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Natural gas — Calculation of methane number of gaseous fuels for reciprocating internal combustion engines —

Part 1:
MNc method

Gaz naturel — Calcul de l'indice de méthane des combustibles gazeux pour les moteurs alternatifs à combustion interne —

Partie 1: Méthode IMc

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Foreword

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Introduction

The globalization of the natural gas market and the drive towards sustainability are increasing the diversity of the supply of gases to the natural gas infrastructure. For example, the introduction of regasified liquefied natural gas (LNG) can result in higher fractions of non-methane hydrocarbons in the natural gas grid than the traditionally distributed pipeline gases for which these hydrocarbons have been removed during processing. Also, the drive towards sustainable gaseous fuels, such as hydrogen and gases derived from biomass, results in the introduction of “new” gas compositions that contain components that do not occur in the traditional natural gas supply. Consequently, the increasing variations in gas composition affect the knock resistance of the gas when used as a fuel. This can affect the operational integrity of reciprocating internal combustion engines.

For the efficient and safe operation of gas engines, it is of great importance to characterize the knock resistance of gaseous fuels accurately. Engine knock is caused by the autoignition of unburned fuel mixture ahead of this mixture being consumed by the propagating flame. Mild engine knock increases pollutant emissions accompanied by gradual build-up of component damage and complete engine failure if not counteracted. Severe knock causes structural damage to critical engine parts, which can quickly lead to catastrophic engine failure. To ensure that gas engines are matched with the expected variations in fuel composition, the knock resistance of the fuel is to be characterized, and subsequently specified, unambiguously.

Traditional methods for characterizing the knock resistance of gaseous fuels, such as the methane number method developed by Anstalt für Verbrennungskraftmaschinen List (AVL) in the 1960s, relate the knock propensity of a given fuel with that of an equivalent methane/hydrogen mixture using a standardized test engine (see References [1], [2] and [3]). Several other methane number methods have since been developed, sometimes based on either the approach or data, or both from the original experimental work performed by AVL.

In recognition of the need to standardize a method for characterizing the knock resistance of gaseous fuels, several existing methods for calculating a methane number have been considered, including the MN_C method outlined in this document. ISO 17507-2 describes the PKI method.

Methods to calculate a methane number are based on the input of the gas composition under investigation. While methods can be fundamentally different in their development approach, ideally the methods produce similar methane numbers for the range of gas compositions they are valid for. Yet, differences in outcome can be observed. Engine manufacturers typically determine the calculation method to be used when specifying a methane number value for their engines as part of their application and warranty statements. In all cases, when specifying a methane number based on either method, or any other method, the method used should be noted.

The MN_C method is based on the original data of the research programme performed by AVL Deutschland (AVL is based in Graz, Austria) GmbH[1] for FVV (the Research Association for Combustion Engines). The methodology first proposed by Deutz (“Klöckner-Humboldt-Deutz AG”)[2],[3] was later amended in 2005 and 2011 by MWM (“Motoren-Werke Mannheim AG”). A more detailed history of the MN_C method can be found in Annex E.

The MN_C method takes the components of the gaseous fuel mixture and groups them together into several ternary and binary groups whose methane number has been experimentally determined. It then determines the overall methane number by applying optimization algorithms to the individual component groupings.