

Nederlandse norm

NEN-EN 14652+A1 (en)

Apparatuur voor het conditioneren van
drinkwater in gebouwen -
Membraanscheidingstoestellen - Eisen voor
functioneren, veiligheid en beproeving

Water conditioning equipment inside buildings -
Membrane separation devices - Requirements
for performance, safety and testing

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Nederlands voorwoord

Voor de in deze norm vermelde normatieve verwijzingen bestaan in Nederland de volgende equivalenten:

<u>vermelde norm</u>	<u>Nederlandse norm</u>	<u>titel</u>
EN 1092-1	NEN-EN 1092-1	Flenzen en hun verbindingen - Ronde flenzen voor buizen, afsluiters, hulpstukken en accessoires, PN-aanduiding - Deel 1: Stalen flenzen (en)
EN 1092-2	NEN-EN 1092-2	Flenzen en hun verbindingen - Ronde flenzen voor buizen, afsluiters, hulpstukken en toebehoren, met PN-aanduiding - Deel 2: Gietijzeren flenzen (en)
EN 1254-1	NEN-EN 1254-1	Koper en koperlegeringen - Hulpstukken - Deel 1: Hulpstukken met uiteinden voor capillaire of hardsoldeerverbinding aan koperen buizen (en)
EN 1567	NEN-EN 1567	Kranen in gebouwen - Waterdruk reducerende kleppen en waterdruk reducerende combinatiekleppen - Eisen en beproevingen (en)
EN 1717:2000	NEN-EN 1717:2000	Bescherming tegen verontreiniging van drinkwater in waterinstallaties en algemene eisen voor inrichtingen ter voorkoming van verontreiniging door terugstroming (en)
EN ISO 228-1	NEN-EN-ISO 228-1	Niet-afdichtende pijpschroefdraad - Deel 1: Afmetingen, toleranties en aanduiding (en)
EN ISO 3696	NEN-EN-ISO 3696	Water voor analytische laboratoriumdoeleinden - Eisen en beproevingsmethoden (en)
EN ISO 3822:series	NEN-EN-ISO 3822:reeks	Akoestiek (en)
ISO 7-1	-	-
ISO 304	-	-
ISO 1219-1	NEN 3348	Hydraulische en pneumatische systemen en componenten - Grafische symbolen (nl)
ISO 12103-1	-	-

English Version

**Water conditioning equipment inside buildings - Membrane
separation devices - Requirements for performance, safety and
testing**

Appareils de traitement d'eau à l'intérieur des bâtiments -
Dispositifs de séparation membranaire - Exigences de
performance, de sécurité et essais

Anlagen zur Behandlung von Trinkwasser innerhalb von
Gebäuden - Membranfilteranlagen - Anforderungen an
Funktion, Sicherheit und Prüfung

This European Standard was approved by CEN on 8 July 2005 and includes Amendment 1 approved by CEN on 10 May 2007.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

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Foreword

This European Standard (EN 14652:2005+A1:2007) has been prepared by Technical Committee CEN/TC 164 "Water supply", the secretariat of which is held by AFNOR.

This document shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2007 and conflicting national standards shall be withdrawn at the latest by December 2007.

This document includes Amendment 1, approved by CEN on 2007-05-10.

This document supersedes EN 14652:2005.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1 A1.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

With respect of potential adverse effects on the quality of water intended for human consumption caused by the product covered by this European Standard, the following is pointed out to the user of this European Standard:

- 1) this European Standard provides no information as to whether the product may be used without restriction in any of the Member States of the EU or EFTA;
- 2) it should be noted that, while awaiting the adoption of verifiable European criteria, existing national regulations concerning the use and/or the characteristics of this product remain in force.

1 Scope

This European Standard specifies requirements relating to the construction, performance and methods of testing for membrane separation systems with a particle rating below 1 µm, namely microfiltration (MF), ultrafiltration (UF), nanofiltration (NF) and reverse osmosis (RO) for drinking water installations inside buildings, intended to remove from the drinking water marginal concentrations of suspended and colloidal solids, microorganisms, organic molecules and/or to reduce the dissolved solids concentration and applies to systems with a minimum pressure of PN 10, connections between DN 15 and DN 100 and a maximum working temperature of at least 30 °C.

This European Standard applies to membrane separation systems, whose elements may be partly or entirely cleanable or disposable in accordance with the type of system. It only concerns units which are permanently connected to the mains supply at the point-of-entry or the point-of-use.

A membrane separation system may include, together with the separation device pre- and /or post-treatment devices.

For the scope of this European Standard:

- separation device shall comply with this European Standard, i.e. without pre-and/or post-treatments;
- where pre-and/or post-treatment devices are incorporated in the system, each of them shall conform to the relevant standard. If this is the case, the complete system shall be considered as conforming as a whole.

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.

EN 1092-1, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 1: Steel flanges*

EN 1092-2, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 2: Cast iron flanges*

EN 1254-1, *Copper and copper alloys — Plumbing fittings — Part 1: Fittings with ends for capillary soldering or capillary brazing to copper tubes*

EN 1567, *Building valves — Water pressure reducing valves and combination water pressure reducing valves — Requirements and tests*

EN 1717:2000, *Protection against pollution of potable water in water installations and general requirements of devices to prevent pollution by backflow*

EN ISO 228-1, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Dimensions, tolerances and designation (ISO 228-1:2000)*

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

EN ISO 3822 (all parts), *Acoustics — Laboratory tests on noise emission from appliances and equipment used in water supply installations*

ISO 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 304, *Surface active agents — Determination of surface tension by drawing up liquid films*

ISO 1219-1, *Fluid power systems and components — Graphic symbols and circuit diagrams — Part 1: Graphic symbols*

ISO 12103-1, *Road vehicles — Test dust for filter evaluation — Part 1: Arizona test dust*

3 Terms and definitions

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

3.1

accessible

fabricated to be exposed for cleaning and inspection using standard available tools if necessary (e.g., screwdriver, pliers, open-end spanner)

3.2

air gap (drain system)

unobstructed vertical distance through the free atmosphere between the outlet of the concentrated discharge pipe and the flood level rim of the receptacle into which it is discharging

3.3

air gap (water distribution system)

unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or faucet to a tank, plumbing fixture or other device, and the flood level rim of the receptacle

3.4

bubble point

minimum pressure required to overcome the surface tension of the water filling the pores of the membrane

3.5

component

separate or distinct part of a drinking water treatment system including, but not limited to, appurtenant accessories such as membranes, filters, housing, tubing, storage tanks, taps, valves, connectors to the feed water supply and connectors to the waste discharge line

3.6

contaminant

any undesirable chemical or microbiological substance or parameter in drinking water

3.7

cross-flow filtration

mode of operation by which part of the water passes through the membrane (product water) and the remaining part is rejected (reject water)

NOTE 1 The reject water, which can be wasted or partly recycled, plays the major role of keeping the membrane surface clean.

NOTE 2 Term "tangential flow" has the same technical meaning.

3.8

daily production

volume of product water produced by the system per day

3.9

dead-end filtration

mode of operation in which all the water feed passes through the membrane (no reject water). Depending on the rate of fouling/clogging of the membrane due to the retained substances, this filtration method is subject to declining rate of flow due to build up of retained matter. The membrane should be cleanable or disposable

3.10

device

complete, assembled, functional system

3.11

disposable component

component that requires periodic replacement

3.12

drinking water

water intended for human consumption as defined in Directive 98/83/EC

3.13

filtrate

water which is obtained by passage through microporous membranes (MF, UF)

3.14

flow controller

device for regulating the flow rate of water

3.15

grade of filtration

minimum membrane particle or dissolved substances rating which expresses the ability of the membrane to retain dissolved or un-dissolved solids of a given size range under normal working conditions irrespective of the nature of the membrane material

3.16

manufacturer

enterprise submitting the membrane module or the device for testing the compliance of that product to this European Standard

3.17

membrane

structure intervening for separating two phases and/or acting as a selective barrier to the transport of matter between the phases adjacent to it

NOTE It is categorised as membrane for MF, UF, NF or for RO in accordance with its construction and performance (see Annex B).

3.18

membrane flux

flow rate characteristics through the membrane that are dependant upon applied pressure and water temperature expressed in volume of product water per surface area unit of membrane and time

3.19

membrane material

material used for manufacturing membranes including organic (polymeric) and inorganic (ceramics, sintered metals or others) materials

3.20

membrane separation system

water treatment system which includes membrane, pressure vessel, fittings, gauges and ancillaries and which may include pre- and post-treatment components

3.21

microfiltration

process which removes particles of a size down to a given rating or a given molecular weight cut-off (MWCO)

NOTE Annex B gives information on each type of membrane.

3.22

module

smallest practical membrane unit which can be directly manifolded to feed streams to separate a feed stream into a reject and a permeate stream once placed in an appropriate housing

3.23

module housing

pressure vessel in which the module is accommodated

NOTE The membrane is usually tested in its final configuration (module) inside its housing specified by the manufacturer.

3.24

nanofiltration

process similar to reverse osmosis where the membrane has a looser structure thus reducing the rejection of monovalent ion

3.25

nominal flow rate

flow rate of water produced, in litres per hour, expressed in relation to the parameters indicated by the manufacturer (namely operating pressure and pressure drop)

NOTE In relation to the cross-flow mode of filtration it is also referred to as product or permeate flow rate.

3.26

operating pressure

pressure specified by the equipment manufacturer to ensure the expected performance

3.27

permeability

for a given fluid at given temperature (viscosity), it represents the flux of the given membrane as a function of the transmembrane driving force

NOTE The permeability coefficient is defined by Darcy's law.

3.28

permeate

water which has passed through the membranes

NOTE The term is currently used in general for membranes operating in the cross-flow mode, sometimes even MF and UF.

3.29

permanent pressure vessel

vessel that contains the cartridge, membrane or media which may be replaced or regenerated at the end of each rated service cycle and has an estimated service life greater than one year

3.30

point-of-entry device

water treatment system installed to treat the drinking water for the majority of the distribution system within the premises

3.31

point-of-use device

water treatment system used to treat the drinking water at a single tap or multiple taps but not for the majority of the facility

3.32

post-membrane treatment

additional treatment of the water subsequent to passage through the membrane(s)

3.33**pre-membrane treatment**

any pre-treatment intended to protect the membrane in order to improve its performance and/or to prolong its lifetime

3.34**product water**

water that has been treated by the system after blending with untreated water, if applicable

3.35**recovery rate**

percentage measure of the amount of influent water which is delivered as permeate with open permeate discharge applicable to cross-flow mode

The recovery rate is calculated by measuring the flow rate of the influent water and the product water (permeate) in accordance with Equation (1):

$$Y = \frac{Q_p}{Q_f} \times 100 \quad (1)$$

where

Y is the recovery rate, in %;

Q_p is the product water flow rate, in m³/h;

Q_f is the influent water flow rate, in m³/h.

3.36**rejection rate**

mean percentage of the un-dissolved particles and of the ionic and molecular (organic) substances removed by the membrane depending on the operating condition as well as on the type of membrane used

The rejection rate is calculated in accordance with Equation (2):

$$R = \left(1 - \frac{C_p}{C_f} \right) 100 \quad (2)$$

where

R is the rejection rate, in %;

C_f is the feed solution concentration of the considered substance;

C_p is the filtrate/permeate solution concentration of the considered substance.

3.37**reject water**

portion of the influent water which is drained to waste

3.38**reference filtration rating**

dimension, in micrometers, of particles at which the overall average cumulative filtration efficiency of a membrane module tested in accordance with the procedure described in A.3.1, is greater than or equal to 99,8 %

3.39

reverse osmosis

process that reverses, by the application of pressure, the flow of water in a natural process of osmosis so that water passes from a more concentrated solution to a more diluted solution through a semi-permeable membrane

3.40

service cycle

frequency of servicing (including replacement of disposable components of the system) required to maintain optimum performance

3.41

size range

contaminant rejection range which, dependent upon the intended function of the membrane, may refer to the size of suspended or colloidal particles and/or to the molecular weight of organic dissolved substances or to the ionic species to be removed

3.42

total dissolved solids (TDS)

remaining solids from a filtrate evaporated to dryness and dried to a constant weight at 180 °C after passing through a 0,45 µm filter

3.43

transmembrane differential pressure

pressure expressed as a function of P_i and P_o and calculated by Equation (3):

$$P_{tm} = (P_i + P_o) / 2 - P_p \quad (3)$$

where

P_{tm} is the transmembrane differential pressure;

P_i is the pressure at the inlet of the module;

P_o is the pressure at the outlet of the module;

P_p is the pressure of the permeate solution.

3.44

turbidity

condition caused by the presence of suspended matter, or colloidal matter, or both, which results in the scattering and absorption of light rays

3.45

ultra-filtration

process which removes dissolved large organic molecules in the size range of approximately 20 000 g/mol to 200 000 g/mol (1 g/mol = 1 Dalton)

NOTE The nominal efficiency is referred as cut-off range.

3.46

unit void volume

total water holding volume of a treatment system with the replaceable treatment components and disposable components in place

3.47

unit volume

total water holding volume of a treatment system with replaceable treatment components and disposable components removed

3.48

cleanable component

component which can be restored to its original, or close to its original, performance by washing in accordance with the manufacturer's instructions. Recovery may progressively deteriorate after successive washings, requiring ultimate replacement. The manufacturer supplies information on how to check the recovery and on criteria for disposal

4 Classification

The membrane separation devices are classified according to the following criteria:

a) membrane material:

- organic (synthetic polymeric structure);
- inorganic (ceramics, metals and metal alloys).

b) type of membrane.

The membrane device can be intended to exploit the following technologies:

- MF;
- UF;
- NF;
- RO.

The main characteristics and limitations of above technologies are given in the Annex B.

c) membrane configuration:

- plate and frame;
- tubular;
- spiral wound;
- hollow fibres.

d) mode of operation:

- dead-end filtration (washable or disposable membrane element);
- cross-flow filtration.

5 Symbols and abbreviations

The generic symbols are given in Table 1.

Table 1 — Generic symbols

Symbol or abbreviation	Parameter	Unit
C_f	Feed solution concentration of the considered substances	mg/l
C_p	Filtrate/permeate solution concentration of the considered substances	mg/l
C	Solid concentration	% m/m
D	Particle diameter	μm
F	Fluorescence of the suspension	—
c	Beads concentration in the fluorescent latex suspension	—
C_i	Influent water concentration	mg/l
$C_p(i)$	Concentration of the monodimensional particles of "X" diameter in the product water	mg/l
$C_i(i)$	Concentration of the monodimensional particles of "X" diameter in the feed water	mg/l
N	Number of particles/ml	—
i	Monodimensional fraction of solid particles	%
m_1	Volumetric mass of the latex suspension	m/v
m_s	Volumetric mass of the latex particles	m/v
P	Pressure in general (specified in the text with pedice and key)	kPa
P_T	First bubble pressure at T °C	kPa
P_{20}	First bubble pressure at 20 °C	kPa
P_{tm}	Transmembrane differential pressure	kPa
P_i	Pressure at the inlet of the module	kPa
P_o	Pressure at the outlet of the module	kPa
P_p	Pressure of the permeate solution	kPa
Q	Flow rate	m^3/h
γ_T	Surface tension at T °C	N/m
γ_{20}	Surface tension at 20 °C	N/m
ΔP	Differential pressure	kPa
λ	Conductivity	ms/m

The graphic symbols used shall conform to the requirements of ISO 1219-1.

