

CERTIFICATE OF ANALYSIS

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Approved signatory
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Signature:Issued by: **EffecTech**Date of Issue: **03 April 2017**Certificate No.: **17/0327/05****EffecTech**

Specialists in Gas Measurement

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Customer : E.ON UK CHP Limited
Westwood Way, Westwood Business Park, Coventry, CV4 8LG.

Sample identification : Kemsley Mill, sample point: 9FGCHV027, 28/03/2017, 09:30 hrs,
line pressure 33 bar, line temperature 7.2°C, sampled by G. Carthew,
sample vessel #RH7005.

Date of analysis : 30 March 2017

Composition

component	amount fraction (% mol/mol)	component	amount fraction (% mol/mol)
helium	<0.0008	2-methylpentane	0.00005 ± 0.00001
hydrogen	<0.0005	3-methylpentane	0.00011 ± 0.00001
argon	0.0091 ± 0.0005	2,2-dimethylbutane	<0.00001
oxygen	0.0034 ± 0.0002	hexanes [†]	0.00003 ± 0.00001
nitrogen	1.6412 ± 0.0060	n-hexane	0.00006 ± 0.00001
carbon dioxide	<0.01	benzene	0.00003 ± 0.00001
methane	92.113 ± 0.018	cyclohexane	0.00002 ± 0.00001
ethane	5.829 ± 0.015	heptanes [†]	0.00002 ± 0.00001
propane	0.3380 ± 0.0013	n-heptane	0.00001 ± 0.00001
iso-butane	0.0302 ± 0.0005	toluene	0.00001 ± 0.00001
n-butane	0.0332 ± 0.0005	methylcyclohexane	0.00002 ± 0.00001
neo-pentane	0.00018 ± 0.00010	octanes [†]	‡<0.00001
iso-pentane	0.00147 ± 0.00011	n-octane	<0.00001
n-pentane	0.00050 ± 0.00010	nonanes [†]	‡<0.00001
		n-nonane	<0.00001
		decanes [†]	‡<0.00001
		n-decane	<0.00001
		C ₆₊ (hexanes+) [§]	0.00038 ± 0.00001

[†] the amount fraction of a grouped component is the sum of all isomers in that group **except** for those identified separately.

[‡] no **individual** isomers could be measured above this limit of detection.

[§] the sum of amount fractions of all hydrocarbons containing six carbon atoms or greater.

Mixture analysed by EffecTech technical methods and in accordance with appropriate international standard methods.

EffecTech is accredited by UKAS to ISO/IEC 17025 : 2005 to undertake the analysis presented in this certificate. The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

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UKAS Accredited Testing Laboratory No. 1927

Certificate number

17/0327/05**Physical Properties**

mean molecular mass	17.183 ± 0.018	kg.kmol ⁻¹		
compression factor	0.9978 ± 0.0010			
			Real gas properties	Ideal gas properties
superior calorific value (gross)	39.07 ± 0.04	MJ.m ⁻³	38.98 ± 0.04	MJ.m ⁻³
	921.72 ± 0.93	kJ.mol ⁻¹	921.72 ± 0.93	kJ.mol ⁻¹
	53.64 ± 0.06	MJ.kg ⁻¹	53.64 ± 0.06	MJ.kg ⁻¹
inferior calorific value (net)	35.24 ± 0.04	MJ.m ⁻³	35.16 ± 0.04	MJ.m ⁻³
	831.34 ± 0.84	kJ.mol ⁻¹	831.34 ± 0.84	kJ.mol ⁻¹
	48.38 ± 0.05	MJ.kg ⁻¹	48.38 ± 0.05	MJ.kg ⁻¹
relative density	0.5944 ± 0.0006		0.5933 ± 0.0006	
density	0.7283 ± 0.0008	kg.m ⁻³	0.7267 ± 0.0008	kg.m ⁻³
Wobbe index	50.68 ± 0.06	MJ.m ⁻³	50.61 ± 0.06	MJ.m ⁻³

The physical properties above are calculated from composition at a reference of 1.01325 bar and at combustion and metering temperatures of 15°C in accordance with international standard ISO 6976:1995 (E) - *Natural Gas - Calculation of calorific value, density and Wobbe index from composition* (including amendment No.1 - May 1998).

carbon emission factor (gross)	50.16 ± 0.06	t(CO ₂).TJ ⁻¹	(CEFG)
carbon emission factor (net)	55.61 ± 0.06	t(CO ₂).TJ ⁻¹	(CEFN)
carbon emission factor (quantity)	1959.7 ± 2.0	g(CO ₂).m ⁻³	(CEFQ)

The physical properties above are calculated for a real gas at a combustion temperature of 15°C in accordance with the guidance, calculations and fundamental physical constants contained in the following documents:

COMMISSION DECISION of 18/VII/2007 establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council of Brussels, 18/VII/2007 C (2007) 3416 final (publ. EU Commission 18th July 2007).

Briefing note on provision of UK natural gas supply data relevant to the EU Emission Trading Scheme (publ. DEFRA 15th August 2005).

Carbon emission factors are calculated using the molecular mass of carbon dioxide summed from individual atomic masses taken from the latest IUPAC tables of atomic masses (Atomic weights of the elements (Review 2000), Pure Appl. Chem. , **75(6)**, 2003, pp. 683-800) and is equal to 44.0095g.mol⁻¹ (publ. IUPAC).

General notes applicable to all calculations above

Note 1:- The gas mixture is assumed dry (free from moisture) for the purpose of these calculations.

Note 2:- Grouped components are given the property of the corresponding normal alkane.