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Marcogaz WG "Gas Quality"

Second Position Paper on European Gas Quality Specification for natural gas Interchangeability

Domestic appliances are not able to tolerate wide variation in natural gas quality without endangering the public; gas quality has to be maintained within defined limits. These limits are currently set nationally and reflect the type, age and condition of the appliance population present within each country. Since 1993 all European appliances are required to comply with the 1990 Gas Appliance Directive 90/396/CEE ("GAD") and are able to tolerate the same range in gas quality, wider than those generally set nationally. The performance of modern, GAD-compliant, appliances should therefore provide the basis for a common European gas quality specification. In this second position paper the Marcogaz Working Group "Gas Quality" suggests parameters for interchangeability and proposes limit values. Consequences arising from harmonising approach are highlighted.

Background

Marcogaz working group "Gas Quality" addresses in this paper the impact of gas quality on domestic appliances and in particular how gas quality should be specified in order to ensure gases are "interchangeable" – i.e., that they can be freely mixed, commingled and traded without risk of unsafe combustion. Domestic appliances are not able to tolerate variations in gas quality outside predefined limits without endangering end users. Whilst industrial and commercial appliances are also affected, combustion control strategies can be devised to combat such variations. The cost of these adaptations and the eventual deterioration of performances are application specific and not studied within this paper.

European countries employ differing means of specifying acceptable limits of gas composition, and this reflects the type, age and condition of the worst performing appliances within each country. The current national limits are specified through a mixture of national legislation and commercial contracts. Changes in both will need to be made before a single European gas quality specification can be adopted.

The first position paper [1] from this working group concluded:

1. That the performance of modern, GAD-compliant [2], appliances should provide the basis for a common European gas quality specification.
2. Upper and lower Wobbe limits should reflect those of the test gases specified in EN437 "Test Gases – Test Pressures – Appliance Categories", with some provision for a safety margin that addresses appliance ageing and maintenance.
3. Additional parameters addressing flashback and sooting should be specified within the framework set down by EN 437.This may lead to a revision of some of the test gases in EN 437.

The first paper also noted that few countries would be able to adopt immediately a new European gas quality specification. To do so will require national programmes of work to either ensure that "pre-GAD" appliances present an insignificant additional risk to the public, or to remove such at-risk appliances from use. In addition, rational safety margins must be set before the specifications can be harmonized. Transitional arrangements and a timetable will need to be agreed for each country.

In this second position paper Marcogaz addresses the second and third points noted above - i.e., upper and lower Wobbe limit values are proposed, parameters to address flashback and sooting are suggested, and limit values are proposed. These proposals are restricted to the specific case of gases of the second family, gas group H. Because some gases not complying with these parameters are already in use locally, use of these proposals is restricted to cross-border trade purposes.

Interchangeability parameters

Most European countries employ limits in the Wobbe index of gases as the principal means of ensuring safe combustion. At high Wobbe index, incomplete combustion occurs and appliances tend to emit high levels of carbon monoxide and consequently present increased risk of deaths by poisoning. At low Wobbe index, flame lift occurs and flames can become unstable and may detach or even extinguish, leading to emission of unburnt flammable gas.

Marcogaz proposes that the upper and lower limit values for Wobbe index should be **47.0 MJ/m^3** and **54.0 MJ/m^3**, respectively [see note 3 regarding reference conditions]. The basis for the selection of these values is as follows:

1. The Wobbe index range should be less than the full range of test gases for H gas in order to provide a safety factor for appliance performance deterioration and differing standards of appliance maintenance that may prevail nationally.
2. The safety factor is based on initial experience of those countries where gases of Wobbe index close to the proposed limit values are actually employed. For the high Wobbe index limit this corresponds to experience in Spain. For the low Wobbe index limit this corresponds to UK.
3. However, no single country has direct experience across the full range of Wobbe indices proposed here. For this reason a period of wider consultation within the European gas industry is recommended.

There are two other types of appliance malfunction that can occur, which are not solely governed by Wobbe index. The first is flashback and is mainly associated with the presence of hydrogen or other high flame speed gases. The second is sooting and is mainly associated with the presence of higher hydrocarbons (those other than methane). Any European gas quality specification will need to cover these forms of malfunction because, whilst they have not been a major issue in the past, future gas operations may lead to use of gases containing either hydrogen or significant levels of higher hydrocarbons.

Marcogaz proposes that hydrogen content is limited to **0.1mol%** in order to control risk of flashback. The addition of gases containing hydrogen into high-pressure natural gas transportation networks has not been considered. If it is considered likely that cross-border trade may lead to natural gases containing hydrogen, then a limiting value for hydrogen content will have to be considered.

