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Method of test for burning velocity measurement of A2L flammable gases

Méthode d'essai pour mesurer la vitesse d'inflammabilité des gaz inflammables A2L

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Foreword

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This document was prepared by Technical Committee ISO/TC 86, *Refrigeration and air-conditioning*, Subcommittee SC 8, *Refrigerants and refrigeration lubricants*.

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Introduction

Safety classification and relative flammability properties of refrigerants are a critical part of ISO 817. The flammability limits of refrigerant gas in air, as described in Annex B of ISO 817:—[1)] give a partial measure of the relative flammability. Another dimension of flammability is how fast a substance burns, releases energy and spreads a flame. One can measure the rate at which a flame front moves through a cloud of refrigerant gas in air, or its burning velocity (BV). This document describes one method that can be useful for BV measurement, and thereby better quantify and compare relative flame fronts for some refrigerant classes. In this test, a flame is allowed to propagate upward (vertically) through a well-mixed, quiescent column of a refrigerant-air mixture enclosed in an open-ended glass tube. Optical systems are used to measure the upward velocity of the flame front.

The measurement of BV has been widely used in the past to compare highly energetic fluids, such as motor fuels and rocket propellants. The BV measurement of slow burning fluids, such as ammonia and fluorinated refrigerants can be more difficult to measure due to the inherent instability of a slow flame. The low rate of energy evolution from a slow flame makes it susceptible to quenching from a variety of sources. For slow burning refrigerants, turbulence and convection currents, can break the flame front, and hence quench the flame. In addition, the test chamber surface can quench free radical flame intermediates as well as extract some of the heat necessary for flame propagation. Gas-phase thermal radiation is also important for flames with low burning velocity. These effects are important to note as they tend to diminish and sometimes quench a weak flame.

The use of the vertical tube method for BV characterization of slow burning refrigerants was the subject of doctoral research which was used in Annex C of ISO 817:— and is the basis for this document.[1] In addition, ASHRAE research notes the use and limitations of the vertical tube technique.[2][3] While the basic framework of the method is relatively simple, some sophisticated imaging instrumentation and mathematics are necessary to extract an average local burning velocity separate from the bulk burning speed as the flame progresses up the tube. Since 2004 other laboratories have used the basic principle of vertical tube method and have shown acceptable results for reproducing the measurement of R-32, at 6,7 +/- 0,7 cm/s. Slower burning velocities (i.e. <4 cm/s) become more difficult to measure reproducibility, so variability may increase as flame instability is increasing. The lower burning velocity limit of this method, as described, is between 3 cm/s and 4 cm/s, depending on the actual design and geometry of the apparatus being used. The uncertainty of the measurement of flames that burn more slowly than R-32 has not yet been determined in any multi lab comparative testing. The appealing aspects of this test are the relative simplicity and low cost of its implementation.

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Method of test for burning velocity measurement of A2L flammable gases

1 Scope

This document specifies a method of measuring the burning velocity (BV) of slowing burning refrigerants (< 10 cm/s) for use with other standards that utilize the BV for determining safety classification of refrigerants (e.g. ISO 817) or that use the BV in establishing requirements on the use of slow burning refrigerants (e.g. ISO 5149).

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

3.1
blends
mixtures composed of two or more refrigerants

3.2
burning velocity
S_u
maximum velocity at which a laminar *flame* propagates in a normal direction relative to the unburned gas ahead of it

Note 1 to entry: This value is expressed in centimetres per second.

3.3
combustion
exothermic reaction between an oxidant (e.g. air) and a combustible fuel

3.4
compound
substance composed of two or more atoms chemically bonded in definite proportions

3.5
flame
space where combustion takes place, resulting in a temperature increase and light emission

3.6
flame propagation
combustion, causing a continuous *flame* which moves upward and outward from the point of ignition without the influence of the ignition source

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