INTERNATIONAL STANDARD

ISO 6072

Third edition
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Rubber — Compatibility between hydraulic fluids and standard elastomeric materials

Caoutchouc — Compatibilité des fluides hydrauliques avec les matériaux élastomères de référence

Reference number
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 6072 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 4, *Products (other than hoses)*.

This third edition cancels and replaces the second edition (ISO 6072:2002), which has been technically revised.

Introduction

In hydraulic fluid power systems, power is transmitted and controlled through a liquid under pressure within an enclosed circuit. Elastomers are used as seals in fluid power systems. Elastomeric materials are any substances having the ability to return to their original size and shape after deformation. Hydraulic fluids are water, oil or other fluids which are forced through an orifice or round a closed circuit. Elastomeric materials and hydraulic fluids are defined as compatible if they are not significantly altered by chemical reaction or physical swelling.

From the changes in volume, hardness, tensile strength and elongation at break, which standard test specimens of a test elastomer undergo when immersed in a certain fluid under specified test conditions (see Table 11), an elastomer compatibility index (ECI) can be established for this fluid and can be expressed in the format given in Clause 5. The ECI (which should be quoted by oil suppliers) allows selection of suitable combinations of fluids and elastomeric materials without prolonged testing and might provide enough information to eliminate totally unsuitable elastomer/fluid combinations without having to resort to extensive screening tests.

Representative standard compositions of various types of elastomer permit evaluation of the effect of hydraulic fluids on such compositions and comparison with commercial elastomeric materials for actual service. They could also assist producers of additives and hydraulic fluids in the development of hydraulic fluids compatible with different elastomer types.

Rubber — Compatibility between hydraulic fluids and standard elastomeric materials

1 Scope

This International Standard specifies test methods for evaluating the effect of hydraulic fluids on standard elastomeric materials that have been manufactured in accordance with specified processes. It allows baseline comparisons of fluids with standard elastomers.

This International Standard provides formulations, mixing procedures and vulcanization procedures for five types of elastomeric composition:

a) acrylonitrile-butadiene rubbers (NBR 1 and NBR 2);

b) fluorocarbon rubber (FKM 2);

c) ethylene propylene diene rubber (EPDM 1);

d) hydrogenated acrylonitrile-butadiene rubber (HNBR 1).

These procedures evaluate the effect of mineral-based, fire-resistant and biodegradable hydraulic fluids on such compositions by measurement, under controlled conditions, of physical properties of standard test pieces of the elastomer before and after immersion in the fluids.

This International Standard does not provide formulations of elastomeric materials for actual service, although service elastomers may be tested using these compatibility procedures if required.

NOTE The elastomeric materials used in these formulations are sensitive to fluid variations and have comparatively high swelling characteristics. Stable cure systems can be used to give adequate storage life.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 37, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties*

ISO 48, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

ISO 815-1, *Rubber, vulcanized or thermoplastic — Determination of compression set — Part 1: At ambient or elevated temperatures*

ISO 1629, *Rubber and latices — Nomenclature*

ISO 1817:2011, *Rubber, vulcanized or thermoplastic — Determination of the effect of liquids*

ISO 2393, *Rubber test mixes — Preparation, mixing and vulcanization — Equipment and procedures*

ISO 2781, *Rubber, vulcanized or thermoplastic — Determination of density*

ISO 5598, *Fluid power systems and components — Vocabulary*

ISO 6743-4, *Lubricants, industrial oils and related products (class L) — Classification — Part 4: Family H (Hydraulic systems)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5598 and the following apply.

3.1
elastomer
macromolecular material which returns rapidly to approximately its initial dimensions and shape after substantial deformation by a weak stress and release of the stress

[ISO 1382:2008[1]]

3.2
test elastomer
rubber vulcanizate with a known composition, used for evaluating the effect of media on elastomers

NOTE In order to minimize error, a test elastomer contains only the most essential ingredients for a vulcanizate.

3.3
commercial rubber
elastomeric material for actual service, the composition of which is not given by the manufacturer and which contains many more ingredients than the standard rubbers in order to fulfil processing and service requirements

NOTE It is not advisable to use commercial rubbers for quality control of media as they are generally subject to larger quality tolerances than test elastomers.

3.4
elastomer compatibility index
ECI
simple one-line designation incorporating the details of the changes in volume, hardness, tensile strength and elongation at break which standard test specimens of a test elastomer undergo when immersed in a particular fluid under specified test conditions

NOTE An elastomer compatibility index can be established for each combination of fluid and test elastomer specified in Table 11.

4 Test elastomers

4.1 General

The mixing and vulcanization procedures given in ISO 2393 shall be followed for the test elastomers.

A single source for each of the ingredients of the test elastomers shall be used and the quality of each batch produced shall be checked.

4.2 Standard acrylonitrile-butadiene rubber with 28 % acrylonitrile content (NBR 1)

4.2.1 Composition by mass

The composition by mass is given in Table 1.

Table 1 — Composition by mass of NBR 1

Material	Parts by mass
NBR [a]	100,0
Zinc oxide (rubber grade)	5,0
Polymerized 2,2,4-trimethyl-1,2-dihydroquinoline (melting point 75 °C to 100 °C)	0,5
FEF carbon black (ASTM designation: N550)	70,0
Dicumyl peroxide (grade with 40 % peroxide content on inert filler)	3,0
Total	178,5

[a] Acrylonitrile content (28 ± 1) %, cold-polymerized, Mooney viscosity (45 ± 5) ML (1 + 4) 100 °C (Perbunan NT2845 from Lanxess or Nipol DN2850 from Zeon Corporation, or equivalent).