6 Construction requirements

6.1 General

Unless otherwise indicated, the following requirements shall be complied with and tested, if necessary on the complete system (device) as supplied by the manufacturer.

6.2 Materials

The membrane, all other components of the separation device and additives in contact with drinking water shall comply with the relevant European Standards concerned with materials and chemicals in contact with drinking water.

A device exclusively assembled with components complying with above relevant European Standard does not require further testing related to materials in contact with drinking water unless differently stated by national regulations.

On the contrary (one or more components not specifically tested), the complete device will be tested in its final arrangement in accordance with the relevant test method unless differently stated by national regulations.

NOTE Products intended for use in water supply systems should comply, when existing, with national regulations and testing arrangements that ensure fitness for contact with drinking water. The Member states relevant regulators and the EC Commission agreed on the principles of a future unique European Acceptance Scheme (EAS), which would provide a common testing and approval arrangement at European level.

If and when the EAS is adopted, European Product Standards will be amended by the addition of an Annex Z/EAS under Mandate M/136 which will contain formal references to the testing, certification and product marking requirements of the EAS.

6.3 Resistance to temperature

Within the service temperature range indicated by the manufacturer, the device shall not have any operating problems due to temperature exposure.

Independently from above temperature range, the device should withstand a water temperature between 5 °C and 30 °C and between 5 °C and 35 °C for ambient air.

6.4 Resistance to hydrostatic pressure

The device shall resist, without damage and leakage, a hydrostatic pressure equalling 3 times the design nominal pressure, with a minimum of 1 MPa or 1,6 MPa if connected with a pressure regulating valve, when tested as defined in A.2.1.

NOTE 1 bar = 100 kPa = 0,1 MPa.

6.5 Resistance to cyclic pressure

The device shall withstand a cyclic pressure fluctuating between 150 kPa and 1,3 times the design nominal pressure, with a minimum of a 1 MPa, when tested as defined in A.2.2.

6.6 Backflow prevention

The device shall include an upstream backflow preventer in accordance with EN 1717.

6.7 Electrical safety

The device shall comply with the relevant safety regulations.

6.8 Noise level

The device shall comply with EN ISO 3822.

6.9 Air vent

The device shall ensure that any trapped air is removed in any operating condition.

6.10 End connections

The fittings used to assemble the device and to connect it with the water main shall conform to the requirements of the relevant European or International Standards EN 1092-1, EN 1092-2, EN 1254-1, ISO 7-1 and EN ISO 228-1.

6.11 Drain connections

Any drain fitting of the device shall be disconnected (air gap) from the drainage system in accordance with EN 1717.

6.12 Component replacement

Any special tool necessary for routine maintenance shall not come into contact with the water intended for human consumption and shall be provided by the device supplier.

The device shall be designed, and suitable instructions shall be provided, such that contamination of the treated water supply is avoided during the component replacement procedure.

6.13 Back-washable modules (MF and UF)

Back-washable modules shall be capable of being cleaned automatically without the aid of tools and the mechanism shall not compromise to the quality of the drinking water.

After back-washing, the module performance shall be recovered.

The back-washable module shall be fitted with a free drain outlet in accordance with EN 1717.

7 Performance requirements

7.1 General

The membrane module performance shall be specified by the manufacturer.

This clause details the minimum acceptable performance level dependent on the type of device, together with appropriate test methods.

The performance shall be rated with respect to the membrane module only (i.e. any pre-treatment and post-treatment excluded) and the challenge water shall contain only the contaminant(s) which the device is intended to remove (i.e. the challenge water shall not contain contaminants which would normally be removed by pre-treatment or post-treatment).

7.2 Hydraulic performance (applicable to MF, UF)

The manufacturer shall declare the maximum pressure drop through the membrane module at the recommended flow rate.

The claim shall be tested in accordance with the test method defined in A.1.1.

The maximum pressure drop shall not exceed the declared value by more than 10 % at the recommended nominal flow rate.

7.3 Mechanical performance

7.3.1 Housing resistance to static pressure

When subjected to a static pressure test as defined A.2.1, the module housing shall show no permanent, visible signs of leakage, permanent deformation, cracks or breaks.

7.3.2 Cyclic pressure test of housing

When tested in accordance with A.2.2, the filter housing shall satisfy the requirement of resistance cyclic pressure variations without showing permanent deformation or leakage.

7.3.3 Module resistance to differential pressure (collapse pressure)

When tested in accordance with A.2.3 and the module is subject to continuous and progressive blinding up to a pressure drop equivalent to 80 % of the nominal pressure rating of the housing, there shall be no discontinuity in the pressure rise, nor, after careful removal and cleaning, any visible damage to the module and module housing.

7.3.4 Module cyclic differential pressure resistance (applicable to MF, UF membranes operating in dead-end mode)

When subjected to a cyclic flow of water sufficient to generate a peak pressure drop of 200 kPa, or greater, at a cycle frequency of 0,05 Hz, for 500 cycles in accordance with A.2.4:

- pressure drop at the peak flow rate shall not fall off during the test;
- there shall be no visible evidence of damage to the module;
- bubble point for the module after the test shall not differ from that measured before the test, by more than 15 %.

7.4 Functional performance

7.4.1 Grade of filtration (particles rating)

7.4.1.1 General

Each membrane is claimed by the manufacturer to reject specific substances (e.g. particles of given size, organic molecules, different ions) to a specified extent (percentage or log-reduction).

The test procedure shall be appropriate to the manufacturer's claims and the relevant test methods could need to be adapted for the specific performance being claimed.

The following performance requirements are the ones commonly adopted for evaluating different types of membranes.

NOTE Most MF membrane manufacturers do not currently use the test method described in A.3.1 for testing the membrane efficiency at a claimed particle rating. They more commonly use test methods for testing the membrane integrity, i.e. the degree to which a membrane device rejects particles of interest.

The integrity tests are mostly based on the First Bubble Point principle, i.e. the surface tension of the water filling the pores of a membrane opposes the air to pass through the membrane when air pressure is applied to one side of the membrane. The Bubble Point is the minimum pressure required to overcome this surface tension which is inversely proportional to the

pore size. Therefore, the First Bubble Point of the membrane permits the calculation of the largest pore size of the membrane.

In practice the application of the test method is limited to the detection of membrane defects (pores larger than 1 µm to 2 µm, i.e. bubble points of 200 kPa to 100 kPa) while the integrity (log-reduction value) is directly measured with challenged water.

As there are many variants of the bubble point test method, which are very often proprietary of the membrane manufacturers, the suitable test methods for testing the MF membrane shall be agreed with the manufacturer himself together with the laboratory in charge of performing the test.

In principle, the bubble point test methods are applicable to any membrane (MF, UF, NF, RO) for detecting defects.

7.4.1.2 Filtration rating (applicable to MF)

The MF module, housed in the manufacturer's recommended pressure vessel, shall verify a filtration efficiency of at least 99,8 % at the manufacturer's designated particle rating for the module, and at the manufacturer's recommended maximum pressure drop, when tested in accordance with the method defined in A.3.1.

7.4.1.3 Organic molecule rejection – molecular cut-off (applicable to UF and to NF and RO only, if claimed)

When the membrane module is tested in accordance with A.3.2, the rejection rate shall not be less than 90 % of the manufacturer's stated value.

NOTE If the membrane is claimed to reject specific organic molecule(s), the challenge water will be spiked with the relevant contaminant(s). In that case the membrane/device manufacturer declares:

- minimum and/or maximum contaminant concentration in the challenge water;
- minimum rejection rate in the given concentration range;
- other testing conditions, which may affect the rejection rate, to be complied with.

In that case, such conditions will be clearly recorded in the performance data sheet of the device (see 8.3).

7.4.1.4 Salinity rejection rate (applicable to NF and RO)

When tested in accordance with the test method described in A.3.3, the membrane module shall achieve a rejection rate of at least 99 % of the manufacturer's stated value.

7.4.2 Recovery rate (daily production rate) (applicable to MF, UF, NF, RO operating in cross-flow mode)

The recovery rate shall be calculated when testing the relevant rejection rate (7.4.1.1, 7.4.1.2 and 7.4.1.3) in accordance with the test method described in A.3.4.

The actual calculated recovery rate shall be at least 95 % of the claimed recovery rate.

NOTE The recovery rate should not be calculated, if the corresponding rejection rate test has not been passed, i.e. the recovery rate compliance is meaningless, if the rejection rate is not complying with the rated claim.

7.4.3 Daily production

When tested in accordance with A.3.4, the daily production shall be at least 95 % of the value claimed by the manufacturer.

8 Instruction and information

8.1 Installation, operation and maintenance instructions – Instruction manual

Specific requirements of the influent water characteristics (e.g., chlorine, bacteria, pH, temperature, iron, turbidity, hardness, pressure) that may affect membrane or other components shall be provided in the language required by the relevant national regulations.

Information setting forth complete, detailed instructions for installation, operation, and maintenance shall be provided with each system. Specific instructions shall include:

- complete name, address and telephone number of manufacturer;
- type of device, model number and trade designation;
- flushing and conditioning procedures;
- production rate in l/d and peak flow rate in l/s for the specified and applicable operating conditions, e.g. pressure drop in kPa;
- maximum and minimum working pressure in kPa;
- maximum and minimum operating temperature in °C;
- detailed installation instructions including a description or schematic diagram of proper connection to the installation system as required by national regulations;
- operation and maintenance requirements, including user responsibility recommended spare parts, removal and disposal of consumables, etc., and where that maintenance and servicing are provided by a third party;
- diagram showing proper air gap installation to drainage system as stated in EN 1717:2000, Clause 9;
- statement describing the amount of water discharged as reject water, if applicable.

8.2 Marking and data plate

The direction of the water flow through the device shall be indicated by a clear and durable marking and shall be visible after installation.

A permanent plate or label shall be affixed to the system in a readily accessible location and shall contain at least the following information:

- model number of system;
- name and address of manufacturer;
- name and address of the after sales service of the provider. Where applicable and appropriate an additional label shall be put in place, with name and address, by the third party charged with maintenance and servicing;
- maximum operating temperature in °C;
- maximum and minimum working pressure in kPa.

8.3 Performance data sheet

A performance data sheet shall be made available to potential buyers for each system and shall include the following information:

- complete name, address and telephone number of manufacturer;
- model number and trade designation;
- reduction capabilities for specific contaminants verified to be reduced by test data including, in tabular form:
 - name of contaminant;
 - average influent and product water level during test and resulting percent reduction;
 - test parameters (temperature, pH and pressure);
- production rate in l/d;
- maximum and minimum working pressure in kPa;
- maximum and minimum operating temperature in °C;
- general installation conditions and needs;
- general operation and maintenance requirements including, but not limited to:
 - user responsibility;
 - replacement elements;
 - parts and service availability;
 - suggested frequency of element and cartridge(s) replacement or service;
- manufacturer's limited warranty.

Where applicable and appropriate, the following information shall be included:

- explanation of performance indicator;
- electrical requirements;
- model number of replaceable treatment components.

Annex A (normative)

Test methods

A.1 Hydraulic performance

A.1.1 General

Testing the differential pressure is applicable to MF and UF membranes operating in dead-end mode.

NOTE The following test should be performed after having tested the compliance of the module (with or without its housing) with the relevant performance test.

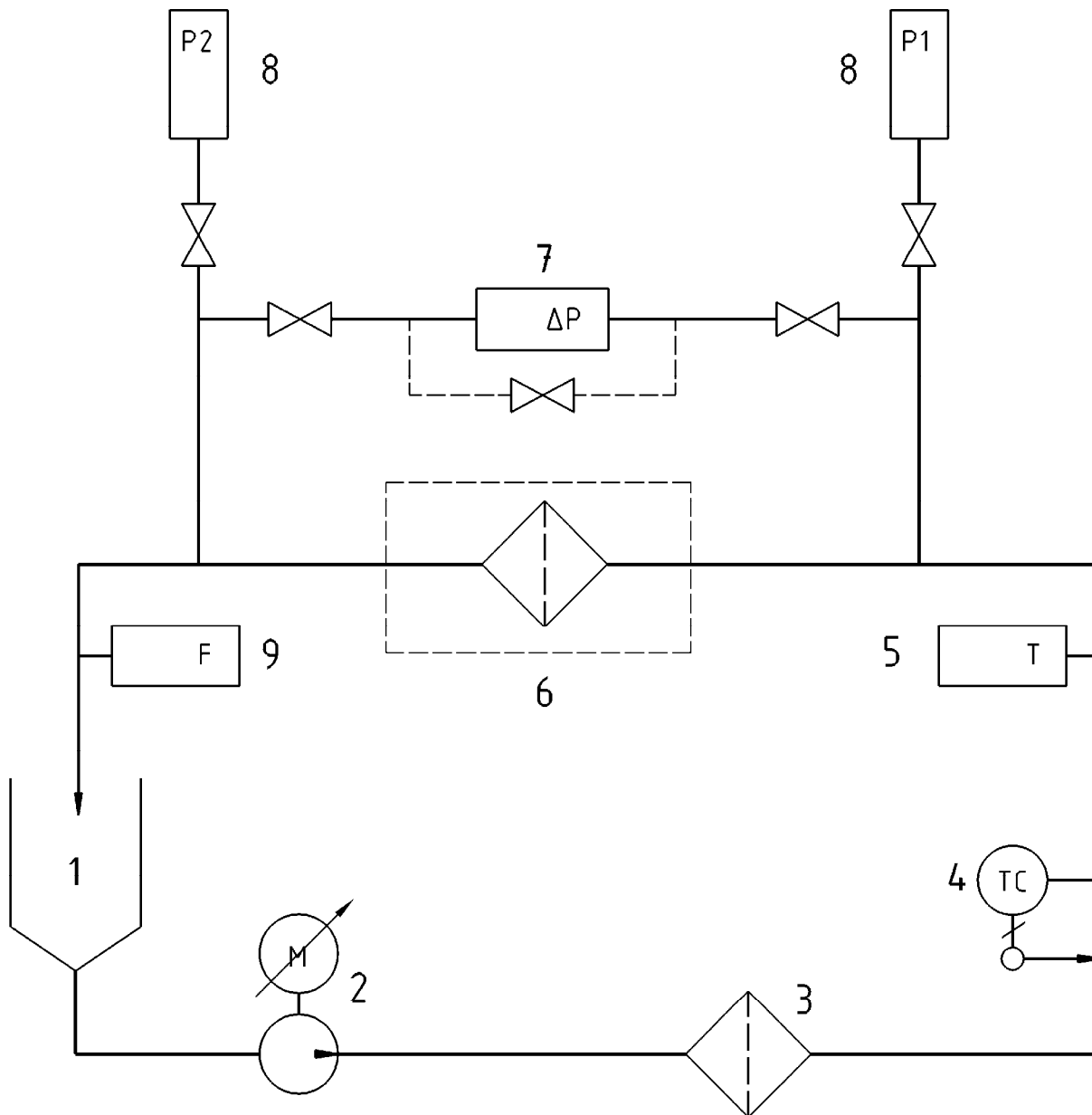
A.1.2 Principle

The test consists of imposing an increasing flow rate of water through the device with the membrane module and measuring the corresponding differential pressure.

