licensee returns.

Clair developers share costs

The eight Clair area co-venturers, who plan to develop the new field west of Shetland, have set up a £25 million appraisal agreement.

The companies – who all hold licences in six adjacent blocks around Clair, situated 75 kilometres west of Shetland – have agreed to a novel farm in to share the considerable risks involved in developing this large but complex oil discovery.

The agreement, subject to approval from the Department of Energy, includes BP, Chevron, Conoco, Elf, Enterprise, Esso, Mobil and Amoco.

Two appraisal wells, costing a total of £25 million, are to be drilled in depths of 200 metres of water. The first stage has already begun.

The Elf-operated rig *Petrolia* spudded a horizontal well at the beginning of May and is to drill down to the basement in block 206/7a.

BP's *Sea Explorer* rig, spudded three weeks later, is to drill a vertical well in block 206/8. If necessary this well will be stimulated by conducting massive hydraulic fracture treatments.

The programme is the result of last year's successful joint studies agreement which included a 3-D seismic survey of the area and a computerised reservoir modelling programme.

These two new wells are aimed at resolving uncertainties highlighted by the joint studies. Part of the problem in appraising a field is where to locate wells so that they can achieve and sustain the best possible production rates. If the two wells prove to be successful, then further appraisal activity, possibly including extended well tests, will be considered for 1992.

Iraq exports

Iraq could export as much as 600,000 barrels of crude a day through its northern pipeline system once UN sanctions are lifted.

According to the *Middle East Economic Survey* (MEES), the pipeline system which links Iraq's northern fields with Turkey is virtually intact despite the recent Gulf war and the Kurdish uprising.

Currently Iraq only uses about 200,000 b/d domestically from the 800,000 b/d production of its northern fields. MEES says any surplus not processed at the Daura and Baiji refineries could be exported.

Also, because most of Iraq's power stations have been destroyed, there are plans for excess fuel oil produced at the refineries to be trucked through Jordan for export from Aqaba.

Iraq has already set up an office in Amman, Jordan, to handle sales of oil as soon as the UN trade embargo is lifted.

Beaufort Sea

Amoco has announced plans to start drilling an exploratory well in the Eastern Beaufort Sea off Alaska in early August.

The Galahad prospect, in Camden Bay some 80 miles east of Prudhoe Bay, will be drilled to a depth of 12,000 feet in 164 feet of water.

Stand-by vessel offshore rescue instructor Iain Letham has been awarded the George Medal by Her Majesty The Queen.

Iain, a member of the Aberdeen-based Maritime Rescue Services Team, was the sole survivor of the fast rescue boat destroyed in an explosion when it raced into the sea of burning oil around the stricken Piper Alpha platform in July 1988.

Alba approval for Chevron

The Department of Energy has announced approval for the Chevron UK operated Alba oilfield.

The Alba field, which is located 130 miles north-east of Aberdeen in Block 16/26, has more than one billion barrels of oil in place with up to 400 million barrels estimated to be recoverable.

The Development Plan calls for the field to be developed in two phases with a platform (Alba Northern) and Floating Storage Unit (FSU) being installed initially in summer 1993 at an estimated cost of £65 million.

Production is expected to begin in January 1994 and quickly build to the phase one peak of 60–70,000 barrels of oil per day.

Phase two will see a facility installed in the southern end of the field approximately five years later with advantage being taken of the experience gained in the first phase.

New formula

British Gas's domestic and small business customers could pay less for their gas over the next five years thanks to a new price tariff formula agreement with Ofgas.

The new complex agreement, due to come into force next April, will mean 17 million British Gas customers will receive a three percentage point reduction on annual inflation-linked price rises.

Under the current formula BG can pass on inflation costs to their customers less two percentage points. From next April BG has agreed to reduce the RPI costs in the formula by five percentage points.

New association

Britain's leading forecourt system service organisations have formed the Association of Forecourt Systems Contractors.

Cameron Technical Services, Gilbarco, PM Services and Wayne Autocourt have formed the AFSC to study and resolve common problems relating to health and safety, legislation and environmental issues.

A main focus of the Association's activity will be to advance safety and uniform standards through pooling information, experiences and research into the potential problems that contractor personnel face while working on forecourts and handling petroleum products.

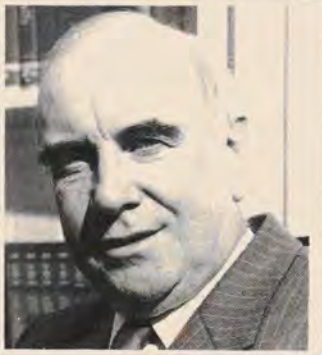
Cossack oil

The Cossack oilfield, discovered in January 1990, has been given the go-ahead. Located about 100 kilometres offshore from Dampier on Australia's northwest coast, preliminary studies indicate recoverable crude oil reserves are estimated to be approximately 80 million barrels. The initial crude oil production rate is presently expected to be in the region of 80,000 barrels per day.

IP President visits Kuwait

BRR Butler OBE, IP President and until recently Managing Director of The British Petroleum plc, returned last month to Kuwait, where he spent some of the early years of his career in the oil industry.

He went there by invitation of the Secretary of State for Energy, Mr John Wakeham MP, to see what contribution the United Kingdom could make to helping the Kuwaitis deal with the serious well-fire problem they have on their hands as a result of the destruction of the wells by the Iraqis.



Carol Reader: Were you looking just at the oil industry or at all the necessary reconstruction?
Basil Butler: We were only looking at the oil industry. In fact there were a British group of contractors, called the Kuwait British Fire Group, as part of the delegation and they had negotiations already going on with the Kuwait Oil Company. I was somewhat involved in that, trying to help them get their negotiations completed with the Kuwait Oil Company.

How much progress has been achieved so far in the oil sector? Is progress slow?
Progress is inevitably a bit slow at the moment because the only process being used for dealing with the oil well fires is to use the well top capping technique and there are only five or six groups of people in the world who can attempt this work and they are all from the United States or Canada. Although there is possibly one British organisation that can attempt this now.

They are hampered by logistical problems, by problems of smoke, by problems of mines and unexploded ordnance lying around the place — so their business is consequently rather slow.

Indeed, I think the whole task has to be accelerated by bringing in other means of dealing with the oil well fires.

Do you think there is scope for new, novel methods to be tried out?
Well, I think one has to look at any good ideas that come along but in fact a lot of people are coming forward with ideas which are quite extravagant and unlikely to be successful in the timescale we are talking about. A lot of them are experimental.

There are two perfectly well-tried techniques which can be used — one is the well top capping which is being done now. The other is deviated drilling to kill the wells from below. I believe that technique ought to be deployed without any further delay.

Kuwaiti oil well fire

Photo courtesy of Ben Gibson/Katz

But that will take time won't it?
Yes, but these wells are shallow. With modern drilling techniques, once the organisation has got into its stride, I think one could kill the wells in pretty quick succession. If you had enough drilling rigs, say 25, you could begin to make a serious impact within weeks.

Is there still a shortage of the necessary materials and equipment?
I believe so. I think much of the equipment that was held in Kuwait was either destroyed or taken away. The teams that have come in to try to deal with the fires have been hampered by the loss of logistical support and by problems of getting materials into the country and sometimes also by administrative problems. The equipment has to come in via Saudi Arabia and that means it has to clear an international border and all that. So I think that's an area where a little bit of organisation could help to accelerate things.

The teams that are out there now are labouring under very great difficulties. You only have to see the situation out there to realise this and there is nobody better than those particular groups of people for dealing with the fires by the well capping technique. My only concern is that it is going to be a slow process if we just rely on them, whereas we could be achieving more, maybe at a higher cost, by using drilling rigs.

I heard that seawater was going to be brought in via an oil pipeline so that there was adequate supplies of water. Is that scheme operational?
Yes, they are already doing that. That

Kuwait — scene of devastation.

is the obvious thing to do. You can reverse the main oil pipelines that normally take oil to the coast for export and pump seawater back. But you need an awful lot of water for this operation.

Has the scale of damage to the oil wells now been fully assessed?
I don't think so. There seems to be uncertainty when we there (which was admittedly two weeks ago) as to precisely how many wells were actually on fire, or had been damaged. There was also uncertainty concerning the extent to which they had been damaged. One of the reasons for this is, I believe, that in the Burgan field in particular which is the largest field in Kuwait, you have got this problem of all the mines and unexploded cluster bombs lying around and people just can't get in there until these have been cleared.

When you saw the situation for yourself was the position better or worse than you had expected?
It was worse than I had expected in terms of the number of wells that were set on fire and the problem of the unexploded bombs around the place. As regards the size of the fires themselves and the smoke, that was much as I had expected. But I had visualised that perhaps 300 wells would be on fire but probably there are more like 800. It is a huge task.

What is the damage at the refineries?
Well, I only went to one refinery; that was the Mina Abdullah refinery where the control room has been totally destroyed by a large explosion, while the whole system of loading and transfer pumps has also been destroyed. There must have been an appalling fire — it is just a mass of twisted steel. It is going to take a long time to get that refinery back into operation again.

I believe the Mina al-Ahmadi refinery, the old KOC one, is less damaged and I heard that they were hoping to get that operating on a partial basis round about September. But of course that will be dependent on having some crude oil to feed into it.

Do you doubt that Kuwaiti crude output will finally be restored to its pre-war levels?
It is very hard to say because there is some damage being done to the oil reservoirs, though I suspect that is not very serious, but many of the wells will have to be re-drilled afterwards and whether they will ever get production back to the level it was before it is too early to say. That is one of the things that really needs to be assessed — what is the effect of all this on the oil reservoirs and what does one need to do to ensure that it does come back into production properly at a later date.

Do you know how all this reconstruction is being funded?
No, I don't know the details. Kuwait has a lot of funds invested and in addition of course I think under the United Nations agreement Iraq is supposed to fund part, if not all, of the reconstruction of Kuwait. I don't know how Iraq is going to do it because they don't have any money either but that is the theory. I think Iraqi production will probably start long before Kuwait's does.

Immediately after the war the Kuwaitis declared that they would no longer use expatriate labour. Do you think that they can manage without it?
I think this was addressed specifically at Palestinian labour, and possibly Iranians. There will certainly be many expatriates working in Kuwait and my belief is that they will need expatriate labour as well as managerial support. But where it will come from I don't know.

It seems there is a reluctance to use Palestinians, though there was not much in the way of Palestinian labour before. They were mostly doing managerial and technical jobs.

I think they ought to perhaps bring in people from the Philippines, Korea and so on.

There always were a lot of Egyptians working in Kuwait and I think they will be encouraged to come back.

The *Independent* talks of 'a fading dream of rich contracts'. Is that how you would describe the present situation?
It is hard to judge but I think that many contracts will come to western companies — British and American and others — because there is a great deal to do.

If you look at the reconstruction of the refineries, the reconstruction of the gathering centres, the offshore loading facilities, all that is going to have to be done. British contractors are in there, in discussion and I still believe that they will get a good share of the work. I don't see why not. It may all take a bit longer than people hoped but the work has got to be done.

'I think Iraqi production will probably start long before Kuwait's does'

Will the companies who originally built the facilities go back and do the reconstruction?
No, not necessarily because time has moved on so that what they did may now be obsolete. Presumably they will now build the best technology available today. So I don't think those who happened to be involved in the early days need necessarily believe that they will be the ones to return.

In my view, the ones which will do

this work will be the ones that try hardest to get in there and beaver away — as I have seen some British contractors doing. The group we were with were very energetic and on the ball.

If firefighting teams are brought in, will they need accommodation, materials and services?
If you look at what I have been saying about bringing in drilling rigs, I suppose that if you bring in 25 drilling rigs you have got to bring in 25 camps to accommodate the people working there, because each rig would have 50/60 people. You have got for starters 50,000 tons of cement, 50,000 tons of mud and 100,000 tons of casing for all these wells, and bulldozers and fuels, food — everything has to be brought in. A lot of it will have to be brought in by air.

How did you travel to Kuwait?
We flew by a commercial airline to Bahrain and then by RAF Hercules. It is not the most comfortable way of travelling but it was very effective.

Is the airport still not operational?
It wasn't when I was there. Though I did see one or two Kuwait Airways planes moving round on the airfield. But the terminal buildings, as I understand, have been destroyed. We came in through a refurbished VIP lounge.

I don't think the world appreciates the scale of the destruction everywhere in Kuwait.

Did you find that the other basic services like water and power were available?
By the time I got there, there was water, not any hot water, and there was power. But they were only managing to keep services going because the population of Kuwait is probably only a quarter or a third of what it was before the invasion and some very good work was done by British contractors in getting those services running again. But there is a lot of reconstruction work in power stations, water desalination plants required before they can get the full population back.

And were the telephones working?
I didn't make any progress on the domestic telephones. Oddly enough, you could phone internationally but you couldn't phone inside the country because the exchanges had been blown up — some by the allies actually.

As you look back after your visit, what is your general impression?
If any major company like Exxon or Shell or BP or anybody had been hit with a problem such as the Kuwait Oil Company has got, it would be an overwhelming issue for even one of those companies. For the Kuwait Oil Company which was set up really as an ongoing operating company, it is just totally overwhelming.

I am convinced that the world has got to help them, to provide logistical and management support and everything else to get things turned around. It is crucial — since my visit, another billion dollars worth of oil has gone up in smoke. The position is totally horrific. ■

World Petroleum Congress

The 13th World Petroleum Congress takes place in Buenos Aires, Argentina, from 20 to 25 October. If you register before 30 June you benefit from a reduction of US$100 in the registration fee. The fee admits you to all plenary and working sessions and official receptions and entitles you to a book of abstracts and 20 preprints.

The Congress brochure is now available from Mrs Pauline Ashby at The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR. Telephone: 071 636 1004. Fax: 071 255 1472. Telex: 264380.

The WPC is the largest international forum for the interchange of technical and managerial information about the petroleum industry. The theme is New Horizons for the Petroleum Industry and participants are expected from 70 countries.

The Congress will be opened by Dr Carlos Saúl Menem, President of the Argentine Republic.

More than 150 papers and posters will be presented, with three concurrent sessions operating for most of the week. Keynote speakers scheduled for the first day include Mr Lo van Wachem of Shell, Mr Richard Stegemeier of Unocal and Dr Subroto of OPEC. Oil ministers from the USSR and Nigeria will also speak at the Congress and there will be addresses by Dr Andrés Sosa Pietri of Petróleos de Venezuela, Mr Euan Baird of Schlumberger and Dr Teruo Noguchi of Koa Oil.

Diplomatic relations were recently restored between the United Kingdom and Argentina and participants can be sure of a warm welcome. A visa is not usually needed for UK passport holders and there are direct flights between London and Buenos Aires.

Participants are free to make their own travel arrangements but Aerolineas Argentinas, the official airline for the Congress, has appointed Dellstar Travel to handle the travel arrangements for British participants. Dellstar has 20 years' experience in South America.

Special fares have been negotiated allowing considerable savings over ordinary fares. This applies to economy, club and first-class travel and the fares are only available through Dellstar. These fares can be supplemented by Visit Argentina Pass air tickets for pre- or post-Congress tours. In addition to the tours listed in the WPC brochure, Dellstar can offer tours to other parts of South America. Please contact Dellstar Travel using the form below.

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WORLD PETROLEUM CONGRESS

20–25 October 1991

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Within sight of European energy co-operation

By Laurens Knegt, Deputy Director-General of Energy, Dutch Ministry of Economic Affairs

The fact that the Dutch Prime Minister Ruud Lubbers is an inventive man is something we in The Netherlands have known for years, but it is now becoming widely recognised in Europe as well. One of Mr Lubbers' ideas has been the establishment of a European Energy Charter, a proposal he launched at the European summit in Dublin in June 1990. Now, a year later, this proposal, which has since been adopted by the European Commission, is slowly but surely beginning to take shape. This article will provide some insight into the background and aims of the proposal, as well as its current state of play.

In the paper which he presented to fellow government leaders on 25 June 1990, Mr Lubbers identified three grounds for co-operation in Europe in the field of energy. The first is that the political situation in Europe has changed drastically following the collapse of totalitarian regimes in Eastern Europe. The time is ripe for far-reaching political co-operation now that the Cold War is a thing of the past. However, the former Communist countries can only set out on the road to economic recovery with the West's help, perhaps not so much in the form of financial help as assistance in know-how and structural investments. Help, moreover, which must be given in as concrete a form as possible. This brings us to the second cornerstone of the plan — namely economic restructuring, since energy is a basic precondition for a well-functioning economy. The third foundation of the 'Lubbers Plan' is energy policy as such. Forms of co-operation between East and West in this area could lead to considerable advantages for all parties involved.

Objective: mutual advantages

Mutual advantages: these are the key words of the energy charter. In business language, this is attractively known as the 'creation of a win-win situation'.

This situation is one which we can easily appreciate once we realise how enormous the reserves of oil, coal and gas are in a country such as the Soviet Union. The exploration and exploitation of these resources could make a considerable contribution to the security of supply of both Western European nations and the Soviet Union's former satellites. The vulnerability of our energy supply was once again shown during the Gulf crisis. Even leaving aside the acute danger posed by that type of crisis, the West's oil supply also faces long-term vulnerability, with market developments pointing to a significant strengthening of the position of the OPEC countries. In short, the exploration and production of Soviet energy reserves would make a huge contribution not only to the diversification of suppliers but to that of fuels as well.

Conversely, an energy charter would also allow the transfer of technology, capital, know-how and hard currency from Western to Eastern Europe. These will be vitally needed by the Soviet Union and Central European countries in developing their energy sector. I have already mentioned exploration activities in the Soviet Union. Greater efficiency in production, transportation and distribution and use is also essential for these countries. Obviously, increased efficiency as such is an important factor for Eastern European economies, but it will also make a significant contribution to environmental protection.

Assuming, for example, we had a sum of $1 million to spend on energy investments in the former Eastern Bloc, we could use it to achieve far greater improvements in the environment there than we could in the West. After all, until recently these countries had nothing even approaching an environmental policy. And, given the continental (in the case of acidification) and worldwide (in the case of global warming) character of environmental problems, all parties involved have a considerable vested interest in such improvements.

Content

Stimulated by further elaboration of the Lubbers' plan by certain member states (The Netherlands, Germany, Britain and Denmark), the European Commission has now begun work on the basic idea behind the concept. In

doing so, however, it has retained the Dutch premier's original idea of establishing a charter based on general principles, while at the same time working out the various aspects covered by it in the form of technical protocols.

In February, the European Commission produced a first draft of the general principles. In essence, this general section comprises a political commitment to energy co-operation and the conditions under which such a commitment can be realised. Such co-operation can only work if the private sector is given the opportunity to play a key role. After all, huge sums are needed for the numerous investments in exploration, production, transportation, efficiency improvements, environmental protection, etc. Such funding cannot be produced by governments alone — private investors, banks and companies in the energy sector would be essential participants. The charter must therefore create the necessary conditions to enable such private investments to be made.

This idea leads to the basic principles contained in the charter. The most important of these are:

- Introducing market prices in Central and Eastern European countries in order to stimulate production and efficient energy use.
- Providing guarantees to private investors for the protection of property, transfer of capital, technology, workers, etc.
- Formulating an energy policy which unites three aspects — security of supply, environmental protection and the free functioning of market forces. This should lead to common aims comparable with those formulated by EC countries in 1986.
- Guaranteeing non-discriminatory access to supplies, while recognising national sovereignty over resources.
- Guaranteeing access to the various markets for operators and suppliers.

These basic principles must be set down in the general section of the charter. They should provide a solution to the difficulties confronting many companies wanting to invest in Central and Eastern Europe and, in particular, in the Soviet Union.

The elaboration of the rest of the charter should be conducted by means of protocols. This is necessary given that the constituent markets in the energy sector are far from homogeneous. The technical characteristics and the degree of involvement of the various governments differ considerably. The European Commission has proposed the following examples for protocols:

- Nuclear energy and safety
- Development of sustainable energy sources
- Improving efficiency and energy-saving
- Gas market
- Modernising the electricity sector and grid connections
- Oil market and the refining sector
- Transfer of technology.

Institutional aspects

It was not Mr Lubbers' intention to create a large, new bureaucratic institution, but rather the opposite. A small secretariat supervising compliance with the charter and utilising the knowledge of existing organisations such as the International Energy Agency (IEA), and the European Commission would seem to be sufficient. The EC has not yet formulated further thoughts on this matter. It is, however, a sensitive issue. The European Commission is understandably looking to play a central role because it has elaborated on the ideas of Prime Minister Lubbers but the IEA possess the specific energy policy know-how needed for international co-operation in this area.

In the meantime, the Community has discussed the Lubbers plan with almost all European countries. Those consulted have, without exception, indicated their willingness to participate. Likewise, the green light has also been given at the highest political level in the Soviet Union. The Soviet Union and its republics are currently preparing a detailed response to the European Commission's draft principles. Recently, a discussion has arisen about the possible participation in the charter of non-European countries. Shortly after Mr Lubbers launched his proposal, the United States, Japan, Canada, Australia and New Zealand showed interest in the plan and indicated their desire to take part. Whether or not this will happen, and how, is now being considered. Certainly it is a politically sensitive subject. At the same time, however, it also testifies to the enormous appeal of the plan.

A further institutional aspect of the legal character of the general section and the protocols. At present, it seems likely that the general section will take the form of a political declaration (a code of conduct), while the protocols will be recognised in international law.

Conclusion

What should the next step be? Obviously, the aforementioned institutional aspects — the choice of secretariat, the question of participation and the legal character of the charter — should be clarified at the earliest opportunity. Nonetheless, the primary concern must be that of substance. The EC aims that discussions on the general section of the charter be concluded by the end of this year. In parallel a start will be made on elaborating the protocols. For this, a contribution on the part of companies active in the energy sector is vital, since it is they who will eventually be doing the work! ■

Underground protection

By Geoffrey Mayhew

Every working day this year, during the course of construction or rebuilding, Mobil retail outlets are being equipped with an ultra sensitive underground environmental protection system. The system is so sensitive that it could detect as little as 50 cc of petroleum product, and pinpoint it to within 1.5 metres over a distance of a mile of underground pipe.

At the same time Mobil is installing storage tanks and pipework below ground made of glass reinforced plastic (GRP), which should never corrode or leak as the material is inert.

Mobil pioneered this type of environmental engineering programme in the United Kingdom due to the company's experience in the United States. There hundreds of sites now have GRP storage and pipework in the ground below the forecourt.

Their UK dealer-owned outlets are also very interested in what is happening and one, in Oxfordshire, asked for technical advice and recently installed GRP tanks and pipework at its own expense.

A hydrocarbon-sensitive cable held beneath the full run of GRP pipework below ground by clips at 450 mm intervals is the essential part of one type of monitoring system Mobil uses. A leak anywhere along the length of pipe, or indeed the smallest presence of petroleum products near the pipe, causes a change in the cable's electrical impedance.

