International Standard

ISO **4451**

Polyethylene (PE) pipes and fittings — Determination of reference density of uncoloured and black polyethylenes

Tubes et raccords en polyéthylène (PE) — Détermination de la masse volumique de référence des polyéthylènes non colorés et noirs

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up has the right to be representedoon that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4451 was developed by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, and was circulated to the member bodies in July 1978.

It has been approved by the member of the following countries :

Australia	Greece	Poland
Austria	India	Romania
Belgium	Ireland	South Africa, Rep. of
Brazil	Israel	Spain
Bulgaria	Italy	Sweden
Canada	Japan	Switzerland
Czechoslovakia	Korea, Rep. of	Turkey
Denmark	Mexico	United Kingdom
Egypt, Arab Rep. of	Netherlands	USA
Finland	New Zealand	USSR
France	Norway	Yugoslavia
Germany, F. R.		

No member body expressed disapproval of the document.

Polyethylene (PE) pipes and fittings — Determination of reference density of uncoloured and black polyethylenes

1 Scope and field of application

This International Standard specifies the method for the determination of the reference density of polyethylene (PE) pipes and fittings.

It applies to polyethylene pipes and fittings, whatever their intended use, which contain only antioxidants or stabilizers necessary for a satisfactory service life and, if necessary, carbon black.

NOTE — A method for the determination of the reference density of polyethylenes coloured by pigments other than carbon black is under study.

2 References

ISO/R 1183, *Plastics — Methods for determining the density and relative density (specific gravity) of plastics excluding cellular plastics.*

ISO 1872, *Polyethylene thermoplastic materials — Designation.*

ISO 4056, *Polyethylene (PE) pipes and fittings — Designation of polyethylene, based on nominal density and melt flow index.*

3 Definition

3.1 reference density of polyethylene pipes and fittings : The density measured at 23 ± 0,1 °C, after annealing by the method described in this International Standard, with an accuracy of ± 0,001 g/cm³. This value represents the maximum value for the density of the product. The relationship between reference density and nominal density is given in the annex.

4 Test pieces

4.1 Preparation

Cut from the pipe or fitting to be tested two test pieces of shape and size in accordance with the requirements of the method of test for density which is chosen.

4.2 Conditioning

Condition the test pieces in an oven with air circulation by the following method :

4.2.1 Keep the test pieces in the oven at 150 ± 2 °C for 1 h.

4.2.2 Leave the test pieces to cool in the oven in such a manner that the temperature falls by 5 ± 0,5 °C/h until it reaches 40 °C.

4.2.3 Remove the test pieces from the oven and allow them to cool in the air until the temperature reaches 23 °C.

NOTE — The conditions specified above are satisfactory for pipe sizes in common use. As it is necessary for the specified temperature to be reached throughout the thickness of the test piece, it may be necessary, in the case of a very thick test piece (for example of a thickness greater than 15 mm) to increase the specified conditioning time.

5 Measurement of density

5.1 Use a method having an accuracy of ± 0,000 1 g/cm³; for example one of the methods described in ISO/R 1183.

5.2 Make the measurement at 23 ± 0,1 °C.

NOTE — The reference temperature of 23 °C has been adopted for this International Standard. For the guidance of those using a temperature of 20 °C, the density of polyethylene decreases by approximately 0,000 6 g/cm³ for each 1 °C rise in temperature over the range from 20 to 23 °C. A similar correction should be applied if the test is performed at 27 °C.

6 Expression of results

6.1 If the pipe material consists solely of the polymer, take the reference density as the density determined in accordance with clause 5.

6.2 If the pipe material contains carbon black, calculate the reference density, $\varrho_r\,23$, in grams per cubic centimetre at 23 °C, by the following formula :

$$\varrho_r\,23 = \varrho 23 - 0{,}004\,5\,c$$

where

$\varrho 23$ is the density of the test pieces, in grams per cubic centimetre, determined in accordance with clause 5;

c is the carbon black content, as a percentage by mass.

