TECHNICAL SPECIFICATION

ISO/TS 12927

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Lubricants, industrial oils and related products (class L) — Family M (Metalworking) — Guidelines for establishing specifications

Lubrifiants, huiles industrielles et produits connexes (classe L) — Famille M (Travail des métaux) — Lignes directrices pour l'établissement de spécifications

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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 3.

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.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed every three years with a view to deciding whether it can be transformed into an International Standard.

Attention is drawn to the possibility that some of the elements of this ISO/TS 12927 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TS 12927 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*, Subcommittee SC 4, *Classifications and specifications*.

Annexes A, B and C of this Technical Specification are for information only.

Introduction

Considering the difficulties encountered in establishing an international specification for metalworking fluids, particularly because of the diversity of the applications and conditions of use, and because of the problems of simulating the actual conditions of use in the laboratory and hence of developing reliable laboratory methods and testing standards, it has been decided to publish guidelines for establishing specifications in the form of a Technical Specification. Therefore, all information provided by this Technical Specification is only informative, except the classifications by family and viscosity.

This Technical Specification contains, in annexes A to C, suggested methods to evaluate some properties of metalworking fluids which are not yet standardized or still subject to discussions.

Lubricants, industrial oils and related products (class L) — Family M (Metalworking) — Guidelines for establishing specifications

WARNING — The handling and use of products as specified in this Technical Specification may be hazardous, if suitable precautions are not observed. This Technical Specification does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this Technical Specification to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1 Scope

This Technical Specification has been prepared with the following purposes:

— to facilitate the application of the ISO 6743-7 classification standard and to precisely state the characteristics to be taken into account to establish specifications for a given application;

— these characteristics could serve as a basis for discussion between the end user and the supplier.

This Technical Specification does not cover specified requirements which should be examined separately with a view to a common agreement between the end user and the product supplier.

This Technical Specification also does not cover the health, safety, disposal and environmental areas which should be dealt with separately, according to the regulations or laws in force in each country.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this Technical Specification. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this Technical Specification are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 2049:1996, *Petroleum products — Determination of colour (ASTM scale)*

ISO 2160:1998, *Petroleum products — Corrosiveness to copper — Copper strip test*

ISO 2592:—[1)] *Petroleum products — Determination of flash and fire points — Cleveland open cup method*

ISO 2719:1988, *Petroleum products and lubricants — Determination of flash point — Pensky-Martens closed cup method*

ISO 3016:1994, *Petroleum products — Determination of pour point*

1) To be published. (Revision of ISO 2592:1973)

ISO 3104:1994, *Petroleum products — Transparent and opaque liquids — Determination of kinematic viscosity and calculation of dynamic viscosity*

ISO 3448:1992, *Industrial liquid lubricants — ISO viscosity classification*

ISO 3675:1998, *Crude petroleum and liquid petroleum products — Laboratory determination of density — Hydrometer method*

ISO 3771:1994, *Petroleum products — Determination of base number — Perchloric acid potentiometric titration method*

ISO 6247:1998, *Petroleum products — Determination of foaming characteristics of lubricating oils*

ISO 6293:1983, *Petroleum products — Determination of saponification number*

ISO 6320:1995, *Animal and vegetable fats and oils — Determination of refractive index*

ISO 6618:1997, *Petroleum products and lubricants — Determination of acid or base number — Colour-indicator titration method*

ISO 6743-0:1981, *Lubricants, industrial oils and related products (class L) — Classification — Part 0: General*

ISO 6743-7:1986, *Lubricants, industrial oils and related products (class L) — Classification — Part 7: Family M (Metalworking)*

ISO 7120:1987, *Petroleum products and lubricants — Petroleum oils and other fluids — Determination of rust-preventing characteristics in the presence of water*

NF T60-187:1991, *Aqueous machining fluids — Emulsifying and solubilising suitability and stability at rest*

NF T60-195:1993, *Aqueous machining fluids — Opacity under diluted form*

NF T60-196:1994, *Non aqueous machining fluids — Assessment of the tendency to form oil sprays*

NF T60-197:1993, *Aqueous and non aqueous metal working fluids — Short and long term storage stability*

3 Explanations of symbols used

3.1 General

In the column headed "ISO-L", in the following tables, the various categories are designated under abbreviated form. Where the complete designation should be ISO-L-MHA or ISO-L-MAA, it is generally permissible to design a product under abbreviated form L-MHA, L-MAA or even MHA, MAA.

In the complete designation, the prefix letter "L" designates the class "Lubricants, industrial oils and related products" according to ISO 6743-0. The letter "M" indicates the family "Metalworking" according to ISO 6743-7.

3.2 Straight (non-aqueous) fluids

a) The group of letters "MH" forms a code which indicates a straight (neat) fluid;

b) the numerical group which appears after each code corresponds to the average kinematic viscosity of the oil expressed according to ISO 3448.

3.3 Water-miscible fluids

a) the group of letters "MA" forms a code which indicates a concentrate to be mixed with water by the end user to form an aqueous fluid;

b) the mention of the viscosity grade of the concentrate is not necessary.

4 Specifications guide

4.1 Introduction

Generally, specifications are made of sets of characteristics

a) identification characteristics;

b) performance characteristics.

4.2 Straight (non-aqueous) fluids

4.2.1 Identification characteristics

These characteristics are commonly used in the characterization of petroleum products, for example: viscosity, specified gravity, flash point, pour point, colour, appearance. See table 1.

4.2.2 Performance characteristics

These characteristics are among the most difficult to define because they must be representative of the properties required in numerous, various and specific applications. Unfortunately, there is a lack of standardized and recognized methods to evaluate performances of products.

Some standardized methods exist but are not representative of actual industrial applications.

Among the critical performance characteristics the following may be mentioned, for example:

— extreme pressure (EP);

— anti-wear;

— friction reduction;

— anti-rust;

— anti-mist;

— filterability;

— compatibility with paints and synthetic materials.

See table 1.

Table 1 — Guidelines for establishing specifications of straight (non-aqueous) metalworking fluids

No.	Identification characteristics	Units	ISO L [a]								ISO standards	Other standards or methods
			MHA	MHB	MHC	MHD	MHE	MHF	MHG	MHH		
1.1	Appearance	rating	a	a	a	a	a	a				Visual
1.2	Colour	rating	a	a	a	a	a	a			ISO 2049	
1.3	Odour	rating	a	a	a	a	a	a				Olfactory
1.4	Density	kg/m^3	a	a	a	a	a	a			ISO 3675	
1.5	Viscosity	mm^2/s [b]	a	a	a	a	a	a			ISO 3104	
1.6	Flash point										c	
	. open cup	° C	a	a	a	a	a	a			ISO 2592	
	. closed up	° C	a	a	a	a	a	a			ISO 2719	
1.7	Pour point	° C	a	a	a	a	a	a			ISO 3016	
1.8	Saponification number	mg KOH/g	d	d	d	d	d	d	d	d	ISO 6293	
1.9	Total sulfur content	% mass	e	e	e	e	e	e	e	e	e	
1.10	Copper strip corrosion	rating	a	a	a	a	a	a			ISO 2160	
1.11	Chlorine content	% mass	f	f	f	f	f	f	f	f	f	
1.12	Elements content	% mass	g	g	g	g	g	g	g	g	g	
2.1	Foaming	ml/ml	a	a	a	a	a	a	a	a	ISO 6247	
2.2	Extreme pressure properties		h	h	h	h	h	h	h	h	h	
2.3	Filterability		i	i	i	i	i	i	i	i	i	
2.4	Anti-rust properties	rating	a	a	a	a	a	a	a	a	ISO 7120 A	
2.5	Anti-mist properties	% mass	j	j	j	j	j	j	j	j		NF T 60-196
2.6	Friction-reduction properties	rating	-	a	-	-	a	a			k	
2.7	Storage stability	rating	a	a	a	a	a	a			l	NF T 60-197
2.8	Machining performance	rating	m	m	m	m	m	m	m	m	m	

[a] This characteristic applies to the type of product.

[b] Indicate the temperature.

[c] Select the most relevant method according to the product type and flash-point value.

[d] The determination of this characteristic may be affected by the presence of some chemical compounds, for example : chlorinated paraffins, sulfurized esters.

[e] Precise the method used, for example : X Ray, combustion. The sulfur content coming from the additives may be indicated by the supplier if necessary (added sulfur, total sulfur, sulfur of base stocks).

[f] Precise the method used. The absence of this element may be requested from the end user, for disposal or environmental reasons.

[g] For metallurgical compatibility reasons, or any other justified reason, the end user may wish to know the nature and content of specific elements. Disclosure of the limits of nature and content of these elements may be negotiated between the end user and the supplier.

[h] Numerous tests exist to evaluate the extreme pressure properties of fluids, for example : Shell 4-ball, Falex, Reichert, Timken. These are examples of suitable products available commercially. This information is given for the convenience of users of this Technical Specification and does not constitute an endorsement by ISO of these products. The end user may ask to document results in given tests, but the presence of extreme pressure additives does not necessarily mean good machining performance. Moreover, no clear correlation has been established until now, between the laboratory extreme pressure screen tests and the machining performance.