This, in turn, causes an alarm to sound and a light to flash in the control box situated in the petrol station's shop or office, where it can be instantly spotted.

At the same time the pump or pumps supplying that line would be automatically closed down and the flow of petroleum stopped.

An important safety aspect of the monitoring system is that no one can switch the flow of petroleum back on until the problem has been investigated and rectified.

A print-out, immediately available from the control box, gives information which can be compared with a map of the fuel line system to show the precise position of the hydrocarbon leak. The system can even monitor the site at a different location via a modem link. For example, it could be transmitted to an environmental protection contractor's office in order to speed up the response time for investigation.

On a major site where the total cost of overall refurbishment is, say £600,000 the GRP element for tanks and pipes plus the environmental monitoring system could amount to some £40,000 — assuming five storage tanks.

'However, the size of a site is not the material factor because the system can be as easily applied to a site with one storage tank and one pump, at much less cost,' said Graham Pooley, Manager, Marketing Engineering, Mobil.

'GRP pipe material does cost more than steel, but against that, the expense of replacement and re-installation in the years ahead should not arise because it does not corrode or wear out. More importantly, we have led the introduction of these materials accompanied by the hydrocarbon sensitive monitoring because of the increasingly important need to be environmentally safe.'

'The extensive experience in America over many years has allowed us to take full advantage of the most up-to-date technology in the use of GRP materials, and also in the ongoing development of environmental monitoring below ground. In the latter, we are currently researching greater precisions than have been possible before.'

Mr Pooley referred to the use of steel in the United States and in the United Kingdom.

'An important contributory factor in the UK's better experience has been a greater use of concrete around the buried tanks and pipework,' he said. 'The development of cathodic protection and other protective means has been extremely efficient, but steel will corrode eventually. While we have dug up underground steel tanks and found them to be in good condition after 30 years, that is not always the case, and is a function of the nature of the surrounding soil and ground water.'

A GRP storage tank of the type being used can vary between 18,000 to 55,000 litres capacity. Mobil is generally installing 36,000 litres tanks. Being of an inert material the GRP tank can be switched from one petroleum product to another.

The excavation required to install a GRP tank is larger than for a steel tank. There is a concrete base, into which fixings are located, and above that a 150 mm layer of pea gravel is placed, on which the tank is bedded. Straps are attached to the fixings and tightened round the tank, and the pea gravel, which is self-levelling, is also used as a back fill.

The pea gravel is permeable, and monitoring wells are sunk at each corner of the tank farm to give warning of any release of hydrocarbon vapour that would result from a leak of product.

Existing codes require that all connections to the tank be located in a manhole, forming a chamber for inspection. This access would be used to seal off a tank in the event of a leak. Traditionally, the chambers have been constructed of brick, which is permeable. The chambers which Mobil are installing with the GRP tanks and pipes are also of non-corrosive GRP material which, being impermeable, provides for the containment of any product spillage.

The pipework, in the case of the storage tank, is made of glass fibres bound in resin which, weight for weight, is stronger than steel. The pipework can withstand pressures up to 200 bars, but in practice the highest pressure experienced with subpump systems is 7 bars. Beneath the forecourt the diameter of the GRP pipe used is 38, 50 and 75 mm. It comes in straight lengths of given size, and is joined using collars at either end to fit to other straights or elbow joints. Connections are bonded with an epoxy cement.

'When we informed the various authorities of what we were planning, they realised we were pioneering the application of a new technology in the United Kingdom,' said Tony Hall, Manager, Construction. 'From the start we gave the fullest information and over the last year seminars have been held at which GRP suppliers have spoken of the American experience.'

The first Mobil site to be converted to GRP pipework with a leak detection system was a Pegasus 21 flagship site at Hammersmith, London. Part of a major rebuild, local authority petroleum officers and construction industry workers were invited to see how the new equipment was installed, and how a new GRP pipework system takes less time than for an equivalent one in steel.

Installing five GRP tanks at a Mobil site.

'Continual leak detection is attracting increasing attention, as is our pioneering use of precision tank testing intended to show leaks that are not revealed by ordinary pressure tests,' said J F Hutt, Manager, Design and Development. 'We are also conducting trials with electronic wet stock control and reconciliation systems. These seek to maintain a balance of wet stock inventory taking account of delivery receipts, and issues through dispensers with appropriate adjustment for variable factors such as temperature, specific gravity tank deformation, etc. A failure to balance, alerts operators to investigate what might be a leak.'

Mobil is convinced that the use of non-corrosive materials for hydrocarbons storage and pipework below ground is essential to protect the environment. But they consider steel will remain the most practical material above ground, because it can be more easily maintained, and is less expensive to install. ■

Cyclar process tested: aromatics from LPG

By Mark Scruton

BP recognised the potential technical and economic merits of upgrading propane and butanes to aromatics in the mid-1970s and initiated development work on the Cyclar catalyst system at that time. The BP/UOP Cyclar process in commercial operation today is the result of many years of cooperative effort between the companies. It combines the novel catalyst formulation invented by BP with the highly successful continuous catalyst regeneration technology developed by UOP.

Aromatics, specifically benzene, toluene and xylenes (BTX) are among the fundamental building blocks of the modern petrochemical industry. These basic components can be converted into intermediate products such as cyclohexane, styrene and terephthalic acid that in turn can be used to make fibres, films, plastics and packaging materials. The demand for aromatics is expected to increase in the future as additional markets for synthetic materials develop and grow.

Furthermore, LPG supplies are expected to increase as natural gas and associated LPG production also continues to grow.

Traditionally aromatics are produced by the catalytic reforming of naphtha or as a by-product from the pyrolysis of naphtha and gas oils in ethylene plants. These routes both require hydrotreating and aromatic extraction units to produce petrochemical-grade BTX. However, in cases where LPG is available at attractive prices, the Cyclar process has the unique ability to convert LPG to petrochemical-quality aromatics in a one-step process and high-quality aromatic products can be produced by distillation alone.

It is this increased demand for high-quality aromatics and the ample supplies of low-cost LPG worldwide which makes the production of aromatics by the Cyclar process economically attractive.

Grangemouth

The applications of the Cyclar system are diverse, and optimum operating conditions are dependent on local site-specific factors. To gain experience and to optimise fully the process to take advantage of various emerging opportunities, BP built a commercial demonstration unit at its Grangemouth refinery complex. The unit was designed to operate over a wide range of process conditions with the flexibility to handle various feedstock compositions.

BP/UOP cyclar unit at Grangemouth. Photograph courtesy of BP.

The plant, commissioned in January 1990, is located within the refinery, and the Cyclar products are blended into the refinery process streams. The 1,000 barrel a day of feedstock capacity plant uses full commercial-scale processing equipment, including the Continuous Catalyst Regeneration (CCR) technology developed by UOP.

The demonstration programme covers a range of process conditions including both a low and a high pressure operation with propane, butane, and a blend of propane and butane feedstocks.

In addition to increasing the existing knowledge of Cyclar reactions, the Grangemouth unit has demonstrated the CCR principle as it applies to the Cyclar process. The CCR section of the Cyclar unit has operated at various operating conditions demonstrating complete catalyst regeneration and the physical durability of the catalyst.

Process chemistry

The Cyclar process converts propane (C3), butane (C4) — or a combination of the two — into aromatic hydro-

carbons in a single reaction step using a unique catalyst system. Simple paraffins (alkanes) are initially dehydrogenated to form olefins (alkenes). These rapidly combine (oligomerize) and form longer carbon chain intermediates which rapidly cyclize to form naphthenes (see **Figure 1**).

The beauty of the system is that this cyclization is promoted by the shape selective properties of the system's specially modified zeolite catalyst which incorporates an inert binder with a non-noble metal promoter. The proprietary zeolite, a synthetic crystalline aluminosilicate, has a number of valuable specific properties, the most important being its regular and stable crystalline structure and its ability to provide the necessary acid medium for the reactions to take place.

Because of the zeolite's structure it can act as a molecular sieve. Only molecules of a certain size can pass through into the catalyst's pores and channels. Once inside the zeolite 'cage', the molecules are immediately dehydrogenated by the metal promoter. Almost simultaneously, the newly-formed highly-reactive olefins oligomerize to higher-molecular-weight intermediates which, in turn, form naphthenic rings. Just as rapidly these naphthenic intermediates are then themselves dehydrogenated to form their corresponding aromatic compounds. This final step is due to the thermodynamically-favourable conditions created by the process.

Because the reaction is so size-specific, liquid product is essentially free of C6-C9 paraffins (alkanes) and is suitable for direct use in most downstream petrochemical conversion processes after only simple fractionation. The aromatic products are primarily BTX.

Because of the way the virtual one-step reaction works, the choice of fresh feed has only a small influence on the relative proportions of BTX in the product. This is quite different from using naphtha where the crude source and the prefractionation scheme are very important in establishing the BTX potential of a feedstock. Also the Cyclar process can efficiently produce petrochemical-grade aromatics from C3, C4, and even C5 paraffins.

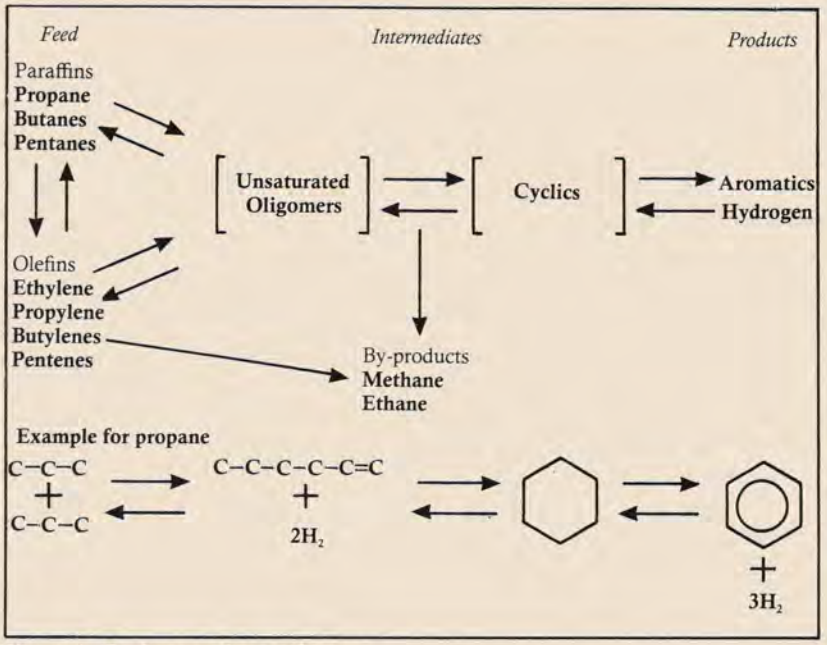


Figure 1: Cyclar reaction pathways

Process flow scheme

Cyclar is made up of two major components — a reaction system and a catalyst regeneration system (see **Figure 2**).

The reaction system is designed to produce aromatics and hydrogen from LPG continuously. It starts when fresh feed is combined with a small recycled stream of recycled unconverted feed and heated to the required reactor inlet temperature. The feed is then converted into aromatic product by passing it through a series of four reactors with interstage heating. The low-pressure drop radial flow reactors are stacked vertically to allow catalyst movement between the reactors. Interstage heating is needed because although some of the reaction steps involve reactions which give out heat, most of the reactions are endothermic.

Part of the heat for the process is provided by the end-product. This is because once the end-product has been through all the four reactors, it is passed through a heat exchanger where the transferred heat, in turn, heats fresh feed entering the system.

The output is then cooled and partially condensed prior to entering a low-pressure separator. Liquid recovered from the separator is fed to a stripper where C6+ aromatics are recovered. Vapour from the separator is compressed and sent to a gas recovery section. Here, hydrogen and light by-products are separated from unconverted feed components. Any aromatic product recovered is sent to the stripper. Any unconverted feed is then mixed with fresh feed and recycled back into the system.

Catalyst regeneration

The dehydrogenation reactions that are the most critical steps in the Cyclar process are favoured at high temperatures and low pressures. Unfortunately, these process conditions are exactly those which increase catalyst coke deposition (carbon build-up) and hence catalyst deactivation.

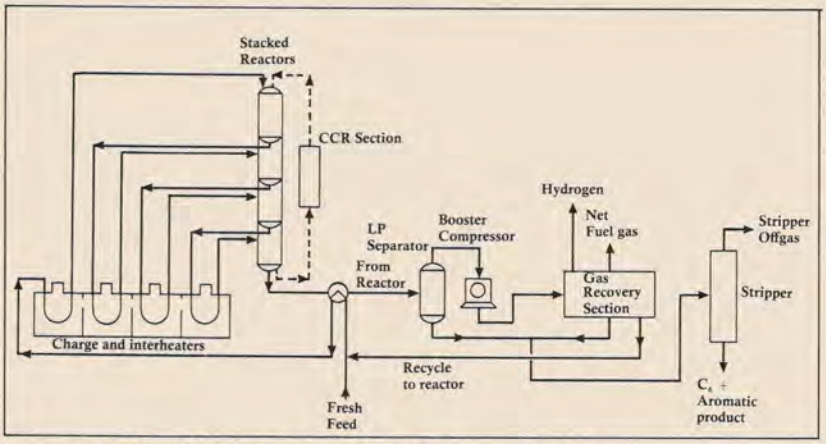


Figure 2: UOP/BP Cyclar process for LPG aromatization

Used catalyst is transferred by lift gas to the top of a regeneration tower. Separated from the lift gas, gravitational forces are used to allow the movement of catalyst down the tower. In the regenerator, carefully controlled oxidation conditions are used to burn the coke and regenerate the catalyst. Once the catalyst has been regenerated, it is returned back to the top of the first reactor by lift gas.

Catalyst movement within the reactors and the regenerator is gradual. The steady replenishment of regenerated catalyst is matched by the removal of the partially deactivated catalyst from the fourth reactor.

This steady-state catalyst condition eliminates the need for changes in process temperatures to compensate for catalyst deactivation. The desired conversion level, yield and product quality are continuously maintained.

Process yields

The Grangemouth plant has processed more than the 1,000 barrel a day design capacity. Test figures for production yields from the pilot scheme showed that the total aromatics yield increased with the carbon number in the Cyclar process.

Aromatics yield increased from 63.1 weight percent with propane to almost 66 weight percent with butane feed.

The effects of feedstock composition on the aromatic distribution in the liquid product are shown in **Figure 3**. The Cyclar liquid product with either propane or butane feed contains about 92 weight percent BTX, the balance is C9+ aromatics. Butane feedstocks produce a product that is leaner in benzene and richer in xylenes than that produced by propane feedstocks.

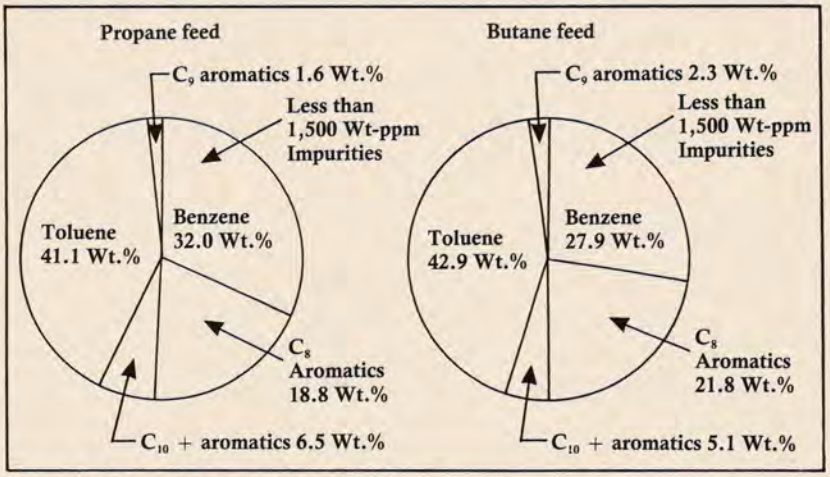


Figure 3: Cyclar C_6 + product breakdown

Reaction pressure also has an impact on process economics. By using a higher pressure there is a reduction of capital equipment size and a reduction in the amount of catalyst needed to run the process.

In the system's high pressure operating mode, aromatics yield using propane as the feed are reduced from 63 wt percent to 55 wt percent and hydrogen yields from 7.5 wt percent to 5 wt percent. At the same time fuel gas yields increase from 29 wt percent to 40 wt percent.

Aromatic production using butane as the feed roughly has the same effect. Yields are reduced from 66 wt percent to 60 wt percent and hydrogen yields from 7 wt percent to 5 wt percent. Fuel gas yields increases from 27 wt percent to 35 wt percent.

The fuel gas by-product consists of 75 percent methane and 20 percent ethane with the balance unrecovered LPG and hydrogen.

BP/UOP have shown, by running the plant for more than a year, that the Cyclar process is a viable alternative to the production of aromatics by traditional routes.

Because of the increasing demand for aromatics worldwide, the Cyclar process could prove to be very attractive to petrochemical concerns in areas like the USSR and South East Asia, where there are large volumes of LPG available and where there are prospects of an increasing demand for aromatic products. ■

Star Enterprise: a prospering joint venture

By Judith Gurney

On 10 November 1988, Saudi Petroleum Minister Hisham Nazer, on behalf of the Saudi Arabian Oil Company (Saudi Aramco), and Texaco President James Kinnear signed an agreement to form a joint venture, called Star Enterprise, for refining, distributing and marketing petroleum products under the Texaco trademark in the East and Gulf Coast regions of the United States. The partner representing Saudi Arabia's interest in the joint venture was to be Saudi Refining, Inc, a wholly-owned subsidiary of Aramco Services Company. The partner representing Texaco's interest was to be Texaco Refining and Marketing (East), Inc, a wholly-owned subsidiary of Texaco Refining & Marketing, Inc. Star Enterprise began operations on 1 January 1989 with assets of approximately $2.5 billion. With headquarters in Houston, Texas, the new company had 4,000 employees at the end of 1990, its second year of operations.

The agreement provided for the purchase by Saudi Refining of a 50 percent interest in Texaco's refining assets and retail marketing system in 26 states, from Maine south to Florida, including the District of Columbia, and west to Texas. The purchase price for this half share of the business was $812 million. It was agreed that Saudi Refining would provide 75 percent of the joint venture's initial oil inventory, about 30 million barrels, and that each partner would contribute a 50 percent share of working capital, other than oil, and extract a 50 percent share of the profits. It was also agreed that the partners would have an equal voice in managing the venture through a Management Committee, of which three members would represent Saudi Aramco and three others, Texaco. Under the terms of the agreement, Star Enterprise had the right to purchase up to 600,000 b/d of Saudi crude at market-related prices for 20 years. It could select the grades of Saudi crude which it wanted to purchase, provided that these were available.

Background

Texaco, which was founded in 1902 as the Texas Company, had a long history of involvement with Saudi Arabia, having joined Standard Oil of California (Chevron) in 1937 as half-owner of the California Arabian Standard Oil Company (Casoc), which later became the Arabian American Oil Company (Aramco). As a result of a contract signed in 1933, Casoc held the concession rights for oil exploration and development in Saudi Arabia and Texaco brought to the partnership an established refining and marketing system. In 1938, oil was found in Saudi Arabia.

In 1973, the Saudi Arabian government bought 25 percent of Aramco, which then also included Exxon and Mobil as partners. By 1980, the Saudis had gained complete control of Aramco's crude oil concession rights, the crude oil that it produced and its crude production facilities. In 1988, a new state oil company, Saudi Aramco, was created following a major reorganisation of the Saudi oil industry. It was the largest oil-producing company in the non-Communist world, with petroleum reserves estimated at 270 billion barrels, about one-quarter of the world's proven reserves. It was no longer content, however, with simply producing crude oil and selling it to consumers.

By the late 1980s, the Saudi government had formulated a master plan designed to extract a share in all the profits in the petroleum business from the wellhead to the gasoline pump. 'International vertical integration is part of our vision,' Mr Nazer explained. 'No producer wants to sell just crude oil. The secret of industrialism lies in value added . . . The consumers must respect the development needs of oil producers and allow them to enter the world of value-added industrialisation.' The Saudis were determined to obtain enough of a presence in consumer markets to ensure long-term, profit-generating outlets. Saudi Aramco was restructured to emphasise bottom-line results and made responsible not only for finding and producing oil but also for developing international downstream arrangements.

There were good reasons for the Star Enterprise joint venture on both sides. It fitted in well with the Saudi master plan and was described as a major achievement in Saudi Arabia's continuing programme of more active involvement in the downstream business. It promised Saudi Aramco a share in the profits of a strong refining and marketing business on the US East

Coast and a degree of stability, which had been lacking during the 1980s, in Saudi crude exports to the United States. The end of the Iran-Iraq war in August 1988 suggested that secure markets, once Iranian and Iraqi oil returned to world markets in pre-war amounts, would be needed.

For Texaco, Star Enterprise presented other benefits. President Kinnear described the formation of the joint venture as one of several major steps to restructure Texaco and boost shareholder value. In 1988, Texaco was just emerging from a disastrous situation. In early 1984, the company had been successfully sued by Pennzoil in a Texas court, and fined a total of $11.1 billion for actions during its purchase of Getty Oil. This fine was later reduced by $2 billion but accrued interest at a rate of some 10 percent annually as Texaco fought the judgment in the courts. To protect its assets, Texaco went into voluntary bankruptcy under the terms of Chapter 11 of the US Bankruptcy Code on 2 November 1987. Shortly thereafter, it reached a $3 billion settlement with Pennzoil and, on 7 April 1988, reversed the voluntary bankruptcy. Central to its subsequent restructuring and reorganisation plan was the formation of Star Enterprise and the sale of Texaco subsidiaries in Germany and Canada.

Star Enterprise brought Texaco a very welcome cash infusion which it calculated as being worth about $1.8 billion when the purchase price of $812 million and the value of inventory, working capital and various cash benefits were totalled up. It also brought the stability of a 20-year supply contract of Saudi crude. The three refineries involved in the joint venture were all designed to run on Middle East crudes; and it was more economical to run them continuously on the same type of crude than periodically to switch them over to other crudes.

Star refineries

Star Enterprise plays a major role in the US refinery scene. In March 1991, the company ranked ninth out of all the oil companies in the United States with refineries of more than 200,000 b/d capacity. The only companies with a greater amount of large refining capacity at this time were Chevron, Exxon, Shell Oil, Amoco, Mobil, BP, Arco and Marathon.

Star owns and operates three refineries located in Convent, Louisiana; Delaware City, Delaware; and Port Arthur, Texas. These have all been designed to handle foreign crudes such as heavy Saudi crudes, as well as lighter crudes. They employ 2,600 workers and operate on a continuous basis, producing unleaded gasolines and diesel motor fuels, aviation and marine fuels, home heating oil, lubricants, petrochemical feedstocks and a range of other products.