A.1.3 Test equipment

The basic components of this test rig (see Figure A.1) are:

- a) source of pressurised water capable of supplying a flow rate 20 % greater than the maximum test flow rate. A suitable control device shall allow continuous variation of flow rate from zero to the desired value;
- b) tank that prevents air entrapment and air particle ingress;
- c) temperature gauge and regulator at $(25 \pm 2) ^\circ\text{C}$;
- d) clean-up filter with threshold smaller than $0,2 \mu\text{m}$;
- e) pressure tapings installed on a straight pipe on both sides of the filter at a distance equal to approximately 6 times the inside diameter upstream and 4 times the downstream diameter;
- f) test liquid: permeate from RO unit, freshly prepared ($< 24 \text{ h}$ before testing);
- g) measuring instruments with the precision as follows:
 - flow rate: $\pm 2 \%$ of actual value;
 - pressure: $\pm 2 \%$ of actual value;
 - temperature: $\pm 0,5^\circ\text{C}$.



Key

- 1 Tank with test liquid (RO permeate)
- 2 Pump
- 3 Clean-up filter (0,2 μm)
- 4 Temperature controller
- 5 Thermometer
- 6 Device to be tested
- 7 Differential pressure gauge
- 8 Pressure gauge
- 9 Flow meter

Figure A.1 — Typical layout of a rig for determination of the differential pressure of a filter element versus flow rate

A.1.4 Procedure

A.1.4.1 Test rig validation

- Install the housing without membrane module.
- Circulate the test liquid at $1,2 Q_v$, where Q_v is the nominal liquid flow rate, until the temperature stabilises at $(25 \pm 2) ^\circ\text{C}$ and, if necessary, until the circuit is clean.
- Ensure the absence of air and the stability of pressure values.

A.1.4.2 Test of the module housing

- Ensure first that, without the membrane module, water flow is not significantly modified by the housing. If there is flow perturbation, install a substitute element (e.g. perforated tube) that creates an identical flow path as similar as possible to that caused by the module. The section for passage through the substitute element shall be as large as possible to minimise the pressure drop. The characteristics of this substitute element shall be described in the test report.
- Adjust the flow rate to $0,2 Q_v$ and note P_1 and ΔP as well as the test liquid temperature.
- Repeat these operations for increasing flow rate values corresponding to increments of $0,2 Q_v$ up to $1,2 Q_v$.
- For each flow rate increment calculate and/or record the differential pressure across the filter housing.

A.1.4.3 Test of the device

- Install the module in the housing and mount the assembly on the test rig. Make sure that the bypass is fully closed.
- Establish circulation in order to expel the air from both the housing and the circuit.
- Repeat the above operations in A.1.4.2 b) to d), taking care to observe the same flow rate increments.

A.1.4.4 Characteristics of the module only

Calculate the pressure drop generated by the filter element only, by deducting the values obtained with the housing only, from those measured on the housing together with its module.

A.1.4.5 Test report

Report all test conditions and results. Plot curves $\Delta P = f(Q_v)$ for the housing alone, for the complete assembly and for the module alone.

A typical test report is given in C.1 and a typical test curve is shown in Figure C.1.

A.2 Mechanical performance

A.2.1 Housing resistance to static pressure (applicable to MF, UF, NF, RO membranes)

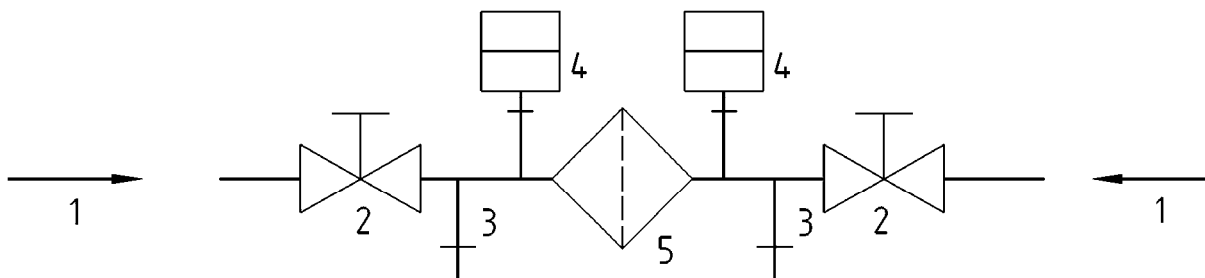
A.2.1.1 Principle

The pressure strength and water tightness of the module housing shall be tested by applying a water pressure of 3 times the nominal pressure P_N for a period of 10^{+2}_0 min.

Those components which are subject to hydrostatic pressure shall be designed for a nominal pressure of not less than 1 000 kPa. In accordance with EN 1567, the devices combined with pressure regulating valves shall be designed at a nominal pressure of not less than 1 600 kPa.

A.2.1.2 Procedure

- a) Install the housing in a test rig as shown in Figure A.2.



Key

- 1 Pressurising device
- 2 Stop valve/solenoid valve
- 3 Drain valve
- 4 Pressure gauge
- 5 Test specimen

Figure A.2 — Cyclic water pressure test of housing

- b) Flush with water to purge air from the circuit.
- c) Increase the pressure to 3 times the nominal pressure P_N and maintain the pressure for 10^{+2}_0 min.
- d) Examine the housing for visible evidence of leakage or damage.

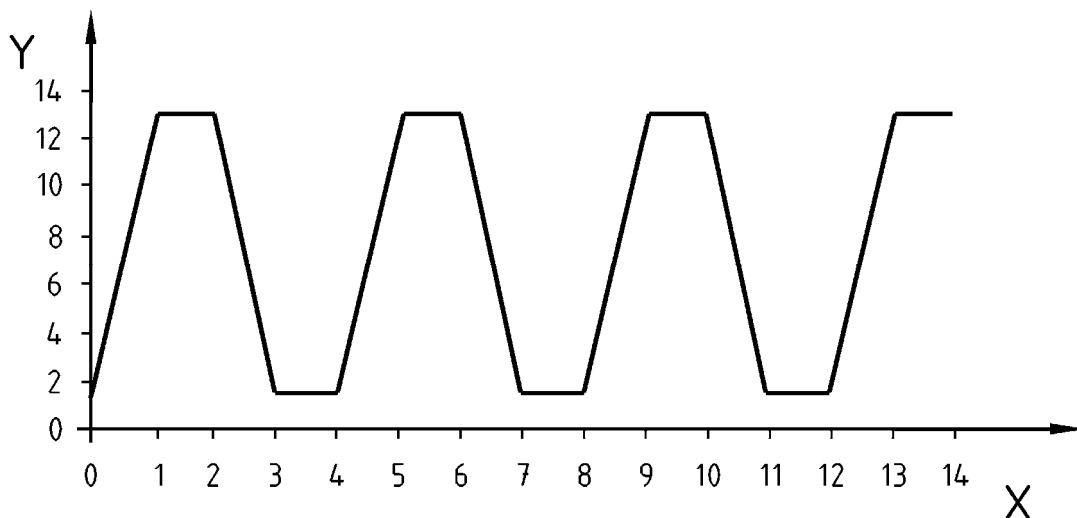
A.2.2 Cyclic water pressure test of housing (applicable to MF and UF membranes operating in dead-end mode)

A.2.2.1 Principle

The housing shall be capable of withstanding not less than 100 000 load cycles with a pressure cycling between 150 kPa and 1,3 times the nominal pressure P_N , at a frequency of $(15 \pm 2) \text{ min}^{-1}$.

A.2.2.2 Procedure

- a) Position the separation device in the test rig shown in Figure A.2.
- b) With both solenoid valves (2) fully open, adjust inlet solenoid opening stop to give an inlet pressure of 1,3 times the nominal pressure P_N .
- c) Then close the inlet valve and adjust closing stop to give an inlet pressure of 150 kPa ~~A1~~ deleted text A1.
- d) Apply 100 000 load cycles with the water pressure cycling between 150 kPa and 1,3 times the nominal pressure P_N , at a frequency of $(15 \pm 2) \text{ min}^{-1}$ (see Figure A.3). The duration of the pressure increase, pressure hold and pressure decrease shall each be $(1 \pm 0,2) \text{ s}$.
- e) Examine the housing for visible evidence of leakage or damage. The housing used for the present test shall not be used for subsequent testing.

**Key**

Y Pressure in kPa/100

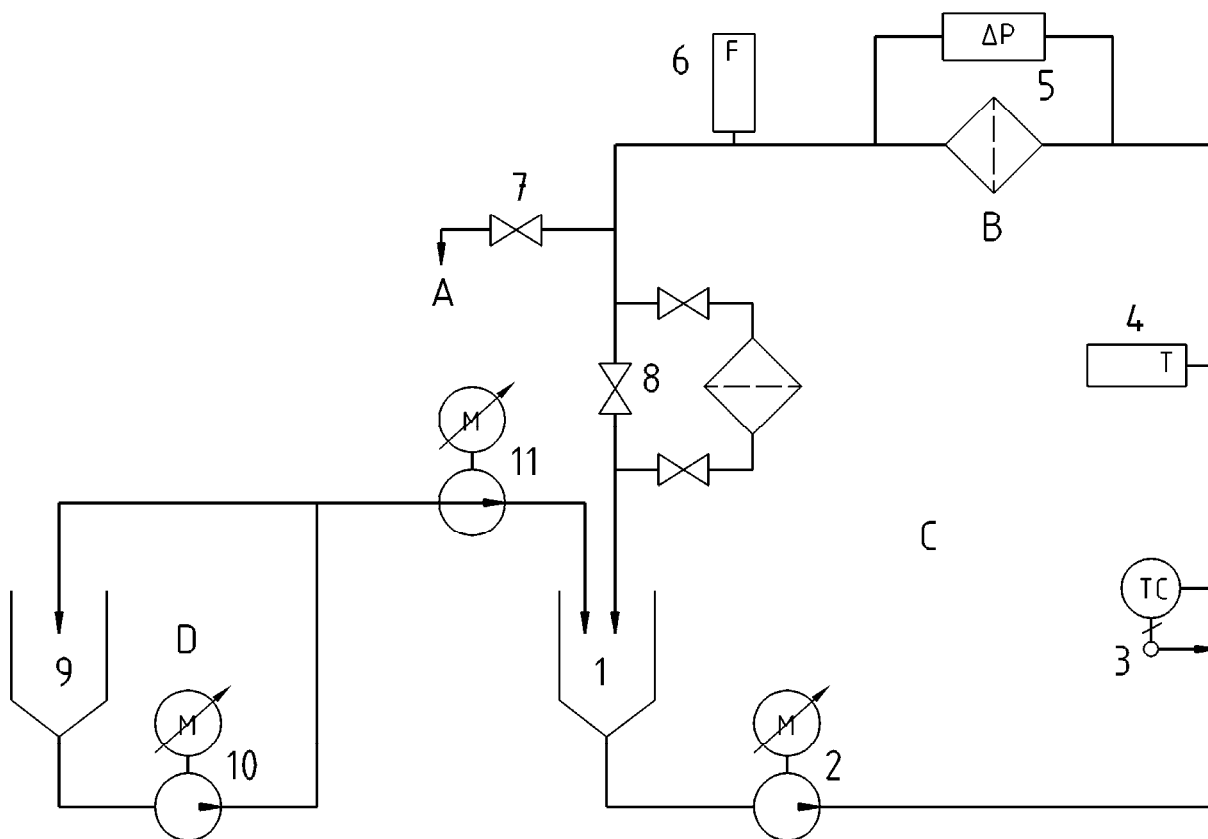
X Time in s

Figure A.3 — Cyclic pressure test**A.2.3 Module resistance to differential pressure (collapse pressure) (applicable to MF and UF membranes operating in dead-end mode)****A.2.3.1 Principle**

The purpose of this test is to check the capability of the membrane module to withstand the specified differential pressure of liquid in the normal direction of flow without collapse or burst.

The test consists of running a contaminated liquid at a specified flow rate through the module inside its housing until it clogs and a predetermined loss of pressure is reached and then to verify that the module is not visibly damaged.

A.2.3.2 Test equipment and materials**A.2.3.2.1 Test rig (see Figure A.4) comprising device test circuit and injection circuit.**



Key

1	Main tank with test liquid (RO permeate)	7	Tap to the control level	A	Outlet to sewage
2	Main pump	8	Clean-up filter	B	Device to be tested
3	Temperature regulator	9	Injection tank	C	Device test circuit
4	Temperature indicator	10	Recirculation pump	D	Injection circuit
5	Differential pressure indicator	11	Injection pump		
6	Flow meter				

Figure A.4 — Test rig for the collapse pressure test

A.2.3.2.2 Device test circuit

The device test circuit comprises the following compartments:

- conical bottom tank (1) having a recommended cone angle of less than or equal to 90 ° and a volume of about 6 l. The liquid enters below the surface so that no air is entrained;
- circulation pump (2) capable of developing the maximum differential pressure and the flow rate as scheduled for the test. It shall be resistant to the highly concentrated contaminant used in the test;
- instruments to measure the temperature (4), the differential pressure (5) and the flow rate (6) at the device connections compatible with the specifications in 7.3.3;
- piping and connectors of the appropriate diameter and length, selected to ensure turbulent flow throughout the whole circuit to prevent particle segregation. The length of the piping shall be reduced to the minimum;

- e) temperature regulator (3) to maintain the temperature at $(25 \pm 2) ^\circ\text{C}$;
- f) drain line and valve (7) to control the level in the main tank (1);
- g) clean-up filter $0,2 \mu\text{m}$ (8).

A.2.3.2.3 Circuit for the injection of the contaminant

The injection circuit comprises the following compartments:

- a) conical bottom tank (9) having a recommended cone angle of less than or equal to 90° and a volume of about 6 l. It is equipped with a contents gauge. The return liquid enters below the liquid surface;
- b) recirculation pump (10) generating a sufficient flow rate to ensure essentially perfect mixing under the test conditions. It shall be resistant to the contaminant used in the test and shall not cause degradation of the contaminant particles;
- c) injection pump (11) to transfer the contaminated fluid from the recycle pipe at a point where the flow is turbulent and discharge it via a flexible pipe immersed in the main tank of the device test circuit.

A.2.3.2.4 Test housing

This can be a housing supplied by the manufacturer or a suitably adapted vessel.

A.2.3.2.5 Test liquid

Mains water.

A.2.3.2.6 Test contaminant

Silica dust as defined in ISO 12103-1 (ISO FTD, particle size $0 \mu\text{m}$ to $80 \mu\text{m}$).

A.2.3.2.7 Measuring instruments

The measuring instruments shall have the following accuracy:

- flow rate: $\pm 5 \%$ of actual value;
- pressure: $\pm 5\%$ of actual value;
- temperature: $\pm 1 ^\circ\text{C}$.

In addition, they shall be resistant to the anticipated conditions of the test.

A.2.3.3 Procedure

For the application of this test, the following shall be specified by the manufacturer:

- flow rate through the module;
 - nominal pressure of the housing and of the module alone;
 - temperature of the liquid.
- a) Rinse both circuits 3 times by circulating the test liquid for 10 min at the maximum flow rate allowed by the installation (make sure the clean-up filter is isolated and that the connections to the housing are directly connected).