[i] This characteristic represents the ability of the fluid to be filtered by the filtration equipment of the end user, without modification of its physico-chemical characteristics. This characteristic can only be evaluated in actual use.

[j] This characteristic permits the verification of the presence of mist suppressors and their efficiency. English translation is available from AFNOR.

[k] Test method and limits to be negotiated between the end user and the supplier. This characteristic is not necessary or useful in all cases.

[l] Short duration test. Temperature to be negotiated between the end user and the supplier. 0 °C may be too low a temperature for active sulfur-containing oils. English translation is available from AFNOR.

[m] Can only be evaluated in actual machining operations. The criteria to be taken into account are to be negotiated between the end user and the supplier.

4.3 Water-miscible fluids

4.3.1 Identification characteristics

These characteristics are related to the concentrate. In some cases, the presence of water or volatile products does not permit the use of the conventional method intended for the characterization of petroleum products. Among the methods likely to raise problems, the following may be mentioned, for example: viscosity, flash point, pour point, emulsibility, see table 2.

4.3.2 Performance characteristics

These characteristics are evaluated on the fluid after dilution either in a standardized water or in the end-user water at accurately expressed strengths compatible with those required by the industrial applications.

There are few reliable standardized and recognized methods to assess the performance of the products.

Among the critical performance characteristics, the following may be mentioned, for example:

— corrosion protection;

— foaming;

— emulsion stability;

— compatibility with metals, lubricating oils, synthetic materials, seals, paints;

— pH;

— innocuity towards the user;

— gumming tendency (sticking-residue-formation tendency);

— extreme pressure (EP);

— anti-wear.

See table 2.

5 Non-exhaustive lists of characteristics to establish specifications

5.1 Introduction

Two lists are presented in tables for:

a) straight (non-aqueous) fluids (table 1);

b) water-miscible fluids (table 2).

These lists are not closed and must be completed to take into account any other specific criteria.

5.2 List of characteristics for straight (non-aqueous) fluids

Table 1 is divided into two parts:

— identification characteristics;

— performance characteristics.

Table 2 — Guidelines for establishing specifications of water-miscible metalworking fluids

No.	Identification characteristics	Unit	ISO L[a]									ISO Standards	Other standards or methods
			MAA	MAB	MAC	MAD	MAE	MAF	MAG	MAH	MAI		
3.1	Appearance	Rating	a	a	a	a	a	a	a	a			Visual
3.2	Colour	Rating	a	a	a	a	a	a	a	a		ISO 2049	
3.3	Odour	Rating	a	a	a	a	a	a	a	a			Olfactory
3.4	Density	kg/m^3	a	a	a	a	a	a	a	a		ISO 3675	
3.5	Viscosity	mm^2/s [b]	a	a	a	a	a	a	a	a		ISO 3104	
3.6	Flash point											[c]	
	. open cup	° C	a	a	a	a	-	-	-	-		ISO 2592	
	. closed up	° C	a	a	a	a	-	-	-	-		ISO 2719	
3.7	Pour point [d]	° C	a	a	a	a	a	a				ISO 3016	
3.8	Refractive index	-	a	a	a	a	a	a	a	a		ISO 6320	
3.9	Neutralization number	mg KOH/g	a	a	a	a						ISO 6618	
3.10	Base number	mg KOH/g	a	a	a	a	a	a	a	a		ISO 3771	
3.11	Saponification number	mg KOH/g	e	e	e	e	e	e	e	e		ISO 6293	
3.12	Mineral/base oil content	% mass	f	f	f	f	f	f	f	f			
3.13	Copper strip corrosion	Rating	g	g	g	g	g	g	g	g		ISO 2160	
3.14	Storage stability [h]												NF T 60-197
	. short duration	Rating	a	a	a	a	a	a	a	a			
	. long duration	Rating	a	a	a	a	a	a	a	a			
4.1	Appearance	Rating	a	a	a	a	a	a	a	a			Visual
4.2	Product type (opacity) [i]	Optical density	a	a	a	a	a	a	a	a			NF T 60-195
4.3	Emulsibility	Rating	a	a	a	a	a	a	a	a			NF T 60-187 [j]
4.4	Emulsion stability	Rating	a	a	a	a	a	a	a	a			k
4.5	Biological stability	Rating	a	a	a	a	a	a	a	a			l
4.6	Hardness range	Degree	m	m	m	m	m	m	m	m			
4.7	Corrosion protection												
	. ferrous metals	Rating	a	a	a	a	a	a	a	a			n
	. non-ferrous metals	Rating	a	a	a	a	a	a	a	a			See Annex A
4.8	Foaming	Rating	a	a	a	a	a	a	a	a			o
4.9	pH value												p
	. fresh blend	pH Units	a	a	a	a	a	a	a	a			
	. after ageing	pH Units	a	a	a	a	a	a	a	a			
4.10	Sticking/Gumming tendency	Rating	a	a	a	a	a	a	a	a			q

a This characteristic applies to the type of product.

b 20 °C is the recommended temperature. Other temperatures may be negotiated between the end user and the supplier.

c Select the most relevant method according to the flash-point value. The presence of water in the concentrates may affect the determination or render it impossible.

d This characteristic is not necessarily applicable to all types of products.

e The determination of this characteristic may be affected by the presence of some chemical compounds, for example: chlorinated paraffins, sulfurized esters, emulsifiers.

f The oil content may be given by the supplier only if necessary.

g This characteristic is required only if copper alloys are used in the concentrate dispensing/mixing equipment or in the machine coolant system or if machining copper alloys.

h For the short term test, 0 °C and 30 °C are the recommended temperatures. However, other temperatures can be agreed between the end user and the supplier, depending on local climatic conditions. English translation is available from AFNOR.

i In most of the cases, a visual inspection is sufficient to determine product class. However, the French standard NF T 60-195 may be used to classify more precisely the product. English translation is available from AFNOR.

j English translation is available from AFNOR.

k Among the possible methods : NF T 60-187, DIN 51367, IP 263.

l Among the possible methods : that described in Annex C, ASTM D 3946 or any other forthcoming suitable method, resulting from the work of specialized groups (for example IBRG/IP).

m The supplier will precise the range of water hardness in which the product can be applied without creating problems of either foaming or stability.

n Among the possible methods : NF T 60-186, IP 125, IP 287, DIN 51360 parts 1 and 2 and ASTM D 4627.

o Among the possible methods : NF T 60-185, IP 312, ASTM D 3519, ASTM D 3601.

p Laboratory ageing methods agreed between the supplier and the end user could be used to evaluate pH stability. Among the possible methods : NF T 60-193 and DIN 51369.

q Annex B describes four alternative methods which may be used to evaluate this characteristic. Any other method negotiated between the end user and the supplier may be used.

5.3 List of characteristics for water-miscible fluids

Table 2 is divided into two parts:

— characteristics of the products as delivered;

— characteristics and performance of the diluted product.

Annex A
(informative)

Water-miscible machining fluids. Anti-corrosive properties in contact with non-ferrous metals

A.1 Scope

This method describes the mode of operation to be applied for the evaluation of the anti-corrosive properties of aqueous machining fluids regarding copper, copper alloys, aluminium and aluminium alloys. This method applies to categories MAA to MAH.

A.2 Referenced standards

ISO 209-1:1989, *Wrought aluminium and aluminium alloys — Chemical composition and forms of products — Part 1: Chemical composition*

ISO 427:1983, *Wrought copper-tin alloys — Chemical composition and forms of wrought products*

ISO 431:1981, *Copper refinery shapes*

ISO 3696:1987, *Water for analytical laboratory use — Specification and test methods*

ISO 6344-1:1998, *Coated abrasives — Grain size analysis — Part 1: Grain size distribution chart*

A.3 Principle

A metallic test piece of specified dimensions is partially immersed for a predetermined time in the fluid to be tested. The aggressiveness of the fluid regarding the metal is assessed from the variations in the appearance of the liquid and the metallic test piece.

A.4 Reagents and materials

A.4.1 Ethanol, technical grade.

A.4.2 Acetone, technical grade.

A.4.3 Water, according to grade 2 of ISO 3696.

A.4.4 Calcium chloride hexahydrate, ($CaCl_2 \cdot 6H_2O$) analytical grade.

A.4.5 Magnesium sulfate heptahydrate, ($MgSO_4 \cdot 7H_2O$) analytical grade.

A.5 Apparatus

Usual laboratory apparatus and glassware together with the following:

A.5.1 Beakers, of 10 ml capacity, four needed.

A.5.2 Pipette, of 5 ml capacity.

A.5.3 Metallic test pieces, 40,0 mm ± 0,2 mm long, 8,0 mm ± 0,2 mm wide and 3,0 mm ± 0,2 mm thick, made of:

— electrolytical copper, Cu-DHP, according to ISO 431;

— bronze, $CuSn_8P$, according to ISO 427;

— aluminium alloy, $AlCu_4MgSi(A)$, according to ISO 209-1;

— or any other non-ferrous metal which is the subject of an agreement between the supplier and the user.

A.5.4 Abrasive paper, P400 grain, according to ISO 6344-1 (for abrasion underwater).