Star Enterprise refineries

	1991	1989
Crude capacity, b/cd	615,000	615,000
Crude capacity, b/sd	663,000	668,000
Cat cracking, fresh feed, b/sd	264,000	260,000
Cat reforming, b/sd	142,000	136,000
Hydrocracking, b/sd	84,000	69,000
Hydrorefining-hydrotreating, b/sd*	256,900	255,500
Alkylation, b/sd	42,200	31,500
Coking, b/sd	46,000	46,000

*Excludes pretreating cat reformer feed, naphtha desulphurisation and naphtha, olefin, or aromatics saturation.

Source: *Oil & Gas Journal.*

The largest of these refineries is Port Arthur, situated in Texas on the Gulf Coast. When it started operations in 1903, Port Arthur's crude oil processing capacity was less than 880 b/d; it is currently 250,000 barrels/calendar day (cd) and 273,000 barrels/stream day (sd). (Calendar day is the average volume a refinery processes each day, including downtime used for turnarounds, and equals the total production for the year divided by 365; stream day is the amount a unit can process when running full capacity for short periods.) Port Arthur now spans 5,000 acres and more than half of its operating units have been constructed since 1970. It is a major producer of base oils for Texaco lubricants and the only Star refinery which produces lubricants and asphalt at a production rate of some 18,770 b/sd and 14,000 b/sd, respectively. Port Arthur had a major unit utilisation rate of 87 percent in 1990, and its current upgrading programme consists of construction of a delayed coker unit, a sulphur recovery unit and a hydrotreater.

The second Star refinery covers nearly 4,000 acres on the Mississippi River in Convent, Louisiana, about midway between Baton Rouge and New Orleans. Convent began operation in 1967 with an initial rated capacity of 100,000 b/cd; by 1984 this had been enlarged to 225,000 b/cd and 240,000 b/sd. Convent is considered a very efficient refinery and recently received a government award for compliance with environmental regulations. Its major unit utilisation in 1990 was 94 percent. Design and engineering work is underway at Convent on two ether units which will supply oxygenates needed for gasoline to meet the recent Clean Air Act emission requirements.

The smallest Star Enterprise refinery, which began operations in 1956, is the Delaware City plant, with a 140,000 b/cd and 150,000 b/sd capacity. Delaware City, which covers over 5,000 acres, has a marine terminal on the Delaware River. It specialises in producing home heating oil and also makes gasoline and diesel fuels. Delaware City expanded its alkylation unit in 1990; its major unit utilisation that year was 99 percent. Like Convent, it will also be fitted with two ether facilities.

Star Enterprise reported that total refinery crude input for these refineries in 1989 was 597,000 b/d and, in 1990, 635,000 b/d. Approximately 85 percent of the crudes used were Saudi crudes; the remainder were domestic, Egyptian and Venezuelan.

Marketing and distribution

The Star Enterprise market is predominantly metropolitan. According to US Federal Highway Administration estimates, motor vehicles in the area served by Star consume 73 billion gallons of motor fuels each year for highway travel, representing 57 percent of total US consumption. Another 2 billion gallons of transportation fuels are consumed annually in the Star marketing region for farm, industrial, aviation and marine applications. Transportation fuels are marketed by Star under the Texaco name and can be purchased with Texaco credit cards.

Star Enterprise has four marketing divisions with a total of 1,000 employees: Northeastern, South-

eastern, Orlando and Southwestern, with headquarters, respectively, in Moorestown, New Jersey; Atlanta, Georgia; Orlando, Florida; and Dallas, Texas. Sales figures in 1990 for the Northeastern Division were 1,390 million gallons of gasoline and 549 million gallons of middle distillates. Comparable figures for the Southeastern Division were 2,038 and 545 million gallons; for Orlando, 510 and 103 million gallons; and for the Southwestern Division, 1,067 and 305 million gallons. According to surveys done by the NPD Research Group of New York, Star had a 12.1 percent share of the motor fuels market in its region for the year 1990 and a 12.2 percent share in the fourth quarter, placing the company as the second largest seller in its operating region, exceeded only by Exxon. Apparently it is about the 10th largest seller of gasoline in the United States.

The four marketing divisions oversee the shipment of refinery products to some 100 distribution terminals, of which 48 are owned and operated by Star and have some 300,000 b/d in storage capacity. These terminals, in turn, distribute to a network of more than 11,000 Texaco-branded filling stations, of which Star owns or leases 1,400. Star supplies about half of these stations directly; the rest are supplied by a network of 600 wholesalers. Star-owned retail outlets, which are owned and operated by StarStaff Inc, a company established by the joint venture partners for this purpose, are located primarily in larger metropolitan markets; those served by wholesalers are in outlying areas. Star also supplies marinas.

Texaco has developed a gasoline, called System 3, which is designed to clean engines; this is now being produced and marketed by Star as well. Texaco and Star Enterprise are also working together to develop reformulated gasolines to meet emission requirements of the US Clean Air Act.

Star has an aggressive capital expenditures marketing programme. In 1990, it acquired 127 gasoline/convenience store outlets in Florida and 24 elsewhere; it also modernised 256 other retail facilities. In addition it constructed 49 new so-called System 2000s facilities, which include car washes and food stores. There were 73 System 2000s operating in 1990, mostly in the Southwestern Division region.

Expectations fulfilled

The second full year of Star Enterprise operations was financially successful, despite the fact that the price fluctuations of crudes during the Gulf War were not always reflected in product price changes. Star's total revenue in 1990 was $8.1 billion. Its earnings before tax were $377 million, an increase of 84 percent over 1989 pre-tax earnings of $205 million. There was a 14.5 percent pre-tax return on average capital employed, up from 9.3 percent in 1989. The partners' equity or investment in Star at year-end 1990 was $2.4 billion, compared to $2.2 billion at year-end 1989.

The partners appear well pleased with the venture. Texaco is in a much healthier state than it was at the start of Star Enterprise; it has pared down its debt and has awarded a dividend increase to shareholders. Saudi Aramco is currently negotiating with Japan to set up a partnership similar to Star. It is also having discussions with South Korea along this line and is looking into refining partnerships in Thailand, Malaysia, Singapore and other Asian countries. ■

Petroleum product blending in the United States

By Don Spooner, GATX Terminals Corporation, Chicago

Petroleum product blending in the United States is one of the links between refinery operations and the distribution of finished products. While the physical process of blending is relatively simple, the dynamics of the markets involved and the multitude of blend components and combinations make the subject more complex than it appears on the surface. This report briefly describes the supply and demand issues behind petroleum product blending, as well as the physical process and the role of the independent storage terminal.

The aim of petroleum product blenders is relatively straight forward: add value to the various blendstocks by combining them in such a way to create a product that meets specifications and is in demand. Generally, blenders begin with product that would not otherwise be marketable as a fuel because it does not meet certain specifications. These products can normally be obtained cheaper than finished, marketable products. The value added comes from the blender's ability to combine these and other commodities and additives in the most cost-effective manner to give products that are competitive with traditionally produced products. Profit margins for blended product vary, depending on the source and cost of the blendstocks and the market for the finished products.

The two most important variables in gasoline blending are vapour pressure and octane number. Since marketable gasoline requires that certain vapour pressure and octane standards be met, the blender will combine the various blendstocks in the most cost-effective combination to conform to the requirements.

Vapour pressure

Vapour pressure, or as it is more commonly called, Reid Vapour Pressure (RVP), is a measure of the volatility of a liquid, or the tendency of the material to vaporise. A light product such as butane has a very high RVP, since it vaporises very easily. The heavier blendstocks have a much lower RVP. **Table 1** indicates the vapour pressures for various gasoline blendstocks. In order for gasoline to be an effective fuel, an RVP in the range of 8.0–15.0 is required. Local requirements or seasonal factors dictate the exact requirement for RVP in individual markets. The blender often begins with a quantity of a heavier compound such as reformate or alkylate, and then 'blends up' with a lighter component to meet specifications. A common method used to quickly raise the RVP of a product is blending with butanes, because of their high vapour pressure. A variety of other combinations are possible in preparing a blend that meets RVP specifications.

Vapour pressure has become much more important in recent years. Many areas of the country now place limits on maximum RVP of 8.0 or 9.0 during the summer months, when higher temperatures cause increased vaporisation of the product. By limiting the vapour pressure, a reduction in evaporative hydrocarbon emissions can be achieved, which can help to reduce harmful ozone levels. To a blender, changing legislation and requirements can be positive. Since the blender can readily create a product that meets various specifications, he has the flexibility to react more quickly to a changing market than many refiners, marketers, or wholesalers.

Octane content

The second critical variable that a gasoline blender is concerned with is the octane content. The octane number provides a relative measure of whether the gasoline will 'knock' in an engine. Simply put, it gives an indication of how well the gasoline will perform in a vehicle. Like vapour pressure, there are certain specifications for the octane number that gasoline must meet to perform properly as a motor fuel. **Table 1** lists the octane numbers for common blending components. Again, the blender may begin with a commodity that is 'off spec' and will then combine it with other blendstocks to meet the desired specifications. Since the blender needs to consider at least two variables (RVP and octane number) and possibly many others, the appropriate formula to achieve all objectives becomes far more complex. Depending on the blendstock, a given component may have the desired effect

Table 1—Gasoline blending components and specifications

Blending Component	Blending Octane Number RVP (1)	MON (2)	RON (2)
Iso-butane	71.0	92.0	93.0
Normal Butane	52.0	92.0	93.0
Reformate 94 RON	2.8	84.4	94.0
Reformate 100 RON	4.2	88.2	100.0
Light Hydrocrackate	3.9	73.7	75.5
Heavy Hydrocrackate	1.7	75.6	79.0
Alkylate	4.6	95.9	97.3
Straight-run Gasoline	11.1	61.6	66.4
Straight-run Naphtha	1.0	58.7	62.3
Cat Cracked Gasoline	4.4	76.8	92.3
Coker Gasoline	4.0	76.6	85.5

(1) Reid Vapour Pressure — a measure of the volatility of a liquid — the tendency of the material to vaporise. Measured in pounds per square inch (psi).

(2) MON = Motor octane number
RON = Research octane number
The octane number is a term used to indicate numerically the relative antiknock value of gasoline. A measure of the gasoline's performance in an internal combustion engine.

on octane, but the opposite effect on RVP. Careful consideration needs to be given to the quantities and types of blendstocks used to meet all of the specifications simultaneously.

In the past, tetraethyl lead (TEL) was added as an octane enhancer. Since the use of lead has been virtually phased out in the United States, other blending compounds have been substituted to raise octane numbers to the appropriate level. **Table 2** lists several alcohols and oxygenates that can be used for octane enhancement. Many of these are readily available in petrochemical refining centres. Actually, the use of these compounds serves a dual purpose. MTBE, for example, is being widely used not only for octane enhancement but also to reduce carbon monoxide emissions from vehicles. Because the US Clean Air Act specifies that oxygenated fuels must be used in certain air quality non-attainment zones, blending of MTBE and other oxygenates is becoming much more common in these areas. Regulations in some areas require as much as 2.7 percent oxygen by weight, which can be accomplished by blending with 15 percent MTBE by volume.

Storage, blending and distribution of oxygenates presents somewhat of a challenge. Although alcohols blend well with gasoline, they also attract water. Since some water is present in most storage and distribution systems, water contamination of gasoline can occur if it is blended with alcohols or ethers. This limits the ways that these blends may be handled and transported.

A blender will not always have a consistent supply of the same types of blending components. On the contrary, blenders are often faced with working with whatever grades can be obtained most cost effectively, whether the source is foreign or domestic. Because of the inconsistency in supply and the large numbers of combinations of blendstocks to achieve the multiple product specifications, computer models are often employed to help find the best solution. However, the usefulness of the computer model is tempered by the experience of the blender, who may trust his own instincts in developing various combinations.

Distillates

In addition to gasoline, distillate fuels and residual fuels are also blended at storage terminals. Like gasoline, there are certain specifications that need to be met for these fuels to be consumed by the end user. For distillates, one of the measured characteristics is the cetane number. Similar to the octane number, the cetane number is a measure of how well the fuel will perform. Meeting the cetane specifications is relatively easily accomplished through blending of a wide range of light gas oil products. Other specifications important to distillate fuels are pour point and flash point. The pour point measures the ability of a petroleum product to flow at low temperatures. The lower the pour point, the better its ability to flow. Kerosene is often blended with other distillate fuels to lower the pour point, and other chemical additives are often added to control the pour point.

From a safety point of view, the flash point is important. Flash point, the lowest temperature at which enough vapours are given off to form a combustible mixture with air, is often controlled to protect against explosions from escaping vapours, especially in furnace oil used in heating systems. Blending of distillates with varying flash points is done to prepare a blend that has the desired specification.

Residual fuel blending is also done at storage terminals, but unlike gasoline or even distillates, the specifications for marketable product are very loose. Sulphur content and

Galena Park terminal

viscosity (the resistance of a liquid to flow) are the two important characteristics. The allowable sulphur content varies widely between geographic areas and by the requirement of the consumer. In most cases, the storage, handling and blending systems must be heated to prevent the product from becoming too thick to move. Blending of residual fuels usually involves combining products with various sulphur contents to achieve the desired grade, or blending heavier oil with lighter stock to attain a less viscous product.

The nature of petroleum product blending, especially gasoline blending, requires good availability of blendstocks and access to various modes of transportation. The first requirement tends to limit significant blending operations to major petroleum and petrochemical refining centres. In the United States, most blending is done on the Gulf Coast, because of the huge, relatively inexpensive and readily available supply of blendstocks. Some blending takes place on the East and West Coasts, but it is not as extensive as the Gulf region. In these regions, blending is often limited to blending up a particular foreign cargo to meet local specifications. Blending is done on a much more routine basis in the Gulf coast region. The exception to this is the addition of certain additives and oxygenates, which is done routinely in most areas of the country as part of the distribution process.

Transportation

Since logistics play a key role in petroleum product blending, access to transport is vitally important to a blender.

Blendstocks move primarily by water, but also can be brought into the blending terminal by truck or pipeline. Likewise, distribution of the finished product to the various markets can be by pipeline, water or truck. A blender needs a storage terminal to provide access to these key modes of transport to be successful in the blending operation. As profit margins of blended product can be thin, achieving efficient and cost-effective means of transport is a top priority.

Blending methods

There are two primary methods of blending petroleum products: blending in a storage tank or truck on a batch basis, and blending in line on a continuous basis. Both methods provide a thoroughly mixed finished product available for distribution. The two methods, however, differ in the ways the components are combined.

Table 2—Alcohols and oxygenates used in gasoline blending

	Blending Octane Number	
	MON (1)	RON (1)
Ethanol	99.0	133.0
Methanol	96.0	130.0
Isopropanol	96.0	121.0
n-Propanol	91.0	117.0
Tertiary Butyl Alcohol	93.0	109.0
n-Butanol	79.0	95.0
n-Hexanol	43.0	56.0
n-Octanol	24.0	23.0
Methyl-Tertiary-Butyl Ether (MTBE)	100.0	118.0
Ethyl-Tertiary-Butyl Ether (ETBE)	102.0	118.0
Methyl-Tertiary-Amyl Ether (TAME)	98.0	111.0
Di-Isopropyl Ether	99.0	110.0
Methyl Phenyl Ether	108.0	112.0
Methyl Tertiary-Hexyl Ether	85.0	93.0
Isopropyl Tertiary-Butyl Ether	96.0	105.0

(1) MON = Motor octane number
RON = Research octane number
The octane number is a term used to indicate numerically the relative antiknock value of gasoline. A measure of the gasoline's performance in an internal combustion engine.

The first method, blending in a storage tank, involves adding the blendstocks to the tank, one at a time, in measured amounts according to the recipe for the particular blend. This method then requires that the tank have a means of agitating or mixing the product after the components have been added. This is done in two ways, depending on how the blend tank is equipped. Some blend tanks have mixers, or motor driven impellers which stir the product. The tank will have one or more mixers, depending on its size. The mixers are generally started when the tank is partially full, and continue while the remainder of the product is being added and for several hours afterwards, until the tank is sufficiently mixed.

Other blend tanks are equipped with eductors, or jet nozzles attached to the inbound piping. The eductors diffuse the product as it enters the tank, and move the product in a circular motion throughout the tank. Each blendstock in turn enters the tank through the eductors, and generally after all components have been added, the batch is adequately mixed. A tank may have more than one eductor, again depending on the size of the tank. Both of these mechanisms for mixing the product in the tank are commonly used in storage terminals.

A related method of in tank or batch blending involves the truck loading process, where the various components are loaded into a truck sequentially, beginning with the smallest quantity product. The action of combining the products in this fashion (which is sometimes called 'splash' blending), together with the agitation caused by the motion of the truck travelling to its destination, sufficiently mixes the product. This is often done with products that individually are 'on spec', but a different blend is desired by the consumer.

The second primary method of blending, in line or continuous blending, is also used frequently in storage terminals. Generally, in line blending involves injecting one product into another as the product is travelling through a pipeline to a storage tank, or to a truck or vessel being loaded. The commodity being added to the primary product is metered, which allows the blender to add a specific quantity of the component to maintain a specified ratio with the main product. Butanes and pour point enhancers are two examples of components blended to refined products in this manner. Because in line blending often requires hardware dedicated to a particular blendstock, it is not as flexible as in tank blending techniques.

In the Gulf area, both Pasadena and

Blend components are commonly brought to the terminal by road.

Galena Park have blend tanks. Nearly 1.5 million barrels of storage at these two facilities is dedicated to product blending. Both gasoline and distillates are blended at these locations. The attractive features of these locations to a blender are good access to blendstock supply because of the proximity to, and pipeline connections with local refineries, and excellent transport access to deliver the finished product.

On the West Coast, blending operations are limited to blending bunker fuels in the Los Angeles area. However, a significant volume of this simpler type of blending is done each year.

The blending operations on the East Coast are less routine than the Gulf area, due to a less stable supply of blendstocks. The GATX Carteret facility, however, due to its key pipeline connections, water access and location, is a site often used for blending operations. Common blending operations at Carteret include blending up foreign cargos to meet local specifications, and blending of gasoline to meet changing vapour pressure requirements due to environmental legislation. ■

Major new product pipeline completed by Fina

Last month Secretary of State for Energy John Wakeham MP visited the Lindsey Oil Refinery at Immingham and officially opened Fina's new trunk pipeline to London and congratulated the company on 'an impressive new addition to the UK pipeline network'.

The Fina-Line is a newly constructed product pipeline which links the refinery in South Humberside to Buncefield, near Hemel Hempstead to the north of London, a distance of 145 miles. At Buncefield there is already a terminal belonging to Hertfordshire Oil Storage Ltd — a major product storage and distribution point for London and the southeast.

Fina's jet fuel will benefit greatly from the new link because of a Buncefield connection into the West London Aviation System pipeline to Heathrow airport where demand for jet fuel is approaching 3 million tonnes and expected to rise further in the coming years, after this year's temporary setback caused by the Gulf War.

At Buncefield the new pipeline will also link into the Thames-Mersey United Kingdom Oil Pipeline (UKOP) network, in which Fina has a 3.8 percent interest.

The construction of the new pipeline has been undertaken completely independently by Fina UK Ltd. With a diameter of 10 inches and a single pumping station at the refinery, it will enable 1.4 million tonnes of white oil products to be carried annually to the biggest consuming region in the country.

Environmental considerations were foremost in the minds of Fina planners when they proposed the pipeline. It will now replace the equivalent of 60,000 vehicle movements in a year. As Mr Wakeham said at the opening, 'Environmental protection has been foremost in the design and construction of the Fina-Line and there will also be major savings in energy, pollution, transport hold-ups and potential accidents'.

Mr Wakeham opens the new pipeline.

Speaking at the opening, Mr E H Demeure de Lespaul, Managing Director, Fina plc, said, 'This pipeline puts Lindsey Oil Refinery into London. It represents the best way to transport products with the least effect on the environment.'

The route of the pipeline crosses six counties, passing through predominantly rural areas. It was chosen after exhaustive studies including an environmental impact assessment, and archaelogical evaluation and land drainage survey. To obtain the consent of several hundred land-owners and authorities was also a detailed and time-consuming business, although only six objected at the statutory public hearings.

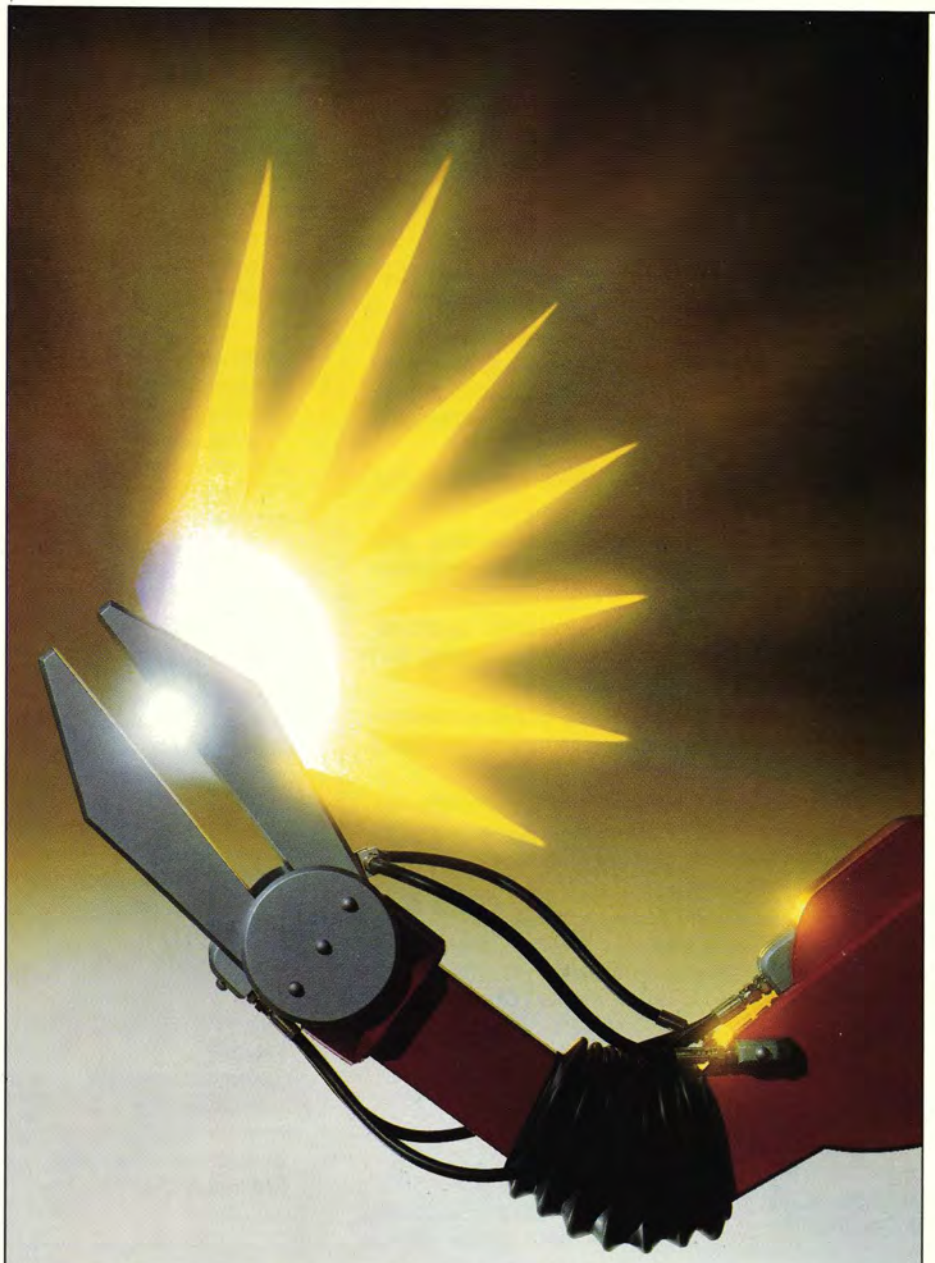
The pipe has been very carefully laid with the minimum of disruption to the surrounding area and the ground reinstated afterwards so that in a short time no sign of the disturbance should be visible and in many instances farming can be resumed on top. The company will inspect the route regularly from the air and make checks on cathodic protection and carry out annual line walking. Internal inspection will be achieved by means of remotely-controlled 'intelligent pigs'.

