A test method for measuring the electrostatic charge produced by aviation filter-monitor retrofit technologies



A TEST METHOD FOR MEASURING THE ELECTROSTATIC CHARGE PRODUCED BY AVIATION FILTER-MONITOR RETROFIT TECHNOLOGIES

First edition

January 2019

Published by **Energy Institute, London**

The Energy Institute is a professional membership body incorporated by Royal Charter 2003 Registered charity number 1097899 The Energy Institute (EI) is the chartered professional membership body for the energy industry, supporting over 20 000 individuals working in or studying energy and 250 energy companies worldwide. The EI provides learning and networking opportunities to support professional development, as well as professional recognition and technical and scientific knowledge resources on energy in all its forms and applications.

The El's purpose is to develop and disseminate knowledge, skills and good practice towards a safe, secure and sustainable energy system. In fulfilling this mission, the El addresses the depth and breadth of the energy sector, from fuels and fuels distribution to health and safety, sustainability and the environment. It also informs policy by providing a platform for debate and scientifically-sound information on energy issues.

The EI is licensed by:

- the Engineering Council to award Chartered, Incorporated and Engineering Technician status, and
- the Society for the Environment to award Chartered Environmentalist status.

It also offers its own Chartered Energy Engineer, Chartered Petroleum Engineer, and Chartered Energy Manager titles.

A registered charity, the EI serves society with independence, professionalism and a wealth of expertise in all energy matters.

This publication has been produced as a result of work carried out within the Technical Team of the EI, funded by the EI's Technical Partners. The EI's Technical Work Programme provides industry with cost-effective, value-adding knowledge on key current and future issues affecting those operating in the energy sector, both in the UK and internationally.

For further information, please visit http://www.energyinst.org

The EI gratefully acknowledges the financial contributions towards the scientific and technical programme from the following companies

Andeavor Phillips 66
BP Exploration Operating Co Ltd Qatar Petroleum
BP Oil UK Ltd Repsol Sinopec
Centrica RWE npower
Chevron North Sea Ltd Saudi Aramco
Chevron Products Company Scottish Power

Chrysaor SGS

CLH Shell UK Oil Products Limited

ConocoPhillips Ltd Shell U.K. Exploration and Production Ltd

DCC Energy
SSE
EDF Energy
TAQA Bratani
ENI
Total E&P UK Limited
E. ON UK
Total UK Limited
Equinor
Tullow Oil
ExxonMobil International Ltd
Uniper
Innogy
Valero

 Innogy
 Valero

 Kuwait Petroleum International Ltd
 Vattenfall

 Nexen CNOOC
 Vitol Energy

 Ørsted
 Woodside

Perenco World Fuel Services

However, it should be noted that the above organisations have not all been directly involved in the development of this publication, nor do they necessarily endorse its content.

Copyright © 2019 by the Energy Institute, London.

The Energy Institute is a professional membership body incorporated by Royal Charter 2003.

Registered charity number 1097899, England

All rights reserved

No part of this book may be reproduced by any means, or transmitted or translated into a machine language without the written permission of the publisher.

ISBN 978 1 78725 059 8

Published by the Energy Institute

The information contained in this publication is provided for general information purposes only. Whilst the Energy Institute and the contributors have applied reasonable care in developing this publication, no representations or warranties, express or implied, are made by the Energy Institute or any of the contributors concerning the applicability, suitability, accuracy or completeness of the information contained herein and the Energy Institute and the contributors accept no responsibility whatsoever for the use of this information. Neither the Energy Institute nor any of the contributors shall be liable in any way for any liability, loss, cost or damage incurred as a result of the receipt or use of the information contained herein.

Hard copy and electronic access to El and IP publications is available via our website, https://publishing.energyinst.org. Documents can be purchased online as downloadable pdfs or on an annual subscription for single users and companies. For more information, contact the El Publications Team.

e: pubs@energyinst.org

CONTENTS

				Page			
Legal	notic	es and d	isclaimers	6			
Forev	vord .			7			
Ackn	owled	lgements	5	8			
1	Intro	duction		10			
2	Rationale used to define the test method						
	2.1	Test rig		11			
	2.2	Relevano	ce of test data to in-service behaviour	11			
	2.3	Simplific	ration of testing	11			
	2.4	Test thre	eshold	12			
		2.4.1	Transient currents and data averaging	12			
		2.4.2	Dealing with conductivity dependence	12			
		2.4.3	Pass criteria	13			
	2.5	Selecting	g a reference element	14			
	2.6	Dealing	with a continuing rise in charge density over a test	14			
	2.7	Dealing	with a change in polarity of charging during a test	14			
3	Outli	ine of tes	st method developed from the stated rationale	16			
4	Materials and equipment						
•	4.1						
	4.2		ssipater additive (SDA)				
	4.3		tem				
	4.4		using				
		4.4.1	Material, downstream residence volume etc.				
		4.4.2	Insulating flanges, gaskets and supports				
		4.4.3	Safety resistor				
	4.5		ng instruments				
	1.5	4.5.1	Ammeter				
		4.5.2	Flow meter.				
		4.5.3	Data logging				
		4.5.4	Conductivity				
		4.5.5	Insulation tester				
		4.5.6	Current source				
		4.5.7	Fuel temperature				
		1.5.7	raci temperature	2			
5	Test procedures						
	5.1	System s	set-up				
		5.1.1	Current meter calibration				
		5.1.2	Flow meter calibration				
		5.1.3	Insulation checking				
		5.1.4	Cleaning the test rig and preparing the test fuel	28			