A.5.5 Abrasive paper, P600 grain, according to ISO 6344-1 (for abrasion underwater).

A.5.6 Graduated cylinder, 100 ml, with a ground stopper, with a haulage of 30 ml above the graduation.

A.5.7 Calibrated flask, of 100 ml capacity.

A.5.8 Balance, accurate to the nearest 0,1 mg.

A.6 Procedure

A.6.1 Preparation of the fluid for testing

A.6.1.1 Preparation of test water

Test water shall be prepared by dissolving 0,076 g ± 0,001 g of calcium chloride (A.4.4) and 0,013 g ± 0,001 g of magnesium sulfate (A.4.5) weighed with the balance (A.5.8) in 1 000 ml of water (A.4.3) using the flask (A.5.7).

A.6.1.2 Preparation of the fluid

The water-miscible fluid shall be prepared at the recommended concentration of use *X* % by adding *X* ml of the test fluid to (100 - *X*) ml of the water prepared in A.6.1.1 and contained in the graduated cylinder (A.5.6). It shall be vigorously shaken.

A.6.2 Preparation of the metallic test pieces

The test pieces shall be polished underwater, first with abrasive paper (A.5.4) and then with abrasive paper (A.5.5). They shall then be rinsed in water and immersed successively in water (A.4.3), ethanol (A.4.1) and acetone (A.4.2) and dried in the ambiant air.

The test pieces shall be used within a maximum of 10 min after rinsing with acetone.

A.6.3 Testing

Put 5 ml of the product to be tested in each of the four beakers (A.5.1) using the pipette (A.5.2) and then immerse a test piece of each metal in the first three beakers. Leave them for 72 h ± 1 h at 23 °C ± 2 °C. The fourth beaker is for the reference sample and is stored under the same conditions.

After 72 h, remove the test pieces and rinse them in the water (A.4.3), ethanol (A.4.1) and acetone (A.4.2). Then leave them to dry in the ambiant air. Keep the fluid.

A.6.4 Rating

The test pieces and fluid shall be rated after testing in accordance with table A.1 and table A.2.

Table A.1 — Rating system of the fluid

Rating	Appearance
0	Appearance unchanged
1	Slight coloration
2	Pronounced coloration
3	Coloration and/or deposit

The appearance of the fluid shall be compared with the fluid in the fourth beaker (A.5.1).

Table A.2 — Corrosion ratings system of the metallic test piece

Rating	Appearance
0	Polished plate
1	Slight tarnishing
2	Considerable or moderate tarnishing
3	Corrosion - pitting

A.7 Expression of results

The results shall be expressed by means of two values, the rating of the test piece and the rating of the liquid, for each of the metallic test pieces, and according to A.6.4.

Table A.3 — Expression of results

Nature of test piece	Appearance of test piece (rating)	Appearance of fluid (rating)
Copper Brass Aluminium alloy		

A.8 Test report

The test report shall contain at least the following information:

a) the type and complete identification of the product under test;

b) a reference to this method, i.e.: Annex A of ISO/TS 12927;

c) the result of the test (see A.7);

d) the concentration of the water-miscible fluid;

e) any deviation, by agreement or otherwise, from the procedure specified;

f) the date of the test.

Annex B
(informative)

Water-miscible machining fluids — Evaluation of gumming tendency

Introduction

Because of their nature, there are several possible methods of evaluating the gums and their tendency to produce the phenomenon of gumming:

a) method A: evaluation of the gumming tendency by measuring the resistance to removal of a ring;

b) method B: determination of the resolubility of the gums;

c) method C: determination of the adhesive force of a spindle/bore fit;

d) method D: determination of the adhesive force between two flat surfaces.

B.1 Scope

This annex describes four methods of evaluating the gumming tendency of the aqueous machining fluids, in various ways. These methods apply to categories MAA to MAH.

B.2 Referenced standards

ISO 286-2:1988, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts*

ISO 3696:1987, *Water for analytical laboratory use — Specification and test methods*

ISO 6344-1:1998, *Coated abrasives — Grain size analysis — Part 1: Grain size distribution chart*

NF A 32-101:1987, *Foundry products — Lamellar graphite cast-iron castings*

B.3 Definition

For the purposes of this method, the following definition applies:

B.3.1 gumming: Through evaporation in the air, water-miscible fluids leave organic and/or mineral residues (gums). Depending on their consistency and their resolubility in water or in the machining fluid, these residues may have harmful consequences on the operation of the machines, for example : blocking of spindles, tool turrets, table saddles or slideways, measuring gauges. These consequences are referred to as gumming.

B.4 Preparation of the water-miscible fluids

The water-miscible fluid shall be prepared at the recommended concentration of use, using a water agreed between the end user and the supplier. This water can be either the water of the end user or any artificial appropriate hardness water [NF T 60-188, DIN 51360, (see bibliography in B.10) or any other appropriate standard].

B.5 Method A: Evaluation of the gumming tendency by measuring the resistance to removal of a ring

B.5.1 Principle

A volume of machining fluid at its normal concentration for use, in which a platinum clamp with a flat ring is immersed, undergoes evaporation under specified conditions. The gumming tendency is evaluated by measuring the force necessary to remove the ring in the absence or in the presence of water.

B.5.2 Reagents and materials

B.5.2.1 **Chloroform,** technical grade.

B.5.2.2 **Water,** according to grade 2 of ISO 3696.

B.5.3 Apparatus

Usual laboratory apparatus and glassware together with the following:

B.5.3.1 **Cast-iron crucible,** as shown in figure B.1 and made of cast-iron FGL 300 according to NF A 32-101.

B.5.3.2 **Lecomte du Nouy-type torsion-wire tensiometer,** allowing pull forces of 180 mN/m, and accessories.

B.5.3.3 **Platinum wire ring,** equipped with a clamp, 0,37 mm ± 0,1 mm in diameter and 60 mm ± 0,1 mm in circumference (which corresponds to a ring diameter of approximately 19 mm).

B.5.3.4 **Ventilated oven,** capable of maintaining a temperature of 85 °C ± 1 °C.

B.5.3.5 **Pipette,** graduated, of 10 ml capacity.

B.5.3.6 **Chronometer,** accurate to 1/10 s.

B.5.3.7 **Desiccator,** equipped with a drying agent, for example: calcium chloride, silica gel.

B.5.3.8 **Abrasive paper,** P600 grain according to ISO 6344-1.

B.5.3.9 **Copper strips,** 5 mm ± 1 mm wide, 70 mm ± 5 mm long and 0,2 mm ± 0,1 mm thick, two are needed.

B.5.4 Adjustment of the tensiometer

First, put the ring (B.5.3.3) in place on the tensiometer (B.5.3.2). Set the vernier to zero and adjust the horizontality of the arm, according to the manufacturer's instructions.

B.5.5 Procedure

B.5.5.1 Preparation

Clean the crucible (B.5.3.1) with the chloroform (B.5.2.1) to remove any trace of gum products. If difficulties exist during cleaning, use the abrasive paper (B.5.3.8) in the water (B.5.2.2).

Use the pipette (B.5.3.5) to transfer 10 ml of the emulsion/solution prepared in B.4 to the crucible (B.5.3.1).

Clean the ring (B.5.3.3) carefully with the chloroform (B.5.2.1) and scorch it with the Bunsen burner. Place the ring and its clamp (B.5.3.3), prepared as indicated above, in the crucible containing the test fluid.

Dimensions in millimetres

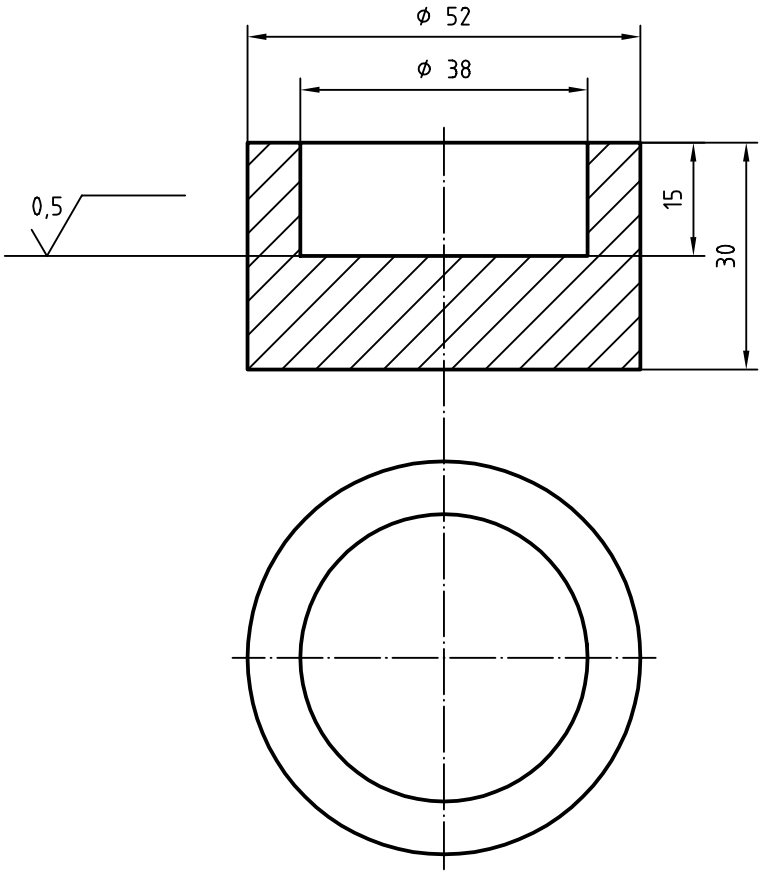


Figure B.1 — Cast-iron crucible

To avoid displacement of the ring, fix the branches of the clamp by means of the two strips (B.5.3.9), folding their ends over the edge of the crucible (see figure B.2).