The pipeline, completed on time, is now being brought into use. It will be controlled from Buncefield by means of the latest computer-based supervisory and data-gathering technology, while a SCADA surveillance system will detect any leaks immediately.

This new scheme represents a very big investment — it has cost Fina plc £45 million but the company was willing to make this considerable outlay, in order to obtain a cheap, fast and environmentally friendly means of getting its products to the southeast.

The Lindsey Oil Refinery is the third largest in the United Kingdom. Built in 1968 as a joint venture between Total and Fina, it is constantly being upgraded — its present throughput is 200,000 barrels per day. It produces a complete range of products from propylene, motor spirits, derv and jet fuel to fuel oil and bitumen. Its processing plant includes a Tertiary Amyl Methyl Ether unit and the first UK Methyl Tertiary Butyl Ether unit, brought into service in 1987. ■

Carol Reader



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FORTHCOMING EVENTS

June

5th
Aberdeen: Seminar on 'Subsea Standardisation — Trend for the 1990's'. Details: Subsea Engineering News, PO Box 213, Swindon SN6 8UA. Tel: (079371) 303. Fax: (079371) 433.

6th
London: Seminar on 'Gas Monitoring'. Details: Sira Communications Ltd, South Hill, Chislehurst, Kent BR7 5EH. Tel: (081) 467 2636. Fax: (081) 467 7258.

10th-13th
London: Course on 'Managing Major Emergencies'. Details: Petroleum Training Federation, Room 326, 162–168 Regent Street, London W1R 5TB. Tel: (071) 439 2632. Fax: (071) 287 5483.

11th-12th
Birmingham: Course on 'Understanding Newer Techniques of Heat Treatment'. Details: Wolfson Heat Treatment Centre, Aston University, Aston Triangle, Birmingham B4 7ET. Tel: (021) 359 3611 ext. 5212. Fax: (021) 359 8910.

11th-12th
Manchester: 'Firex North — Exhibition and Conference'. Details: Caroline Fletcher, Paramount Exhibitions and Conferences, 17–21 Shenley Road, Borehamwood, Herts WD6 1RT. Tel: (081) 207 5599. Fax: (081) 207 2598.

13th-14th
Rome, Italy: Conference on 'Energy in the New Europe'. Details: Amanda Jenkins, Conference Organiser, DRI Europe Ltd, Wimbledon Bridge House, 1 Hartfield Road, Wimbledon, London SW19 3RU. Tel: (081) 543 1234. Fax: (081) 545 6248.

Call for Papers

A conference on 'Materials and Design Against Fire' will be held in London on October 27–29 1992.

The aim of this international conference, which will be principally scientific and technical in nature, is to bring together a number of aspects of materials and design for fire protection from different engineering disciplines.

Papers are invited on recent developments in the following categories:

Fire science and engineering — chemistry and dynamics, fire and blast severity, fire growth prediction and smoke and toxicity.

Materials — fire protection insulation systems, durability of fire characteristics, materials testing and traditional methods.

Design case histories — examples of fire protection engineering developments in major new engineering projects.

Applications — new material applications in different industry sectors, novel designs using existing materials and mitigation of material hazards by other fire protection measures.

Synopses of up to 250 words should be sent by 19 June 1991 to: Ms Alison Edgar, Conference Department C438, Institution of Mechanical Engineers, 1 Birdcage Walk, London SW1H 9JJ. Tel: (071) 973 1281. Fax: (071) 222 9881.

18th-20th
Birmingham: RoSPA International Safety & Health Exhibition. Details: Glenis Kendall, RoSPA, Cannon House, The Priory Queensway, Birmingham B4 6BS. Tel: (021) 200 2461.

19th-21st
Cannes, France: Conference on 'Multi-Phase Production'. Details: Mrs Kit Stones, Conference Organiser, 5th Multi-Phase, BHR Group Ltd, Cranfield, Bedford MK43 0AJ. Tel: (0234) 750422. Fax: (0234) 750074.

24th
London: Conference on 'Energy Investment Limiting the Risk'. Details: Mary Scanlan, BIEE, 9 St James's Square, London SW1Y 4LE. Tel: (081) 997 3707. Fax: (081) 566 7674.

24th-25th
Florence: 'European Refining Conference'. Details: Ms Mireia Mangual, WEFA Energy, 60/62 Margaret Street, London W1N 7FL. Tel: (071) 631 0757. Fax: (071) 631 0754.

25th-26th
London: 'Managing Energy Price Risk'. Details: IIR Ltd, 28th Floor, Centre Point, 103 New Oxford Street, London WC1A 1DD. Tel: (071) 412 0141. Fax: (071) 412 0145.

26th-28th
London: Course on 'Introduction to Oil Industry Operations Course'. Details: Caroline Little, The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR. Tel: (071) 636 1004. Fax: (071) 255 1472.

27th-28th
London: Conference on 'Offshore Oil Construction and Supply Contracts'. Details: Christine Rickards, Legal Studies and Services Ltd, Bath House, 56 Holborn Viaduct, London EC1A 2EX. Tel: (071) 236 4080. Fax: (071) 489 0849.

July

1st-3rd
London: Course on 'Introduction to Petroleum Economics'. Details: Caroline Little, The Institute of Petroleum.

Call for Papers

The 'Clean Seas 91' conference, co-sponsored by the IP, is being held between 19–22 November 1991 at Valetta, Malta.

The theme of the conference will be international co-operation and will tackle the problems of keeping the seas clean and the issues facing governments, international agencies, industry and science.

Papers are invited on the following topic areas:

- **★ Legislation**
- **★ Coastal pollution**
- **★ Coastal zone management**
- **★ Oil industry pollution**
- **★ Industrial pollution**
- **★ Pollution from shipping**

Abstracts of up to 200 words should be submitted by 8 June to: Alison Toal, Conference Executive, Spearhead Exhibitions Ltd, Rowe House, 55–59 Fife Road, Kingston upon Thames, Surrey KT1A 1TA. Tel: (081) 549 5831. Fax: (081) 541 5657.

FORTHCOMING EVENTS

2nd-3rd
London: Conference on 'North Sea Oil and Gas'. Details: Financial Times Conference Organisation, 126 Jermyn Street, London SW1Y 4UJ. Tel: (071) 925 2323. Fax: (071) 925 2125.

7th
Cardiff: Conference on 'Nitrogen in Fossil Fuels and NOX Emission Control'. Details: Mrs D Price, School of Engineering, University of Wales, PO Box 917, Cardiff CF2 1XH. Tel: (0222) 874797. Fax: (0222) 874209.

8th-10th
Honolulu: '14th IAEE International Conference'. Details: Mary Scanlan, BIEE, 9 St James's Square, London SW1Y 4LE. Tel: (081) 997 3707. Fax: (081) 566 7674.

8th-11th
Cranfield: Course on 'Pumps in Service'. Details: Short Course Administrator, Department of Fluid Engineering and Instrumentation, School of Mechanical Engineering, Cranfield Institute of Technology, Cranfield, Bedford MK43 0AL. Tel: (0234) 752766. Fax: (0234) 750728.

8th-12th
New York, USA: Seminar on 'Modern Developments in Boiling Heat Transfer and Two-Phase Flow'. Details: Office of Continuing Education, Rensselaer Polytechnic Institute, Troy, New York 12180-3590. Tel: (518) 276 8351.

9th
London: Meeting on 'Gas in the Single European Energy Market'. Details: Mary Scanlan, BIEE, 9 St James's Square, London SW1Y 4LE. Tel: (081) 887 3707. Fax: (081) 566 7674.

14th-20th
Warwick: 'Ninth International Conference of Women Engineers and Scientists'. Details: Conference Associates and Services Ltd ICWES9, Congress House, 55 New Cavendish Street, London W1M 7RE. Tel: (071) 486 0531. Fax: (071) 935 7559.

30th-2nd August
Darwin, Australia: Conference on 'Oil and Gas in the World's Fastest Growing Economy — The Timor and Arafura Seas'. Details: Mr B Jones, Deputy Director, Special Projects and Marketing Division, NT Dept Mines and Energy, GPO Box 2901, Darwin 0801, Australia. Tel: (089) 89 5295. Fax: (089) 89 5289.

August

11th-16th
Edinburgh: 'The First International Offshore and Polar Engineering Conference'. Details: International Society of Offshore and Polar Engineers, PO Box 1107, Golden, CO 80402-1107. Fax: 1 303 420 3760.

September

3rd-6th
Aberdeen: 'Offshore Europe 91'. Details: Spearhead Exhibitions, 55 Fife Road, Kingston upon Thames, Surrey KT1A 1TA. Tel: (081) 549 5831. Fax: (081) 541 5657.

4th-6th
Bradford: Course on 'Particle size measurement and sampling'. Details: Dr L Svarovsky, Reader in Chemical Engineering and Powder Technology, Department of Chemical Engineering, University of Bradford, Bradford, West Yorkshire BD7 1DP. Tel: (0274) 733466. Fax: (0274) 727859.

16th-19th
Oxford: Seminar on fire fighting foam 'Foam System Selection and Design Criteria'. Details: Resource Protection Ltd, Suite 3, Lloyd Berkeley Place, Pebble Lane, Aylesbury, Bucks HP20 2JH. Tel: (0296) 399311. Fax: (0296) 395669.

17th-19th
Birmingham: International Water Exhibition 'IWEX '90'. Details: Paul Tweedale, Turret Group plc, Turret House, 171 High Street, Rickmansworth, Herts WD3 1SN. Tel: (0923) 777000. Fax: (0923) 771297.

Call for Papers

The first Mediterranean oil and gas exhibition and conference, co-sponsored by the IP, will be held between 28–31 January 1992 at Valetta, Malta.

The conference will address the particular technical problems, legal concerns, and commercial incentives involved in operating in the Mediterranean area.

Papers are invited under the following broad subject areas:

- **★ The establishment of a Mediterranean oil and gas congress**
- **★ Advances in enabling systems and technology**
- **★ Practical and operational considerations.**

A 200 word summary should be submitted by 10 June 1991 to: Spearhead Exhibitions Ltd, Rowe House, 55–59 Fife Road, Kingston upon Thames, Surrey KT1A 1TA. Tel: (081) 549 5831. Fax: (081) 547 2807.

18th-19th
Sutton Coldfield: Symposium on 'Offshore Safety and Reliability'. Details: SARSS 91, The Safety and Reliability Society, Clayton House, 59 Piccadilly, Manchester M1 2AQ. Tel: (061) 228 7824. Fax: (061) 236 6977.

20th
Oxford: Seminar on 'Gaseous Extinguishing Agents — Applications and Protection Alternatives'. Details: Resource Protection Ltd, Suite 3, Lloyd Berkeley Place, Pebble Lane, Aylesbury, Bucks HP20 2JH. Tel: (0296) 399311. Fax: (0296) 395669.

24th-27th
Bradford: Course on 'Solid-liquid separation'. Details: Dr L Svarovsky, Reader in Chemical Engineering and Powder Technology, Department of Chemical Engineering, University of Bradford, Bradford, West Yorkshire BD7 1DP. Tel: (0274) 733466. Fax: (0274) 727859.

26th
London: Conference on 'Marine Fuels and Lubricants'. Details: Caroline Little, The Institute of Petroleum.

29th-2nd October
London: Conference and exhibition on 'The Way Ahead — Hydrocarbons for the 1990s'. Details: AAPG International Conference, PO Box 979, Tulsa, OK 74101-0979, USA.

30th-1st October
London: '1991 European Seminar on the Refurbishment of Bulk Liquid Storage Tanks'. Details: Stephanie Hodder, Institute for International Research, 11th Floor, Alembic House, 93 Albert Embankment, London SE1 7TY. Tel: (071) 587 1117. Fax: (071) 587 3703.

Automotive fuels for the future

By WE Betts, Esso Research Centre

In the past the search for alternative sources of automotive fuel has been geared to concern over eventual crude oil shortages. However, the current force driving research on alternative fuels is the pressure to improve the environment by reducing emissions from vehicles.

Environmental solutions

Effective solutions to reducing automotive emissions are dependent on the optimum combination of fuel characteristics and automotive technology. At one extreme, considered later, are alternative fuels and new engine technology. But over the next two decades it is most probable that the existing distribution system of gasoline and diesel, combined with the application of known engine technology, will continue to supply the bulk of automotive demands.

The key change for environmental reasons in automotive fuels has been the introduction of unleaded gasoline. Producing octane quality through refinery processing rather than lead alkyls, adds to refinery costs and energy consumption and so has increased European CO_2 emissions. These penalties have to be balanced against the two-fold benefits — reduction of toxic lead emissions and paving the way for the use of exhaust catalysts which require unleaded fuel. Hence, the full benefit of the financial and environmental investment in unleaded gasoline will only be obtained when exhaust catalysts are in widespread use.

Efficient refineries aim to meet product specifications with minimum production costs. This means minimum energy consumption and hence minimum CO_2 emissions. It is important to recognise that, as with the introduction of unleaded gasoline, changes in fuel specifications increase refinery energy demand, increase crude imports and increase CO_2 emissions. Hence it is essential that any changes for environmental reasons consider the total system to ensure that perceived improvements in one area are not outweighed by increased emissions elsewhere.

European gasoline and diesel reformulation?

Reformulation of gasoline and diesel can help to solve environmental problems but it is important that the emissions and fuel economy goals set by legislators are solved by the most cost effective, energy saving and environmentally effective means. Optimum environmental solutions can be determined by research to identify the best balance between changes in fuels and application of vehicle technology. A $40 billion auto/oil company programme is underway in the United States, to study various options of vehicle and fuel changes.

With the current European interest in evaporative emissions there are pressures to reduce gasoline volatility. Volatility is a compromise **(Figure 1)** between conflicting technical requirements of automobiles. Oil companies carry out extensive studies to identify the optimum requirements of different car populations. Volatility is thus optimised from country-to-country and season-to-season to best meet the technical requirements for easy starting, smooth driveability, rapid warm-up and good fuel economy. Reducing volatility below the technical optimum would reduce evaporative emissions (although much less effectively than a carbon canister) but would increase tailpipe hydrocarbons and, by raising fuel consumption, would increase CO_2 emissions **(Figure 2).** Cars warm up faster on volatile gasoline and so the choke comes off quicker, while catalysts reach operating temperature sooner, resulting in lower cold start emissions and better fuel economy. Over 80 percent of tailpipe emissions on a typical European trip of 10 kilometres occurs in the first two minutes from a cold start. It is this crucial period of emissions which would be worsened by reducing gasoline volatility. This is a classic example of the need to consider the overall impact of changes and to base decisions on data from carefully controlled studies rather than on misguided perceptions.

Diesel fuel characteristics are also under continuous review. Diesel cars already produce very low CO and HC tailpipe emissions (comparable with catalyst-equipped gasoline cars), have negligible evaporative losses and, due to their excellent fuel economy, produce less CO_2 emissions. The key concern for diesel vehicles is the emission of particulates.

The application of electronic controls, turbocharging, intercooling and high pressure injection systems etc all help to reduce particulates. In addition, oxidation catalysts are increasingly being fitted to vehicles. Closing the diesel system with a catalyst effectively decouples exhaust emissions from diesel fuel properties except for sulphur content. Catalysts, especially if operated above 350°C, tend to convert sulphur dioxide gas to sulphate which then contributes to the weight of particulates. The effect is exaggerated due to the presence of bound water. There are catalyst installations which operate below the sulphate conversion temperature and catalysts which are sulphur tolerant. Nevertheless it is probable that diesel sulphur will be cut to assist the diesel system to be closed with catalysts.

Alternative fuels

There are a variety of alternative fuels in use or under development around the world. Many will find applications in limited areas with tied fleets, particularly in environmentally sensitive areas. If a new fuel is widely distributed and available, precautions are necessary to prevent motorists using

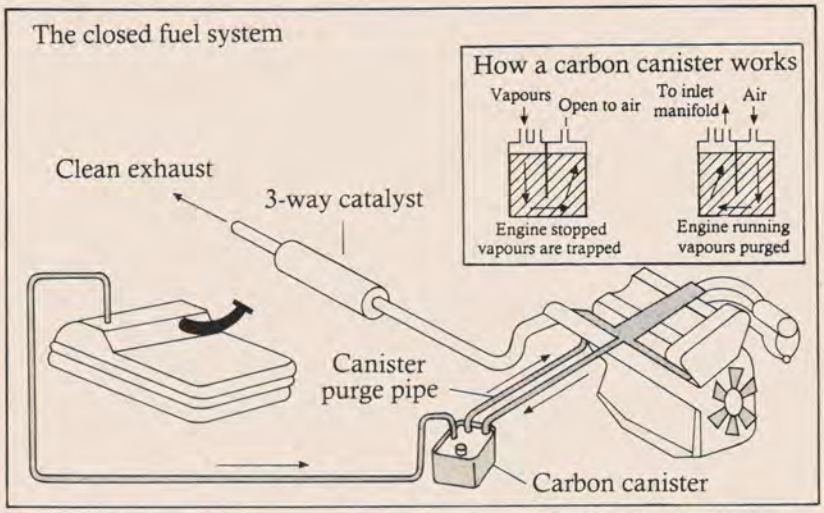

Figure 1 Closing the fuel system with exhaust catalyst and on-board carbon canister to capture evaporative and refuelling losses is the best available technology for controlling gasoline vehicle emissions (CONCAWE)

the wrong grade of fuel for their vehicle (eg narrow nozzles and filler openings for unleaded catalyst cars).

Methanol

Methanol can be produced from crude oil, natural gas or coal and so could ensure availability of transportation fuel for several hundred years on current estimates of energy reserves.

Methanol has good octane properties which allow higher compression ratios to be used for better fuel efficiency and power in methanol-dedicated vehicles. However, the lower heat content of methanol, only half the energy content of gasoline, will produce a greater fuel consumption than gasoline and result in a shorter driving range before refuelling is needed.

A key advantage of pure methanol (M100) is that it is clean burning with no hydrocarbons, PCA (polycyclic aromatics) or benzene exhaust emissions and very low evaporative losses. However, the use of methanol increases emission of aldehydes which form smog.

Pure methanol has a low vapour pressure and high heat of vaporisation which results in poor cold starting ability. M100 also suffers from safety problems because, unlike gasoline, the vapour above the liquid in the vehicle's fuel tank is in the explosive range. In the event of a fire M100 burns with a colourless flame presenting an additional hazard. A further disadvantage is that methanol is toxic and accidental spillages are soluble in water.

Methanol requires a dedicated distribution system and care is needed to ensure that materials used in vehicles' fuel systems are compatible with methanol. Special engine lubricating oil is also required.

Given this combination of advantages and disadvantages it appears unlikely that M100 will feature as a widespread fuel within the next 15–20 years. Its most likely introduction will be via flexible fuelled vehicles (FFVs) able to run on any mixture of gasoline and methanol. Fleet testing of several hundred FFVs is being carried out in the United States. This approach overcomes difficulties with vehicle range and limited areas of methanol distribution but the FFV cannot employ the high compression ratio efficiency available to M100.

A more likely route to methanol usage, and one that is commercially used in Brazil, is the use of a near neat methanol-based fuel such as M85 (85 percent methanol with 15 percent gasoline). This retains the exhaust emission benefits of methanol but the evaporative emissions are similar to gasoline (although less photochemically reactive). The key improvements for M85 compared to pure methanol is in satisfactory cold starting performance, a non-explosive vapour in the fuel tank and a luminous flame in the event of an accidental fire.

Widespread usage of M85 is also unlikely in the short term, however it may find application in limited areas of distribution with restricted area fleet operators. For example, some US bus companies running diesel powered vehicles are considering converting to methanol to reduce particulate emissions in city centres.

Methanol has been widely used in gasoline at low concentrations, up to 3 percent in Europe, as a gasoline extender and high octane component rather than as an alternative fuel. Where a new component is added to gasoline or diesel fuel, its concentration is limited by the need to maintain the essential characteristics of the fuel required by the existing car population. In this application no change to the vehicles or distribution systems is needed. A co-solvent (normally tertiary butyl alcohol) is required to prevent phase separation.

The 3 percent limit for methanol is imposed to ensure compatibility with elastomers and fuel system components in the existing car population.

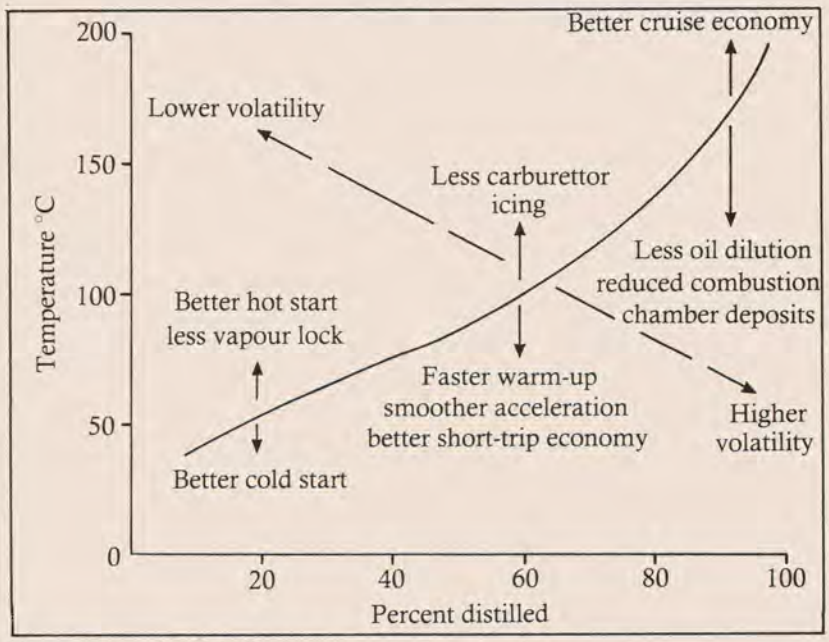

Figure 2 Gasoline volatility is an important compromise

Additionally, methanol has a very high blending vapour pressure which needs to be limited for satisfactory vehicle operation under hot driving conditions.