Perbunan® NT2845 and Nipol® DN2850 are examples of suitable products available commercially. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of these products.

4.2.2 Mixing procedure

Follow the procedure a) to m), maintaining the surface temperature of the rolls at (50 ± 5) °C.

a) Band crude rubber with the mill opening set at 1,4 mm and break down.

b) Add the zinc oxide, then the polymerized 2,2,4-trimethyl-1,2-dihydroquinoline evenly across the rolls at a constant rate.

c) Make 3/4 cuts on the rolls from one end diagonally to the other end.

d) Add approximately half the carbon black evenly across the rolls at a constant rate.

e) Open the mill at intervals to maintain a constant bank.

f) Make three 3/4 cuts from each side.

g) Add the rest of the carbon black, plus any ingredients that have dropped through to the pan.

h) Add the dicumyl peroxide evenly across the rolls.

i) Make six 3/4 cuts from each side.

j) Cut the batch from the mill and set the opening to 0,2 mm.

k) Pass the rolled stock endwise through the mill six times.

l) Sheet off samples at 2,2 mm and allow to cool on a flat metal surface.

m) Prepare samples for curing.

4.2.3 Preparation of standard vulcanized sheets

Prepare standard vulcanized sheets by curing sheets (2,0 ± 0,2) mm thick for 20 min at 170 °C.

4.2.4 Control tests

Carry out all the tests specified in Table 2 on the sheets prepared in 4.2.3.

Table 2 — Control tests for NBR 1

Control test	Property requirement	Unit	Document specifying test method
Hardness	80 ± 3	IRHD	ISO 48
Tensile strength, type 2 dumb-bell test piece	≥ 20	MPa	ISO 37
Elongation at break, type 2 dumb-bell test piece	≥ 150	%	ISO 37
Compression set after 22 h at 100 °C, using a type B test piece obtained by plying three discs	≤ 20	%	ISO 815-1
Density	1,23 ± 0,02	Mg/m^3	ISO 2781
Percentage change in mass after 22 h immersion at (23 ± 2) °C in ISO liquid B [70 % (by volume) pure 2,2,4-trimethylpentane and 30 % (by volume) pure toluene]	27 [a]	%	ISO 1817

[a] Typical value (recommended range 27 ± 5).

4.3 Standard acrylonitrile-butadiene rubber with 34 % acrylonitrile content (NBR 2)

4.3.1 Composition by mass

The composition by mass is given in Table 3.

Table 3 — Composition by mass of NBR 2

Material	Parts by mass
NBR [a]	100,0
Zinc oxide (rubber grade)	5,0
Stearic acid	1,0
Polymerized 2,2,4-trimethyl-1,2-dihydroquinoline (melting point 75 °C to 100 °C)	0,5
FEF carbon black (ASTM designation: N550)	50,0
Tetrabenzylthiuram disulfide	3,0
N-Cyclohexyl-2-benzothiazylsulfenamide	2,0
Sulfur (rubber grade)	0,5
Total	162,0

[a] Acrylonitrile content (34 ± 1) %, Mooney viscosity (56 ± 5) ML (1 + 4) 100 °C (N237 from JSR Corp. or Nipol DN3350 from Zeon Corporation, or equivalent).

N237 and Nipol® DN3350 are examples of suitable products available commercially. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of these products.

4.3.2 Mixing procedure

Follow the procedure a) to m), maintaining the surface temperature of the rolls at (50 ± 5) °C.

a) Band crude rubber with the mill opening set at 1,4 mm and break down.

b) Add the zinc oxide and the stearic acid, then the polymerized 2,2,4-trimethyl-1,2-dihydroquinoline evenly across the rolls at a constant rate.

c) Make 3/4 cuts on the rolls from one end diagonally to the other end.

d) Add approximately half the carbon black evenly across the rolls at a constant rate.

e) Open the mill at intervals to maintain a constant bank.

f) Make three 3/4 cuts from each side.

g) Add the rest of the carbon black, including any ingredients that have dropped through to the pan.

h) Add the tetrabenzylthiuram disulfide, the *N*-cyclohexyl-2-benzothiazylsulfenamide and the sulfur evenly across the rolls.

i) Make six 3/4 cuts from each side.

j) Cut the batch from the mill and set the opening to 0,2 mm.

k) Pass the rolled stock endwise through the mill six times.

l) Sheet off samples at 2,2 mm and allow to cool on a flat metal surface.

m) Prepare samples for curing.

4.3.3 Preparation of standard vulcanized sheets

Prepare standard vulcanized sheets by curing sheets (2,0 ± 0,2) mm thick for 20 min at 170 °C.

4.3.4 Control tests

Carry out all the tests specified in Table 4 on the sheets prepared in 4.3.3.

Table 4 — Control tests for NBR 2

Control tests	Property requirement	Unit	Document specifying test method
Hardness	70 ± 3	IRHD	ISO 48
Tensile strength, type 2 dumb-bell test piece	≥ 15	MPa	ISO 37
Elongation at break, type 2 dumb-bell test piece	≥ 300	%	ISO 37
Compression set after 22 h at 100 °C, using a type B test piece obtained by plying three discs	≤ 20	%	ISO 815-1
Density	1,18 ± 0,02	Mg/m^3	ISO 2781
Percentage change in mass after 22 h immersion at (23 ± 2) °C in ISO liquid B [70 % (by volume) pure 2,2,4-trimethylpentane and 30 % (by volume) pure toluene]	23 [a]	%	ISO 1817

[a] Typical value (recommended range 23 ± 5).

4.4 Standard fluorocarbon rubber (FKM 2)

4.4.1 Composition by mass

The composition by mass is given in Table 5.