Place the assembly in the oven (B.5.3.4) at 85 °C and leave it for 72 h ± 1 h.

After 72 ± 1 h, remove the assembly from the oven, transfer it to the desiccator (B.5.3.7) and leave it to cool for 3 h ± 5 min.

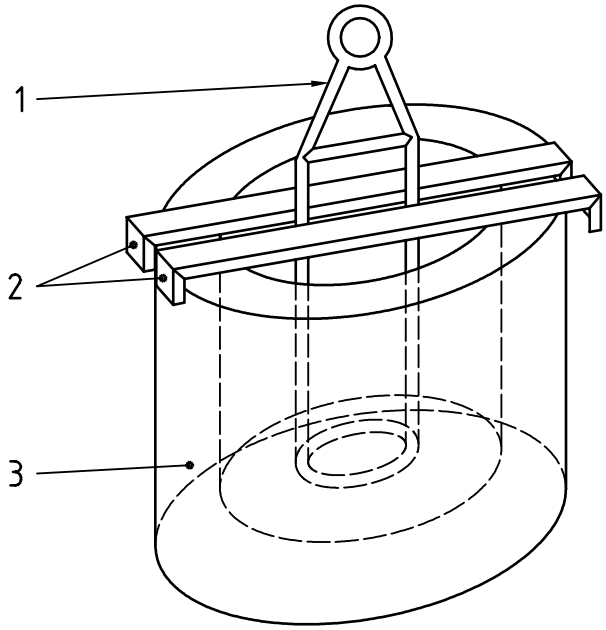
NOTE Avoid transporting the desiccator during the cooling period so that the ring does not slip.

Remove the copper strips (B.5.3.9), taking great care not to touch the branches of the clamp.

Place the crucible on the support of the tensiometer. The room temperature shall be 23 °C ± 2 °C.

Adjust the height of the tensiometer support so that the pulling arm is in a horizontal position between the two parallel markers.

Attach the clamp containing the ring to the arm, taking great care not to move the ring.



Key

1 Ring (B.5.3.3)
2 Copper strips (B.5.3.9)
3 Crucible (B.5.3.1)

Figure B.2 — General scheme

B.5.5.2 Measurement

Two measurement procedures can be performed after preparation:

B.5.5.2.1 Variant 1: Measurement of the pull strength

Progressively increase the pull force by 5 mN/m every 20 s.

If the ring is pulled away at a value under 180 mN/m, read the pull-strength value by unit of length on the dial.

If 180 mN/m is reached without the ring peeling away, stop the test.

B.5.5.2.2 Variant 2: Measurement of the pull strength after contact of the deposit with distilled water (softening)

Add 10 ml of water (B.5.2.2) and leave undisturbed for 30 min ± 5 min at room temperature.

NOTE It is also possible to use the fluid at its normal concentration for use, instead of distilled water.

Then proceed as indicated in B.5.5.2.1.

B.5.6 Expression of results

The fluid gumming tendency is expressed by the arithmetical mean of three tests of the force necessary to pull away the ring, expressed in mN/m. If the ring does not peel away at 180 mN/m, the result shall be recorded as > 180 mN/m.

B.6 Method B : Determination of the back solubility of the gums

B.6.1 Principle

Specified volumes of the machining fluid at the concentration normally used are placed in watch -glasses and submitted to evaporation under specified conditions. After evaporation, the fluidity of the residue and its solubility in water are determined under specified conditions.

B.6.2 Reagents and materials

B.6.2.1 **Water,** according to grade 2 of ISO 3696.

B.6.2.2 **Mixture,** made up of 50 ml of toluene (B.6.2.4), with 5 ml of water (B.6.2.1) and 495 ml of anhydrous isopropyl alcohol (B.6.2.5).

B.6.2.3 **Water,** according to grade 3 of ISO 3696.

B.6.2.4 **Toluene,** technical grade.

B.6.2.5 **Isopropyl alcohol,** technical grade.

B.6.3 Apparatus

Usual laboratory apparatus and glassware together with the following:

B.6.3.1 **Watch-glasses,** with an external diameter of 100 mm. Two are needed.

B.6.3.2 **Beaker,** of 1 000 ml capacity, low-sided.

B.6.3.3 **Separating funnel,** of 100 ml capacity, and support.

B.6.3.4 **Natural convection oven,** capable of maintaining a temperature of 70 °C ± 2 °C.

B.6.3.5 **Forced convection oven,** capable of maintaining a temperature of 70 °C ± 2 °C

B.6.3.6 **Mechanical agitator,** capable of operating at 600 r/min, and its chuck.

B.6.3.7 **Stainless steel blade,** fitted in the agitator, 120 mm long, 19 mm wide and 1,5 mm thick.

B.6.3.8 **Desiccator,** equipped with a drying agent (e.g. silica gel).

B.6.3.9 **Folded filter paper,** 185 mm diameter.

B.6.4 Procedure

NOTE This test can also be used to evaluate the gumming tendency of a water-miscible machining fluid in use. In this case, care must be taken to separate out the foreign oils, using the separating funnel (B.6.3.3) for 4 h. The separated aqueous phase is then filtered on the folded filter paper (B.6.3.9) placed in a funnel.

B.6.4.1 Evaporation

Into two watch-glasses (B.6.3.1), weighed beforehand to the nearest milligram, transfer 20 ml of the product to be tested. Place the watch-glasses respectively:

— in a natural convection oven set to 70 °C ± 2 °C for 24 h;

— in a forced air oven set to 70 °C ± 2 °C for 15 h.

At the end of the indicated periods, remove the watch-glasses from the ovens and place them in the desiccator (B.6.3.8) to cool for 1 h. Then weigh each of the watch-glasses and deduce the mass of the dry residue *A*.

B.6.4.2 Evaluation of the residue

B.6.4.2.1 Flow properties

One of the two watch-glasses (B.6.3.1) containing the residue after evaporation is maintained in a vertical position (between the thumb and forefinger). The time taken for the first drop to appear on the edge of the watch-glass is then measured.

If this time is:

— less than 30 s, the residue is considered to be fluid;

— more than 30 s, the residue is considered to be non-fluid.

The appearance of the residue is also noted:

— presence or absence of crystalline deposits;

— adhesive aspect (creation of a thread by pulling).

B.6.4.2.2 Determination of the back solubility of the residue

A diagram of the apparatus is given in figure B.3.

The mechanical agitator (B.6.3.6), fitted with its blade (B.6.3.7), is positioned so that the edges of the blade are situated 10 mm from the bottom of the beaker (B.6.3.2) and 15 mm from the edge.

The beaker (B.6.3.2) is filled with water[2)] (B.6.2.1) to a point 35 mm below the upper edge.

The watch-glass (B.6.3.1) is fixed onto the support, with the concave side towards the blade of the agitator.

The watch-glass must be totally immersed in the water, with its lowest edge 10 mm from the bottom of the beaker and the edges of the horizontal diameter touching the side of the beaker.

Set the agitator rotating at a speed of 600 r/min ± 10 r/min for 15 min ± 15 s.

At the end of this time, remove the watch-glass, dip it three times for 2 s in a beaker containing water (B.6.2.3) and leave it to drain for 15 s ± 1 s. If residues have been deposited on the back of the watch-glass, remove them using a paper soaked in the mixture (B.6.2.2).

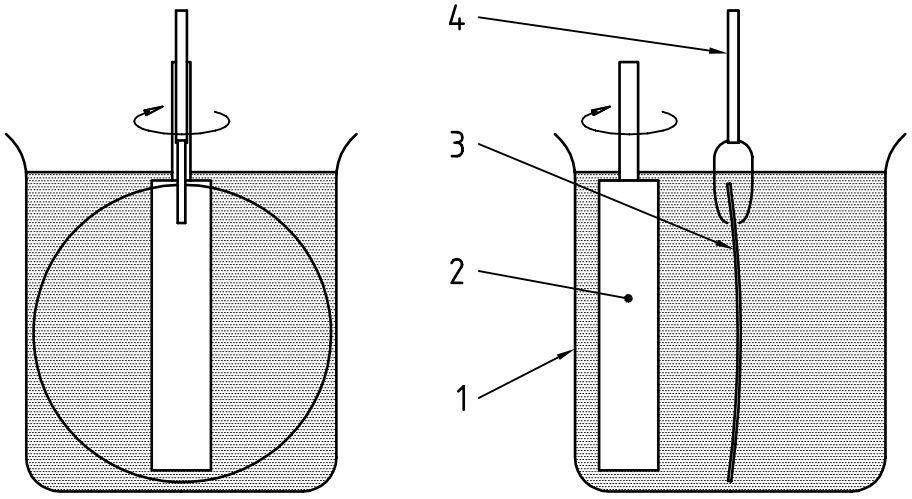
Then, dry the watch-glass in the oven (B.6.3.4) for 2 h ± 5 min at 70 °C ± 2 °C. At the end of this time, leave it to cool for 1 h in the desiccator (B.6.3.8). Then weigh the watch-glass and deduce the mass of residue *B*.