The use of methanol in gasoline varies depending on the relative cost of methanol versus gasoline. Currently the economics favour converting methanol to MTBE (methyl tertiary butyl ether) which has excellent octane properties with negligible effect on vapour pressure. Up to 15 percent of MTBE can be blended into gasoline and, due to its octane benefits, it is in widespread use in unleaded gasolines.

Ethanol

The main interest in ethanol arises because it can be manufactured from renewable energy resources by fermentation of agricultural crops. Although this is not an energy efficient process it is attractive in some countries such as Brazil as a means of reducing imports of crude oil. Ethanol only starts to become economic as an automotive fuel when crude oil prices exceed around $40 per barrel. Hence its use depends on tax subsidies. These are available in several countries on the grounds of reduction of emissions or because it is a renewable resource and reduces dependency on crude oil.

Ethanol, like methanol, has good octane properties. Fuel consumption is better than methanol but still around 40 percent greater than gasoline. Exhaust and evaporative emissions are similar to those discussed for methanol.

As with methanol, vehicle redesign is required to overcome inherent problems with cold starting, driveability and compatibility with fuel system materials. A dedicated distribution system is needed and the ethanol must be made non-potable.

Use of neat ethanol as an alternative fuel has the advantage that the vehicle and distribution technology is commercially proven and available in Brazil. However, neat ethanol is probably too expensive to find general application except where special needs to reduce emissions or crude imports warrant subsidies to encourage its use.

Liquefied petroleum gas

Liquefied petroleum gas (LPG) for automotive use consists of a mixture of mainly butane and propane. It is used in many countries — wherever the taxation system makes it economically attractive. LPG has low exhaust emissions which make it particularly valuable for use in vehicles which operate indoors such as forklift trucks. It has good cold weather performance and excellent octane quality.

LPG has a lower density and a lower energy content on a volumetric basis than gasoline and so has a lower mileage range per fuel tank volume. It is normally used in dual-fuelled vehicles which are adapted to operate on LPG and gasoline to provide a greater driving range and for areas where LPG is not generally available.

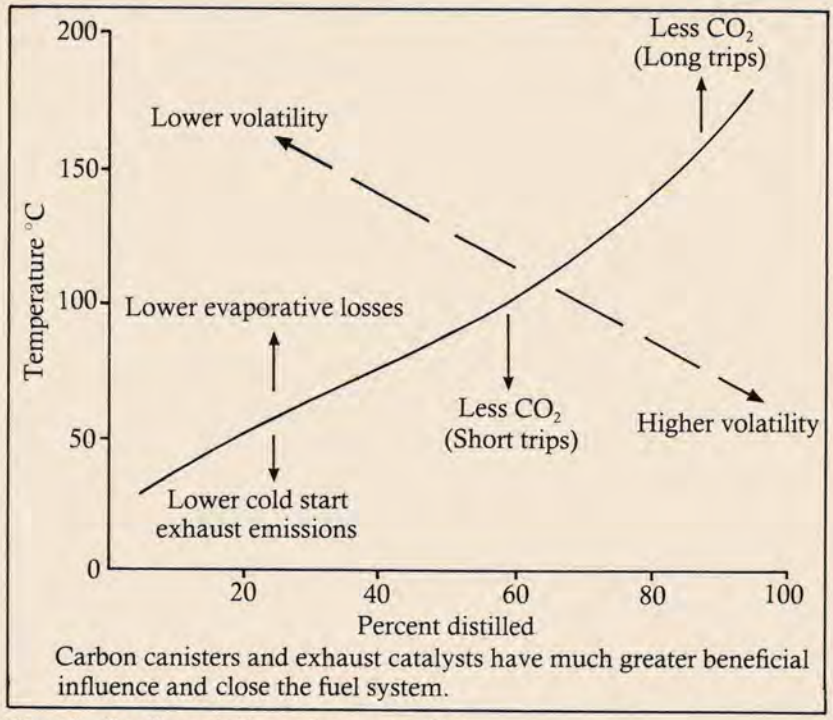

Figure 3 Gasoline volatility environmental effects

Compressed natural gas

Natural gas consists mainly of methane. It is used for automobiles in parts of Italy, New Zealand and the USA. Compressed natural gas (CNG) is pressurised up to 220 atmospheres and stored on the vehicle in a heavy pressurised fuel tank which needs to be about four times the volume of a gasoline tank to provide the same driving range. Like LPG, this means that CNG vehicles are often dual-fuelled with gasoline.

Experimental buses and trucks are operating in the United States and Germany fuelled by CNG in diesel engines converted to spark ignition. Operating range is only one sixth that for the same volume of diesel fuel.

The high pressure needed for CNG adds to the cost. An interesting development is the possibility of using activated charcoal storage, as used in carbon canisters to control evaporative emissions. By adsorbing natural gas at 35 bar onto charcoal, gas densities can be obtained equivalent to compressed gas at over 100 bar. Although there is a further loss in operating range the lower pressure can reduce the operating costs.

CNG has good driveability performance and produces low levels of exhaust gas pollutants. However, there is normally a loss of power compared to a gasoline engine and there are safety fears in the event of an accident.

Liquefied natural gas

By liquefying natural gas the density is increased so that a similar driving range to gasoline can be obtained with a fuel tank only around 50 percent larger. However, the fuel tank is expensive with vacuum insulation needed to keep the LNG at $-162°C$. Liquefied natural gas is vaporised before use, so a similar loss in volumetric efficiency and power as with CNG is experienced.

The high hydrogen to carbon ratio of natural gas results in lower CO_2 emissions per mile than a gasoline vehicle. However, the outlook is that it is likely to be available only in areas of favourable tax and for tied fleets operating in restricted areas.

Hydrogen

Interest in hydrogen has re-emerged because it is perceived as having almost perfect exhaust emissions with no CO_2 'greenhouse' gas. Hydrogen has a wide ignitability range and burns

cleanly to produce only water and some NOx. However, the production of CO_2 in hydrogen manufacture, from natural gas, coal, or electrolysis of water, also needs to be considered. If electricity from fossil-fuelled power-stations is employed to manufacture hydrogen, the global environmental benefits are extremely dubious. The manufacture of hydrogen and a dedicated distribution system would require massive investment.

A key problem for hydrogen is vehicle tank storage which would require an expensive heavy tank to contain hydrogen in compressed gas or liquid form. Such vehicles would have a limited range between refuellings. An alternative being demonstrated in a number of test vehicles is the use of a metal hydride which absorbs hydrogen and then releases it in use by the application of heat (for example from the car's exhaust). The hydride approach overcomes safety problems associated with compressed or liquid hydrogen but would also have a limited driving range. Refuelling hydride tanks is a slow process although it can be speeded up by circulating cooling water to remove the heat generated as the hydrogen is absorbed into the metal hydride.

Current hydride storage developments look promising but the requirement for an environmentally friendly cheap source of electricity is unlikely to emerge in the short term. Given the present prohibitively expensive costs, hydrogen-fuelled vehicles are likely to be restricted to a few environmentally-critical applications, eg operation inside buildings or enclosed areas with poor ventilation.

Electricity

The key advantages of electric cars are that they are quiet and pollution-free with the potential to minimise smog problems in cities.

The disadvantages are linked to the heavy batteries which limit performance and driving range unless a dual-fuel system is employed. It is difficult to provide in-car heating without reducing the driving range, and recharging is a lengthy process. However, improved batteries are under development and many vehicle manufacturers have prototypes under test.

Environmentally the electric car only moves the source of pollution away from the city centre to the source of generation. Coal-fired power generation (the major source of UK electricity) is an inefficient process so that electric cars produce several times more CO_2 and SO_2 than gasoline vehicles. This is more easily dispersed from a remote power-station but the global burden is increased. Given the intense research for better batteries and the encouragement to use electric vehicles in some cities, it is likely that electricity will become an increasingly important automotive fuel over the next 20 years.

Overall view

For the next several decades the inherent advantages of a high energy to volume ratio and wide availability will continue to make gasoline and diesel the principle fuels for automotive transport.

Control of vehicle emissions will be achieved more quickly by the application of existing proven technology, such as three-way catalysts and carbon canisters, than by the development of alternative fuels.

Alternative fuels will find a limited market where special needs, eg high pollution zones, can justify their extra cost.

Research to improve fuels for special cases and, longer term, to develop alternatives for energy security will continue to ensure that petroleum companies have the appropriate fuels for their customers.

Continuing co-operative research by the oil and automobile industries will guide the optimum cost effective balance between changes in fuels and developments in automotive technology to meet the emissions and fuel economy goals set by legislation. ■

Acknowledgement
This article is based on extracts from a presentation by Mr Betts to the London Branch of the Institute of Petroleum in February.

Geological survey requires new funding

From April 1993 the government is to withdraw its 100 percent funding of the British Geological Survey's Regional Mapping Programme. After that date, the Survey will have to generate funds from other sources to continue its important offshore work. In an interview with the *Petroleum Review*, John Hull, BGS's Petroleum Geology, Geophysics and Offshore Surveys Director, outlines the importance of the survey — started more than 25 years ago — and the challenges ahead.

For as government funds dry up, the Survey is looking for help from oil companies to meet its biggest challenge yet — the geological mapping of British-designated waters in the Atlantic, including the 'frontier area' to the west of Shetland.

Mark Scruton: What is the role of the British Geological Survey (BGS)?

John Hull: The BGS has a national remit to improve our knowledge and understanding of the geology of the United Kingdom landmass and its adjacent offshore areas. This is done mostly by publishing the results of its systematic surveys as maps, books, professional papers or reports. We also have a responsibility to develop and maintain a national geosciences database in a readily accessible and usable form, which may be used to provide impartial advice on geological matters to government departments, public authorities, private sector organizations and individuals.

What is the role of your division?

The division, one of four programme divisions within the BGS, covers the areas of Petroleum Geology, Geophysics and Offshore Surveys.

The majority of our work is related to the oil sector and is of interest to government and the oil companies. Each group has a remit as its name implies, ie, Petroleum Geology, Marine and Coastal Geology, Marine Operations, Biostratigraphy & Sedimentology, Global Seismology and Geomagnetism. Collectively their strength stems from their monitoring of specific topics and the ease with which multi-disciplinary teams can be created to address particular problems.

For instance, the North Sea is a relatively seismically active area so companies can be given advice by the Seismology Group about possible hazards to installations, whereas other groups can advise on the best locations for their pipelines. Even sunspots are monitored by the Geomagnetism Group, because of their effect on the earth's magnetic field. Advance notice of magnetic storms is useful to oil companies because of the possible adverse effects on directional drilling, navigation and, say, pipeline operations. It may be necessary to suspend operations in some circumstances.

John Hull

All the hydrocarbons data collected offshore — whether by the government or the oil industry — has to be sent to us, where it is held in confidence on behalf of the Department of Energy until declassified. Other geological and geophysical data are, however, available to the scientific and commercial communities. In practice these arrangements mean that data collected by the Petroleum Geology Group are confidential while data collected by the other groups are mainly in the public domain.

What areas have already been assessed as part of the Regional Mapping Programme?

We started working offshore in 1967. Initially, because of the available technology, BGS surveys were carried out in the shallower, more protected, inner areas. Since then the surveys have been extended out across the UK continental shelf down to the 200 metre isobath. In addition to these surveys we complement our own field programmes with data and other material from other sources. All the data are then used to create maps. From this information we have produced 342 maps of one type or another, which are scientifically interesting, and which have proved useful to oil companies and organizations interested in the resource of the seabed or its engineering development.

What others areas of British-designated waters have yet to be assessed?

We are hoping to survey the deeper water areas, concentrating on the northwest of the United Kingdom, including the Rockall Trough and the Rockall Plateau. This is no small task; together, these areas constitute the largest part of the United Kingdom still

requiring a primary geological survey, with an extent some 110 percent larger than that of the total land area of the United Kingdom. Additionally, there are small gaps in our knowledge of the coastal geology where, historically, the water is too deep for the Land Survey to walk offshore and too shallow for ships to survey.

How were the initial offshore surveys financed?
To start with the work was totally funded by the Department of Education and Science through the Natural Environment Research Council. Gradually, because of the importance of the work, the Department of Energy assumed responsibility for a large part of the Regional Mapping Programme, currently about 80 percent. However all this is to change. Despite a large part of the geology of Britain still being unknown, the government has decided to withdraw the funding of the RMP from April 1993 when the present phase of the work is completed. Consequently, new types of funding are being investigated. Additionally, following a recent review by accountants Price Waterhouse, the idea now is that the Survey should create 'business opportunities' to generate profits which can be put back into the scientific core programme.

How will you fund future surveys?
Future core programme surveys, as opposed to business opportunities, will be funded by consortia between government departments and, say, oil companies. This is not a new idea in the marine area. Since 1985 we have been able to establish four very successful consortia in different years and to drill sites of interest to all participants with funding from interested companies. The government is now asking us to do this again, but on a bigger scale and for the purpose of undertaking a strategic long-term survey. In an ideal world such a survey could take up to 10 years to complete and publish, but in practice it will probably have to be broken down into two to three year modules which meet the technical objectives of BGS and any participating oil companies. Some government funds will also be needed to facilitate this work.

The Price Waterhouse review also recommended another approach to business opportunities. Apart from its Core (Science Budget) Programme, BGS previously carried out work in response to a commission, when one was approached for advice or information. Now, where BGS perceives it has something worthwhile to sell, it will be necessary to market strongly the appropriate expertise, data interpretations and services.

Chris Browitt (head, Global Seismology) right explains earthquakes to Rear Admiral Alan Shepard (moon astronaut, Apollo XIV) and the Mayor of Houston during a visit to BGS, Edinburgh.

Why were the UK designated limits revised in 1990?
UK designated limits are constantly kept under review. In 1989 the Foreign Office and the Irish government agreed to a new set of median lines, including that running westwards in the Atlantic from between Scotland and Ireland, which has since been ratified. The Foreign Office has yet to agree finally the national limits with the Faeroes and Iceland. In such negotiations an understanding of the geology of the underlying rocks and crust is relevant.

Are there basic similarities between the underlying geology in the North Sea and that of the 'unknown' areas west of Shetland? Also are there any differences?
Over the years some seismic work has been carried out by universities and other organisations from the coast into the oceanic areas west of Britain. The data obtained are somewhat inconclusive and therefore there is still considerable debate about the geological structure and the rocks which underlie the region. In the west, part of the problems relate to the timing of the opening of the proto-Atlantic and the present Atlantic Ocean. In the North Sea the continental rifting was even older and this results in different types and ages of sediment being found.

How 'unknown' are these areas? Has the BGS carried out any preliminary cores, for instance?
To produce maps of the inner shelf we have had to take some shallow cores and, using our own equipment, we have obtained cores beneath almost 2 km of water on the Continental Slope. From such information we have found that there are some interesting structures on the eastern flanks of the Rockall trough. But we would have to collect more data before we could establish a definitive geological overview. Data from other sources, eg university research teams, other institutions and oil companies are either too old, inaccessible or still confidential.

If BGS gets the funding, how long do you think it would take to cover the area west of Scotland? Are there any specific problems to be overcome?
Negotiations are in hand to put together a consortium of government departments and oil companies. One way the government may make funding attractive would be for it to give oil companies preferential rights to the information for an agreed time. The problem is that ideally the information should pass into the public domain as soon as is practicable. Such matters will be addressed in negotiations. The RMP of the inner shelf has cost over £50 million so far. I don't think I'm being unrealistic in saying that, because of technological advances and different types of objective, it will cost less in time and money to finish the proposed new survey of the west. I estimate that it could take only 10 years if appropriate funding can be attracted. If the funding is not forthcoming, then serious consideration will have to be given to whether or not BGS should continue with this type of work. If the answer is no, then sadly a large part of Britain will remain unknown for the foreseeable future, and the expertise generated over the past 25 years will be dissipated, despite the high standing in which BGS's marine science and engineering activities are held in the United Kingdom and overseas as a result of its research carried out during this period. ■

Technology puts shale oil twins back in favour

By William Scholes

Renewed interest in Australia's shale oil twins, Southern Pacific Petroleum NL (SPP) and Central Pacific Minerals NL (CPM) is persisting despite weakening crude oil prices.

The new interest in these stocks has surprised local analysts in Australia. Previously the stocks have had strong price rises when world oil stocks were under threat, but those in the know say circumstances about shale oil have changed.

The main change is that the potential for shale oil production is now technology driven, rather than driven by the world oil price. The companies, whose directors have their hopes pinned on the development of Queensland's vast oil-bearing shale rock deposits, began their exploration in many parts of Australia after the oil price shocks of the 1970s. Prices were then considered to be on a permanent rise which meant at some point shale oil production, then a high-cost operation, would be economical.

But, apart from a brief spurt upward last year, after Iraq's invasion of Kuwait, the oil price has not performed, meaning that the potential for shale oil production would appear to have faded. However, the smart money said otherwise and has driven the share prices of Southern Pacific and Central Pacific skyward. Central Pacific has climbed to $A1.20 and Southern Pacific up to 46c.

These rises restored the twins' market prices to the levels they reached last October when crude oil prices went beyond $US40 a barrel. The present price of crude is less than half that.

Major buying interest came out of New York. Both stocks are backed by a large number of potential barrels of oil reserves, and because of improved extraction techniques, it may now be possible to produce oil from the shale rock for as little as $US20 a barrel.

In Central Pacific's case each share is backed by 147.76 barrels of oil reserves, while each Southern Pacific share is backed by 54.97 barrels. The companies have shale oil reserves along coastal Queensland equivalent to 20 billion barrels, making it one of the largest shale oil resources in the world.

The technological advances which renewed the interest were highlighted in the annual reports of the companies released in mid-April 1991, although the reports stopped short of detailing estimated development and production costs.

Nevertheless the reports said the companies were well advanced in the development of plans for the first commercial project based on the Stuart deposit about 12 kms northwest of the port of Gladstone. Chairman and managing director Sir Ian McFarlane of SPP/CPM said by the end of 1990 the technical review and cost evaluation of the Stuart project undertaken by two major international engineering groups had been completed. This work also included detailed studies of the engineering and costing of the principal subcontractor areas, namely mining, retorting, and upgrading.

In setting this assignment SPP/CPM requested the engineering groups to submit proposals for the construction of Stuart Stage One on fixed price, turnkey projects and to provide performance guarantees and equity contributions to the project.

'It is pleasing to report that on a comparable basis, the project capital and operating cost estimates of the two engineering groups were close to the companies' estimates,' Sir Ian said in the 1990 annual report.

'The companies are aiming to reach a definitive agreement with one or other of the engineering groups without delay. In particular, the companies are discussing the required performance guarantees.'

The Stuart project will be developed in three stages with initial production expected from 1992.

The first stage will be a 4,250 barrel a day demonstration plant followed a year later by production of 14,000 barrels a day in stage two and 60,000 barrels in the final stage.

SPP/CPM have been researching the commercial viability of shale oil production for eight years in conjunction with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Fuel Technology division.

The CSIRO shale oil project manager, Greg Duffy, said researchers had been tinkering away at the shale oil production process, making it more efficient, during the past seven years.

The project has cost about $A10 million to date with 35 percent of this funded by federal grants and the remainder by SPP/CPM. CSIRO has also been studying conversion of natural gas to gasoline.

Shale oil production

Oil shale production in Australia began in the 1860s and reached its peaks during World War I and World War II with a plant at Glen Davis near Lithgow in New South Wales, processing rich but thin deposits of shale oil before becoming uneconomic in the early 1950s.

Shale oil is a soft rock which is crushed and heated to high temperatures to produce a gas which becomes oil when liquified. About one tonne of

shale oil is required to produce one barrel of oil.

It is then 'hydro-treated' — that is, mixed with hydrogen under high pressure to remove impurities such as sulphur, nitrogen and oxygen, which occur in higher concentrations than in naturally occurring oil.

According to CSIRO researchers, oil could be produced from either natural gas or shale for around $A30 a barrel, but an initial multi-million dollar capital outlay would be needed to set up large scale processing plants.

Dr Gary Foulds, senior research scientist on the CSIRO natural gas project, estimated that a world oil price of between $A43 and $A50 a barrel would make the cost of such a plant worthwhile.

Dr Greg Duffy, principal scientist on the oil shale project, said a similar figure would apply to an oil shale processing plant. 'We're getting to the point where the borderline economics may favour building a small pilot plant', he said.

While Australia's petroleum reserves are dwindling, shale oil reserves are estimated to be so vast that at present consumption rates they would last much longer than 100 years. Shale and natural gas are both strong contenders for synfuel processing. Some scientists prefer the natural gas option because they claim the technology for processing has already been proven in large scale operations. However, the Rundle twin companies are equally convinced their process is already proven.

A recent agreement signed between the United States and Australia will allow the two nations to fully exploit the impending emergence of oil shale as a primary fuel. The agreement between the CSIRO and the US Department of Energy allows for the exchange of information in key areas of oil shale research.

CSIRO officials said the agreement was an important step towards establishing shale oil as a viable economic alternative to petroleum in the next century when Australia's domestic oil production is expected to satisfy less than half the country's requirements.

Former Queensland Mines and Energy Minister Martin Tenni urged the Federal Government to offer substantial incentives for R & D in liquid fuel options. Mr Tenni saw shale and ethanol options as worthy of encouragement by tax breaks otherwise Australia would face a crippling national fuel bill.

Mr Tenni said Canberra did not seem prepared to openly debate the nation's fuel options. 'The fact of the matter is that we must explore onshore and at the same time, the nation has to give very serious consideration to dollars and cents incentives for development of shale oil, coal oil and ethanol,' he said.

The development of ethanol as an octane-booster in liquid fuels would substantially underwrite the health of the Queensland sugar industry at a time when growers felt the industry needed some support, he said.

Dr Peter Alfredson, CSIRO Fuel Technology division chief, said that it was in Australia's long-term strategic and economic interests to develop the technology to extract oil from shale. 'The rapid depletion of our own domestic oil reserves and the traditionally volatile nature of the oil industry could create a situation where oil from shale becomes a real alternative much sooner than energy analysts think. Australia needs to be ready to take advantage of these opportunities if they arise,' he said.