Annex

Relationship between reference density and nominal density

As the nominal density is one of the criteria for the designation of polyethylenes (see ISO 4056 and ISO 1872), it has been considered useful to indicate here the relationship between the reference density, as determined in accordance with this International Standard, and the nominal density.
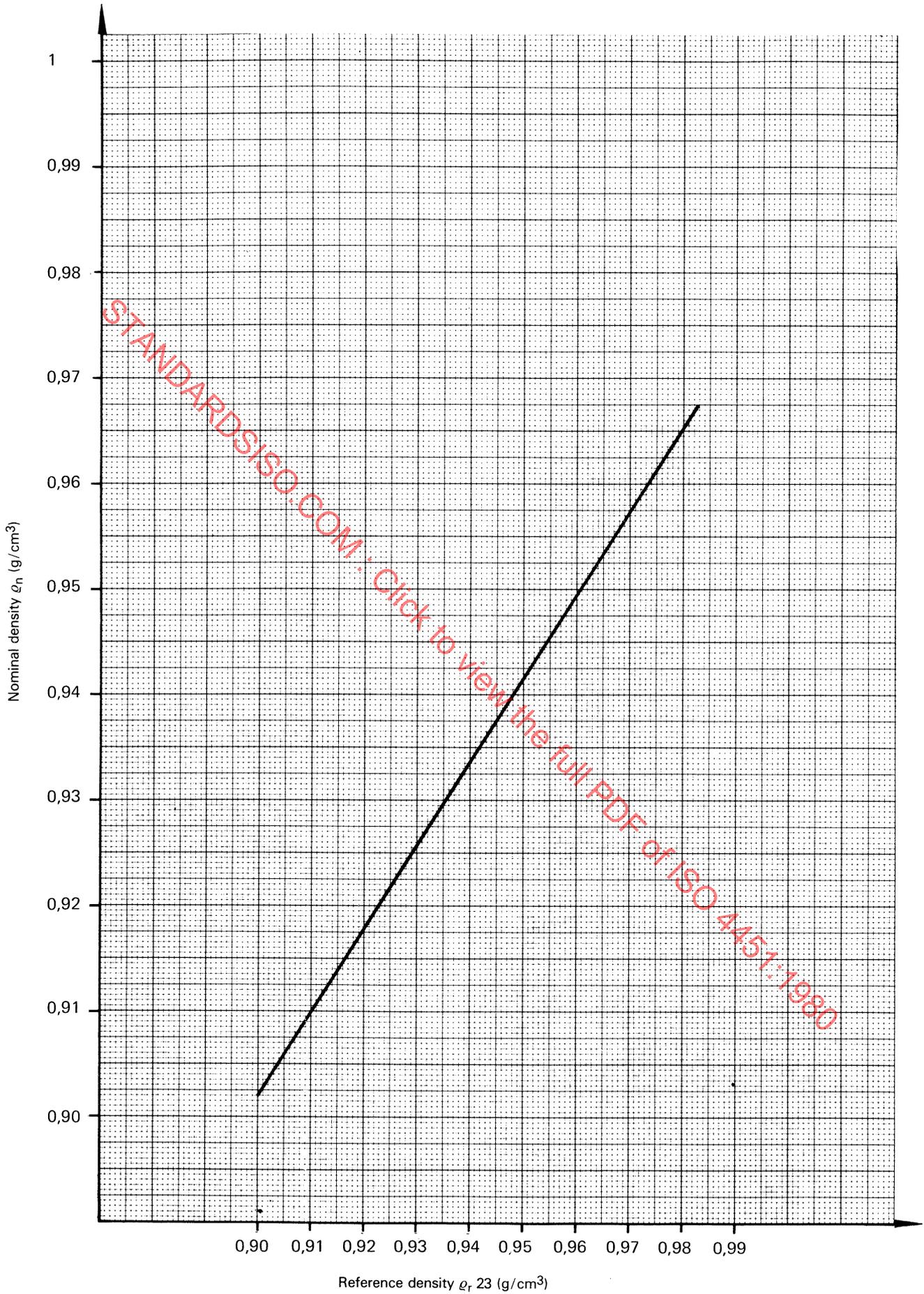
The nominal density at 23 °C, ϱ_n 23 in grams per cubic centimetre, is given by the formula :

$$\varrho_n\ 23 = (0,793 \times \varrho_r\ 23) + 0,188$$

where ϱ_r 23 is the reference density, in grams per cubic centimetre.

A graph showing the relationship between the reference density and nominal density is given in the figure.

Figure