B.6.5 Calculation

The back solubility of the residue, *S*, in percentage *(m/m)* is expressed by means of the following equation:

$$S = \frac{A - B}{A} \times 100 = \frac{C}{A} \times 100$$

2) The water can be replaced with the fluid at the concentration normally used



Key

1 Beaker
2 Raddle of the stirrer
3 Watch-glass
4 Nippers

Figure B.3 — Device to solubilize the residue

where

A is the mass of dry residue obtained in B.6.4.1;

B is the mass of residue obtained in B.6.4.2.2;

C is equal to *A* - *B*, the mass of soluble product.

B.6.6 Expression of results

The fluidity and the appearance of the residue are expressed according to B.6.4.2.

The back solubility of the residue *S* (%) is determined on the residues obtained under the two types of evaporation conditions (B.6.4.1) (S_{24h} and S_{15h}).

B.7 Method C: Determination of the adhesive force of a spindle/bore fit

B.7.1 Principle

A stainless spindle is set in place, in the presence of the fluid, in a block containing a bore. The block/steel assembly is dried and then placed on the pan of a balance which can be used to measure the effort necessary to detach the spindle from the bore.

B.7.2 Reagents and materials

B.7.2.1 Chloroform, technical grade.

B.7.2.2 Acetone, technical grade.

B.7.3 Apparatus

Usual laboratory apparatus and glassware together with following:

B.7.3.1 Stainless steel block, 22 mm in diameter and 15 mm high, pierced at the centre by a hole 8 mm in diameter (see figure B.4).

Dimensions in millimetres

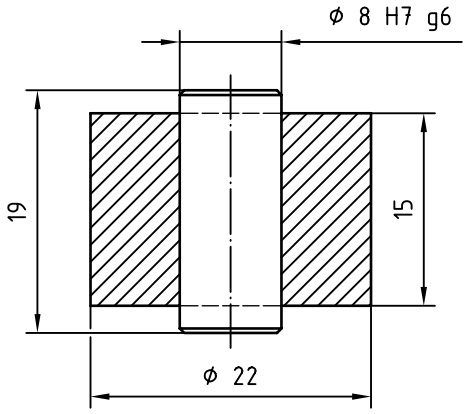


Figure B.4 — Bore/spindle system

B.7.3.2 Stainless steel spindle, 8 mm in diameter and 19 mm high, tapered on both sides. This spindle is fitted into the hole in the block H7 g6, according to ISO 286-2 (see figure B.4).

B.7.3.3 Beaker, of 100 ml capacity, low-sided.

B.7.3.4 Balance, accurate to the nearest 0,1 mg.

B.7.3.5 Lint-free paper.

B.7.4 Procedure

B.7.4.1 Cleaning of the bore in the block and the spindle

The bore in the block (B.7.3.1) and the spindle (B.7.3.2) are carefully cleaned using the lint-free paper (B.7.3.5) soaked in chloroform (B.7.2.1) in order to remove any residues/deposits/gum remaining from the previous test. After cleaning, they are rinsed in acetone (B.7.2.2) and dried at room temperature.

B.7.4.2 Measurement

The emulsion prepared in B.4 is transferred to the beaker (B.7.3.3). The block (B.7.3.1) is immersed in the emulsion and the spindle (B.7.3.2) is then fitted into the hole in the block (see figure B.5).

The block/spindle assembly is then removed from the emulsion and left to dry at room temperature for 96 h ± 1 h.

At the end of this period, the assembly is placed on the pan of the balance (B.7.3.4) and the force necessary to separate the spindle from the bore can be measured by pressing the spindle with a finger (see figure B.6).

B.7.5 Expression of results

Express the results as the force *F,* in newtons, needed to separate the spindle from the bore.

$$F = (m_s - m_a) \times 9{,}81 \times 10^{-3}$$

where

m_a is the mass, in grams, of the assembly ;

m_s is the mass, in grams, corresponding to the separation.

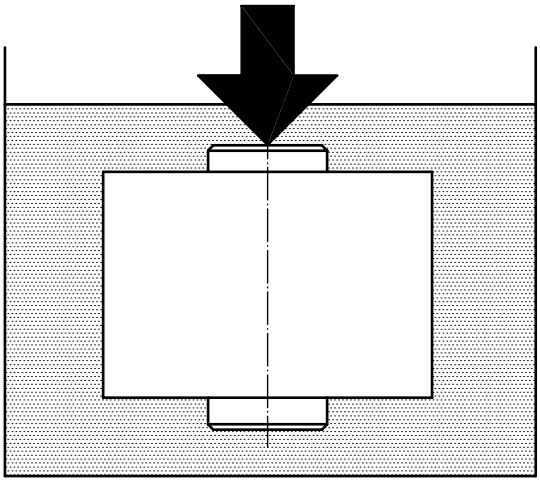


Figure B.5 — Bore/spindle system Adjustment of the product

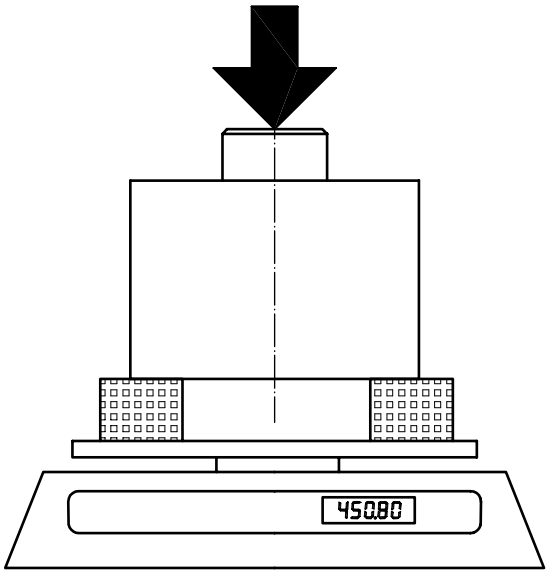


Figure B.6 — Determination of the adherence force between bore and spindle

B.8 Method D: Determination of the adhesive force between two flat surfaces

B.8.1 Principle

Two flat surfaces coated with the product to be tested are subjected to desiccation under specified conditions. After desiccation, a traction machine is used to determine the force necessary to separate the two surfaces.

B.8.2 Reagents and materials

B.8.2.1 **Chloroform,** technical grade.

B.8.2.2 **Acetone,** technical grade.

B.8.3 Apparatus

Usual laboratory apparatus and glassware together with the following:

B.8.3.1 **Steel templates,** four are needed (see figure B.7).

B.8.3.2 **Covers,** corresponding to each template (see figure B.7).

B.8.3.3 **Masses of 1 kg.** Eight are needed.