Contents continued

			Page
	5.25.35.45.5	Setting the volumetric flow rate. Procedures for additive treatment to raise the conductivity. 5.3.1 General. 5.3.2 Equations and example calculations. Procedure for selecting the highest-charging reference element. Main test procedure. 5.5.1 Element handling and conditioning. 5.5.2 Running the tests. 5.5.3 Follow-up test sequence for rising current readings.	29 30 31 31
6	Data 6.1 6.2	analysis Normal runs with no polarity change Runs with a change of polarity	34
7	Repo	rting	36
8	Refer	rences	37
Anne	xes		
Anne	хА	What current is indicated by the measurements?	38
Anne	х В	Conductivity test method	39
Anne	хС	The influence of departures from rated flow	40
Anne	x D	Example template for reporting test data	42

LIST OF FIGURES AND TABLES

Figures	Pa	ge
Figure 1 Figure 2 Figure 3 Figure 4 Figure 5 Figure 6	Schematic outline of features needed in host system Schematic diagram of housing. A typical PTFE insulating flange Simple current source for checking current measurement capability Current measurement check configuration a). Current measurement check configuration b)	19 21 23 26
Tables		
Table 1 Table 2 Table C.1 Table C.2	Maximum downstream residence volumes for single elements (with $T=0.5 \text{ s}$) Test matrix	32 40

LEGAL NOTICES AND DISCLAIMERS

This publication has been prepared by the Energy Institute (EI) Aviation Committee.

The information contained in this publication is provided as guidance only, and although every effort has been made by El to assure the accuracy and reliability of its contents, El MAKES NO GUARANTEE THAT THE INFORMATION HEREIN IS COMPLETE OR ERROR-FREE. ANY PERSON OR ENTITY MAKING ANY USE OF THE INFORMATION HEREIN DOES SO AT HIS/HER/ITS OWN RISK. TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, THE INFORMATION HEREIN IS PROVIDED WITHOUT, AND EI HEREBY EXPRESSLY DISCLAIMS, ANY REPRESENTATION OR WARRANTY OF ANY KIND, WHETHER EXPRESS, IMPLIED OR STATUTORY, INCLUDING, WITHOUT LIMITATION, WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, TITLE AND NON-INFRINGEMENT. IN NO EVENT SHALL EI BE LIABLE TO ANY PERSON, OR ENTITY USING OR RECEIVING THE INFORMATION HEREIN FOR ANY CONSEQUENTIAL, INCIDENTAL, PUNITIVE, INDIRECT OR SPECIAL DAMAGES (INCLUDING, WITHOUT LIMITATION, LOST PROFITS), REGARDLESS OF THE BASIS OF SUCH LIABILITY, AND REGARDLESS OF WHETHER OR NOT EI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES OR IF SUCH DAMAGES COULD HAVE BEEN FORESEEN.

The contents of this publication are not intended or designed to define or create legal rights or obligations, or set a legal standard of care.

El is not undertaking to meet the duties of manufacturers, purchasers, users and/or employers to warn and equip their employees and others concerning safety risks and precautions, nor is El undertaking any of the duties of manufacturers, purchasers, users and/or employers under local and regional laws and regulations. This information should not be used without first securing competent advice with respect to its suitability for any general or specific application, and all entities have an independent obligation to ascertain that their actions and practices are appropriate and suitable for each particular situation and to consult all applicable federal, state and local laws.

EI HEREBY EXPRESSLY DISCLAIMS ANY LIABILITY OR RESPONSIBILITY FOR LOSS OR DAMAGE RESULTING FROM THE VIOLATION OF ANY LOCAL OR REGIONAL LAWS OR REGULATIONS WITH WHICH THIS PUBLICATION MAY CONFLICT.

Nothing contained in any El publication is to be construed as granting any right, by implication or otherwise, for the manufacture, sale, or use of any method, apparatus, or product covered by letters patent. Neither should anything contained in the publication be construed as insuring anyone against liability for infringement of letters patent.

No reference made in this publication to any specific product or service constitutes or implies an endorsement, recommendation, or warranty thereof by El.

EI, AND ITS AFFILIATES, REPRESENTATIVES, CONSULTANTS, AND CONTRACTORS AND THEIR RESPECTIVE PARENTS, SUBSIDIARIES, AFFILIATES, CONSULTANTS, OFFICERS, DIRECTORS, EMPLOYEES, REPRESENTATIVES, AND MEMBERS SHALL HAVE NO LIABILITY WHATSOEVER FOR, AND SHALL BE HELD HARMLESS AGAINST, ANY LIABILITY FOR ANY INJURIES, LOSSES OR DAMAGES OF ANY KIND, INCLUDING DIRECT, INDIRECT, INCIDENTAL, CONSEQUENTIAL, OR PUNITIVE DAMAGES, TO PERSONS, INCLUDING PERSONAL INJURY OR DEATH, OR PROPERTY RESULTING IN WHOLE OR IN PART, DIRECTLY OR INDIRECTLY, FROM ACCEPTANCE, USE OR COMPLIANCE WITH THIS STANDARD.