- b) Check the integrity of the test module (see A.2.4.7).
- c) Set up the test housing on the test rig without the module.
- d) Circulate the test liquid through the test housing at a temperature of $(25 \pm 2) ^\circ\text{C}$ and at the manufacturer's specified flow rate. Note the test flow rate, the differential pressure ΔP_h in the test housing alone and the temperature of the liquid.
- e) Prepare the injection circuit by introducing into the reservoir about 6 l of tap water and a mass of contaminant 20 % greater than the mass M expected to generate the specified ΔP within about 1 h. A preliminary test may be necessary to determine the required mass M . Adjust the flow rate of the injection pump to about 5 l/h.
- f) Set up the module in the test housing.
- g) Subject the module to the specified flow rate and temperature as stated in d). Note the differential pressure across the clean unit (ΔP_m).
- h) Put the injection pipe from the injection pump into the main tank (1) and turn the pump on.
- i) Maintain the test flow rate as specified in d).
- j) Record the differential pressure across the test housing.
 - If the differential pressure steadily increases, continue injecting the contaminant until the differential pressure is equal to that of the end test differential pressure and proceed as in k).
 - If the differential pressure decreases or remains the same for at least 3 min (inflexion point) before the specified end of test differential pressure is reached. This means that either the cake has cracked and water is channelling through the cracks or there is a degradation in the structure of the module. If this is the case, follow the procedure in l).
- k) If there is a steady increase in the loss of pressure,
 - when at the end of test the differential pressure is reached, stop the injection pump, put the clean-up filter into service, circulate the fluid for 30 min and record the module ΔP_f .
 - stop the main pump. Then take the module out of the test housing and clean it taking care not to damage it. Examine it carefully and make a note of any visible defects or distortions.
- l) If there is a decrease in differential pressure before the end of test differential pressure is reached or if it remains the same, stop the injection pump. Then stop the main pump.
- m) Note the differential pressure ΔP_i at the inflection point on the curve $\Delta P = f(t)$ minus the differential pressure of the test housing (ΔP_h).

A.2.3.4 Acceptance criteria

- a) If 30 min after completion of the injection the differential pressure across the module has not fallen and if there are no visual defects on the subsequently removed module, the element has passed the test.
- b) If there is a decrease of the differential pressure or if it remains the same, conclude that the filter element is not resistant to the specific differential pressure.

A.2.3.5 Test report

The test report shall include the following information:

- reference to this European Standard;

- name of the test laboratory;
- name of the operator;
- date of the test;
- module manufacturer;
- product code;
- batch number;
- production number;
- filtration rating;
- test temperature and flow rate;
- contaminant retained;
- specified differential pressure;
- differential pressure across the new module and the housing;
- differential pressure measured at the end of the scheduled test;
- differential pressure growth curve throughout the testing time;
- observations and descriptions of possible defects.

An example of a test report is given in C.2 and a typical collapse curve is shown in Figure C.2.

A.2.4 Module cyclic pressure resistance (applicable to MF and UF membranes operating in dead-end mode)

A.2.4.1 Principle

The module is subjected to cyclic differential pressure in order to simulate fatigue experienced in the normal service life of the module.

The outcome of the test is determined by comparing the values of the first bubble point before and after the flow cycles without visible evidence of damage.

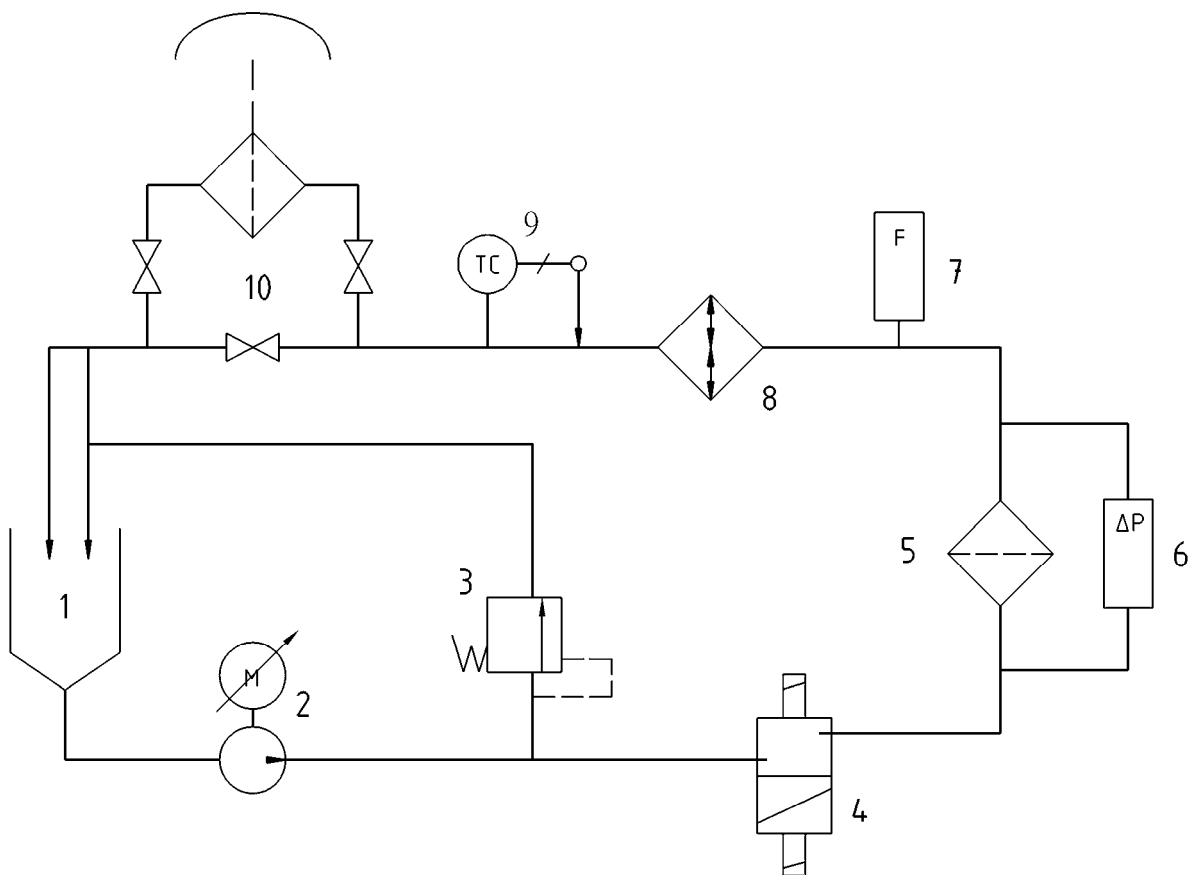
A.2.4.2 Test equipment and materials

A.2.4.2.1 Test rig (see Figure A.5)

The test rig comprises the following components:

- a) conical bottom tank (1) with a volume of at least a 5 l;
- b) pump (2), preferably of the gear type;
- c) solenoid valve (4) operated by a pulse generator;
- d) temperature regulation device (9);

- e) module housing (5) with or without the module (it can be the housing supplied with the device or other suitable pressure vessel);
- f) pressure gauge and differential pressure gauge (6) compatible in terms of range and sensitivity with the test specifications;
- g) counter to record the number of flow cycles;
- h) flow meter (7) compatible with the test specifications and accurate to 2 %;
- i) device for measuring and recording the temperature, the flow rate and the differential pressure with a frequency response compatible with the flow rate cycle;
- j) clean-up filter (10) with a maximum reference filtration rating of 0,2 µm;



Key

- | | |
|---------------------------------------|------------------------------------|
| 1 Tank with test liquid (RO permeate) | 7 Flow meter |
| 2 Pump | 8 Heat exchanger |
| 3 Pressure regulator | 9 Temperature sensor and regulator |
| 4 Solenoid valve | 10 RO clean-up filter |
| 5 Membrane under test | |
| 6 Differential pressure gauge | |

Figure A.5 — Cyclic pressure resistance test rig

A.2.4.2.2 Test liquid.

Freshly prepared RO water (< 24 h before testing).

A.2.4.3 Test rig validation

- a) Set up the module housing or the housed module.
- b) Attach the pressure gauge to the point where the liquid flows into the test module housing.
- c) Regulate the temperature to $(25 \pm 2) ^\circ\text{C}$ and the flow rate to flow rate claimed by the manufacturer.
- d) Run 10 cycles varying the flow through the housed module from zero to that required to generate a pressure drop of 200 kPa at a frequency of 0,05 Hz.
- e) Record the upstream pressure.
- f) Check that there is no surge in pressure greater than 10 kPa.

A.2.4.4 Procedure

- a) Check the integrity of the module (see A.2.4.7).
- b) Mount the module housing on the test rig without the module.
- c) Circulate the test liquid through the clean-up filter for at least 10 times of volume of the unit.
- d) Measure the differential pressure for six flow rate values through the empty test housing at a rate between 50 % to 100 % of the nominal flow rate at a temperature of $(25 \pm 2) ^\circ\text{C}$.
- e) Put the module into the housing.
- f) Adjust the temperature to $(25 \pm 2) ^\circ\text{C}$ and regulate the output to obtain a net differential pressure of 200 kPa through the housed module.
- g) Set up the timer such that the solenoid valve varies the rate of flow through the housed module from zero to the output specified in f), with a cycle variation frequency to 0,05 Hz, for 500 cycles.
- h) Record the differential pressure throughout the test. Check that there is a plateau reached at maximum and minimum pressure.
- i) When the stabilised differential pressure drops by more than 10 % compared with the initial value specified in f), make a note of the number of cycles and stop the test.
- j) Carefully rinse the filter element with water to remove all traces of the test liquid and dry it carefully.
- k) Check the quality of the module (see A.2.4.7).

A.2.4.5 Acceptance criteria

- The net differential pressure shall remain within the limits of $\pm 10 \%$ of that specified in A.2.4.4 f) throughout the test.
- There shall be no visible fault in the structure of the housing.
- The difference between the bubble points between and after the test shall be within 15 % of the initial value.

A.2.4.6 Test report

The test report shall include the following information:

- reference to this European Standard;
- name of the test laboratory;
- name of the operator;
- date of the test;
- device manufacturer;
- product code;
- batch number;
- production number;
- filtration rating;
- test liquid, type, test temperature;
- percentage difference between the point of the bubble point before and after the test;
- test flow rate;
- differential pressure at the housing ends and net differential pressure at the beginning and end of the test;
- number of cycles that were scheduled and the number of cycles carried out;
- differential pressure variation curve;
- observations.

An example of a test report is given in C.3.

A.2.4.7 Integrity inspection and measurement of First Bubble Point

A.2.4.7.1 Principle

The module is immersed in a wetting liquid and rotated, if possible and necessary. The air pressure inside the module is slowly increased and the air pressure at which a stream of bubbles first appears is recorded.

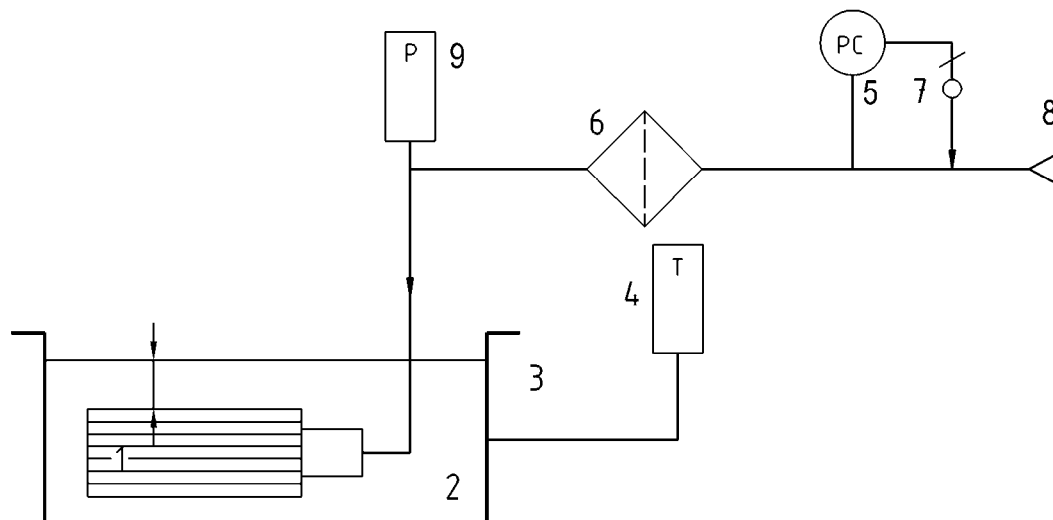
A.2.4.7.2 Test equipment and materials

A.2.4.7.2.1 Test rig (see Figure A.6)

The test rig comprises the following components:

- a) source of compressed air or nitrogen (N₂) (8), dried, de-oiled, filtered at 0,2 µm (6), with a pressure regulator (7) up to and including 1 000 kPa with a precision of the set read value (5) of 5 %;
- b) tank (3) and the mechanical, manual or automated equipment to rotate element (1);
- c) temperature regulator and tension measuring device (4) for the test liquid (2);

- d) device for wetting the element in the test liquid under vacuum (9);
- e) correctly calibrated tensiometer with a stirrup to determine the surface tension of the test liquid in accordance with ISO 304.



Key

- | | | | |
|---|---------------------------|---|--|
| 1 | Rotation device | 6 | Device to be tested |
| 2 | Tank with test liquid | 7 | Pressure regulator |
| 3 | Filter | 8 | Compressed air or nitrogen |
| 4 | Tension measuring device | 9 | Device for wetting the element in test liquid under vacuum |
| 5 | Pressure measuring device | | |

Figure A.6 — Test rig

A.2.4.7.2.2 Test liquid

Isopropanol (C_3H_7OH) or alternative as appropriate with a known surface tension and filtered at $0,2 \mu m$.

A.2.4.7.3 Procedure

- a) Measure and record the surface tension and temperature of the test liquid. If liquid is re-used for several serial tests, change it as soon as its surface tension varies by more than 1 % from the initial value.
- b) Wet the module by immersing it in the test liquid and maintain it under a vacuum of at least 50 kPa for a period of 15 min.
- c) Break the vacuum.
- d) While maintaining the element immersed or wetted, place it in the test apparatus first filled in with test liquid so that its rotation axis is parallel with the surface of the liquid.
- e) Adjust the level of the liquid to be at (10 ± 2) mm above the element. Verify that the temperature is between $15^\circ C$ and $25^\circ C$.
- f) Apply a progressively increasing pressure of gas inside the element by steps of 50 kPa and ensure a total rotation at each step. Stop the pressure increase when a stream of bubbles arises from a point on the surface of the module. Record the corresponding pressure and liquid temperature.
- g) Reduce pressure to atmospheric and repeat operations b) to f) twice with a wetting period of 15 min.

A.2.4.7.4 Expression of test results

- a) Correct pressure values measured in A.2.4.7.3 g) to bring them back to 20 °C by using the Equation (A.1).

$$P_{20} = P_T \times \frac{\gamma_{20}}{\gamma_T} \quad (\text{A.1})$$

where

P_T is the first bubble pressure at T °C, in kPa;

P_{20} is the first bubble pressure at 20 °C, in kPa;

γ_T is the surface tension at T °C, in N/m;

γ_{20} is the surface tension at 20 °C, in N/m.