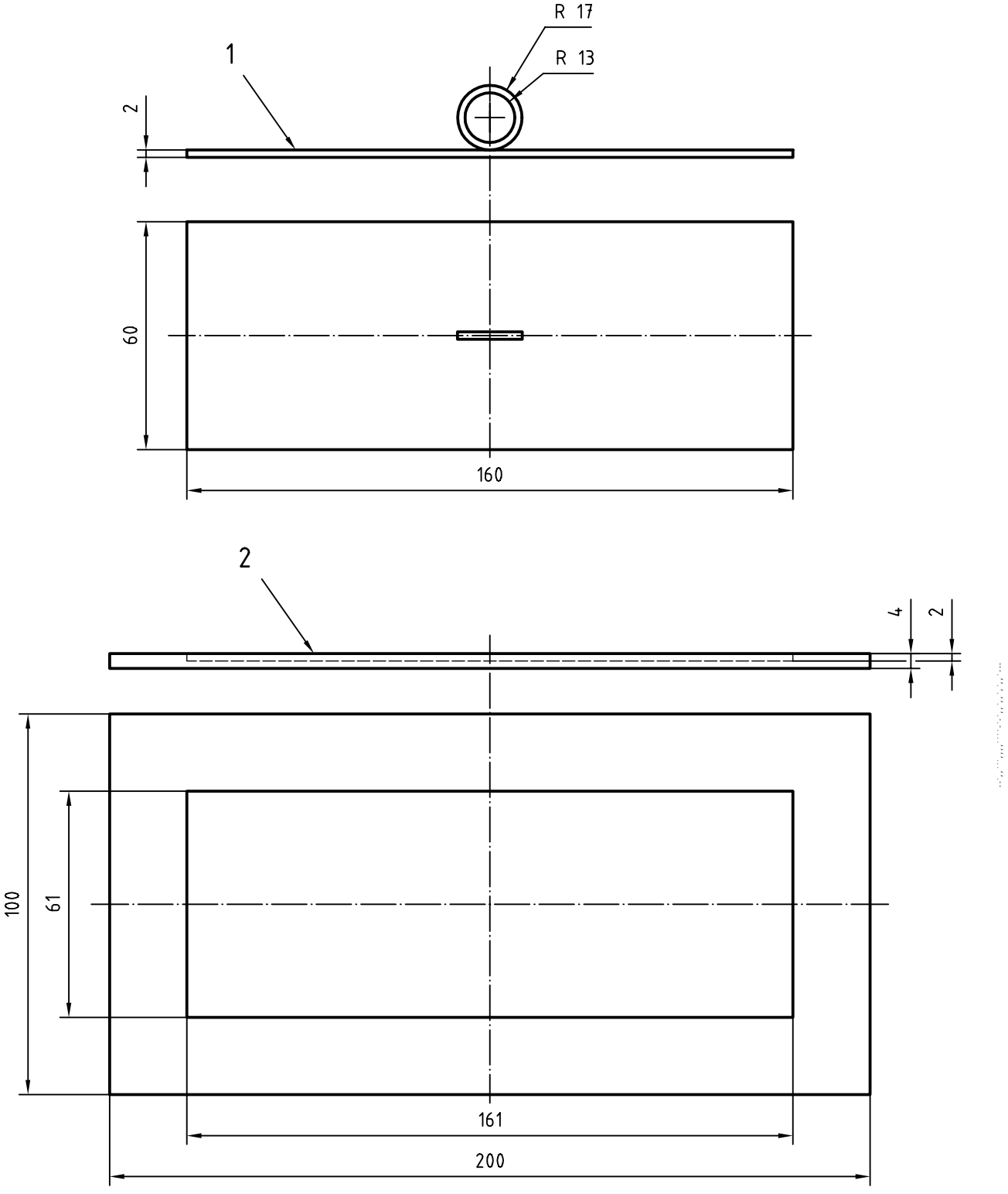
B.8.3.4 **Natural convection oven,** capable of maintaining a temperature of 105 °C ± 2 °C.

B.8.3.5 **Paint brush**

B.8.3.6 **Glass rod**

B.8.3.7 **Traction machine,** capable of providing a pull speed of 75 mm/min, equipped with a cell for measuring forces of up to 5 kN.

Dimensions in millimetres



Key

1 Cover

2 Template

Figure B.7 — Template and cover

B.8.3.8 Lint-free paper

B.8.3.9 Balance, accurate to the nearest 0,1 mg.

B.8.4 Procedure

B.8.4.1 Cleaning of templates and covers

The templates (B.8.3.1) and covers (B.8.3.2) shall be carefully cleaned using the paper (B.8.3.8) soaked in chloroform (B.8.2.1), then rinsed in acetone (B.8.2.2) and dried in the ambiant air.

B.8.4.2 Measurement

4 g ± 0,1g of the fluid to be tested are weighed inside each of the four templates (B.8.3.1) and then spread using the glass rod (B.8.3.6). The templates are then placed in the oven (B.8.3.4) at 105 °C ± 2 °C for 60 min ± 5 min.

At the end of this period, remove the four templates from the oven. The four covers (B.8.3.2), carefully coated with the fluid to be tested using the paint brush (B.8.3.5), are placed on the templates in such a way that the two surfaces adhere totally.

Two masses (B.8.3.3) are placed on each of the four covers. The templates, covers and masses are then returned to the oven for 60 min ± 5 min at 105 °C ± 2 °C, after which they are removed and cooled at room temperature for at least 3 h. The masses are left on each cover.

The masses are then removed. The template/cover assembly is placed in the traction machine (B.8.3.7) with the pull speed set to 75 mm/min. The force *F* required to separate the cover from the template is then measured in newtons.

B.8.5 Expression of results

The test is performed twice. This gives height measurements of the force *F* (F_i). The force *F* is then expressed by means of the following equation:

$$F = \frac{1}{8}\sum_{i=1}^{i=8} F_i$$

The value of the gumming *G* is expressed in newtons per square metre by means of the following equation:

$$G = \frac{F}{S}$$

where

S is the area, in square metres, of contact between the cover and the template.

B.9 Test report

The test report shall contain at least the following information:

a) the type and complete identification of the product under test;

b) a reference to the method used, i.e. ISO/TS 12927/annex B/method A, B, C or D;

c) the concentration of the aqueous fluid (see B.4);

d) the hardness of the water used (for methods A, C and D);

e) the result of the test:

— method A, according to B.5.6;

— method B, according to B.6.6;

— method C, according to B.7.5;

— method D, according to B.8.5 ;

f) any deviation, by agreement or otherwise, from the procedure specified;

g) the date of the test.

B.10 Bibliography

NF T 60-188, *Aqueous machining fluids — Preparation of synthetic water for testing*

DIN 51360, *Testing of cooling lubricants — Determination of corrosion preventing characteristics of water mixed cooling lubricants — Chip/filter paper method*

Annex C
(informative)

Water-miscible machining fluids — Evaluation of the biological stability

Warning — The use of this method may involve hazardous materials, operations and equipment. This method does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this Technical Specification to establish appropriate safety and health practice and determine the applicability of regulatory limitations prior to use.

NOTE This method is currently under study to become a French standard (AFNOR).

C.1 Scope

The purpose of this method is to evaluate the biological stability of water-mixed machining fluids, fresh, diluted in a water of known hardness. This method applies to categories MAA to MAH.

C.2 Referenced standards

DIN 51360:1981, *Testing of cooling lubricants — Determination of corrosion preventing characteristics — Chip/filter paper method*

IP 287:1994, *Determination of rust prevention characteristics of water mix metal working fluids — Chip/filter paper method*

NF T 60-186:1993, *Aqueous metalworking fluids — Evaluation of rust prevention properties on contact with ferrous metals*

NF T 60-193:1993, *Aqueous machining fluids — Determination of the pH value*

C.3 Principle

A given volume of dilution of the test product is circulated in a special apparatus. The following parameters are set: volume, flow rate, temperature, concentration and dilution water.

At regular intervals, the liquid is inoculated with a special inoculum. Simultaneously, samples of the liquid are taken out to check the growth of the bacterial population and the following characteristics: pH value, rust protection properties.

C.4 Reagents and materials

C.4.1 Water, according to grade 2 of ISO 3696.

C.4.2 Calcium chloride hexahydrate ($CaCl_2 \cdot 6H_2O$), analytical grade.

C.4.3 Magnesium sulfate heptahydrate ($MgSO_4 \cdot 7H_2O$), analytical grade.

C.4.4 Cast-iron chips, from NF T 60-186, IP 287 or DIN 51360 are suitable.

C.4.5 Inoculum, consisting of seven species:

a) five bacteria:

— pseudomonas oleovorans;

— pseudomonas aeruginosa;

— escherichia coli;

— citrobacter freundii;

— proteus vulgaris;

b) one yeast:

— Candida lipolitica;

c) one fungus:

— Fusarium solani.

The inoculum is kept freeze-dried and is available in disks. Each dose, for a single inoculation contains 10^8 viable bacteria, 10^7 viable yeasts and 10^3 viable fungi. Before use, the inoculum is slowly rehydrated in 10 ml of water during 30 min to 35 min.

NOTE A suitable inoculum is available from: MTS Microbiologie Test Services - Zone Industrielle de Carros - B.P. 83 - 06 513 CARROS - FRANCE - Tel: +33 4 92 08 61 20.

This information is given for the convenience of users of this Technical Specification and does not constitute endorsement by ISO of this product.

C.4.6 Cleaning product, hypochlorite free.

C.5 Apparatus

Usual laboratory apparatus and glassware together with the following:

C.5.1 Circulating system, as described in figure C.1, consisting of:

C.5.1.1 Stainless steel kettle, cylindrical with a conical bottom, with a capacity of 10 l, fitted with a level indicator and a removable cover. The bottom exit pipe, fitted with a vane, shall be protected with a stainless steel grid (120 mm × 120 mm; sieve 1/1; cross wires of 0,6 mm diameter). Figure C.2 gives a drawing of the kettle.

C.5.1.2 Tripod to support the kettle (C.5.1.1).

C.5.1.3 Glass refrigerating coil, connected to tap water (tube of 7 mm internal diameter, 5 spires of 210 mm diameter).