'These shales are a reasonable alternative for supplies of oil in Australia.'

Australia's major oil-bearing shales are in eastern Queensland. The Division of Fuel Technology has been investigating the properties of Australian oil shale and adapting existing processing technologies to suit their particular characteristics since 1982.

Dr Alfredson said the Division's scientists had always worked closely with their colleagues in America. He said that the agreement with the United States not only formalised this relationship but would result in much closer co-operation and lead to optimum use of respective research expertise.

The areas of research covered by the agreement are analysis of mining methods, optimisation of oil production during retorting, and studies of mineral reactions and their relationship to control of air pollution. Under the SPP/CPM scheme a Canadian-developed plant will process 6,000 tonnes of oil shale each day to produce 1.35 million barrels of oil a year at an expected operating cost of $US13 a barrel. If everything goes to schedule, SPP/CPM hope to enter the 21st century with a full-scale plant producing 60,000 barrels of syncrude a day or just over 18 million barrels worth $A450 million a year. Processing 125,000 tonnes of shale daily, this operation would cost $A1.6 billion.

Following the false starts of the 1980s, these plans will obviously be met with some scepticism from industry analysts. But the level of confidence is high at SPP/CPM because of the following: The fully owned Stuart deposit is based on the Kerosene Creek section which can yield about 170 litres of syncrude a tonne or three to four times the level elsewhere; Alberta Oil Sands Technology and Research Authority's (AOSTRA) Taciuk process, adapted for oil shale use, uses a conventional rotary kiln which is inexpensive to build and operate; pilot plant tests have been carried out on 1,400 tonnes of Stuart shale.

Three Australian refineries have already provided 'a clean bill of health' for syncrude, which is devoid of sulphur and nitrogen impurities and is reportedly of better quality than the average commercial oil.

Sir Ian McFarlane, Chairman of the twin companies, said that when oil prices crashed in mid-1986 executives at the two Canadian syncrude plants which produce more than 200,000 barrels of synfuels a day reacted with more than disappointment. But significant cost cuts were later achieved with Suncorp reporting that it reduced cash costs a barrel from an average $C33.50 in 1985 to just over $C14 a barrel since 1987.

Suncorp uses a first generation AOSTRA plant and its successor at Stuart will involve a dry process that enables spent shale to be disposed of in more environmentally friendly mined-out pits. Sir Ian, who launched his search for Australian oil shales just before the oil price shock in 1973, said: 'What the last few weeks in Kuwait has done substantiates what we've said for years and years. The Middle East is unstable and should not be relied on for oil. These shales are a reasonable alternative for supplies of oil in Australia.'

With the world's biggest oil consumer, the United States, now dependent on oil imports for half its needs and expectations that OPEC could again control world oil supplies by the mid-1990s, analysts believe the time is right for synthetic fuels.

New Zealand's gas to gasoline plant is now producing above capacity com-

mercially. Shell is building a liquid-fuels plant based on natural gas in the Malaysian state of Sarawak which is expected to be profitable. Engineering studies by an international company and financing arrangements will be completed in the next few months with the expectation that the Stuart plant will get the green light by June next year with initial syncrude output likely from 1992. Sir Ian said he believed economies of scale would enable operating costs for the final-stage plant to drop to about $US10 a barrel. Even the relatively small output from the demonstration plant would cut Australian imports $A50 million a year based on round-the-year operation and current cost of oil imports. The third stage of development would see the value of import replacement rise dramatically. Industry authorities point out that production cost factors vary from place to place, and even depend on interest rates. Shale oil project financiers have to be sure that prices will stay high. Any shale oil project would have high up-front capital costs and very long lead times, making the economics quite different to that of the production of regular oil.

The oil industry has been warning the community about the decline in Australia's oil reserves for many years, often as part of a long-running battle with the Federal Government over taxes and exploration incentives. These warnings have been more serious of late. Although Shell has taken a 41.67 percent equity in the 4.4 billion barrel Yaamba shale deposit north of Rockhampton, Queensland, where the twin companies have a 16.66 percent stake, most oil companies greatly cut back research in alternative fuels.

The twin companies have had access to research data from Exxon's work on Rundle shale at its pilot retort in Baytown, Texas, and from detailed studies by a Japanese consortium on the Condor deposit near Proserpine.

They have also sponsored independent studies on retorting at the CSIRO Division of Fuel Technology, Queensland University's Chemical Engineering Department, the Australian Mineral Development Laboratories (AMDEL) and the Colorado School of Mines.

Company officials said the AOSTRA Taciuk processor consists of one 7.2 m diameter horizontal rotating vessel 37 m long which houses four compartments that preheat the dried shale, carry out oil shale pyrolysis, spent-shale combustion and heat recovery from combusted shale. The 4.5 rpm processor is driven by a multiple-tyre drive system. Retort temperature is approximately 500°C. The kerogen in the shale is pyrolysed to oil vapour and hydrocarbon gas. The superheated vapours pass through cyclones to a primary and secondary fractionator where it is condensed into a shale distillate, shale naphtha, condensed water and uncondensed hydrocarbon gas. Shale naphtha is cooled prior to being hydrotreated and fractionated into a butane stream and a naphtha stream.

Stuart oil shale project.

The AOSTRA Taciuk retort technology is preferred to fluidised bed systems, on which the CSIRO and the universities have been working.

The twin companies have signed a technology agreement with the Canadians which will allow them licence-free use of the technology for worldwide oil shale application.

Associate Professor Geoffrey Sergeant of the University of New South Wales School of Chemical Engineering and Industrial Chemistry and Head of the Department of Fuel Technology is investigating the possibility of the Rundle and Stuart shale oil deposits being an economic source of road-quality bitumen.

'If we can show that the Rundle and Stuart shales will yield road-quality bitumen, we would achieve two goals', Sergeant said.

'We would effectively lower the end price of petroleum-type products from the shale, making the deposits more economically viable, and we would save Australia the cost of importing crude for bitumen.

'Extracting the shale oil and converting it into a full range of petroleum products would make the plant enormously expensive. The task would be simpler and cheaper if a bitumen plant were built with it, to absorb all the heavy products.'

This research project is being funded jointly by the Federal Government, Southern Pacific Petroleum NL and Esso Australia and starts from kerogen, the black oily product which is given off when the crushed shale is heated to 500°C. The kerogen is then further distilled and separated into a soft bitumen and a light oil fraction which will later be tested for its suitability as a lubricating oil. The bitumen has been shown to have three main ingredients: asphaltenes, maltenes and PNAs, or polar naphthenic aromatics.

Prof. Sergeant said their task was to manipulate the amounts of these constituents to arrive at the right physical properties for the bitumen. One technique is to blow air through the hot bitumen to increase its viscosity and lower its temperature susceptibility so it does not melt on a hot day. He said the research strategy was to take the process successfully through each stage in the laboratory.

'If we succeed at every stage, we have shown the process is viable on a laboratory scale. If we fail at any stage, we have shown that the process is not feasible, in which case the proposed shortcut, to the production of oil from shale may not be an option,' he said.

Even a failure would provide valuable information about Australia's fossil fuel reserves, so it is important to maintain objectivity. So far the researchers have succeeded. They have shown that the yields are good and that the viscosity and heat susceptibility are acceptable. The next task is to improve the ductility. They have shown that poor ductility is caused by too much wax so they are now working on removing the excess. ■

. . . publications

Bitumen

The Shell Bitumen Handbook **(Shell Bitumen, 1990), ISBN 0951662503, 336pp, £15.00.**

Beginning with the basics of bitumen, its manufacture, storage and handling are explained, followed by a comprehensive section on specifications and quality. Bitumen emulsions are dealt with in a special chapter. The mechanical testing and physical properties of bitumen, its structure and rheology, properties such as durability and adhesion, and the influence of these properties on performance practice are all set out in individual chapters. A separate chapter is devoted to the recent and expanding practice of enhancing the performance of bitumens by the addition of a whole range of modifiers. Other chapters present aspects of bituminous mixes — the form most often used in paving.

Diving

Diving Chamber Fire Response Times — Offshore Technology Report **prepared by Technica (Department of Energy, 1990), ISBN 0114133425, £33.00.**

The report contains the work carried out on behalf of the Department of Energy concerning the risks of fire in diving chambers and the necessary response times to such fires.

Air Range Diving Support Vessel Guide, **The Chief Inspector of Diving, Petroleum Division, Department of Energy (Department of Energy, 1991), ISBN 011413345X, 39pp, £28.00.**

This publication describes what constitutes an appropriate Air Range Diving Support Vessel and the approach to its operation in the exploration for and exploitation of mineral resources on the UK Continental Shelf. It is based on a digest of industry experience obtained from discussions with representatives of over thirty companies and associations. It is intended to aid oil companies, ship owners and operators, diving contractors, shipyards and others.

Fouling

Fouling Notebook, **TR Bott (Institution of Chemical Engineers, 1990), ISBN 0852952597, 136pp, £29.50.**

Fouling has been relatively little studied in a systematic way that would be of assistance to designers and operators of heat exchangers. The book attempts to remedy this. Background notes and information on the costs of fouling are used to introduce the subject. The main part of the notebook deals with the mitigation of fouling problems in a logical way starting with the conception of the heat exchanger, the basic design, start-up and commissioning, normal operation, and techniques for improving the performance of heat exchangers. There is also a short section on the retrofit methods available for resolving persistent fouling problems.

Fluid control

Developments in Valves and Actuators for Fluid Control — Proceedings of the 3rd International Conference, **edited by DR Airey (Scientific and Technical Information Limited, 1990), ISBN 1855980010, 283pp, £78.00.**

In this book, systems designers, manufacturers, operators and researchers explore ideas and experiences and examine how valves, both conventional and novel types, can be used to keep industrial processes environmentally safe. Studies include how design, performance and better valve selection can ensure greater reliability and safety in the nuclear, oil and chemical industries.

General

Oil, Gas and Development — A View from the South, **TM Boopsingh (Longman Trinidad Ltd, 1990), ISBN 9766310014, 426pp.**

The author, Mr Boopsingh, is a former Permanent Secretary in the Trinidad and Tobago Ministry of Energy. The book is the first in-depth examination of the petroleum industry in Trinidad and Tobago and describes itself as 'a worm's eye view of the world of oil'. The book, while having as background the so called 'energy crisis', uses the period of falling oil prices in the eighties as its locus, in order to deal with some of the many issues confronting the developing world.

Hazardous areas

Classification of Hazardous Locations, **AW Cox, FP Lees and ML Ang (Institution of Chemical Engineers, 1990), ISBN 0852952589, 201pp, £75.00.**

This report sets out to assess the feasibility of classifying hazardous locations in a quantitative way. The authors conclude that it is feasible and in doing so they have gathered together a huge amount of data and information on classifying hazardous locations, creating a summary of current methods worldwide.

Instruments

Instrument Engineer's Yearbook **(The Institute of Measurement and Control, 1991), ISBN 090445725X, 192pp, £22.00.**

Launched in 1985, the Instrument Engineer's Yearbook now includes names and addresses, trade names, agents and distributors, product and service headings and up-to-date listing of the industry's standards from over 29 organisations.

Petroleum Geochemistry

Practical Petroleum Geochemistry, **Brian Cooper (Robertson Scientific Publications, 1990), ISBN 1853652180, 182pp, £75.00.**

This book shows how geochemical data aids in finding hydrocarbons by following consistent rules of interpretation. It offers a comprehensive review of the techniques used in the interpretation of data and bridges the gap between controlled laboratory systems and the needs of the exploration geologist to provide precise estimates of geochemical change within the restraints of limited geological data.

Systems integration for refinery planning and scheduling

By John Holmes, Consultant, SD-Scicon

Planning and scheduling in a refinery is complex because of two main characteristics:

— It makes use of complex techniques, principally linear programming (LP), simulation modelling and artificial intelligence (AI). These techniques are frequently not properly understood by the end-users.

— It involves a considerable amount of data, drawn from different computer systems which are often incompatible from an open systems viewpoint and contain inconsistent data.

Of the two characteristics, the computer software industry has focused on developing the mathematical techniques, with the result that there are now a number of software packages supporting LP production plan optimisation, production plan simulation and others. These range from home-grown spreadsheet systems to powerful combined LP, simulation and graphics packages.

Somehow, the second characteristic, that of system integration, has been obscured by the mathematical niceties and their development into software packages. Cynically, the mathematical models are easier to sell because they catch the imagination more than the basic need to feed them data.

It is evident that the evolution of the planning and scheduling models has advanced further than the data management systems essential to support their use. Some refineries have learned this hard fact because they have installed planning and scheduling systems but they are realising only a small part of their potential benefits because the data is not available on an accurate and timely basis. Typical problems are:

- The end-user has to enter manually significant amounts of data to make the system run.
- The Planning and Scheduling Department has to check the data captured from other systems because it frequently has errors or missing values.
- The level of expertise needed to transfer the data between systems and insert the data in the planning and scheduling models is beyond the abilities of the average end-user and is restricted to certain 'expert users.'
- There is not a single planning and scheduling model, but a hierarchy of different ones, each using their own mathematical technique. Data must be transferred between the models.

In essence, systems integration is concerned with making data available, on an accurate and timely basis, to all users with access rights to that data. This article addresses the problems and issues involved for planning and scheduling.

Planning and scheduling is the hub

All systems can be classified by their input and output data, and the nature of the processing involved. This leads to an analysis of data flows between the systems — the output of one system is the input to another. At this point it can be deduced that some systems are mainly data providers, such as the tank gauging, movement monitoring and laboratory systems. They obtain their input data from manual data entry or automatic capture from process instrumentation. Conversely, some systems are largely data users. Management reporting systems fall into this category. Their input comes from the data providing systems and their output is not directly fed back to other systems (although there is an indirect feedback; in the case of management reporting systems the result is decisions affecting the organisation, its facilities and their operation).

Planning and scheduling is not so easily classified as a data provider or a data user — it is both. For example,

Refinery department	Data providing system	Data provided
Process area	Movement monitoring	Movements
Offsites area	Tank gauging Movement monitoring Tank composition	Inventories Movements Compositions
Laboratory	Laboratory system	Quality data
Maintenance	Maintenance system	Maintenance schedule Emergency maintenance
Purchasing and selling	Nomination system	Nominations 'What-if' receipts and despatches

Table 1: Data providing systems

information on tank inventories is combined with data from other systems to generate an operations schedule for the tank farm. Feedback of stocks from the tank gauging systems completes the cycle. The same cycle of data capture, processing by planning and scheduling systems, and feedback applies to other systems such as the laboratory system, movement tracking, product despatch and receiving systems, etc. In this sense, planning and scheduling is at the hub of the information flows of the manufacturing organisation. This has major implications for the systems integration.

There is a pattern common to the data flows between planning and scheduling and each of the data providing systems which can be generalised as follows:

- Monitor: The data providing systems supply the boundary conditions for the planning and scheduling activities, such as opening inventory, plant status information, etc. They also feedback data for comparison with the original plan in order to improve the accuracy of the planning models.
- Plan/schedule: The planning and scheduling system combines the data from the data providing systems and creates a new or revised production schedule.
- Execute the schedule: The production schedule instructions are used to operate the plant, coordinate maintenance activities, schedule samples and coordinate receipts and despatches.

Key objectives

There are two key objectives relating to systems integration, data quality and system responsiveness. These are amongst the most frequent causes of system problems and are major contributors to successful implementations.

Data quality: This first and most important objective almost goes without saying, the input data must be complete, accurate and available on a timely basis. These requirements are not automatically satisfied by the data providing system; each has its own ideas of completeness, accuracy and timeliness. For example, refineries often have several different (and incompatible) tank gauging systems which satisfy the needs of operations but not planning and scheduling which needs the combined inventory data.

Planning and scheduling responsiveness: The second objective relates to the use of planning and scheduling systems, which must always be responsive to changes such as receipt or despatch re-timings, plant breakdowns, investigation of what-if possibilities, etc. Sometimes this objective is difficult to reconcile with powerful mathematical techniques which rely on significant reprocessing of the source data into a format appropriate to the mathematics. LP is a case in point. Another problem often encountered with scheduling systems is that changes require the user to repeat almost the entire scheduling process. Lack of system responsiveness, for whatever reason, leads to the system not being used effectively.

Integration

There are commonly five or more data providing systems which are candidates for integration with the planning and scheduling systems. Obviously there is a cost of developing integrated systems but it may not be necessary or desirable to integrate all the data providing systems. The key issues in determining whether to integrate systems are the benefits of data quality and planning and scheduling responsiveness, as described above. The candidates for integration are:

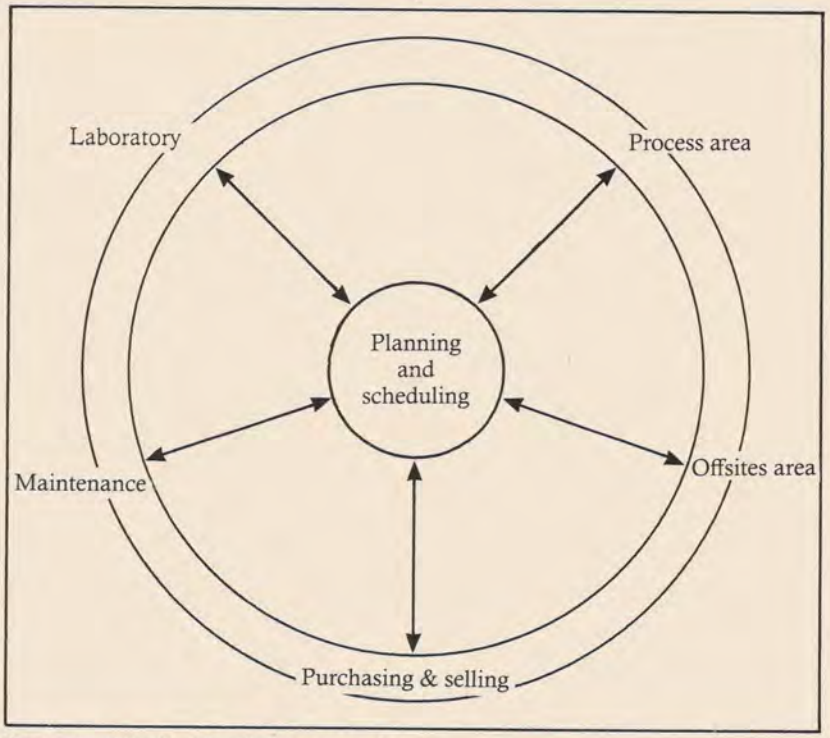

Figure 1 The 'hub' of information flows

- Tank gauging systems provide inventory volume information. The main problems for integration arise because refineries have often installed several types of gauging systems from different manufacturers, or some tanks may not even be connected to a gauging system at all. The cost of developing interfaces to incompatible tank gauging systems can be high, and connecting tanks to a gauging system and installing the instrumentation can be higher still.

  Inventory data is essential for planning and scheduling but may only be needed on a day-to-day basis rather than a real-time basis. Tank gauging systems are a prime candidate for integration with planning and scheduling systems because the volume of data is significant and operators frequently have to manually enter data for ungauged tanks or faulty instrument readings.

- Movement monitoring systems track and log movements on the plant. The systems are often based on manual input by the plant operators and these frequently suffer from major data omissions and inaccuracies. Integration with the tank gauging systems and scheduling systems has significant benefits, since these systems provide the base data for defining the movements. The movements base data can be updated on-line with actual movement volume, timing and other information by the plant operators, radically improving data quality. Integration may be costly but considerable cross-validation of automatically captured data, as well as manually entered data, is possible. Some systems use AI techniques to assist the validation of the data.

  As an extension, some movement monitoring systems track certain key qualities of tanks and movements. This may be valuable to Planning and Scheduling in the absence of laboratory generated qualities or until they are available.

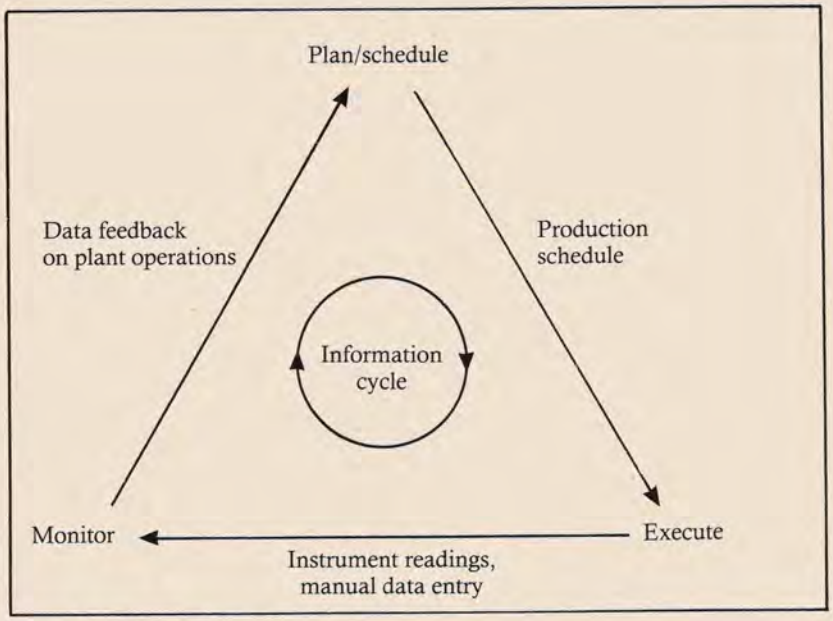

Figure 2 Cycle of data flows

- A laboratory system records quality measurements for tank stocks and movements, both of which are needed by planning and scheduling systems. In favour of integration is that the quality measurements are communicated to Planning and Scheduling (and other users) immediately they are available and without transcription errors. Transcription errors, in particular, have resulted in off-spec blends which have been expensive to correct later.

- A composition tracking system calculates the composition of the contents of certain tanks on the basis of the original composition and volume in the tank and the movements into the tank. It is used by planning and scheduling systems to predict the yields from units fed from these tanks, often in conjunction with process models. Without systems integration the most common approach is to use average yields with a corresponding loss of accuracy in planning and scheduling.

- A nomination system maintains records of the nominated receipts and despatches. The main benefit of integration is the avoidance of transcription errors.

- A maintenance management system and planning and scheduling systems need to coordinate the maintenance and production schedules.