- b) Calculate the standard deviation of the three pressure values.
c) Print test report with all operating conditions and test results.

A.2.4.7.5 Criteria for acceptance

- a) If the standard deviation varies by more than $\pm 5\%$, repeat the test.
b) The test has been passed if the First Bubble Point meets the specifications of the manufacturer.

A.3 Functional performance

A.3.1 Filtration rating (applicable to MF)

A.3.1.1 Principle

The present test method is intended to give information about the particle rating of different MF membranes based on the membrane selectivity with respect to latex particles. It is not intended to give an absolute criterion for evaluating the membrane efficiency nor for setting-up comparison between membranes.

The test method determines the particle rating of the MF membranes by using monodimensional suspensions of beads of fluorescent latex.

The filtration efficiency particle rating is expressed as a function of the concentrations of solid particles in the feed and permeate waters (see Equation (A.2)):

$$E(i) = \left(1 - \frac{C_p(i)}{C_f(i)} \right) \times 100 \quad (\text{A.2})$$

where

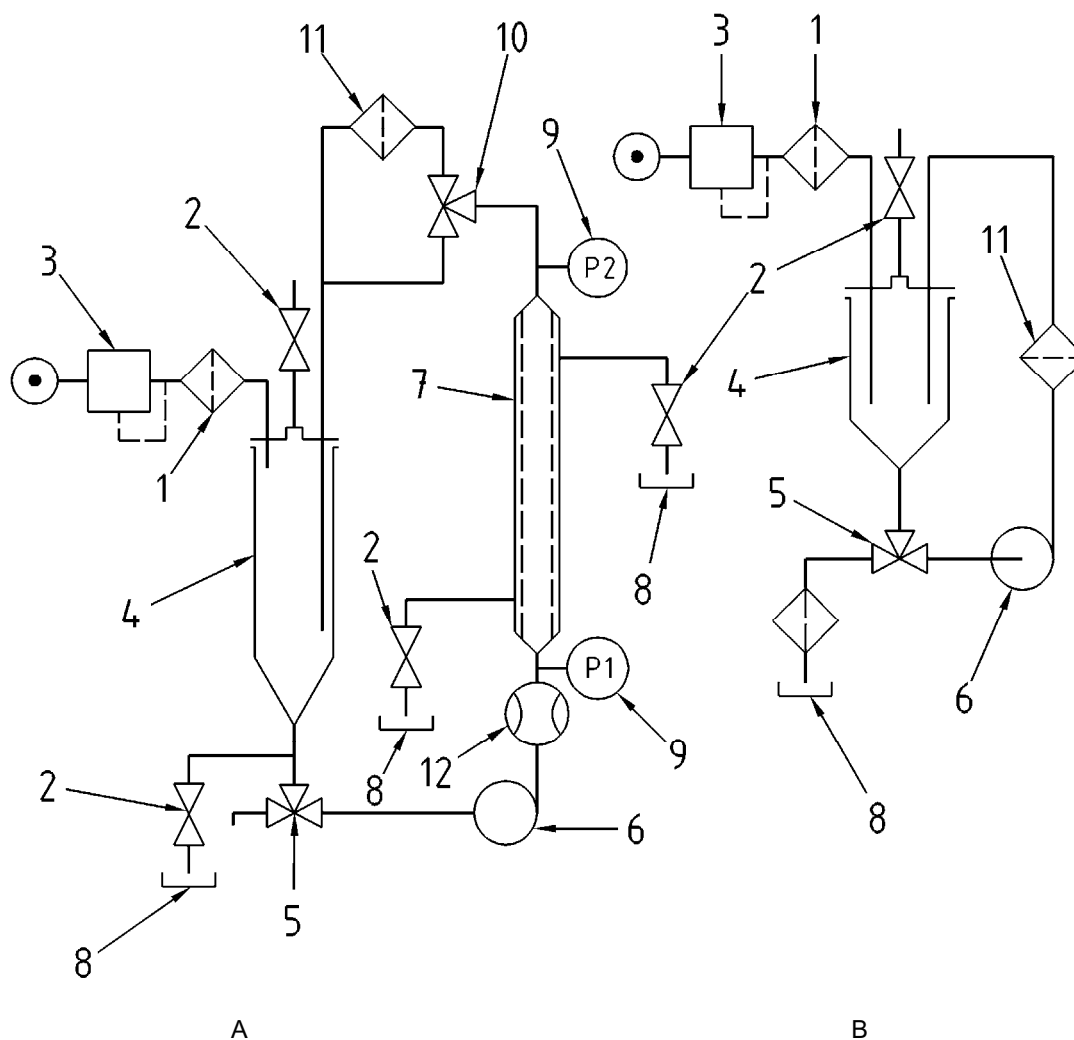
$E(i)$ is the filtration efficiency for the monodispersed fraction of solid particles i , in %;

$C_p(i)$ is the concentration of monodispersed particles i with diameter x in the product water;

$C_f(i)$ is the concentration of monodispersed particles i with diameter x in the feed water.

A.3.1.2 Test equipment and materials

a) Test rig in accordance with Figure A.7;



Key

A	Set-up for testing cross-flow devices	6	Recirculation pump
B	Set-up for testing dead-end devices	7	Membrane under test
1	Air filter	8	Sampling valve
2	Stop valve	9	Pressure gauge
3	Pressure regulator	11	Clean-up filter
4	Latex suspension tank	12	Flow meter
5, 10	Three-way valve		

Figure A.7 — Filtration rating test rig

b) laboratory apparatus:

— spectrofluorometer.

This instrument provides a trace of the excitation and the emission spectra of latex suspensions for selecting the operating wavelengths in the range of minimum 4 nm;

— laboratory suspension tank equipped with ultrasound generator.

c) glassware:

- micropipettes, volume 2 µl to 10 µl;
- flasks of different volumes;
- containers of different volumes.

d) test fluids:

- deionised water, filtered at 0,1 µm, freshly prepared (less than 6 h before its use), stored in inert closed tank;
- compressed oil-free dry air, microfiltered at 0,1 µm.

e) membrane module:

The membrane module, housed in a suitable pressure vessel or in the housing supplied by the manufacturer, shall be conditioned as per manufacturer's instructions.

f) test particles:

Use batches of aqueous suspensions of latex fluorescent beads of known granulometry and concentration.

It is recommended to use at least 6 monodimensional suspensions of different granulometry in the size range of the membrane pores size.

In addition it is preferable to select particles of the same colour (same excitation and emission wavelength) in order to let the spectrofluorometer to give comparable results when analysing samples of reject water.

The excitation and emission wavelength used shall be determined starting from the correspondent spectra traced for each lot of particles.

The operator shall ascertain that:

- fluorescence of the latex suspensions is only due to the particles themselves;
- test water is not introducing any interfering fluorescence (reference water);
- there is no fluorescence loss due to adsorption on the membrane;

by performing the following steps before starting the test:

- for each batch of suspended particles, prepare a suspension of latex beads at the pre-set test concentration with reference water;
- measure the fluorescence of above suspension;
- measure the intrinsic fluorescence of the membrane.

Then dip the membrane in the latex suspension for 1 h and, after rinsing with the water defined in d), measure again the membrane fluorescence.

The difference between the two measurements shall not exceed 1 %. If not, adjust pH and start again the above mentioned procedure.

Filter a small volume of the suspension through a membrane having a pores size much smaller than the latex beads diameter and measure the fluorescence of the filtrate. The measured fluorescence shall not exceed the 0,5 % of the fluorescence of the suspension at the test concentration.

NOTE For information on availability or supply source of fluorescent latex beads, it is recommended to contact CEN Management Centre or the National Standards Organisation.

A.3.1.3 Procedure

A.3.1.3.1 General

The following testing procedure shall be followed for each batch of monodimensional diameter particles and for both dead-end and cross-flow membrane operating modes.

A.3.1.3.2 Circuit validation

- a) Fill-up the test tank with water as defined in A.3.1.2 d).
- b) Switch-on the recirculation pump.
- c) Put the test tank under pressure.
- d) Let the water recirculate through the clean-up filter for approximately 10 min.
- e) Take a sample.
- f) Analyse the sample with the spectrofluorometer at the same excitation and emission wavelengths selected for the testing. The measured values shall not exceed the 10 % of the smaller measurement made in A.3.1.2 f).

A.3.1.3.3 Preparation of the latex suspensions

- a) Calculate the number of latex beads theoretically necessary to cover approximately 0,5 % to 5 % of the geometrical surface of the membrane under testing.
- b) Calculate the number of latex particles per unit volume by using the following Equation (A.3):

$$n = \frac{6 \times 10^{10} \times C \times m_1}{\pi \times m_s \times d^3} \quad (\text{A.3})$$

where

n is the number of latex particles/ml;

d is the latex particle diameter, in μm ;

C is the solid concentration in the latex suspension, in % (m/m);

m_1 is the volumetric mass of the latex suspension (g/ml);

m_s is the volumetric mass of the latex particles (g/ml).

- c) Define the volume of the suspension V to be filtered thus defining the N number of total particles by Equation (A.4):

$$N = n \times V \quad (\text{A.4})$$

where

N is the total number of particles;

n is the number of particles/ml (see Equation (A.3));

V is the volume of suspension, in ml.

The volume of suspension shall be at least two times the volume of the complete installation (not including the tank).

- d) Submit the concentrated suspension to ultrasound for 30 s with manual stirring.
- e) Draw with the micropipette the volume of suspension provisionally defined in A.3.1.2 f).
- f) Add water specified in A.3.1.2 d) up to the volume V (it could be necessary to adjust the pH in order to avoid the latex particles being adsorbed on the membrane surface thus preventing them passing through the larger pores).
- g) Draw 50 ml of suspension.

A.3.1.3.4 Filtration of the latex beads suspension (dead-end mode)

- a) Empty the already cleaned circuit.
- b) Install the membrane module into the circuit.
- c) Bypass the clean-up filter.
- d) Transfer into the test tank the suspension prepared in accordance with A.3.1.2 f).
- e) Pressurise the test circuit to the pressure forecast for the tested module.
- f) Draw the filtrate for analysis.

A.3.1.3.5 Filtration of the latex beads suspension (cross-flow mode)

- a) Empty the cleaned circuit.
- b) Install the membrane module into the circuit.
- c) Bypass the clean-up filter.
- d) Adjust the three-way valve to let the cross-flow.
- e) Transfer into the test tank the suspension prepared according to A.3.2.2.
- f) Pressurise the test circuit to the pressure forecast for the tested module.
- g) Start pumping and adjust the flow rates according to the membrane type.
- h) Draw the filtrate and the reject water from the sampling points.
- i) Stop after having collected at least five samples of filtrate and five samples of reject water.

A.3.1.3.6 Sample analysis

Measure the fluorescence of the samples collected as indicated in A.3.1.2 f), A.3.1.3.4 and A.3.1.3.5 at the wavelength determined according to A.3.1.2 f).

A.3.1.4 Expression of results

- a) The measured values of fluorescence permit calculation of the retention rate of the module with respect to a latex suspension of beads whose average diameter is known in accordance with the Equation (A.2).

- b) The particle concentration is defined by the linear calibration relationship (A.5):

$$F = f(c) \quad (A.5)$$

where

F is the fluorescence of the suspension;

c is the beads concentration in the fluorescent latex suspension.

- c) Validate the test as stated in A.3.1.3.2. The operating conditions during each test (circulation flow rate, pressure, pH, recovery rate and temperature) shall be recorded in the testing report.

A.3.2 Organic molecule rejection (molecular cut-off) (applicable to UF, NF¹⁾ and RO¹⁾)

A.3.2.1 Principle

A.3.2.1.1 Introduction and field of application

The retention rate test method, performed with a standard solution of a given organic matter, facilitates the selection of the membrane for separating organic substances from real water.

The retention rate is based on two main criteria:

- solute behaviour in the solution which depends on the molecule configuration, on its concentration and on the dynamic parameters notably the molecular cut-off and the operating pressure;
- physico-chemical interaction between the membrane material and the dissolved molecules.

Taking into account the wide spectrum of the molecular masses of the solutes concerned with the family of the polymer tracers, the selected test surrogates are:

- polyethylene glycol (PEG) (polyethanediol, HO [-CH₂-CH₂O-]_nH);
- dextrane ((C₆H₁₀O₅)_n).

However, for specific application and/or claim the exact contaminant molecule shall be tested.

The present test method describes the method for testing the retention rate of standard solutes by porous membranes.

The present test method applies to UF, NF and RO membranes operating in the cross-flow mode where both the solvent and the solute flows follow a convection mechanism under a pressure gradient irrespective of the membrane materials and their geometry. However, the test method applies equally to dead-end mode operation with the test rig and procedure adjusted accordingly.

A.3.2.1.2 Test principle

The test method principle is based on the experimental measurement of the retention rate of polymer tracer and by drawing the curve of distribution of the retention rate as a function of molecular mass of the polymer.

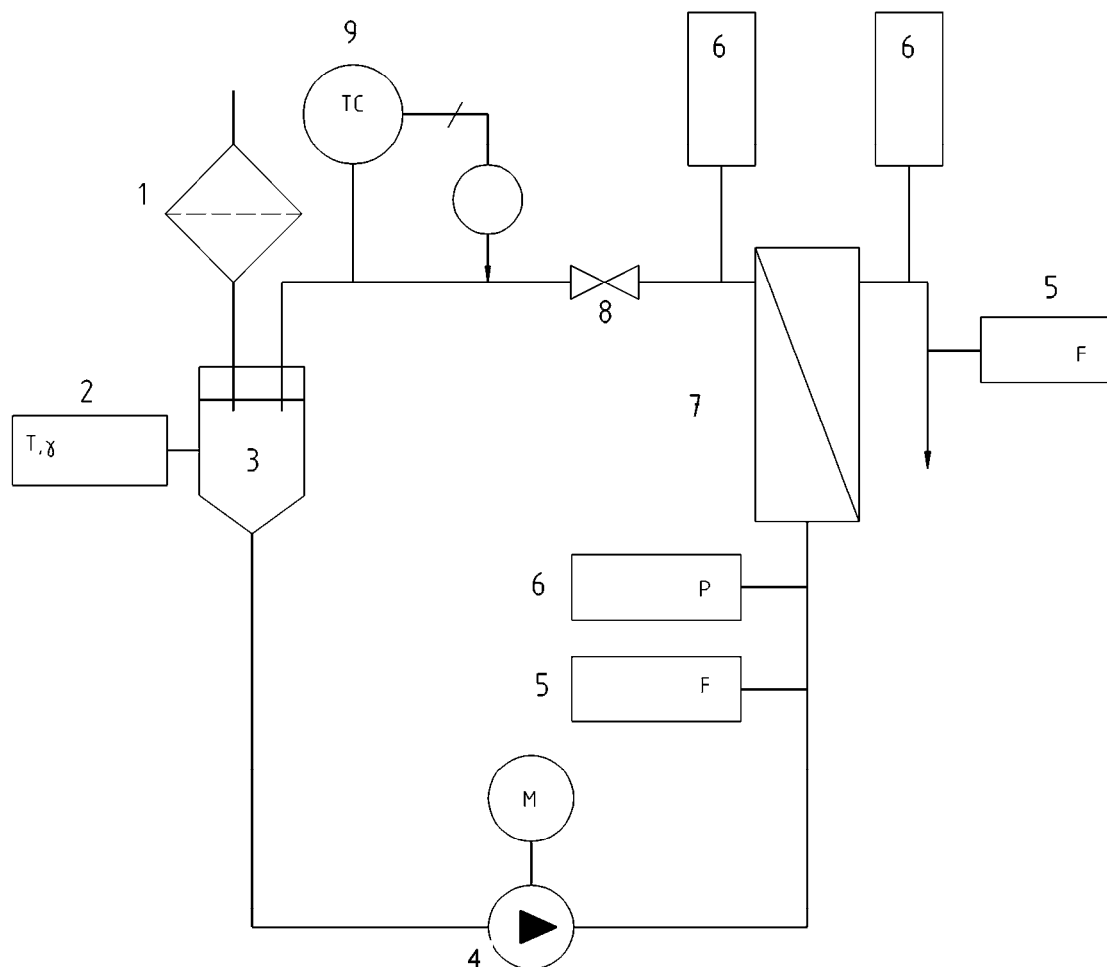
As the polymers may be partially adsorbed by the membrane depending on its nature, the obtained results depend also on the operating conditions and on the membrane material.

