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Petroleum products — Density versus temperature relationships of current fuels, biofuels and biofuel components

Produits pétroliers — Densité contre température relations des carburants actuels, les biocarburants et leur composants

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by ISO/TC 28, *Petroleum and related products, fuels and lubricants from natural or synthetic sources*.

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Introduction

The density of hydrocarbon fuels at a standard condition of temperature and pressure is used to define the quantity (standard volume) of the product during trade and fiscal transactions. To ensure standardization in the calculation of standard volume and density from actual conditions the thermal and pressure expansion factors are calculated through the application of standardized methods and algorithms.

In the advent of new fuel compositions like HVO ("Hydrogenated Vegetable Oil") as well as blends with bio products like ethanol and FAME ("Fatty Acid Methyl Esters") in the markets, the question was raised whether the density/temperature relationships, which have been applied for more than 60 years to transform the density or volume of a petroleum product, are a temperature measured at transport time or a "reduced" density or volume value at a standard temperature (15°C and in some areas 60 °F).

In order to identify potential differences for these new products, the German petroleum standardization committee (DIN-FAM) started as early as 2003 to make extensive density/temperature measurements starting with FAME. Examination of additional products followed, and other associations like AFNOR and the Energy Institute (EI) also shared their results of similar investigations.

This document also recommends procedural steps to obtain data which will determine the thermal expansion of new or alternative fuels and blends hence allowing a comparison to accepted and standardized correction factors (e.g. Petroleum Measurement Tables - ISO 91, IP 200 and API MPMS chapters 11.1, 11.2.4 and 11.5).

This document collates the executed measurements, modelling procedures and results in order to keep measured data available for later reference, including some recommendations for further work and a list of possibly unresolved questions.

For a number of reasons the work has been restricted to fuels, bio fuel components, and their blends and to some burner fuels and components. The majority of these examined products followed European Fuel Specifications such as EN 228, EN 590, EN 14214, EN 15376, and the reference temperature was kept at 15 °C. The work only covers the thermal expansion of the products at a standard condition of pressure and has not been extended to compressibility.

This document also recommends procedural steps to obtain data which allows a decision to be made on whether any completely new fuel composition can or cannot use the published internationally accepted API Petroleum Measurement Tables ("PMT") which are also the basis of several international and national petroleum measurement standards.

In addition, this document contains an extensive list of publications which can yield further in-depth information about this complex and interesting petroleum measurement topic.

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Petroleum products — Density versus temperature relationships of current fuels, biofuels and biofuel components

1 Scope

This document lists and describes recent density measurements at different temperatures for biofuel components and biofuel blends such as gasoline E5, E10, E85 and biodiesel B100, B7, as well as domestic heating oils and paraffinic diesel fuels.

It can be used to calculate <alpha15>, the thermal expansion coefficient from a given temperature to 15 °C. This document can also serve to compare several aspects of density/temperature modelling and to check for compliance with and limitations in relation to existing calibration requirements. It can help in the determination of specific necessities for the grouping of fuels into common product family classes, also suggesting ways to treat fuels or components with an unusual behaviour. In addition, this document proposes possible steps for an internationally harmonized handling of new components coming into the market.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Summary

Several extensive sample sets comprising artificial blends as well as market fuels were analysed with respect to their temperature-dependent densities. The purpose of these analyses was to find out if the density, as well as the volume, at a certain temperature can be predicted using the constants, group constants and regression models of the internationally used API Petroleum Measurement Tables (PMT) published in 1960 and revised in 1980[13].

The examined products were:

— diesel fuels (B0, B5, B7) according to the European standard fuel specification EN 590[28], supplemented by some additional blends with FAME;

— fatty acid methyl esters (biodiesel) of different compositions and origins which are in the market today[31];

— petrol (E0, E5, E10) according to the European standard fuel specification EN 228[27], supplemented by some additional blends with ethanol up to E100;

— domestic heating fuels according to DIN 51603-1[29], also as low sulfur grade;

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