Marcogaz proposes that relative density is limited to a maximum of **0.70** [see note 3 regarding reference conditions] in order to control risk of sooting. The basis for our selection of this value is as follows:

1. Sooting is associated with the presence of higher hydrocarbons and relative density correlates well with higher hydrocarbon content.
2. Experience within Denmark and Germany, where there are currently limit values for relative density of 0.70 and 0.75.
3. Studies carried out by this working group to correlate UK parameters with relative density indicate that sooting limit considerations are not significant below a relative density of 0.70.
4. Known or anticipated sources of gases with relative density greater than 0.70 are assumed to be consumed locally only and not feature in cross-border trade. A period of consultation within the gas industry is recommended to confirm this.

Calorific Value

Marcogaz recommends no specific limits on calorific value, because it is not a specific interchangeability parameter. However an upper limit for calorific value of **45.18 MJ/m^3** is implied by our proposed upper limits for Wobbe index and relative density. Similarly, a practical lower limit in relative density of 0.5548 (corresponding to methane) and the proposed lower Wobbe limit imply a lower limit for calorific value of **35.01 MJ/m^3**. Therefore, the calorific value range implied by the proposed Wobbe index and relative density limits is **35.01-45.18 MJ/m^3**. This is a wider range than that of the original EASEE-Gas proposal of 37.0-46.0 MJ/m^3.

Any upper limit in calorific value in excess of the implied value of 45.18 MJ/m^3 would be unworkable, as no gas would comply with our proposed Wobbe index and relative density limits. Any lower limit in calorific value in excess of the implied value of 35.01 MJ/m^3 would - in effect - raise the lower limit in Wobbe index. For example, the original EASEE-Gas proposed lower calorific value limit of 37.0 MJ/m^3 corresponds to a Wobbe index of 49.89 MJ/m^3. This would result in a more restrictive range than currently in operation in some European countries.

Consequences of adopting a Common European Gas Specification on Interchangeability

It is worth recognising some of the consequences arising from an attempt to harmonise gas quality specifications and those relating to interchangeability in particular:

1. Transition to a common specification would pose widely differing degrees of difficulty for different countries. In Spain, for instance, very little problems would be perceived. In the UK and Denmark, substantial changes to one (Denmark) or both (UK) Wobbe index limits would be required. This would require changes in

national legislation and some degree of appliance population management. In view of the large number of pre-GAD appliances, the cost of appliance population management should not be under-estimated.

2. Marcogaz recognises that - in allowing a common safety factor to set Wobbe index limits - different standards for appliance maintenance are in use throughout Europe. It may therefore be desirable to ensure a common approach to frequency of appliance maintenance, so consultation with the appliance manufacturing and maintenance industry is required in this area. Again this could have significant financial impact in some countries.
3. In principle, removing older appliances with more modern, post-GAD, ones would result in improvement in energy efficiency and emissions of carbon dioxide and nitrogen oxides. This might benefit those countries with a relatively older appliance population. The benefits are not quantifiable with any certainty at this stage.
4. Widening the range in Wobbe index of gases - although not hazardous for post-GAD appliances - could result on some reduction on operational performance (reduced efficiency and increased emissions). The reduction in performance is not quantifiable with any certainty at this stage.
5. Although not specifically considered here, widening the range of Wobbe index of gases for industrial and commercial gas-utilization equipment may require adjustment and/or adaptation, and may result in deterioration in performance. Here too, the total costs of adaptation and the degree of deterioration depend upon the specific equipment, and are not quantifiable with any certainty at this stage.

Notes/References

1. Marcogaz Working Group "Gas Quality". Position Paper on European Gas Quality Specifications. 20th February 2003.
2. Since 1993 all European appliances are required to comply with the 1990 Gas Appliance Directive 90/396/CEE ("GAD") and are able to tolerate a wider range in gas quality than any limits set nationally.
3. Throughout this paper the following conditions apply for the expression of Wobbe index, calorific value and relative density: combustion temperature 15°C; metering temperature 15°C; metering pressure 101.325 kPa; calorific value and Wobbe index are based on gross values; volume at reference metering conditions are for the real gas. Approximate conversions between these and other reference conditions – calculated according to Table A.1 of ISO 13443:1996 - are given in Table 1 below.

Table1: Wobbe index, relative density and gross gas calorific value expressed at different reference conditions and different energy units

	15°C, 15°C, 101.325 kPa	**25°C, 0°C, 101.325 kPa**
Wobbe index	**47.0 – 54.0 MJ/m^3**	49.54 - 56.92 MJ/m^3 13.76 - 15.81 kWh/m^3
Relative density	**0.5548 – 0.70**	0.5549 – 0.7001
GCV (derived from above values)	**35.01 – 45.18 MJ/m^3**	36.91 – 47.63 MJ/m^3 10.25 – 13.23 kWh/m^3