1) Only where the device manufacturer claims a retention capacity with respect to organic molecules.

A.3.2.2 Test apparatus

The test apparatus (see Figure A.8) shall permit the measurements of the permeation flow through the membrane under the following constant conditions:

- stirred test solution tank;
- cross-flow velocity;
- differential pressure;
- temperature of solution.



Key

- | | |
|---------------------------------------|--------------------------|
| 1 Air filter 0,2 µm | 6 Pressure gauges |
| 2 Temperature and conductivity meters | 7 Module to be tested |
| 3 Test solution tank | 8 Counter pressure valve |
| 4 Main pump | 9 Temperature regulator |
| 5 Flow meters | |

Figure A.8 — Test rig for cross-flow mode of operation

It is recommended that the permeate is collected in a tank with a recirculation pump for facilitating the sample drawing and for minimising the time needed for obtaining steady-state condition of the tested membrane.

The following parameters shall be checked:

- The operating temperature shall be constant and suitable for the membrane and for the solution stability.
- The transmembrane differential pressure shall be roughly equal to the pressure difference between the average of the module inlet and outlet pressures minus the pressure of the permeate.
- This pressure shall be suitable for the membrane specifications and for the module.

In the cross-flow mode of operation, the circulation velocity shall be as high as possible and adapted to the module characteristics.

In any case the pressure at the outlet of the module shall be higher than the permeate pressure.

The membrane shall be conditioned as required by the manufacturer before putting it in service. A new membrane shall be conditioned to eliminate any manufacturing debris and shall be cleaned at least once in accordance to the manufacturer's instruction.

A.3.2.3 Selection of the tracer polymers

The recommended polymers are dextrane and PEG.

The operator of the laboratory shall ascertain whether these polymers are compatible with the membrane material, in particular:

- no reaction shall occur between the testing polymers and the membrane material;
- testing polymers are not irreversibly adsorbed either on or inside the membrane;
- no irreversible clogging occurs.

A.3.2.4 Analysis methods

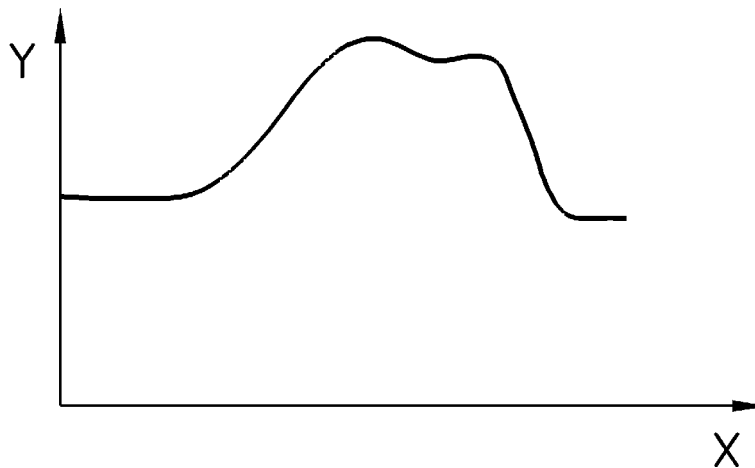
The analysis methods used shall permit the determination of the dissolved substances in both inlet and permeate solutions as well as their distribution as molecular mass.

It is recommended to use gel permeation chromatography for separation and analysing the polymers.

Depending on the selected polymers, the columns to be used are commercially available together with the relevant information for adjusting the parameters of the analysis.

NOTE When using dextrane, the driving solvent is filtered, RO treated or distilled water, then degassed and treated with 0,1 % sodium azide (NaN_3). The flow rate is 0,5 ml/min.

The volume of the injection loop is between 20 μl and 200 μl (see Figure A.9).



Key

Y Relative concentration
X Elution time (min)

Figure A.9 — Example of chromatogram of commercially mixed dextrans (concentration 2 g/l)

A.3.2.5 Testing apparatus and typical operating conditions

A.3.2.5.1 General

The test apparatus shall allow measurements of permeation fluxes of water and polymer solutions through the membrane while adjusting and keeping constant the parameters which can influence fluxes, such as:

- solution tank stirring;
- velocity of cross-flow;
- differential pressure between the two sides of the membrane;
- temperature of the filtrate.

It is recommended to use a system with filtrate recirculation and easy collection of the samples. In addition, it is important to minimise the dead volume of the module on the filtrate side in order to reduce the time needed for obtaining a steady concentration.

The experimental parameters to be controlled are:

- operating temperature which, in any case, shall be stable and matching the membrane specification as well as the solution stability;
- transmembrane pressure shall be compatible with the membrane/module specifications.

In cross-flow systems, the circulation velocity shall be as high as possible compatible with the characteristics of the tested module inside the housing.

As a general rule, the pressure at the module outlet shall be higher than the filtrate pressure.

In addition, the membrane shall be conditioned and decontaminated in accordance with the manufacturer's instructions before testing.

A.3.2.5.2 Test solution definition

Both dextrane and PEG are commercially available under given fractions of molecular mass.

They are supplied as a blend of fractions close to the nominal molecular mass appropriate for membrane performance verification over a wide range of molecular mass.

A.3.2.5.3 Preparation and characterisation of the test solution

Arrange the blending of the same polymer type in accordance with Table A.1.

The standard solution is characterised by liquid chromatography coupled with a refractometer or by UV in accordance with the type of polymer.

The total volume of the prepared solution shall be at least twice the volume of the installation (volume of test rig and of its components including the volume of the module). The volume of the permeate not re-circulated shall not exceed the 10 % of the total volume of the utilised water.

Table A.1 — Correlation between the cut-off capacity of the membranes and the distribution of the molecular masses of the standard molecule

Range of cut-off capacity of the membranes	Type of standard polymer	Composition of the blended standard molecules g/mol	Concentration before blending g/l
100 to 1 500	PEG	200	5
		600	5
		1 500	5
1 501 to 5 000	PEG	1 500	5
		2 400	5
		8 000	5
5 001 to 10 000	PEG	3 600	5
		8 000	5
		10 000	5
10 001 to 100 000	Dextrane	10 000	0,5
		20 000	1
		110 000	0,5
100 001 to 300 000	Dextrane	70 000	0,8
		250 000	0,8
		500 000	0,6
> 300 000	Dextrane	250 000	0,8
		500 000	0,8
		2 000 000	0,6

A.3.2.5.4 Test conditions

- velocity as required by the manufacturer;
- pressure such that Equation (A.5) is fulfilled:

$$\frac{Q_w}{Q_i} \geq 0,7 \quad (\text{A.5})$$

where

Q_w is the flow rate after washing-off the molecules;

Q_i is the initial flow rate.

- maximum temperature: 30 °C.

A.3.2.5.5 Sampling and samples conditioning

The preservation conditions of the membranes in the period preceeding the test shall be carefully checked in accordance with the manufacturer's recommendation.

A.3.2.6 Procedure

A.3.2.6.1 Preliminary test

- Check the condition of membrane in accordance with the manufacturer's recommendation. This will permit definition of a pressure range within which the flow rate stays directly proportional to the pressure. Select the operating pressure inside that range.
- After the operating conditions are selected, run a preliminary filtration, lasting approximately 20 min to 30 min with test solution sufficient for achieving steady condition of flow.
- After the rinsing of the membrane at the working temperature, measure again the membrane nominal flow rate.
- The operating conditions are accepted only if the nominal flow rate decrease does not exceed the 30 % of initial value. If that is not the case, wash the membrane again till the initial condition is recovered, decrease the operating pressure and re-start with the preliminary test.

A.3.2.6.2 Measurement of the retention rate

- If the preliminary test was positive, start the filtration run as described in A.3.2.4.
- Set the working pressure at the lowest experimental figure of flow curve which fits with the conditions of the preliminary test.
- When the flow rate is stabilised (the stabilisation time should not exceed 20 min to 30 min), draw the permeate and the feeding solution samples. Collect a minimum of three samples at the same operating pressure, spaced at 20 min intervals.
- Immediately analyse the collected samples (see Figures A.10 a) and A.10 b).

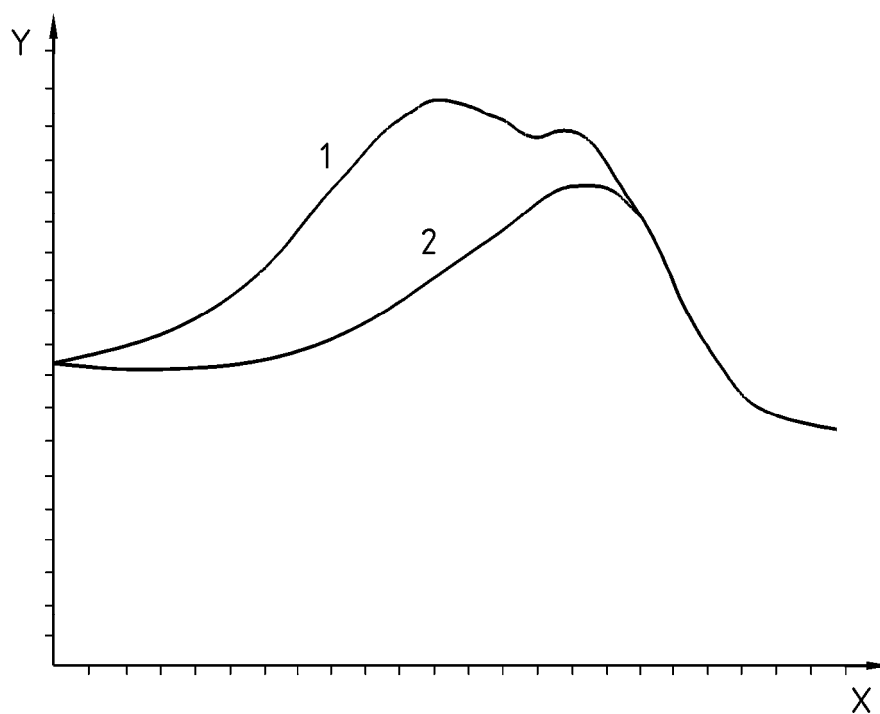


Figure A.10 a)

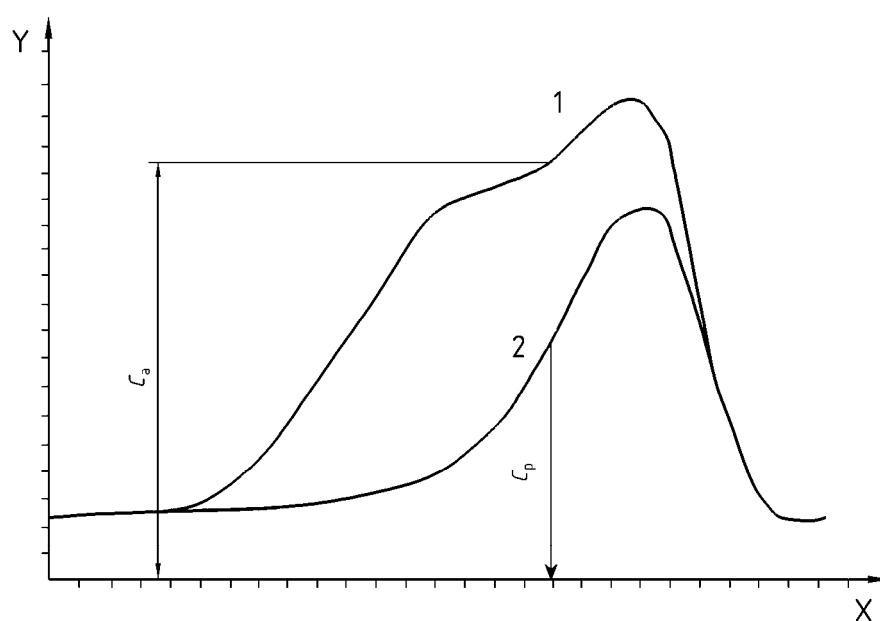


Figure A.10 b)

Key

Y Relative concentration

X Elution time (min)

1 Feeding solution

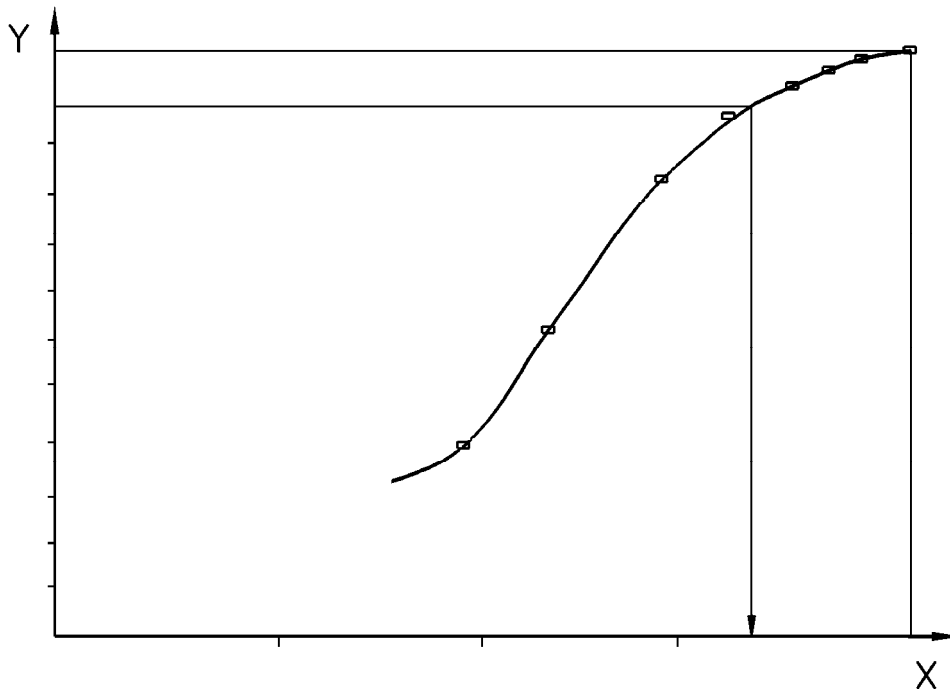
2 Permeate

 C_a Concentration in feeding solution C_p Concentration in permeate

Figure A.10 a) and b) — Examples of chromatogram related to a blending of three fractions of dextrane before and after the passage through the membrane

A.3.2.7 Expression of results

From the distribution curves of the feed and permeate solutions as obtained from each sample, calculate inside the range 0 % and 100 %, the percentage of retention T_R as a function of the molecular masses contained inside the blend by plotting the curve $T_R = f(M)$ (see Figure A.11). From that curve obtain the cut-off threshold.