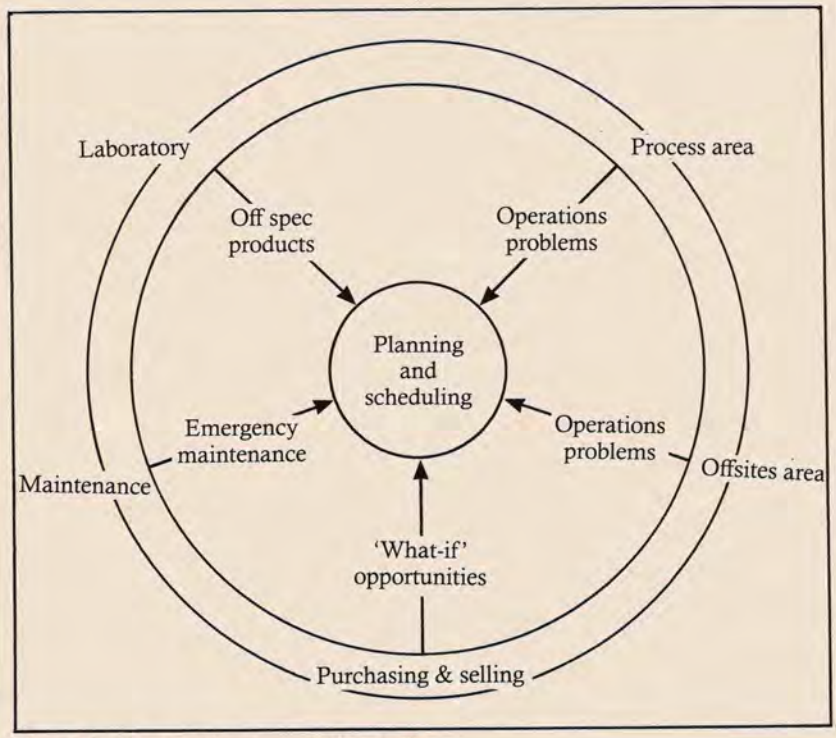

Figure 3 Responsiveness requirements

Integration of planning and scheduling systems

Although there is obviously a strong desire to use a single system to satisfy the needs of planning and scheduling this is not often possible. A single tool or method is OK in theory but in practice, limitations on computer performance reduce the responsiveness to unacceptable levels. Large planning/scheduling models are also notoriously user-unfriendly. An example of this is the use of LP to solve time-based scheduling problems. In practice refinery-wide LP models, which may have in the order of 2500 columns and 2000 rows, are too unwieldy for five more time periods in a multi-period LP. There are many other instances where a single method or tool is not the best solution for practical reasons.

The most common solution to this problem is to develop a hierarchy of individual planning and scheduling sub-systems, which must then be integrated into a single unit. Typically, the hierarchy addresses a longer time period but lesser detail or limited scope at the highest level, and a shorter time period and greater detail or wider scope at the lower levels. This approach of balancing the planning/scheduling period versus the degree of detail or breadth of scope is frequently encountered. It is a compromise between the functional requirements of planning and scheduling and the need for responsiveness, fast turn-round and user-friendliness in the system.

The hierarchy of planning and scheduling systems usually has three levels:

1. Optimise production strategy: the topmost level is concerned mainly with determining the optimum unit modes and blend compositions. In order to make the problem solvable with a reasonable amount of user effort and in a reasonable amount of computer time some assumptions are needed. For example, the exact timings of movements are ignored, certain plant capacity constraints are ignored and others are greatly simplified.
2. Outline feasible schedule: this is concerned with converting the previously defined optimum production strategy into an outline feasible schedule with respect to inventory, plant throughput and capacity constraints, receipts and despatches. To constrain the problem to a realistic size some simplications are usually needed, the main ones being to group the tanks and to simplify the treatment of unit yields and operating modes. This allows the user to investigate what-if scheduling problems such as the effect of changes to the scheduled plant operations, or modifications to the receipt and despatch schedules.
3. Schedule in detail: this is concerned with converting the outline feasible schedule into a detailed schedule that can be executed directly by Operations Department. The schedule goes down to the level of movements between individual units, blenders, tanks and import/export facilities. To cover this level of detail it is usually necessary to limit the period to one to three days in order to constrain the problem to a reasonable size. The shortness of the period often precludes any evaluation of last-minute changes to the plant operation or receipt/despatch schedules but this is better done using the outline feasible schedule sub-system.

Planning/schedule level	Period	Scope	Techniques
Optimum production strategy	> −1 mth	Part, entire or multi-refinery	LP, AI
Outline feasible schedule	5–30 days	Part or entire refinery	Simulation, AI
Schedule in detail	1–3 days	Part or entire refinery	AI, LP

Table 2: Planning and scheduling levels.

Systems integration must address the data flows between the planning and scheduling sub-systems as well as integration with the outside world of other systems. Since the sub-systems are based on different models of the manufacturing process, and probably using different mathematical techniques, the problems of integration are often complex. ■

1992 IP Diary

Orders are now being taken for the 1992 IP Diary. The leather covered diary has the IP crest (as above) reproduced at the top with the date and gives ample space for a company logo to be embossed underneath. The diary will be available in late Autumn.

The colour of the cover will be burgundy.

The diary contains 32 pages of specially printed copy, including oil industry statistics collected by the Institute of Petroleum.

The cost for a single diary is £6.50 (incl. p&p and VAT) and £7.50 overseas.

Discounts are available for bulk orders as follows:

25–49 diaries: £4.75 + VAT each
50–999 diaries: £4.50 + VAT each
1000+ diaries: £4.25 + VAT each

Embossing of company logos is available at extra charge.

Enquiries and orders should be made to:

Susan Ashton, Institute of Petroleum,
61 New Cavendish Street, London W1M 8AR
Telephone: 071 636 1004. Fax: 071 255 1472
Telex: 264380

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The Institute of Petroleum

MAKING CLEANER FUELS IN EUROPE— THEIR NEED AND COST

16 October 1991

A one-day conference to be held at
The Cavendish Conference Centre, London

The subject of cleaner fuels is both topical and vital, in the light of today's growing realisation that we must preserve our environment both now and for future generations.

This conference therefore starts with an exposition of the issues driving our policy makers in Europe towards targets for fuels specifications and emission levels, and outlines the progress that has been achieved. The specifications cover not only automotive fuels but residual fuels for industrial and marine use. There are papers on gasolines and the impact of the new US Clean Air Act on Europe; and diesel with its ever-reducing sulphur requirement and compositional problems consequent on whitening the barrel. And what about marine bunkers? Ought we still to burn high sulphur residues at sea, and continue to suffer problems of fuel instability and incompatibility? Or should we pursue ways of destroying poor quality fuels in refineries and use low sulphur atmospheric residues as marine fuels? A final paper then looks at the extra European investment and operating costs in the 1990s, occasioned by quality changes and estimated demand projections, to give a 'bottom line' perspective on the whole issue.

All these topics are addressed by experts in their field, who will be available to answer questions in an Open Forum session at the end of the day.

This is an important and timely conference, of major interest and value to all those engaged in the fuels business. It would be unwise to miss it.

For further information, and a copy of the registration form which will be available shortly, please contact **Caroline Little**, The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR, UK. Telephone: **071-636 1004.** Fax: **071-255 1472.** Telex: **264380.**

South Wales branch

The force that through the green fuse drives the flower, drives my green age.

Dylan Thomas — 1914–53

The South Wales branch was the first branch of the Institute, founded in 1929 by five employees of the National Oil Refinery (now BP Oil Llandarcy Refinery Limited) at Llandarcy.

Until the early 1960s Llandarcy was the centre of IP activities, with the BP refinery providing all the committee and membership. Committee meetings were held in the office of the refinery general manager who (understandably) was the chairman.

At this time the growth of the oil industry at Milford Haven provided the opportunity to broaden the branch's sphere of activity to embrace these new companies and gradually the Milford refineries were to become more and more influential in branch affairs.

The decision to invite these companies into the IP family was momentous but another quite extraordinary event was taking place, although the significance of it was not clear at the time! On 7 February 1963 at the AGM a voice from the floor startled the meeting by suggesting that a motion to invite committee representatives from companies other than BP was unconstitutional. The fact that a constitution existed may have surprised most of the members there but anyone with the audacity to quote from it was a person to be noticed. It wasn't long before a Mr J B Williams was elected onto the committee but not without a struggle! It took an adjourned committee election, a ballot and a second ballot and finally the chairman to invoke his co-opting powers to confirm it. Suffice to say Jim Williams has been serving on the committee ever since. Retirement from full-time employment proved no obstacle and he is the longest serving committeeman, treasurer and cornerstone of the branch.

The branch celebrated its golden jubilee in 1979 with the IP President, Branches Committee, Refinery Managers and local dignitaries present. The festivities are remembered for a highly entertaining after dinner speech by Mr E Thornton who as the only surviving member of the original committee was the Guest of Honour.

The present committee comprises elected representatives from the BP companies at Swansea and the oil companies at Milford/Pembroke plus a university lecturer and school teacher. Meetings alternate between Swansea and Milford and involve a round trip of 125 miles. This diversity of location remains one of our greatest difficulties. It is interesting to note that a Milford branch was considered in 1973 but never materialised.

We have developed into a fully integrated branch with strong representation from both southern corners of the principality, the decision to remain a single branch has been vindicated. Membership is predominantly drawn from the oil refineries and it is not surprising that our programme carries a strong downstream flavour but we have spread our wings and have been very successful in attracting members from many local industries as diverse as river authorities, local computing and even British Rail.

Llandarcy Refinery. Courtesy of BP.

We provide a programme of meetings from September to April with a golf tournament in June. The programme is an amalgam of technical, topical and local interest subjects with a visit or two thrown in. Some visits have developed into 'weekend breaks' and highly successful visits have been made to the channel tunnel, Sellafield and BP's Wytch Farm development in Dorset.

Educational links

There has been considerable emphasis in recent times on the education links both from the Institute and industry. Much work is being done and the branch has developed its own 'schools initiative' programme. This gives us hope for the future. The broad aim is to make contact with GCSE and 'A' level students in comprehensive schools and through this contact to make them aware that there are worthwhile opportunities in the petroleum industry and that an Institute exists which will be of benefit to them.

We are fortunate to be guided by Chris Saunders, a committee man who has worked in the oil industry and is presently head of science at Pembroke School. He has masterminded the initiative. A lecture is held at the school under the auspices of the IP with lecturers provided by the oil companies. The content covers subject matter which is an integral part of the science curriculum. A successful pilot lecture was held in 1989 and four more are planned for 1990/91. We intend to establish these lectures as a regular part of the IP activities in the area. An integral part of the initiative is to encourage students to attend the monthly meetings and this has been very successful.

Our chairman, Steve Vines, is one of Gulf Oil's senior engineers at their Milford Refinery and is in his first year of office having served a three-year apprenticeship as deputy chairman. I often think that the branch rules must have been devised by the chairman as that post has an official two-year tenure, whereas the treasurer and secretary seem to go on forever!

I recall clearly an afternoon in April 1980 when the chairman of the day, who was the Technical Manager at BP Oil, Llandarcy, asked me to do him a favour. 'There wasn't much work involved in it,' he said. He left shortly afterwards. If anyone knows where Alan Harrison is please let me know, I've been trying to catch up with him for 10 years!

I believe the branches play a significant role in representing the IP interests in all corners of the United Kingdom and although we all operate differently we share a common desire to further the ideals of the Institute but success can only be achieved with a dedicated committee, support from the Institute and cooperation from the oil industries in our areas. I am glad to say we have all three ingredients in abundance in the South Wales branch and hope to continue to play our part in the Institute in the years to come.

I J Thomas
Hon Secretary

Attracting the right graduates

The MORI organisation has been carrying out annual surveys of the attitudes of final-year undergraduates towards industry and commerce at large for almost 20 years.

In 1989 the Institute of Petroleum bought in to the MORI survey for three years and sponsored 12 petroleum-specific questions with the objective of finding out how final-year undergraduates were perceiving the upstream and downstream sectors of the oil industry in comparison with other industries.

The 1989 survey results showed that student interest in all major industries was low in comparison with banking, accountancy and management consultancy and very low in comparison with the financial services sector.

However, the 1989 results of the MORI survey were only a one off snapshot of the industry. Trend information is usually of more interest and so, when the 1990 survey results became available, an executive review meeting was held at the Institute on 21 March 1991 in order to contrast the 1989 and 1990 results. The MORI consultant, Michele Corrado, told delegates that interest in the oil industry by final year undergraduates over the period 1989 to 1990 had fallen by two points to 23 percent contributing to a decline of nine points since the high of 32 percent in 1987.

A third of final-year students in 1990 believed that oil exploration and production was a declining industry and one in five that its employment packages were deteriorating (the equivalent downstream figures were 25 percent and 15 percent respectively).

There was general agreement at the meeting that if the oil industry wanted to attract the best graduates then it would be necessary to change the perceptions which final-year undergraduates have about the industry.

In order to take action to raise the oil industry's profile amongst the undergraduate population and to pursue important initiatives in schools, the Institute is now in the process of recruiting an Education Services Manager.

Mr Bruce Hepburn, Managing Director, Industry Ventures Ltd, was the second speaker at the executive review meeting. He described a National Engineering Audit which his organisation was about to undertake. The Audit would comprise four surveys on:

(i) Graduate engineers recruitment.
(ii) Work experience for engineering undergraduates provided by companies.
(iii) Attitudes of schools to engineering and the effectiveness of school/industry liaison.
(iv) Training, development and retention of engineers.

At the present time it was estimated that across all UK industries some £16 million was being spent in sponsoring engineering students on degree courses. Of this, £6 million was being wasted as the work experience, whether it was an industrial period in a sandwich degree course, summer vacation work or a project assignment, was causing 37 percent of sponsored engineering students to switch off from engineering as a career!

The oil industry is very concerned about the recruitment of good engineers. A number of oil companies are already sponsors of the National Engineering Audit. It may be appropriate for the IP to sponsor a booster question of the effectiveness of work experience for engineering undergraduates when they obtain this experience in an oil company. Detailed discussions are to be held with Industry Ventures Ltd to explore ways in which oil companies in general, and the IP in particular, can participate in the National Engineering Audit.

Mr Roger O'Neil, Vice-President Administration, Mobil Europe and Vice-President, Institute of Petroleum, who chaired the executive review meeting, concluded the meeting by saying that Mr Bruce Hepburn, a graduate in engineering from Imperial College, had destroyed the image that an engineer could not be an entrepreneur!

Towards a training framework for the 90s
A one day conference at The Institute of Petroleum on Thursday, 24 October 1991

In the 1990s evidence is emerging of the devolution of training responsibilities in companies both to line managers and to individual employees, who will actually implement plans for their staff and personal development respectively, with training departments acting as resource centres and focus points for training information and evaluation.

To go down this road requires a training framework which can be readily understood and accessed by all concerned.

The Institute of Petroleum Personnel, Education and Training Discussion Group will therefore organise a one day conference on 24 October, 1991 to provide human resource specialists and training staff with an opportunity to exchange views on the way forward for the 1990s. In particular, emphasis will be placed on the integration of new education and training initiatives into a single meaningful training framework. The relative merits of MCI (Management Charter Initiative), MBAs (Masters courses in Business Administration), Chartered Engineering status, the new Continuing Professional Development initiative from the Engineering Council, NVQs (National Vocational Qualifications) will all be highlighted, together with experiences in implementation. In addition, the European dimension has added further initiatives with which to co-operate such as COMETT, EuroPro, EurIng etc. Their contribution to the overall training framework will also be discussed in the conference.

Major subjects to be covered in the conference will include the following:

- The need for the integration of new initiatives to be effective and the concept of a coherent framework.
- The concept of continuing professional development and the new national initiative from the Engineering Council.
- Modular MSc and MBA qualifications. The new concept of credit accumulation and transfer (CATs). Accreditation of in-company training and projects. How the business schools are working with industry today.
- How to integrate distance learning into company and university accredited programmes.
- MCI — how far have we got? Do employees and employers now accept MCI as a sound route to both management competence and business qualifications?
- How to use the NVQ ladder to 'grow' people.
- What are the most likely European initiatives to interest oil and gas company trainers in the 1990s?

Further details of this conference will be published in *Petroleum Review* later in the year. Meanwhile, if you are interested in attending the conference, please note the date in your diary.

Education and training — the European dimension

At a recent meeting of the Institute's newly-formed Personnel, Education and Training Discussion Group, Ian Williamson, Director of The College of Petroleum Studies, presented a discussion paper on 'Education and Training — The European Dimension'.

The paper centred on the European issues most likely to be of interest to oil and gas companies in the 1990s as shown below:

- Trans-national collaborative courses eg EAP-MBAs, IFP/Delft/Imperial reservoir engineering programme etc.
- Licences to practise eg European Engineer (Eur Ing).
- Trans-national learning and credit accumulation schemes eg EuroPro.
- Co-operative industry/provider training schemes eg COMETT-sponsored (Community Programme for Education and Training in Technologies) distance learning for oil and gas economics.
- Training initiatives to assist Eastern Europe eg TEMPUS.

Additionally information was presented on the organisation of the EEC Directorates which had an interest in the education and training field, the sources of funding and an analysis of the current education and training programmes being sponsored by the Directorates such as DG I, DG VIII and DG XVII. There was particular emphasis on EEC programmes from Task Force: Human Resources, Education, Training and Youth, such as ERASMUS COMETT and EUROTECNET.

Mr Williamson mentioned that at the moment it appeared that universities, polytechnics and training organisations were taking the main initiative in European co-operation and that this was possibly due to a feeling that there were extra resources available in Europe, considering the financial pressures on Higher Education establishments in the United Kingdom. Nevertheless there seemed to be some very worthwhile trans-national co-operative programmes emerging, such as the reservoir engineering initiative between Imperial College, Institut Français du Petrole (IFP) and the Technische Universiteit Delft. There was also evidence of significant changes in attitudes to co-operation at universities, for example Warwick University had recently claimed links with 25 organisations in collaborative ventures. Also mentioned was the tri-country MBA offered by EAP — The European Management School in Berlin, Paris and Oxford.

Another interesting trend was being led by Neste Oy in Finland, along with Helsinki University of Technology (HUT) to provide international credits for work undertaken on short courses, projects in-company and attendance at specified university programmes, all of which could be accredited towards an MSc degree of HUT. This programme known as Euro Pro is starting up in 1991 and UK institutions such as The College of Petroleum Studies (CPS) and Salford University are cooperating, as are IFP and other organisations in Europe. This programme is supported under the EEC's COMETT programme.

COMETT is a very significant EEC programme, which has been the main catalyst in improving co-operation between universities and industry, to provide training courses which are relevant to the needs of industry. At the present time, CPS is leading a COMETT project to introduce specialised distance learning programmes for the oil, gas and chemical industries and about 20 major oil and gas companies in nine European countries have joined this partnership, which is starting work this year.

Another subject of much interest was the course accreditation of programmes and qualifications and here it was stressed that the title Euro Engineer (Eur Ing) was slowly gaining favour and this had been supported in the United Kingdom by IMechE. Similarly the Institution of Chemical Engineers was considering such a trans-national licence to practise.

As is well known, many European and American oil companies are now penetrating Eastern Europe and the Soviet Union, with joint venture projects in both the upstream and downstream areas. Significant training problems could emerge from these new ventures, particularly in the areas of management, economics and legal training. Some companies were now busy locating high-potential East Europeans and sending them to the USA or to European affiliates to obtain business experience, with a view to sending them back to manage projects in the East. Mr Williamson highlighted the many problems which the EEC was having in trying to provide funding for training and education initiatives and said that so far the results had been very disappointing. For example in the EEC's TEMPUS programme, 1380 bids for training had been received from Hungary and Poland but the EEC had only had sufficient monies to fund about 10 percent of these projects. Mr Williamson pointed out that until the East European universities and training institutions adopted the teaching of Western style management and economics, there would continue to be a problem and he felt that the EEC's main funding priority should be directed to the area of institution building rather than of helping individual projects.

Publication

Engineering Futures — New Audiences and Arrangements for Engineering Higher Education. A report of the papers presented, discussions and major recommendations of a conference on the future supply of engineers. Available from The Engineering Council, 10 Maltravers Street, London WC2R 3ER.

Continuing professional development

The Engineering Council has announced plans for a national system to promote and encourage continuing professional development (CPD) for engineers and technicians.

The system calls on engineers and technicians, in partnership with their employers, to carry out a planned programme of CPD. It will enable individuals to update and develop their knowledge and skills and help industrial companies to improve their performance.

The Engineering Council will develop and promote Codes of Practice and the system will involve close collaboration between the Council, the professional engineering institutions, the engineering industry and the providers of training for CPD. The Council is recommending that engineers and technicians carry out a minimum of 35 hours per year of CPD.

A document, 'A national system for continuing professional development — framework for action', outlines the responsibilities of all partners involved in CPD. The system will be developed over the next three years with the help of a team of regional officers.

Award for Wood Group

Wood Group Production Technology has won the prestigious Queens Award for Technological Achievement, for the development of a Permanent Downhole Readout (PDR) tool.

The company specialises in the development and provision of advanced, high reliability downhole measurement systems, whether for permanent installation or short duration surveys, and capable of long term reliable operation at extreme pressures, temperatures and severe mechanical shock loading.

The project to develop a PDR tool started in 1986, when it was recognised that existing tools had very low reliability rates (sometimes as little as 10–15 percent). Development was equally funded by Wood Group, Mobil North Sea and the Offshore Supplies Office.

The main innovations were the design of a fully patented one-piece gauge holding mandrel with a high level of mechanical integrity and permitting sensor and electronics duplication. The design of a cable/connector splice providing high mechanical strength and improved pressure energised metal sealing, and the development of an alternative cable construction technique allowing the manufacture of longer splice free cables with improved mechanical performance and corrosion resistance.

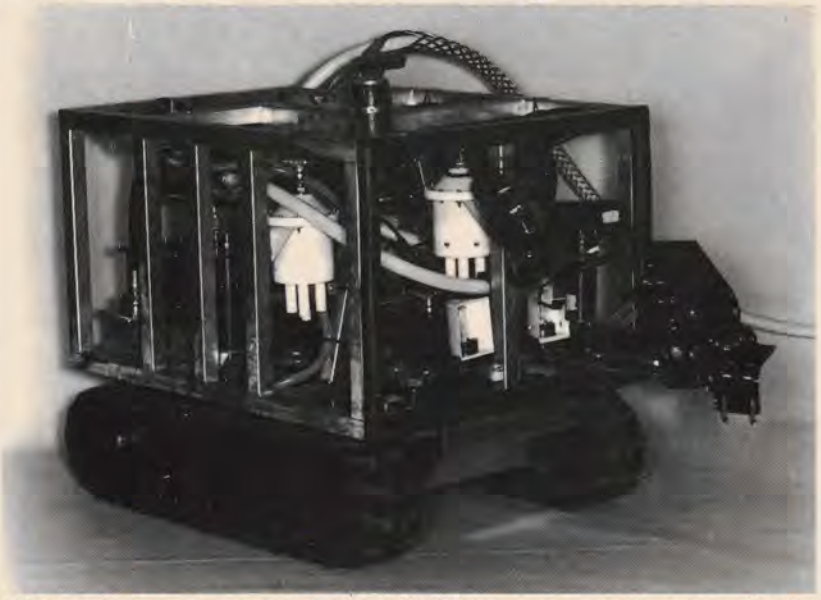
Another Queens Award winner was Gateshead-based firm Anson Ltd.

