Protocol for the estimation of petroleum refinery process plant fugitive VOC emissions

PROTOCOL FOR THE ESTIMATION OF PETROLEUM REFINERY PROCESS PLANT FUGITIVE VOC EMISSIONS

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FOREWORD

The majority of refinery volatile organic carbon (VOC) emissions are from diffuse emission sources. These can be 'area' sources such as storage tanks or 'point' sources such as pressurised components on a process plant e.g. pipe flanges, valves, pumps, etc. These point diffuse emission sources are commonly referred to as fugitive emission sources.

Fugitive emissions can be reduced by the detection and subsequent repair of leaking components. Such leak detection and repair (LDAR) programmes have been undertaken in all UK refineries over the past few years and requirements for them are included in refinery permits.

Fugitive emissions cannot be measured over the long-term but have to be estimated. There are a number of estimation methods available to industry. The oil industry submission for VOCs to the UK inventory is based on a simple methodology provided in the EI *Protocol for the estimation of VOC emissions from petroleum refineries and gasoline marketing operations*.

The first edition of the protocol provides an emission factor based on refinery throughput. The factor takes no account of the emission reductions achieved through the LDAR programmes being undertaken and thus overestimates the contribution made by the oil refining sector to the UK VOC inventory.

This publication lists methods for the estimation of fugitive emission leak rates (kg/h) and provides a protocol for converting these leak rates into annual estimates of refinery process plant fugitive VOC emissions. The protocol takes into account the reductions in emission rates resulting from LDAR programmes.

This protocol is referenced within the second edition of EI *Protocol for the estimation of VOC emissions from petroleum refineries and gasoline marketing operations* (published February 2010).

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1 INTRODUCTION

Volatile organic compounds (VOCs) have been the subject of wide-ranging European legislation over a number of years. This is because of concerns about ozone which is formed by the photochemically reactive compounds in the presence of nitrogen oxide.

To permit the impact of legislative reduction programmes to be established and to assist in setting new targets, national inventories of emissions have been compiled. More recently values of annual emissions have been required of industry as input to the European Pollutant Emissions Register (EPER) and its successor the European Pollutant Release and Transfer Register (E-PRTR).

Emissions can either be measured or estimated. Measurements of emissions over the long-term can only be made for sources which have a stack to which an emissions monitor can be connected – so called 'channelled sources' [1], e.g. process heaters. However, in a refinery only a very small proportion of the VOCs emitted are from combustion [2].

The great majority of VOC emissions are from diffuse (i.e. non-channelled) emission sources. These can be 'area' sources such as storage tanks or oily-water treatment facilities or 'point' sources such as pressurised components on process plant e.g. pipe flanges, valve stem glands, pump seals, etc. These point diffuse emission sources are commonly referred to as fugitive emission sources.

Reductions in diffuse emissions due to product handling e.g. storage and loading, have been achieved through the implementation of emission controls such as those mandated by the 'Stage 1' Directive [3].

Fugitive emissions from pressurised components have been reduced by identifying leaking components and their subsequent maintenance. Such leak detection and repair (LDAR) programmes have been undertaken in all UK refineries over the past few years and requirements for them are included in refinery permits.

Leak detection surveys have traditionally employed conventional hydrocarbon monitors using, for example, flame ionisation detectors (FIDs). These involve measurements of VOC concentration at potential leak points and the derivation from these of hourly mass leak emission rates [4] [5]. More recently optical gas imaging (OGI) techniques have been developed which permit the use of hand-held cameras to scan remotely for leaking components. The use of these cameras has a number of advantages compared to traditional monitors. This has resulted in the US EPA permitting OGI equipment to be used as an alternative to conventional monitors for the detection of leaks from process plant components [6].

By their nature fugitive emissions cannot be measured over the long-term but have to be estimated. There are a number of estimation methods available to industry. The oil industry submission for VOCs to the UK inventory is based on the methodologies outlined in EI *Protocol for the estimation of VOC emissions from petroleum refineries and gasoline marketing operations* [7]*.

For fugitive emissions that protocol provides a simple emission factor based on refinery throughput. The factor takes no account of the emission reductions achieved

* Second edition was published in February 2010 and references this publication [8].

through the LDAR programmes being undertaken and thus overestimates the contribution made by the oil refining sector to the UK VOC inventory.

This report outlines the different methodologies available to derive emission rates from leak detection surveys. In addition to conventional LDAR techniques, this report also considers the use of optical gas imaging equipment. Although OGI techniques have great potential to simplify the identification of leaking equipment, currently, as with the other techniques used, they cannot provide a direct quantitative measure of VOC mass flux. Considerable work has been undertaken in the USA, therefore, to develop emission rate factors for this type of technology and these are provided in this report.

The main purpose of an LDAR programme is to reduce VOC emissions and not to quantify them. None of the devices employed directly provide quantitative values of emission flux and these have to be derived using factors or algorithms. The use of correlation equations (section 4.2) is the method referred to by CEN [5], but these equations cannot be used with OGI techniques. The significant practical advantages of OGI techniques in leak detection have been recognised. This report, therefore, does not specify a recommended emission rate estimation method but provides for the use of both conventional VOC monitors and OGI cameras.

To permit more accurate reporting by refineries to the national VOC inventory, this report provides a protocol for the annual estimation of VOCs from fugitive process sources using the values of emission rates derived from LDAR surveys. This protocol can be used for all emission rate calculation methodologies.

It should be recognised that emission estimations may differ from one calculation method to another [9]. If refineries change the methodology used to estimate fugitive emissions, this may result in reported variations in VOCs which are not the direct result of LDAR programmes.

2 SCOPE

This publication lists methods for the estimation of fugitive emission leak rates (kg/h) and provides a protocol for converting these leak rates into annual estimates of refinery process plant fugitive VOC emissions. The protocol takes into account the impact of potential reductions in average emission rates resulting from LDAR programmes.

The emission factors provided are only for pressurised components on refinery process plant. The protocol, therefore, is not applicable to diffuse area sources such as storage tanks. Factors for chemical plant can be obtained from the US EPA (1995) *Protocol for equipment leak emission estimates* [4]. Similarly all but one of the estimation methods are not applicable for refinery off-sites and marketing facilities where the components are not subject to high pressure duty. Fugitive emissions from gasoline marketing terminals are typically less than 1 te/a [2]. Guidance on estimating fugitive emissions for these types of facilities and pipeline pumping stations is provided in the EI VOC protocol [8].

This publication does not provide details of how to set up, calibrate or use the monitoring equipment employed in LDAR surveys. These (currently only for conventional VOC monitors) are given in EN 15446:2008 [5]. Guidance on the use of OGI systems is under development by API.