Key

Y Retention rate T_R
X Molecular mass M

Figure A.11 — Representation of the retention rate of a membrane as function of the molecular mass of the used dextrans

A.3.2.8 Test report

The test report shall at least contain:

- reference to this European Standard;
- reference to the brand name of the tested module;
- connection of the test with the module history;
- operating conditions for each measurement: membrane geometry, test solution composition, pressure, temperature, circulation velocity;
- membrane nominal flow rate tested before and after the test;
- cut-off threshold as determined in accordance with A.3.2.7;
- any particularity of the equipment or the procedure with respect to the present European Standard.

A.3.3 Salinity rejection rate (applicable to NF and RO)

A.3.3.1 Principle

The salinity rejection rate shall be tested by treating a challenge water through the membrane device.

The testing conditions shall be specified by the membrane (device) manufacturer in accordance with the claimed performance.

The device shall be tested without any pre- and post-treatment components including the pressurised storage vessel of the product water, if existing.

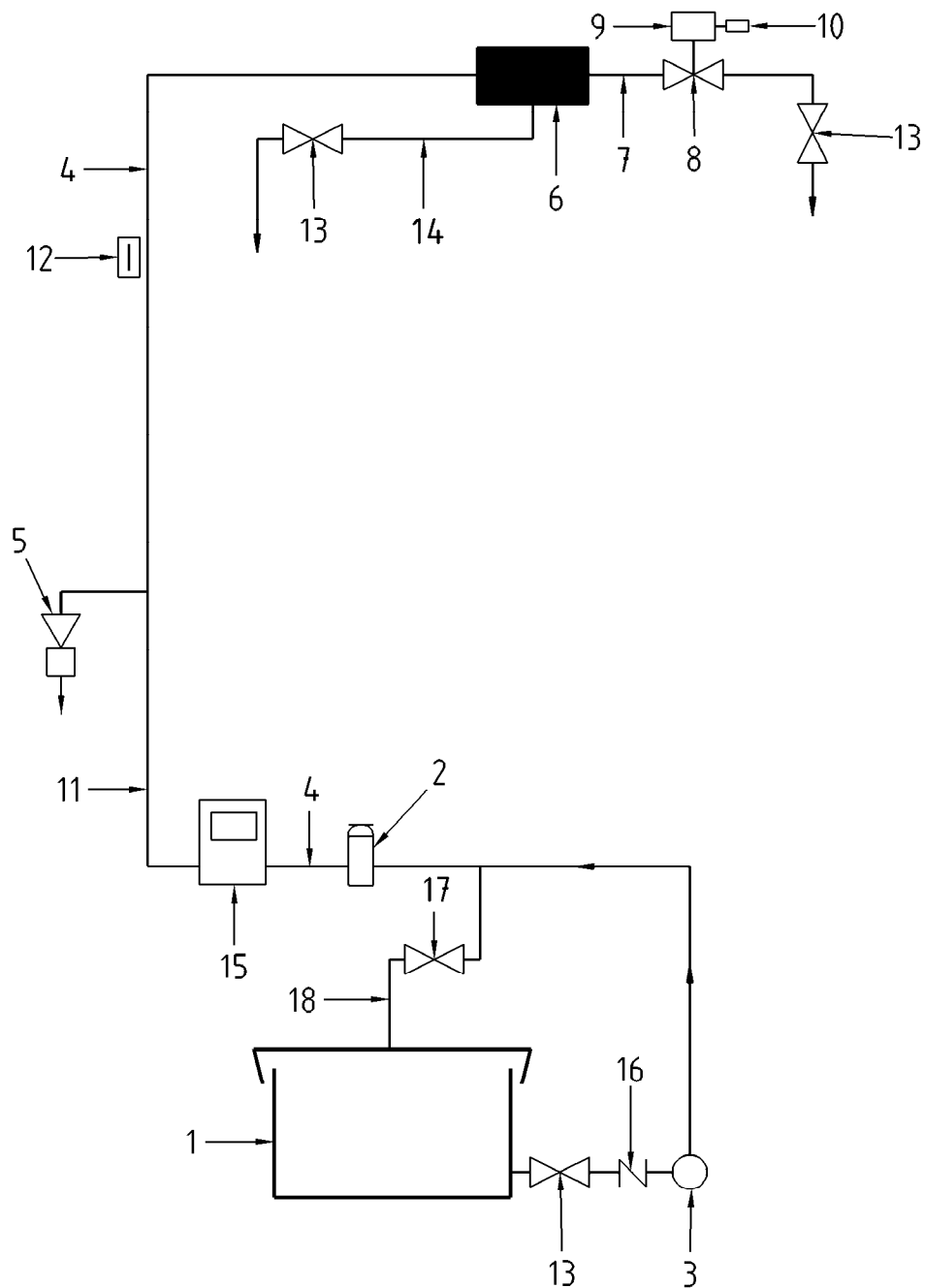
A.3.3.2 Test equipment and materials

a) Test rig:

The device or the membrane module housed in suitable pressure vessel shall be installed in test rig as shown in Figure A.12.

The basic components of this test rig are:

- source of pressurised test water (see b));
- temperature gauge and regulator at $(25 \pm 2) ^\circ\text{C}$;
- sampling points for testing raw water, product water and reject water.



Key

- | | | |
|--|---|---------------------------------|
| 1 Storage tank | 8 Solenoid valve | 16 Check valve |
| 2 Pressure regulator | 9 Timer with impulse counter | 17 Bypass flow throttling valve |
| 3 Corrosion resistant circulation centrifugal pump | 10 Timer, electrical disconnect switch | 18 Bypass return |
| 4 Pressure gauge (pressure recorder) | 11 Feed water for device to be tested | |
| 5 Sample valve inlet | 12 Thermometer (temperature recorder) | |
| 6 Device to be tested | 13 Valve, stream isolation | |
| 7 RO product water line | 14 Reject water line | |
| | 15 Chart recorder, recording conductivity monitor | |

Figure A.12 — Example test apparatus

b) Test solution.

The test solution shall be prepared by dissolving a suitable quantity of salt in grade 3 water in accordance with EN ISO 3696. The prepared test solution shall conform to the following specifications:

- turbidity: < 1 NTU;
- pH: 6 to 8;
- temperature: (25 ± 2) °C.

Unless differently specified by the manufacturer, the following salts shall be used for preparing the test solution:

- for testing RO membrane approximately 750 mg/l of reagent grade sodium chloride (NaCl) (conductivity approximately 1 500 μ S/cm).
- for testing NF membrane approximately 2 070 mg/l of reagent grade magnesium sulphate heptahydrate ($\text{MgSO}_4 \cdot 7 \text{H}_2\text{O}$) (conductivity approximately 1 000 μ S/cm).

The volume of the test solution shall allow at least 2 h of continuous feed of the tested system.

A.3.3.3 Procedure

- a) Tested device (module) shall be conditioned in accordance with the manufacturer's instructions using the appropriate test water specified above.
- b) Adjust the static pressure to 350 kPa (or to the pressure specified by the manufacturer).
- c) Check that the feed water solution temperature is kept within the given limits during the test. As the feed water is continuously recycled by blending product and reject waters it could be difficult to maintain the required temperature. If this is the case, as an alternative, a continuous make-up of water solution may be used.
- d) The water samples, influent and product waters, shall be drawn contemporaneously at the following elapsed times:

Day 1: at 4, 12 and 16 h;

Day 2 to 4: every 6 h;

Day 5 to 6: stagnation period (no water treatment);

Day 7: 144 h total elapsed time;

Day 7: 148 h total elapsed time.

NOTE In order not to modify the blending ratio of product and reject water, the reject water is collected contemporaneously with each product water sample but not analysed.

A.3.3.4 Expression of results

Each water sample shall be analysed for the relevant parameter (salinity or Mg hardness) and for each couple of samples, drawn at the same elapsed time, the rejection rate shall be calculated as follows by using Equation (2) where the feed water and permeate concentration are expressed as conductivity or TDS for RO membranes and as Mg hardness for NF membranes.

A.3.3.5 Evaluation criteria

For complying with the requirement in accordance with 7.4.1.3, the calculated rejection rate shall be at least 99 % of the rated capacity.

A.3.4 Recovery rate. Daily production (applicable to MF, UF, NF, RO operating in the cross-flow mode)

A.3.4.1 Principle

As the recovery rate represents the ratio between the volume of product water of desired quality and the volume of feed water necessary for achieving such product, the determination of the recovery rate shall be subordinate to the compliance of the membrane device with the relevant required quality performance.

The recovery rate is calculated by using the Equation (1) where the values Q can be expressed as instantaneous flow rate or volume of water collected during a pre-set time period.

A.3.4.2 Test equipment

The test equipment shall be the same used for testing the relevant rejection rate (particles, organic molecules, salinity).

The test rig shall be completed with flow meters installed at least on the feed and product water piping.

A.3.4.3 Procedure

- a) On day 1 (see A.3.3.3) after the first 4 h of service, collect the product water for an additional 1 h. Repeat this on day 7 after the 148 h elapsed time. The results of the two samplings shall be mathematically averaged and the average, multiplied by 24, represents the daily production rate.
- b) Contemporaneously to the sampling/determination of the rejection rates, the flow rates shall be recorded and the recovery rate calculated. Alternatively (e.g. in case of too low flow rate), feed water and product water are collected from the sampling points for a given, equal time period and the recovery rate calculated as above.

Annex B (informative)

Types of membrane

B.1 Comparison of membrane technologies

In Table B.1 the main characteristics and features of the membrane types are given.

Table B.1 — Membrane technologies compared

Feature	MF	UF	NF	RO
Polymers	Ceramics Polypropylene Polysulfone Polyvinylidene fluoride Polytetrafluoroethylene polyacrylonitrile	Ceramics Cellulosics Polysulfone Polyvinylidene fluoride	Thin film Composites Cellulosics Polyamide	Thin film Composites Cellulosics Polyamide
Matter size rejection range ^a $\overline{A_1}$ (μm) $\overline{A_2}$	0,05 to 1,0 (10,0)	0,001 to 0,05	0,000 1 to 0,001	<0,000 1
MWCO (g/mol)	>100 000	2 000 to 100 000	300 to 1 000	100 to 300
Suspended solids removal	Yes	Yes	Yes	Yes
Dissolved organics removal	Little	Moderate	Yes	Yes
Dissolved inorganic removal	None	None	Yes	Yes
Microorganism removal ^b	Protozoa (cysts and oocysts), algae, bacteria	Protozoa (cysts and oocysts), algae, bacteria, virus	All	All
Osmotic pressure effects	None	None	Moderate	High
Concentration capabilities	High	High	Moderate	Moderate
Energy usage	Low	Low	Low-moderate	Moderate
Membrane stability	High	High	Moderate	Moderate
^a The size rejection rate is purely indicative. Different ranges are frequently given in the literature. Refer to the manufacturer documentation. ^b The microorganism removal shall be intended as potential capacity related to the nominal pore size of the considered membrane. The actual capacity, in terms of log-reduction, shall be proved with tests and, if necessary, ensured.				

B.2 Membrane separation system description

Such separation takes place in physical and chemical-physical processes which reduce the ion and/or molecule and/or the suspended particle content of a water.

The separation is made by permeating the water through the membrane.

For dead-end mode of operation, all the influent water passes through the membrane leaving contaminants on the surface of the membrane. For cross-flow mode operation, the influent water flows tangentially across the membrane, some (referred to as the permeate) flows through the membrane reducing the contaminant content as it does so. The remainder (referred to as the reject) is directed to drain (or perhaps reprocessing for series operation) and contains an increased level of contaminants over the influent water.

Depending on the characteristics of the membrane, this process can pass range progressively from a solely physical phenomenon (separation caused by steric interaction between the porosity of the membrane and the size of the suspended particles and of the molecules to be eliminated, such as MF and UF often referred to as micro-porous membranes) to a more complex chemical-physical phenomenon, generally involving the osmotic pressure of the solution, such as NF and RO often referred to as semi-permeable membranes).

In this latter case the separation is obtained by applying an appropriate pressure, greater than the osmotic pressure of the aqueous solution for treatment, thus separating the elements in the ionic state (salts).

The mechanism on each membrane will be mainly physical or mainly chemical-physical, to varying extents, and this establishes the performance characteristics of the membrane itself.

Since osmosis is a specific phenomenon which takes place on particular types of membranes, and unless specifically indicated to the contrary, the general term "membrane separation" also includes NF and RO.

As the separation efficiency can be roughly related to membrane pore size, as shown in Table B.1, RO membranes will be capable of removing larger contaminants associated with NF, UF and MF performance (similarly NF in relation to UF and MF, and UF in relation to MF).

However this capacity is only seldom exploited as the larger contaminants can produce undesirable clogging and fouling. For this reason a membrane separation system is usually an equipment assembled with a pre-treatment before the membrane for protecting its efficiency.

Such pre-treatment can include filters of different types, activated carbon filter for eliminating oxidants which may negatively react with some polymeric membranes etc.

If the membrane nominal flow rate is low (e.g. with RO membrane), a collection tank is installed downstream of the treatment in order to store enough water to feed the tap.

Annex C (informative)

Typical test reports

C.1 Test report N° Z/2005 "Differential pressure versus flow rate"

TEST REPORT N° Z/2005 "DIFFERENTIAL PRESSURE VERSUS FLOW RATE"

Test laboratory: Test date: Operator:

1. Device and module identification

Manufacturer: Module ID: Housing ID:

Reference flow rate (m³/h): RFT (μm): Bubble point (kPa):

Substitute element description:

2. Operating conditions

Test fluid Temperature $\boxed{A_1}$ (25 ± 2) °C $\boxed{A_1}$: Viscosity at T °C (mm²/s):

3. Test results

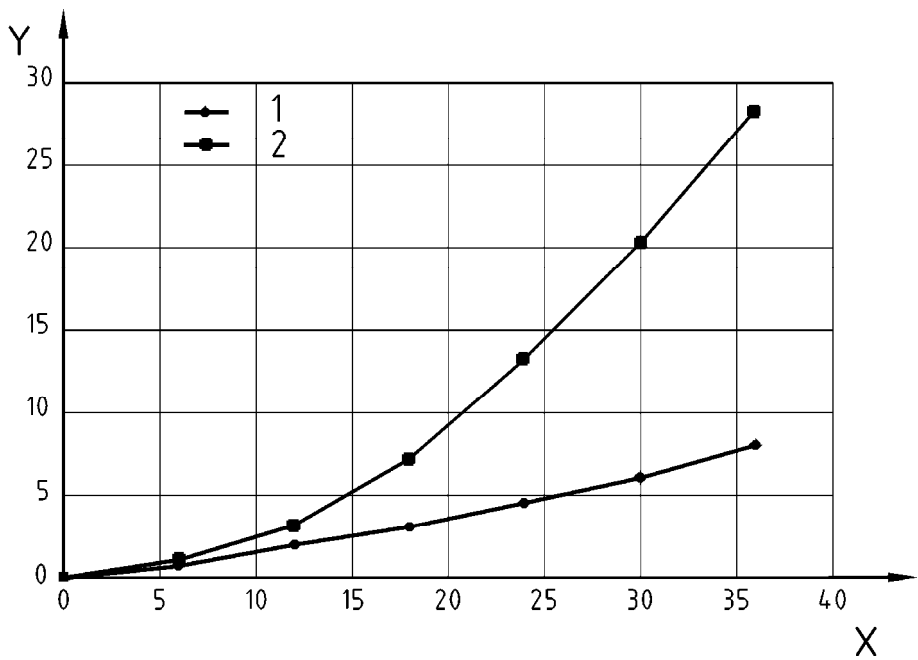
1. Instantaneous results

Flow rate ^a l/min		Module inside housing			Module housing only			Module
Rated	Measured	P_1^b a	P_2 b	ΔP c	P_1 d	P_2 e	ΔP f	c – f
0,2 Q_N								
0,4 Q_N								
0,6 Q_N								
0,8 Q_N								
1,0 Q_N								
1,2 Q_N								
1,0 Q_N								
0,8 Q_N								
0,6 Q_N								
0,4 Q_N								
0,2 Q_N								
^a The flow rate values indicated are suggestions. The values of the flow rate may be modified in accordance with the requirements of the test procedure. ^b Specify the relative pressure and pressure differential units.								

