CERTIFICATE OF CALIBRATION

Approved signatory
Name: **Sam Heede**
Signature:

Issued by: **EffecTech**
Date of Issue: **17 September 2015** Certificate No.: **15/0847/01**

EffecTech
Specialists in Gas Measurement

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UKAS CALIBRATION 0590

Customer	:	CAC Gas & Instrumentation Pty. Ltd. Unit 3, 36 Holbeche Rd., Arndell Park, NSW 2148, Australia.
Customer reference	:	PO No.PO1531
Cylinder number	:	D408967
Date of calibration	:	15 September 2015
Date of expiry	:	14 September 2020
Description	:	Multi-component calibration gas mixture for use in natural gas analysis

Composition

component	amount fraction (%mol/mol)
nitrogen	2.523 ± 0.009
carbon dioxide	0.993 ± 0.003
methane	89.588 ± 0.02
ethane	4.962 ± 0.013
propane	1.004 ± 0.004
iso-butane	0.2987 ± 0.0010
n-butane	0.3000 ± 0.0011
neo-pentane	0.0991 ± 0.0009
iso-pentane	0.1000 ± 0.0007
n-pentane	0.1000 ± 0.0008
n-hexane	0.0307 ± 0.0005

Contents pressure at calibration	:	93 bar
Cylinder size	:	10 litres (water capacity)
Cylinder material	:	aluminium
Valve outlet connection	:	BS341 - No.4
Recommended minimum usage pressure	:	3 bar
Minimum storage (transport) temperature	:	-23°C
Minimum usage temperature	:	15°C

Mixture calibrated by EffecTech technical methods and in accordance with ISO 6143:2001 - *Gas Analysis — Determination of Composition of Calibration Gas Mixtures — Comparison Methods*

To re-order this calibration gas mixture contact EffecTech quoting certificate number 15/0847/01.
telephone : +44(0)1889 569229, fax : +44(0)1889 569220, email : gas@effectech.co.uk

EffecTech is accredited by UKAS to ISO/IEC 17025 : 2005 to undertake the calibration 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.

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UKAS Accredited Calibration Laboratory No. 0590

Certificate number

15/0847/01

Physical Properties

Physical properties are calculated from composition in accordance with the international standard ISO 6976:1995 (E) including amendment No.1 - May 1998.

Properties are calculated at a reference pressure of 1.01325 bar and at reference temperatures stated.

Note :- In accordance with the recommendations of the international standard, the gas mixture is assumed dry (free from moisture) for the purpose of these calculations.

	Reference Conditions (Primary) Combustion 15°C Metering 15°C		**Reference Conditions (Secondary)** Combustion 0°C Metering 0°C	
General Calculations				
Mean molecular mass	18.041 ± 0.019	$\mathrm{kg.kmol^{-1}}$	18.041 ± 0.019	$\mathrm{kg.kmol^{-1}}$
Compression factor	0.9976 ± 0.0010		0.9971 ± 0.0010	
Real gas calculations				
Superior calorific value	39.33 ± 0.04	$\mathrm{MJ.m^{-3}}$	41.57 ± 0.05	$\mathrm{MJ.m^{-3}}$
	927.60 ± 0.93	$\mathrm{kJ.mol^{-1}}$	929.04 ± 0.93	$\mathrm{kJ.mol^{-1}}$
	51.42 ± 0.06	$\mathrm{MJ.kg^{-1}}$	51.49 ± 0.06	$\mathrm{MJ.kg^{-1}}$
Inferior calorific value	35.50 ± 0.04	$\mathrm{MJ.m^{-3}}$	37.47 ± 0.04	$\mathrm{MJ.m^{-3}}$
	837.36 ± 0.84	$\mathrm{kJ.mol^{-1}}$	837.50 ± 0.84	$\mathrm{kJ.mol^{-1}}$
	46.41 ± 0.05	$\mathrm{MJ.kg^{-1}}$	46.42 ± 0.05	$\mathrm{MJ.kg^{-1}}$
Relative density	0.6242 ± 0.0007		0.6244 ± 0.0007	
Density	0.7649 ± 0.0008	$\mathrm{kg.m^{-3}}$	0.8073 ± 0.0009	$\mathrm{kg.m^{-3}}$
Wobbe index	49.78 ± 0.05	$\mathrm{MJ.m^{-3}}$	52.61 ± 0.06	$\mathrm{MJ.m^{-3}}$
Ideal gas calculations				
Superior calorific value	39.23 ± 0.04	$\mathrm{MJ.m^{-3}}$	41.45 ± 0.05	$\mathrm{MJ.m^{-3}}$
	927.60 ± 0.93	$\mathrm{kJ.mol^{-1}}$	929.04 ± 0.93	$\mathrm{kJ.mol^{-1}}$
	51.42 ± 0.06	$\mathrm{MJ.kg^{-1}}$	51.49 ± 0.06	$\mathrm{MJ.kg^{-1}}$
Inferior calorific value	35.41 ± 0.04	$\mathrm{MJ.m^{-3}}$	37.37 ± 0.04	$\mathrm{MJ.m^{-3}}$
	837.36 ± 0.84	$\mathrm{kJ.mol^{-1}}$	837.50 ± 0.84	$\mathrm{kJ.mol^{-1}}$
	46.41 ± 0.05	$\mathrm{MJ.kg^{-1}}$	46.42 ± 0.05	$\mathrm{MJ.kg^{-1}}$
Relative density	0.6229 ± 0.0007		0.6229 ± 0.0007	
Density	0.7630 ± 0.0008	$\mathrm{kg.m^{-3}}$	0.8049 ± 0.0009	$\mathrm{kg.m^{-3}}$
Wobbe index	49.71 ± 0.05	$\mathrm{MJ.m^{-3}}$	52.52 ± 0.06	$\mathrm{MJ.m^{-3}}$