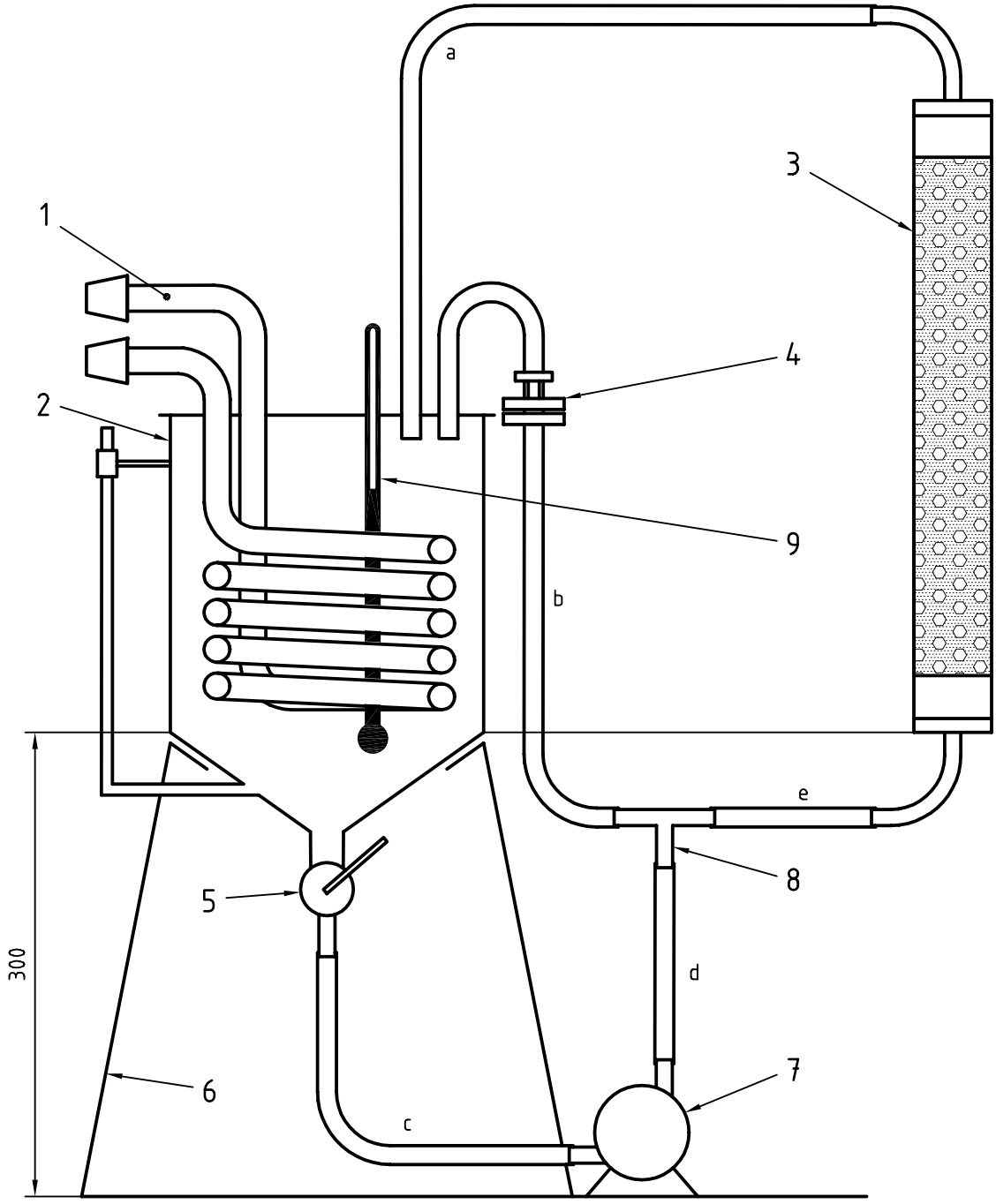
C.5.1.4 Stainless steel centrifugal pump, capable of a 350 l/h flow rate at 6 m pressure head.

C.5.1.5 Glass column (see figure C.2).

C.5.1.6 Tubes, silicon rubber (10 mm internal diameter).

C.5.1.7 Y connection.

Dimensions in millimetres



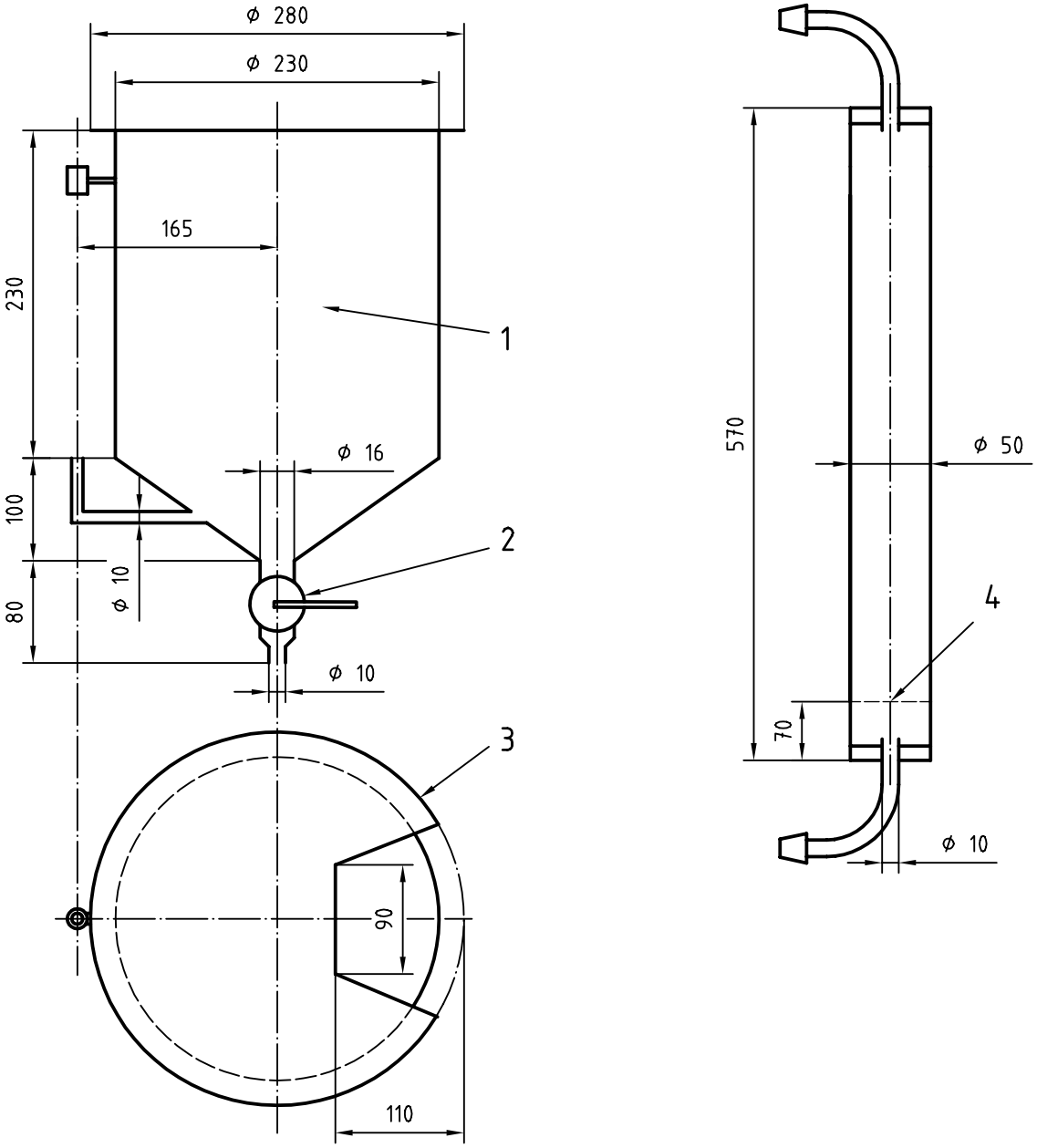
Key

1 Coil (C.5.1.3)
2 Kettle (C.5.1.1)
3 Column (C.5.1.5)
4 Mohr clamp (C.5.7)
5 Bushel valve
6 Tripod (C.5.1.2)
7 Pump (C.5.1.4)
8 Y connection (C.5.1.7)
9 Thermometer (C.5.4)

Length of the tubes (C.5.1.6): a = 500 mm ± 50 mm
b = 450 mm ± 50 mm
c = d = 200 mm ± 50 mm
e = 300 mm ± 50 mm

Figure C.1 — Schema of the circulation system

Dimensions in millimetres



Key

1 Kettle (C.5.1.1)
2 Bushel valve
3 Cover
4 Glass grid

Kettle and cover (C.5.1.1) Glass column (C.5.1.5)

Figure C.2 — Schema of the kettle, cover and glass column

C.5.1.8 All necessary holding devices (clamps, fixtures, etc...).

C.5.2 Glass balls of 6 mm, 8 mm and 10 mm diameter.

C.5.3 Gauze band, complying with national pharmacopoeias.

C.5.4 Thermometer, up to 60 °C, accuracy 1°C.

C.5.5 Graduated cylinder, 250 ml.

C.5.6 Graduated cylinder, 2 000 ml.

C.5.7 Mohr clamp.

C.5.8 Beaker, of 200 ml capacity. Four are needed.

C.5.9 Cleaning devices, for example bottle brush.

C.5.10 Chronometer, or stop watch, accurate to 1 s.

C.5.11 Nylon brush, nail type.

C.5.12 Sampling bottles of 100 ml capacity, with an opening of 30 mm minimum.

C.5.13 Apparatus necessary for microbiological counts:

C.5.13.1 Bacteriological oven, regulated at 30 °C ± 0,5 °C.

C.5.13.2 Laboratory oven, regulated at 180 °C ± 2 °C or autoclave regulated at 120 °C ± 2 °C.