2. Average values

Average ΔP^a	Flow rate l/min ^a					
	0,2	0,4	0,6	0,8	1,0	1,2
Module inside housing						
Module housing						
Module						
^a Specify the relative pressure and pressure differential units.						

4. Observations:
.....



Key
1 Cartridge
2 Housing
Y Differential pressure (kPa)
X Flow rate (l/min)

Figure C.1 — Typical differential pressure versus flow rate curve

C.2 Test report N°Z/2005 "Verification of module resistance to differential pressure (collapse pressure)

TEST REPORT N° Z/2005 "VERIFICATION OF MODULE RESISTANCE TO DIFFERENTIAL PRESSURE (COLLAPSE PRESSURE)

Test laboratory..... Test date.....

Operator.....

1. Module identification¹⁾

Manufacturer..... Batch N°

Product code N°..... Production N°

Reference retention capacity..... μm

Specified differential pressure..... kPa

Predicted filtration rate..... %

2. Operating conditions

Test liquid: tap water Test contaminant:..... Batch N°

Test flow rate..... l/min

Test temperature:..... °C

End test differential pressure: $\Delta P_f =$ kPa

3. Test results

Bubble point :..... kPa

Differential pressure at start of test

— Filter housing alone ΔP_h kPa

— Filter housing with module ΔP_m kPa

— Clean module $\Delta P_{hm} = \Delta P_m - \Delta P_h$ kPa

Visual examination : Deformation or defects of module: YES NO²⁾

Resist to specific differential pressure: YES NO²⁾

Differential pressure at point of inflexion: ΔP_i kPa

¹⁾ Information supplied by the manufacturer before the test.

²⁾ Delete as appropriate.

4. Observations

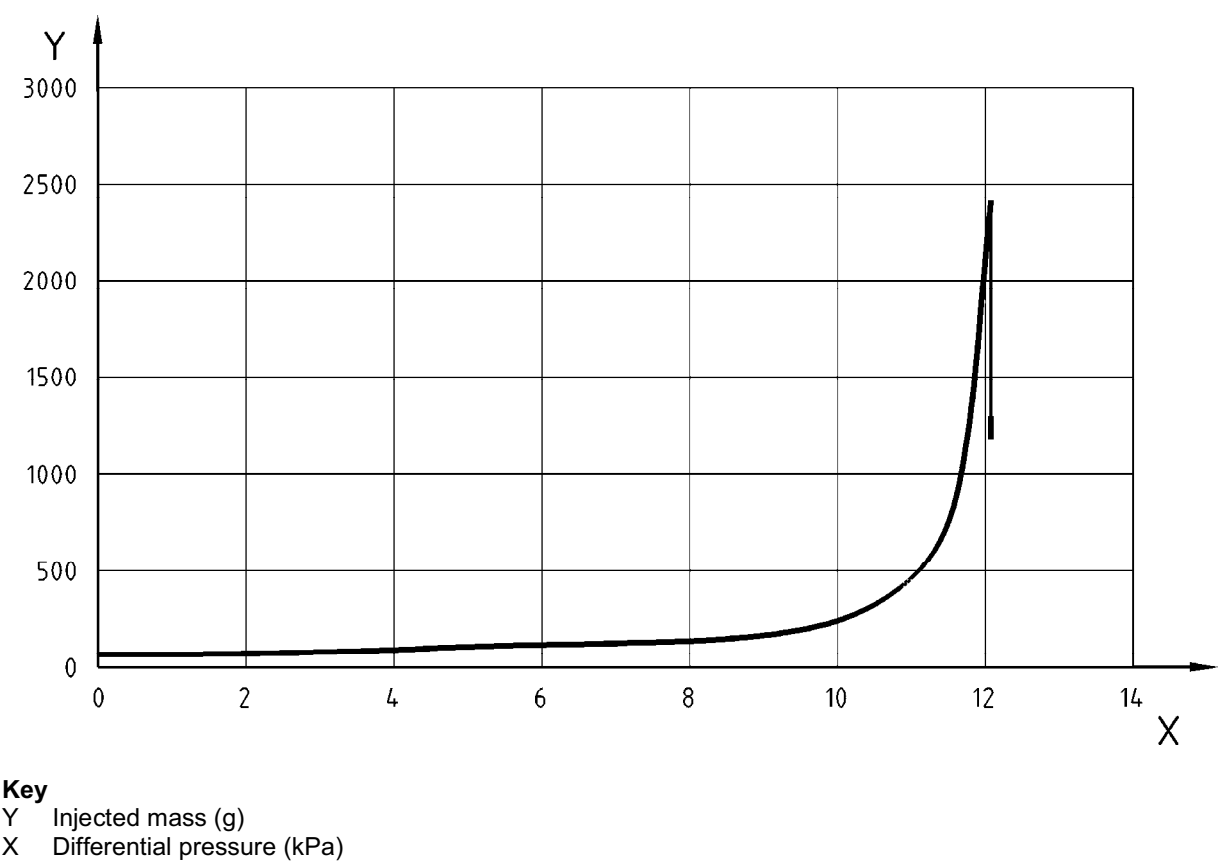


Figure C.2 — Typical collapse curve

C.3 Test report N° Z/2005 "Verification of module cyclic pressure resistance"

TEST REPORT N° Z/2005
VERIFICATION OF MODULE CYCLIC PRESSURE RESISTANCE

Test laboratory..... Test date.....

Operator.....

1. Module identification

Manufacturer..... Batch N°.....

Product code N°..... Production N°.....

Filtration rate.....%

2. Operating conditions

Test liquid: Freshly RO treated water

Test temperature.....(25 ± 2)°C

Test flow rate..... Number of cycles scheduled: 500

3. Results

Bubble Point/

— before test: kPa+/-.....kPa

— after test: kPa+/- kPa

Percentage difference

— Differential pressure at the test housing connections:

— Net differential pressure before test:

— Net differential pressure after test:

— Variation in differential pressure during the test:

Number of cycles carried out:

Visual examination:

Deformation: YES NO¹⁾Degradation: YES NO¹⁾**4. Observations.....**

¹⁾ Delete as appropriate.

Annex D (normative)

A1 Installation, operation and maintenance

D.1 Introduction

This annex defines essential information and instructions on the installation, operation, maintenance and repair of membrane separation devices. It transposes the general requirements in EN 15161 into specific requirements for membrane separation devices.

Correct operation and maintenance of the device is essential for successful and hygienic performance. Devices in compliance with this European Standard shall be provided with all necessary information and instructions on operation and maintenance appropriate to the device being supplied. The following information is stipulated as a minimum, it is not exhaustive and it is not intended to substitute for the supplier's instructions.

NOTE For the purposes of this European Standard the supplier is the organisation whose name is identified on the product being sold. The supplier may or may not be the manufacturer.

D.2 Installation requirements

D.2.1 Equipment selection

Selection of a device that is appropriate to the performance and operational expectations, and to the intended installation site, is essential. Information outlining the key installation and operation requirements shall be made available at the point of purchase, in the form of either brochures or specification sheets or clearly marked on the external product packaging. This information shall identify limitations on the location for installation in terms of dimensional requirements and environmental conditions (e.g. ambient temperature). The information shall offer guidance on frequency of periodic operation and maintenance along with any associated accessibility required. It shall also identify the water supply requirements (pressure limitations, pipe sizes) along with proximity requirements for other services which may be necessary such as availability of electric power, drainage facilities etc.

D.2.2 Installation

Installation instructions, provided with the device shall include a list of the components provided with the device along with a list clearly identifying any other components deemed necessary to complete a successful installation (e.g. pressure reducing valve). The characteristics of such additional equipment shall be clearly identified.

The instructions shall include a sequenced procedure outlining assembly of the components including connection to the water supply and to any other service(s) required. The instructions shall include definitive guidelines identifying the dimensional and orientational requirements essential to position the device and its ancillaries in order to provide adequate access for operation and maintenance at the chosen installation site.

In addition, the installation instructions shall include a checklist to ensure that the device is located:

- in a suitable location (e.g. clean, well ventilated, adequately illuminated and protected against pests, frost, physical damage) within the domestic water distribution system;
- remote or insulated from sources of heat (e.g. washing machines, dishwashers, boilers, cookers and hot water pipework);

- as close as possible to the existing distribution system and to other necessary services;
- avoiding or minimising dead-legs that can encourage stagnation.

NOTE Drinking water for cleaning purposes and appropriate waste disposal facilities should be available.

D.2.3 Labelling

The device as supplied shall be labelled, with a durable waterproof label mounted on, or close to the device, with the information required in accordance with 8.1.

D.2.4 Commissioning

The instructions shall contain a procedure for putting the device into service including as a minimum:

- initial filling and pressurisation of the system;
- checking for leaks;
- flushing requirements (time and/or volume);
- setting-up, e.g. flow rate adjustment (in absence of flow regulation);
- performance check, including
 - determination of salinity of raw and treated waters;
 - determination and application of the adjustments according to the instruction manual (e.g. pressure, reject flow);
 - report on settings in the logbook;
 - control of parameter(s) in the scope of the device.

The instructions shall provide advice on checking performance and, where a control kit is provided, detailed instructions on the use of it and interpretation of the results.

D.2.5 Hand over

The instructions shall identify that, where commissioning is carried out by a third party, this third party shall, after checking the performance of the device, hand over to the owner all of the printed instructions on its use (e.g. testing procedure and frequency, actions to be taken dependant upon the testing results), along with the updated logbook and the control kit, where provided, for monitoring the device performance.

NOTE 1 Depending on the intended application of the membrane separation devices, the control kit could include one or more of the following:

- conductivity measurement or equivalent (for RO, NF);
- hardness measurement (for NF);
- specific contaminant determination.

NOTE 2 In its simplest form, the logbook may be a single sheet (which may be adhesive backed to secure to the device) which permits, at the very least, a record of the operations performed during the last maintenance and of the performance checks.

D.3 Operation requirements

The instructions shall include procedures on checks to be made by the user during normal day to day operation for optimum performance of the device. The checklist shall include, as a minimum, instructions:

- to be alert to the treated water quality with respect to the treatment expectations (e.g. conductivity of the treated water);
- to carry out performance checks using the control kit, if provided;
- to call for maintenance, if the device has not been used for a long time.

D.4 Maintenance requirements

In order to maintain optimum performance of the device, the instructions shall include procedures and checks to be made at specified time intervals, including instructions:

- to carry out the replacement procedure of the pre-treatment cartridges in accordance with the instructions (to include dismantling, cartridge disposal, cleaning, reassembly, preconditioning etc., as appropriate);
- to record on the logbook the date of above interventions;
- to inspect the disassembled system for signs of leakage or damage;
- to call for repair in the event that any defect or failure is noticed (e.g. flow or conductivity of the treated water).

The instructions shall provide guidance on the hygiene precautions necessary for any maintenance operations that require dismantling of the system.

NOTE An example of good practice is as follows:

Hygiene. Maintenance operations that require dismantling the system, such that water contact parts are exposed, should be subject to careful, hygienic control in order to avoid contamination of the system. Preferably, disposable gloves should be used to avoid personal contamination of the system parts; any tools used that may come into contact with the wetted parts should be cleaned and disinfected in accordance with the instructions before use. Disposable parts should be carefully disposed of and the replacement parts should remain sealed in its protective wrapping until the last practical moment.

Routine maintenance and timely replacement of consumable parts are essential to the satisfactory performance of the device. Failure to replace, e. g. pre-treatment cartridges or filters, can result in damage to the expensive membrane or low flow.

Regular use is also important. Long periods of stagnation can give rise to off-taste in the treated water so, as with any drinking water supply, the system should be flushed before reuse, if it has been out of use for a period of several weeks or more.

D.5 Repair requirements

D.5.1 General

The instructions shall include advice stating that any corrective action carried out on the system that is not regarded as routine and, therefore, not described in the instructions, is to be performed only by a competent repair person. The instructions shall identify, either contact details for approved repair engineers or alternatively provide a route (telephone, website) for contacting the supplier to obtain information on such service.

D.5.2 Repair documentation

The instructions shall contain a statement advising that a record of any repair intervention is kept within the logbook.

D.6 Troubleshooting

The instructions shall provide guidance on troubleshooting in the event that problems occur with the device.

An example of a troubleshooting guide is given in Table D.1.

Table D.1 — Troubleshooting guide (example)

Type of membrane	Observation	Possible cause	Recommended monitoring and/or control in operation	Remedy
MF and UF	ΔP increase Flow rate decrease	Clogging Low supply pressure	In and out manometers Flow meter Visual control	Clean or replace the module Expert control and water analysis
	ΔP decrease Flow rate increase Poor water quality	Breakage	In and out manometers Flow meter Visual control	Expert advice Replace the module
	Off-taste/off-odor ΔP increase Flow rate decrease	Cleaning maintenance need	As per instructions Water meter (volume) Timer	Actions as per instructions
	Performance not as expected	Specified failure	Test kit, if any	Expert control
NF and RO	ΔP increase Flow rate decrease Variation in treated water quality	Clogging Low supply pressure	TDS/conductivity meter Flow meter Pre-treatment/in and out manometers	Check and, in case, replace pretreatment cartridge Expert control
	TDS increase in treated water	Breakage/salinity leakage	TDS/conductivity meter	Expert control Replace the module
	Flow rate decrease	Loss of production	Visual detection Temperature check (performance data sheet) Flow meter	Expert control
	Off-taste/off-odor ΔP increase Flow rate decrease	Cleaning/maintenance need	As per instructions Water meter (volume) Timer	Actions as per instructions
	Flow increase Quality decrease	Oxidation of membrane	TDS/conductivity meter Flow meter Chlorine control	Replace the module
	Performance not as expected	Specific failure	Test kit, if any	Expert control

A1

Bibliography

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ISO 10523, *Water quality — Determination of pH*

98/83/EC, Council Directive of 3 November 1998 on the quality of water intended for human consumption