The company gains the award for developing a swivel joint for use in otherwise rigid steel piping systems generally installed in and around the wellhead area of oil and gas fields.

The joint does not leak under high pressure or temperature experienced offshore, and maintenance costs have been reduced by 50 percent.

Anson's claim the working life of their joint is at least 2.5 times that of existing equipment.

Seabed crawler system



Offshore Systems Engineering Ltd (OSEL) has come up with a cost effective solution to complex subsea work — Navtrax, a versatile and stable platform from which a comprehensive range of tools and sensors can be deployed.

Virtually unaffected by currents, Navtrax is a compact, remotely operated, hydraulically powered, tracked seabed crawler which can be used for anything from pipeline inspection to transponder recovery.

Weather window expander

The Norwegian diving support vessel *Seaway Pelican* has been upgraded with a new Hydralift load-handling system with active heave compensation, which would allow subsea operation in rough weather.

A vessel with a wide weather window cuts costs by being able to go on working in high seas instead of having to wait for calmer days before being able to tackle operations offshore.

Safe and smooth load handling against the seabed was secured by a new CCS, crane-control system, with 'intelligent' automatic transitions between the three crane modes 'normal', 'heave compensated' and 'constant tension'.

The design criteria required load handling in up to Beaufort 6 conditions with a significant wave height of 4 m, resulting in a vertical crane-tip movement of ± 2 m and speeds up to 1.6 m/sec. Tests have confirmed better than 95 percent compensation.

Auto lighting

Parkersell Retail Petroleum Services, has launched a range of automatic lighting control systems known as the LCS 90.

The LCS 90 lighting control system controls electricity consumption by dividing illuminated areas of the forecourt into individually controlled zones. These are automatically adjusted by solar sensors and time switches to maintain required lighting levels during site operation hours.

Siberian bugs

Oxford Virology plc has developed a naturally occurring Siberian bacterial strain which breaks down the hydrocarbon content of crude oil.

Unlike dispersant techniques based upon the use of detergents or superheated steam ecologically damaging side-effects are minimal and the products of breakdown are ultimately carbon dioxide and water.

Under suitable conditions slick degradation can be extremely rapid, and because of the fast growth of the bacterial population in the presence of high concentrations of oil initial seedage dosages are low. Once the oil has been digested, the bacteria rapidly die out.

New oil-eater

Oil-Eater, a new, fast acting oil absorbent, available from Sorbican Distribution Ltd, acts instantly and absorbs many times its own volume of oil and chemical-based liquids.

A specially processed, lightweight peat fibre, Oil-Eater is a naturally occurring material, 100 per cent organic, non-toxic and very easy to use.

Successful marine oil trials

Trials of a new 'green' marine oil from Texaco have proved so successful that the National Rivers Authority (NRA) has given it its highest accolade.

Engineers from the NRA's southwest region were so impressed with the new biodegradable two-stroke engine oil they recommended it should be used on all their boats.

The oil, called Motex S Outboard, prevents pollution to waterways and coastlines, because it is made of biodegradable esters which can be eaten by water-borne bacteria.

And in addition to these green benefits, Motex S Outboard still gives a top performance for all watersports engines.

Body scanner X-rays rocks

UK Oil companies will soon be able to use a former hospital body scanner to x-ray rock samples (cores) taken from North Sea oil and gas wells.

The scanner will give scientists a picture of the internal structure of a core sample to help determine how oil and gas recovery can be increased.

The scanner will form part of the new Aberdeen Rock Imaging Centre (ARIC) being established by The Petroleum Science and Technology Institute with assistance from the Oil and Gas Group of Scottish Enterprise (SE) and the local enterprise company, Grampian Enterprise Ltd.

'The ARIC will be the only facility of its type in Britain and will assist UK oil and gas companies in determining the potential production yields of North Sea wells,' said Mr Tom Cross, Director of Contract Research at the Institute.

The Centre will be located at the Offshore Technology Park (OTP), Bridge of Don, Aberdeen where it will begin operations this summer.

'As well as providing a facility for examining complex core samples, the ARIC will have a dedicated research programme making it a centre of excellence for rock imaging', said Mr Cross. 'The ARIC will strengthen Aberdeen's position as a world analytical centre and help locally based companies in winning overseas contracts.'

'The location of the ARIC at Aberdeen's OTP further underscores the Park's position as a world leader in innovation,' said John Kelly, Director of Industry at Grampian Enterprise.

'This facility offers great opportunities for research into imaging techniques and a unique service to Britain's oil and gas industry.'

'The OTP is leading the way in world wide research and development and it is only fitting that this advanced facility is located on the OTP,' he said.

Fuel dispenser

Pumptronics is launching a completely new range of fuel dispensers at the 1991 Forecourt Marketing Show. The shape of the new pumps has been developed specifically for Pumptronics, in conjunction with forecourt automation specialists Micrelec plc, by one of the UK's leading industrial designers.

One unique feature of the new design which conforms to BS7177 Part I, is the range of upgrade paths available. All exterior cladding is fully removable to allow pumps to be completely re-clad on site without incurring the expense of removing the dispenser from the forecourt. The new design shape can also be retro-fitted to current Pumptronics models.

The complete range of Pumptronics pumps, comprising Mono, Twin, Quadro and Multi-Product Dispensers are all fully compatible with Micrelec equipment, including the Master series RECAL pump controller and DATAPOS point-of-sale terminal.

Wax fingerprints

BP are using sophisticated rheological techniques to investigate the properties of wax deposits accumulations in pipelines.

A VOR rheometer from Huntingdon-based Bohlin Reologi, helps scientists to identify these waxes and show how they can be altered by modifying chemicals.

In simple terms, a rheometer is capable of measuring the visco-elastic flow properties of materials and showing how they change under different conditions. Bohlin claim that this technique can help the oil industry to increase productivity.

Ultrasonic bolt service

Pilgrim Moorside Ltd, the bolt and bolting systems specialist, has a new highly developed ultra-sonic bolt stress monitoring system.

The Boltscope system works simply by measuring the time taken for an ultrasound wave to travel and return along the length of a fastener.

Unusual project

The Offshore Division of Avon Industrial Polymers, part of Avon Rubber plc, has successfully completed an unusual engineering project.

Glasgow-based Norson Power approached Avon for help after winning an order from Pirelli to install a powered hydraulic cable laying mechanism on board the company's ship *Guilio Verne.*

Engineers needed to prevent the drive pinions and gear teeth on the 30 metre diameter cable reel becoming jammed in operation with the natural sea-swell movement of the boat.

Avon solved the problem by designing special rubber bushes to take up the deflection.

Chessell upgraded

Chessell has just launched an upgraded version of its 342 100 mm chart recorder. Based on the company's popular 301 concept, the 342 is a 1, 2, or 3 pen modular recorder providing a low cost solution to a wide range of petroleum industry requirements.

Swivel joints

The piped transfer of liquids, fluids, greases, slurries, powders — even gases and pelletised solids — is a basic requirement found throughout the oil industry. Where pipework is static, few problems arise but when flexibility is a prerequisite such as with joints to hoses, swivel arms, rotating drums and similar articulated joints, difficulties with standard fittings can occur.

Now from Stockport-based Rotaflow is a range of high quality, engineered swivel joints, designed to a standard format, but assembled to individual customer requirements to give economical 360° flexibility, and which have been developed to give trouble free, full bore flow.

Rotaflow swivel joints consist of a casing into which is fitted the rotating inner sleeve, and which, because its internal diameter is close to the nominal bore of the pipework, will not cause any pressure drop in the material being pumped. The joints are capable of carrying a wide variety of materials, even at high pressure, or at high or low temperatures.

Unlike ordinary flexible joints, the Rotaflow range incorporates a special bearing arrangement: rather than using two sets of ball bearings, Rotaflow joints have one race of ball bearings, and a set of corrosion resistant needle rollers which give excellent load carrying capability. The large bearing contact area has the advantage of absorbing shock loads and whiplash effects which can cause rapid wear and subsequent downtime.

Storage tanks go 'green'

Joseph Ash Storage Tanks is stepping up output of a new 'green' product range — double-skinned storage tanks.

The Birmingham-based company, a member of Ash & Lacy plc, has patented a new 'above-ground' product, five months after introducing special double-skinned tanks designed specifically for underground use. Currently, Joseph Ash manufacture up to 3,000 tanks a year, supplying petrol companies, heating engineers and specialised customers throughout the United Kingdom. But now it anticipates a production boost as industry generally becomes more environmentally-friendly.

The newly-patented double-skinned above-ground tank is ideally suited for the storage of hazardous liquids on construction sites or for use at transport contractor depots.

. . . people

Mr Glenn Tilton, above, a Vice President of Texaco Inc, has been designated Chairman of Texaco Ltd. Mr Tilton, who is currently President of Texaco Refining and Marketing Inc in the United States, succeeds **Mr Peter Bijur.** Mr Bijur has continued to hold the position of Chairman of Texaco Ltd since assuming the post of President Texaco Europe in November last year. Mr Tilton moves from Houston where, as President of Texaco Refining and Marketing Inc, he had responsibility for all of Texaco's US operations and interests in refining, marketing and related product activities, including lubricants, business services and credit card marketing.

Ramco Oil Services plc, the Aberdeen based pipe care maintenance and protection company has appointed **Mr Steven Bertram** as Financial Director. Mr Bertram joined Ramco Oil Services as Financial Controller in 1986 and was additionally appointed Company Secretary in 1989.

Ranger Oil Limited have appointed the **Right Honourable Sir Peter Morrison, MP** to its board as a Non-Executive Director. **Mr Alan Henderson**, Vice President, Director of Corporate Relations, has resigned from the Board to allow for this appointment.

Mr Stan Jones has been appointed Marketing Director of Gulf Oil (Great Britain) Limited, a subsidiary of Chevron Corporation. Mr Jones, formerly Manager, Retail Marketing succeeds **Mr Mott Groom** who has taken early retirement.

The merging of Vikoma International and Hoyle Marine has created one of the largest manufacturers of oil spill containment and cleanup systems and has led to new appointments in both companies. **Mr Keith Reynolds** becomes Chairman of both Vikoma International and the renamed Vikoma Hoyle. **Mr Brian Brown** becomes Managing Director of Vikoma Hoyle in Liverpool and **Mr Graham Norman** takes over as Managing Director of Vikoma International on the Isle of Wight.

Sir Philip Jones has been appointed Chairman of Total Oil Holdings. Sir Philip is currently Chairman of Total Oil Marine and is also non-executive Director of IVO Energy Ltd, Gas Transmission Ltd and Chairman of Dames & Moore, Barry Ltd.

Mr John Speirs has been appointed Chairman of Dramgate Limited, the offshore shipping and manufacturing group. Mr Speirs is Managing Director of Norsk Hydro (UK) Ltd and first became involved in the offshore oil and gas industry when he was Divisional Director of the National Enterprise Board and responsible for British Underwater Engineering Ltd (BUE). He was a Director of BUE between 1979 and 1987 and Chairman of Mono Pumps Ltd from 1988 until its acquisition by Dresser Industries in 1990.

GATX Terminals Limited have appointed **Mr Andrew Ottaway** as Sales Manager and **Sue Brownjohn** as Chemicals Executive in their Marketing Department.

Mr Malcolm Leatherbarrow has been appointed Head of the Fire Service College's Industrial Training Unit. Mr Leatherbarrow joined City of Salford Fire Brigade in 1962 and from 1974 to 1988 was with the Greater Manchester Fire Service where he reached the rank of Divisional Officer. He joined the Fire Service College three years ago as Head of the Breathing Apparatus Training School, before moving on to the School of Command. **Mr Ron Cameron** has been appointed as the College's Marketing Manager to ensure that the College responds to and meets the training needs of its clients from all sectors of industry and commerce by developing and promoting tailor made packages either at the College or at the client's site.

Smedvig Limited the Aberdeen based international subsidiary of marine contractors Smedvig AS has made three new management appointments. **Mr Robert Warrack** joins as Marketing Manager, **Mr John Milne** as Materials Manager and **Mr Ron Matheson** joins as Director Designate of DS Technical Resources, a subsidiary of Smedvig Limited.

Uniface UK Limited, a supplier of advanced fourth generation and database application development systems, has appointed **Mr Steve Nash** as Sales Director.

Mr John Collins, Chairman of Shell UK, has been appointed head of the government 'Advisory Committee on business and the environment'. Issues on the committee's agenda include environmental management, recycling and global warming.

Stena Offshore have promoted **Mr Steve Assiter**, above, to Financial Director. Prior to joining Stena Offshore Mr Assiter was a Director and Financial Controller of Vann Systems, a subsidiary of the Halliburton Group.

Mr Kenneth Huffman has been appointed as Vice President-Investor relations of Occidental Petroleum Corporation. Mr Huffman was previously Vice President of Finance for American Exploration Company, an energy, exploration and production company in New York and Houston. From 1982 to 1989 he served as Director of investor relations and financial planning for the Sun Oil Company.

Solus Schall, the inspection services group, have made two management appointments at their Aberdeen headquarters. **Mr Derek Allan** has joined the company as Operations Manager with responsibility for Nondestructive Testing and Inspection. **Mr John Troup** has joined as Operations Manager responsible for Manpower and Vendor Inspection.

Three new directors have been appointed at Hayward Tyler Fluid Dynamics, the pump manufacturers, for the power and subsea markets. The new Directors are **Mr Simon Poulton**, who becomes Finance Director, **Mr Ian Jenner**, who becomes Manufacturing Director and **Mr Eric High**, the company's Quality Director.

Institute News

Obituary

Mr P W Proctor

Mr Peter Proctor was a Fellow of the Institute who served on the IP Council from 1985 until shortly before his death and represented his company, Phillips Petroleum Products Ltd, on the Institute's Oil Industry Liaison Committee. He also served on Membership Committee for nearly 12 years, including two as Chairman.

Peter's enthusiasm and commitment to the Institute will be much missed.

New Fellow

Capt B. Pyburn, MBE, joined BP Tanker Company as a cadet and, after a twelve year period at sea in which he attained his Master's Certificate, came ashore as Berthing Master at the Sullom Voe Terminal in Shetland. In 1980 he left Shetland to assist in the establishment of the BP Oil Spill Base at Southampton, eventually becoming the Manager and steering the base from a BP sponsored facility to a joint venture with the oil majors. In 1989 Captain Pyburn led a party of experts to assist Exxon during the *Exxon Valdez* incident and is currently Manager Environmental Response Activities for BP International. He was awarded the MBE for services to Oil Spill Response in the Queen's Birthday Honours in 1990.

New Collective Member

Land Restoration Systems (UK) Ltd, (LRS), is a multi-disciplinary company providing consulting and contracting services in the environmental field, principally related to contaminated land. LRS head office is located in Slough, Berkshire with the research and development laboratory facilities based in Dublin, Eire.

LRS was formed in 1986 with the principal objective of developing biological treatment techniques to remediate polluted soils and groundwater. The scope of operations has expanded over the last five years to also provide a comprehensive environmental consultancy service and alternative remediation solutions to the petrochemical industry throughout Western Europe.

Benevolent Fund

The Institute of Petroleum has a Benevolent Fund for the provision of financial and other relief or assistance to persons in need who are or have been members of the Institute and the wives, widows, families and dependent relatives of such persons as the Management Trustees in their absolute discretion think fit. If members of the Institute are aware of any such persons, even if their membership of the Institute has ceased, they are asked to inform Mr AEH Williams at the Institute. Applicants would be asked to complete a form giving details of their financial circumstances which would be treated in strict confidence. Help might be given for temporary difficulties, such as the cost of convalescence following illness.

Institute News

Around the Branches

North East
2 July: visit — Phillips Petroleum, Seal Sands.

Shetland
17 June: 'Port Control', Shetland Islands Council, Ports & Harbours Department, Sella Ness.

West of Scotland
12 June: Golf Match.

New Members

Armstrong AC, 2 Rosemount House, 30 Rosemount Place, Aberdeen AB2 4XU
Azzan AH, Sharjah Municipality, PO Box 2178, Sharjah, United Arab Emirates
Barnsdall D, 2 Thatched Cottages, Barrow Gurney, Bristol BS19 3SA
Bigley PN, 7 Constables Leys, Kimbolton, Cambridgeshire PE18 0JG
Bryson TS, 1 Cairn Crescent, Alloway, Ayr KA7 4PP
Bull JA, Manager, Terminals Engineering, Texaco Ltd, 1 Knightsbridge Green, London SW1X 7QJ
Christoforou CM, 78 Upper Cranbrook Road, Redland, Bristol BS6 7UP
Clubley SM, Rose Cottage, Church Street, Naseby, Northamptonshire NN6 7DA
Cole KJ, Church Hill View, 1 Mill Lane, Kinver, Stourbridge DY7 6LE
Collins T, 225 Wilmington Gardens, Barking, Essex IG11 9TZ
Dalgleish IS, Norwood, 31 Bellevue Road, Ayr KA7 2SA
Dali A, Haihar, Trio L-Inbid, Attard, Malta
Danyali V, 15 Lenthall Avenue, Grays, Essex RM17 5AX
Day SF, 16 Fox Dene, Godalming, Surrey GU7 1YQ
Derkink BJ, Managing Director, Omniquest International, Am Birkengarten 6a, Ottobrunn, Germany 8012
Doble LA, Greystones, Main Street, Kirk Ireton, Derbyshire DE4 4LD
Doyle AR, Burmah Petroleum Fuels Ltd, Burmah House, Pipers Way, Swindon, Wiltshire SN3 1RE
Dutton DW, 26 Wicklow Heights, Wicklow, Co Wicklow, Ireland
Dutton J, Trelayne, Bowcott Hill, Arford, Hampshire GU35 8DF
Elian B, Executive Chairman, Alpha Petrolube, PO Box 3377, Limassol, Cyprus ZCYP
Elliott RM, 34 York Terrace East, Regent's Park, London NW1 4PT
Ellis B, 54 Heol-Y-Pentre, Pentyrch, Mid Glamorgan CF4 8QE
Eynatten JL, Fruithoflaan 118-B.10, 2600 Antwerp-Berchem, Belgium
Fraser M, Esso Petroleum Co Ltd, 5 Otterburn Park, Edinburgh EH14 1JX
Graham AR, General Manager, BP Middle East, PO Box 51092, Mina, Al Fahal, Oman
Grech M, Les Jummelles, Triq San Mikiel, L-Iklin Lija, Malta
Greenslade CJ, 55 Princes Gardens, Cliftonville, Kent CT9 3AS
Gummer S, Global Engineering, PO Box 8688, Doha, State of Qatar
Hart K, Corporate Finance Petroleum Dept, Kleinwort Benson, 20 Fenchurch Street, London EC3P 3DB
Hodge SMC, 12 Highgate close, London N6 4SD
Lancaster D, 12 Willows Close, Wistaston, Crewe, Cheshire CW2 6TD
Lindfield DR, Via Roma 47, Cagliari, Italy 09124
MacGregor JR, 51 Woodrush Crescent, Locks Heath, Southampton SO3 6UP
MacMillan IA, Chelston, Old Road, Barlaston, Staffordshire ST12 9EQ
Marlow G, 46 Petersham Drive, Dudlows Green, Appleton, Warrington, Cheshire WA4 5QF
Marston DT, 61 Scott Road, Lowton, Warrington, WA3 2JG
McDonnell SP, GP-Elliott Electronic Systems Ltd, Elliott House, 8 Deer Park Road, Merton, London SW19 3TU
Murphy K, Flat 4, 68 Warminster Road, London SL25 4DQ
Musseli SR, La Tourelle, Sheaths Lane, Oxshott, Surrey KT22 0QU
Osbourne TS, Drilling Fluids Consultant, The Old Rectory, South Reston, Louth, Lincolnshire LN11 8JQ
Otta K, 45 Tudor Close, Belsize Avenue, London NW3 4AG
Olid S, 131 Monkhams Lane, Woodford Green, Essex IG8 0NW
Poole RW, 66 Scrivens Mead, Thatcham, Newbury, Berkshire RG13 4FQ
Pooley GR, Manager, Marketing Engineering, Mobil Oil Co Ltd, Clock House, Frogmoor, High Wycombe, Buckinghamshire HP13 5AB
Purcell AM, 5 Merritt Road, Didcot, Oxfordshire OX11 7DF
Simpson S, St James's Research, 15 Stafford Mansions, Stafford Place, London SW1E 6NL
Smith PJ, Exploration Manager, Sovereign Oil & Gas PLC, The Chambers, Chelsea Harbour, London SW10 0XF
Spice PL, The Whins, Firth, Orkney KH17 2HQ
Stuart CFF, 16 Exmoor Close, Irby, Wirral, Merseyside L61 9QR
Sutcliffe F, 160 Hutcheon Street, Aberdeen AB2 3RX
Tatlow J, 64 Whinmoor Court, Leeds LS14 1NX
Taylor KH, South Broom, Westover Road, Milford-on-Sea, Lymington, Hampshire SO4 0PH
Thompson R, 4 Murray Place, Smithton, Inverness IV1 2PX
Thorndycraft JW, Cliff Cottage, Muchalls, Stonehaven, Kincardineshire AB3 2RN
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Deliveries into Consumption

UK deliveries into inland consumption of major petroleum products —Tonnes — March 1991

Products	*Mar 1990†*	*Mar 1991**	*Jan–Mar 1990†*	*Jan–Mar 1991**	*% change*
Naphtha/LDF	299,520	303,470	911,920	986,990	8.2
ATF—Kerosine	508,340	419,780	1,451,090	1,259,510	−13.2
Motor Spirit	2,144,310	2,071,090	5,917,980	5,689,790	−3.9
of which unleaded	667,670	812,650	1,792,010	2,200,210	22.8
Super unleaded	74,600	94,300	191,990	252,820	31.7
Premium unleaded	593,070	718,350	1,600,020	1,947,390	21.7
Burning Oil	208,610	175,070	639,540	766,090	19.8
Derv Fuel	981,800	886,270	2,643,340	2,591,150	−2.0
Gas/Diesel Oil	809,560	658,740	2,331,400	2,400,970	3.0
Fuel Oil	1,469,000	1,060,010	3,464,080	3,122,520	−9.9
Lubricating Oil	77,494	62,040	206,534	187,460	−9.2
Other Products	546,206	494,480	1,823,036	1,345,720	−26.2
Total above	7,044,840	6,130,950	19,165,560	18,350,200	−4.3
Refinery Consumption	505,070	482,920	1,476,120	1,481,160	0.3
Total all products	7,549,910	6,613,870	20,641,680	19,831,360	−3.9

†Revised *Preliminary

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