ADVICE on the storage and use of your calibration gas mixture

The calibration gas mixture supplied to you contains components which are condensable under certain conditions of temperature. It is important that these conditions are avoided where possible during storage and usage of the mixture.

Please read this advice in conjunction with recommended storage/usage conditions given on the certificate of calibration.

Storage

*Has the ambient temperature during **storage** dropped below the hydrocarbon dew temperature at contents pressure?*

If so then there will be stratification of your mixture into two phases (vapour and liquid)

The withdrawal of any gas phase content from this two phase mixture will invalidate the certified reference values we have provided with your calibration gas.

Advice before use

There will be no record of the minimum temperature to which your gas mixture has been exposed in transport to you. Hence, there is no guarantee that the gas mixture has not been exposed to temperatures below the hydrocarbon dew temperature of your mixture at contents pressure. If you suspect the gas has been exposed to temperatures below this the contents must be allowed to equilibrate at a greater temperature for a minimum period of about 24 hours. Following this equilibration time your mixture should be entirely homogeneous and gaseous. Often, it is good practice to roll the cylinder, where possible, to encourage mixing during equilibration.

Use

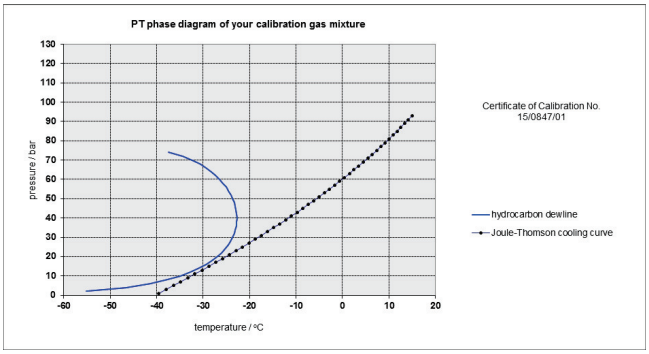
*When in **use** does condensation occur in your gas mixture following depressurisation as a result of cooling?*

Your gas mixture cools when it is depressurised through your pressure regulator. This is called Joule-Thomson (or Joule-Kelvin) cooling. If the gas cools to below the hydrocarbon dew temperature at its pressure then your mixture will stratify into two phases (vapour and liquid).

If this occurs the gas phase composition delivered to your application will not be representative of the certified reference values we have provided with your calibration gas.

Advice during use

The diagram below shows the pressure-temperature phase characteristics of your particular calibration mixture. Conditions shown to the left of the hydrocarbon dewline are in the two phase (liquid and vapour) region, whilst to the right your mixture remains as a single phase vapour. The cooling curve shown does not enter the two-phase region.



This demonstrates that during use your mixture remains entirely in the vapour phase should it be depressurised in a single stage from contents pressure and at a starting temperature of 15°C.

Technical information : The dewline and the cooling curve were calculated using EffecTech's proprietary software solution DewCalc™ and constructed using the Redlich-Kwong-Soave (RKS) equation of state (EOS) and the cooling curve generated from a simulated isenthalpic flash calculation assuming adiabatic conditions starting at contents pressure and the stated temperature.