
**Petroleum products — Prediction of the
bulk moduli of petroleum fluids used in
hydraulic fluid power systems**

*Produits pétroliers — Détermination des modules de compressibilité
volumique des fluides pétroliers pour systèmes de transmission hydraulique*



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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 6073 was prepared by Technical Committee ISO/TC 28, *Petroleum products*.

This second edition cancels and replaces the first edition (ISO 6073:1980), which has been technically revised.

Annexes A and B of this International Standard are for information only.

© ISO 1997

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet central@iso.ch
X.400 c=ch; a=400net; p=iso; o=isocs; s=central

Printed in Switzerland

Petroleum products — Prediction of the bulk moduli of petroleum fluids used in hydraulic fluid power systems

1 Scope

This International Standard specifies a procedure for predicting the bulk moduli of petroleum or hydrocarbon oils used as fluids (in the absence of air bubbles) in hydraulic fluid power systems and for other purposes.

This International Standard provides graphical techniques to obtain moduli of such fluids without using extended calculations and with the accuracy that would be required for the practical calculation of hydraulic system parameters. The useful temperature range is from 0 °C to 270 °C, with a pressure range of approximately 100 kPa to 700 MPa. Annex A gives some example calculations.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 91-1:1992, *Petroleum measurement tables - Part 1: Tables based on reference temperatures of 15 degrees C and 60 degrees F.*

ISO 3675:1993, *Crude petroleum and liquid petroleum products - Laboratory determination of density or relative density - Hydrometer method.*

ISO 3838:1983, *Crude petroleum and liquid or solid petroleum products - Determination of density or relative density - Capillary-stoppered pycnometer and graduated bicapillary pycnometer methods.*

ISO 12185:1996, *Crude petroleum and petroleum products - Determination of density - Oscillating U-tube method.*

3 Principle

A bulk modulus is selected according to the problem and conditions of operation, and the predicted value is obtained from the determination of density and reference to one or more of the nomographic figures provided.

4 Definitions

For the purposes of this International Standard, the following definitions apply:

4.1 bulk modulus: The measure of resistance to compressibility of a fluid taken as the reciprocal of the compressibility.

4.2 isothermal bulk modulus: Modulus data based on equilibrium conditions and constant temperature.

4.2.1 isothermal secant bulk modulus (B_T): The bulk modulus, resulting from pressure change from atmospheric to the working pressure.

$$B_T = -V_0[(p - p_0)/(V_0 - V)]_T$$

4.2.2 isothermal tangent bulk modulus (K_T): The bulk modulus, representing the true rate of change at the working pressure.

$$K_T = -V(\partial p/\partial V)_T$$

$K_T > B_T$ except at atmospheric pressure, where $K_T^0 = B_T^0$

4.3 isentropic bulk modulus: The volumetric modulus of elasticity under conditions of constant entropy. It applies under conditions where pressure changes are rapid and there is no opportunity for the temperature to reach equilibrium.

4.3.1 isentropic secant bulk modulus (B_S): Defined as

$$B_S = -V_0[(p - p_0)/(V_0 - V)]_S$$

4.3.2 isentropic tangent bulk modulus (K_S): Defined as

$$K_S = -V(\partial p/\partial V)_S$$

5 Symbols and units

The following symbols are used in the text and figures of this International Standard. The units shown are those preferred; if other units are used, the outcome of some multiples will be affected.

Symbol	Designation	Unit
B_S	Isentropic secant bulk modulus	MPa
B_T	Isothermal secant bulk modulus	MPa
B_T^0	Isothermal secant bulk modulus at atmospheric pressure	MPa
c_p	Specific heat capacity at constant pressure	J/(kg·K)
k_S	Adiabatic coefficient of compressibility	MPa ⁻¹
k_T	Isothermal coefficient of compressibility	MPa ⁻¹
K_S	Isentropic tangent bulk modulus	MPa
K_T	Isothermal tangent bulk modulus	MPa
K_T^0	Isothermal tangent bulk modulus at atmospheric pressure	MPa
p	Gauge pressure	kPa or MPa
p_0	Atmospheric pressure	kPa
S	Entropy	J/K
T	Temperature	K
V	Volume	m ³
V_0	Volume at atmospheric pressure and temperature	m ³
θ	Temperature	°C
ρ	Density at a given pressure	kg/m ³
ρ_0	Density at atmospheric pressure	kg/m ³

6 Determinations

6.1 Determine the density at 15 °C in accordance with ISO 3675, ISO 3838 or ISO 12185.

6.2 Determine the density at the required temperature in accordance with ISO 91-1.

NOTE — The densities determined above are at atmospheric pressure.

7 Predictions

7.1 Isothermal secant bulk modulus

7.1.1 From figure 1, read off the isothermal secant bulk modulus at a reference pressure of 150 MPa.

7.1.2 Transfer the figure obtained in 7.1.1 to the ordinate of figure 2, and move horizontally until this value intersects with the 150 MPa line. A line drawn vertically from this point gives values of the isothermal secant bulk modulus at other pressures. Read off the appropriate values on the ordinate.