C.5.13.3 Culture media, for the counts of:[3)]

— total germs (dip slide);

— yeast (dip slide);

— moulds (dip slide);

C.5.14 Calibrated flask, of 1 000 ml capacity.

C.5.15 Balance, accurate to the nearest 0,1 mg.

C.6 Procedure

Mount the test rig described in figure C.1 without the column. Choose a location, neither in a dark area nor directly exposed to sun shine.

3) ORION DIAGNOSTIVA (EASICULT TTC for total germs, EASICULT M for yeast and moulds), DIFCO (HYCHECK Total count, HYCHECK for yeast and moulds), STERLING (STERIBIOTEST GKT Total count, STERIBIOTEST HS for yeast and moulds), are examples of suitable products available commercially. This information is given for the convenience of users of this method and does not constitute an endorsement by ISO of these products. Equivalent products may be used if they can be shown to lead to the same results.

C.6.1 Filling of the column

Weigh 200 g ± 10 g of each type of glass balls (C.5.2) and 15 g ± 1 g of cast-iron chips (C.4.4) in the four beakers (C.5.8)).

Stack four thicknesses of gauze (C.5.3) on the glass grid of the glass column (C.5.1.5).

Add the biggest glass balls and then the smallest ones to the column, and finally add the cast-iron chips.

Fix the nozzles and connect the column to the circulating system (see figure C.1).

C.6.2 Preparation of the metalworking fluid solution.

Prepare 5 l of test water by dissolving 0,380 g ± 0,001 g of calcium chloride (C.4.2) and 0,066 g ± 0,001 g of magnesium sulfate (C.4.3) per 1 000 ml of water (C.4.1) using the flask (C.5.14) and the balance (C.5.15).

NOTE 1 This preparation should preferably be done on Monday.

Fill the kettle (C.5.1.1) with 4 850 ml ± 50 ml of the prepared test water, using the cylinder (C.5.6), the water temperature [measured with the thermometer (C.5.4)], being 23 °C ± 2 °C, and open the valve.

NOTE 2 Any other suitable water can be used.

Start the pump (C.5.1.4) and, by means of the Mohr clamp (C.5.7), regulate the flow rate at the exit of the glass column to a value of 80 l/h ± 10 l/h determined by means of the graduated cylinder (C.5.5) and the stop watch (C.5.10).

After 1 min of circulation of the water (C.4.1), add, by means of the cylinder (C.5.5), 150 ml ± 5 ml [3 % (*V/V)*] of the machining fluid.

NOTE 3 Any other concentration can be used.

Rinse the cylinder (C.5.5) by means of the solution so obtained.

Put the cover on the kettle.

Allow the water to circulate in the refrigerating coil (C.5.1.3) and adjust the water flow rate so as to maintain the temperature of the solution at a value of 23 °C ± 2 °C [measured with the thermometer (C.5.4)].

NOTE 4 Other temperatures can be used, depending on the applications of the water-miscible fluid (metal rolling for example). Application of higher temperatures up to 65 °C will require the selection of other bacteria species.

This is the starting time of the test, t_0.

C.6.3 Carrying out of test

Perform the test according to the cycle described in table C.1.

The operation shall be carried out in the order 1 to 8.

Perform the cycle described in this subclause six times.

NOTE During the testing, it is worth noting any change in the aspect of the circulating solution, for example: deposit formation, foam appearance.

During interruption of the test at the weekend, close the inlet of the column with a Mohr clamp to avoid drying of the column.

The samples shall be examined during the 24 h after sampling.

Table C.1 — Cycle of operation

Operations	No.	Time after time (t_0) of start up or start up again						
		Monday 5 min max.	Tuesday 24 h ± 1 h	Wednesday 48 h ± 1 h	Thursday 72 h ± 1 h	Friday 96 h ± 1 h	Weekend	Monday 168 h ± 1 h[a]
Sampling of 100 ml in the bottle (C.5.12) at the outlet of the column	1	X						X
Determination of pH[b] and rust protection[c]	2	X						X
Total germs: - dipping of the slide - reading	3			X	X	X[d]		
Yeasts: - dipping of the slide - reading	4			X		X		X[d]
Moulds - dipping of the slide - reading	5			X		X		X[d]
Inoculation with the inoculum (C.4.5)	6	X	X	X	X	X		X[e]
Top up of the kettle with fresh fluid solution[f]	7	X						X[e]
Stop the circulating of the fluid during 64 h	8					X[g]		

a Monday "168 h" is also the beginning of the next cycle. For each cycle, start the same operation again at the same time.

b NF T 60-193 prescribes a suitable method (see C.2).

c NF T 60-186 prescribes a suitable method (see C.2).

d The second reading shall preferably be retained, except if it was not readable. The first reading being, in this case, taken into account. If the first reading was not readable (slide fully covered), the note "zero" shall be attributed.

e Except for the 6th cycle.

f At 3 % (*V/V*) concentration as in C.6.2.

g At t_0 + 104 h.

C.6.4 Microbiological counts

This subclause describes how to perform the microbiological counts of the aqueous cutting fluids during testing of biological stability. This method of microbiological counts is a simplified one, using preprepared culture media, specified according to the species to be numbered.

C.6.4.1 Operating procedure on total germs, yeasts and moulds

The sampling bottle (C.5.12) shall be sterilized at 120 °C under 1 bar in the autoclave (C.5.13.2) or at 180 °C in the oven (C.5.13.2) during at least 2 h.

The seeding of the culture media shall be carried out within 2 h of the sampling. If not, the sample shall be kept in the dark, at 5 °C ± 2 °C.

Dip the slide covered with the appropriate culture medium in the sample for 30 s. Put the slide in the tube. Place the tube in the bacteriological oven (C.5.13.1) for incubation.

At the end of the incubation period, read the number of colonies and/or compare the aspect of the culture media against comparison boards.

NOTE The incubation period is generally 48 h for the total germs, between 48 and 96 h for yeasts and moulds.

In any case, follow the instruction of the dip-slide suppliers (see C.5.13.3).

C.6.4.2 Disposal of the slides

The slides can be easily disposed off by:

— incineration;

— dipping in a disinfectant medium;

— desinfection through autoclave.

C.6.5 Cleaning of the system

Drain out the system.

Dismantle the tubes (C.5.1.6) and the stainless steel grid of the kettle (C.5.1.1). The tubes must be discarded.

Empty the column (C.5.1.5) and discard the mixture of glass balls and chips.

Clean with tap water blended with the cleaning product (C.4.6) and, with the help of the brush (C.5.11) and the cleaning devices (C.5.9), all parts of the circulating system, including the pump (C.5.1.4).

Rinse the whole assembly five times with tap water.

Mount the apparatus for a new test.

C.7 Results

In table C.3, gather all the results obtained during the trial:

— total germs (*GT*) and rating;

— yeasts (*Y*) and rating;

— moulds (*M*) and rating;

— pH value and rating;

— rust-protection properties and rating.

Ratings are given in table C.2.

The biostability of a metalworking fluid solution is established by giving, after each cycle, an overall rating corresponding to an average of the rating value of the five characteristics checked.

C.8 Precision

The precision of the present method is under evaluation.

Table C.2 — Ratings

Number of total germs/ml (*GT*)	Rating	Moulds presence (*M*)	Rating
10^3	10	none	10
from 10^3 to 10^4	6	+	6
from 10^4 to 10^5	4	++	2
from 10^5 to 10^6	2	+++	0
10^6	0		
Number of yeasts/ml (*Y*)	**Rating**		
10^3	10		
from 10^3 to 10^4	6		
from 10^4 to 10^5	4		
from 10^5 to 10^6	2		
10^6	0		
pH Variation [a]	**Rating**	**Corrosion Value**	**Rating**
0 to 0,3	10	0-0	10
from 0,3 to 0,5	6	0-1	10
from 0,5 to 0,7	4	1-0	10
from 0,7 to 0,9	2	1-1	10
0,9	0		
		1-2	6
		2-2	2
		2-3	2
		2-4	2
		3-3	0
		3-4	0
		3-5	0

[a] Compared to pH value of the fresh product.

Table C.3 — Biological stability of aqueous machining fluids - Table of results

	Annex C of ISO/TS 12927						NF T60-193		NF T60-186		Global rating
	Total Germs (*GT*)		Yeasts (*Y*)		Moulds (*M*)		pH		Corrosion		
Cycle	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating	
N° 0											
N° 1											
N° 2											
N° 3											
N° 4											
N° 5											

C.9 Test Report

The test report shall contain at least the following information:

a) the type and complete identification of the product under test;

b) a reference to this method, i.e. ISO/TS 12927, Annex C;

c) the result of the test according to C.7;

d) any observation of the variation of the aspect of the product during testing;

e) any deviation, by agreement or otherwise, from the procedure specified;

f) the date of the test;

C.10 Bibliography

PSA testing method D 60 1605 : "micro biological counts" [4)]

PSA testing method D 55 1721 : "biological stability of aqueous cutting fluids" [4)]

4) Available from: Secrétariat CNOMO, Automobiles CITROËN - Service DMS/GIO/CNE - 225, quai Aulagnier, 92600 Asnières, France.

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