INTERNATIONAL STANDARD

ISO 8638

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Extracorporeal blood circuit for haemodialysers, haemofilters and haemoconcentrators

Circuit sanguin extracorporel pour les hémodialyseurs, les hémofiltres et les hémoconcentrateurs

Reference number
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Contents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 8638 was prepared by Technical Committee ISO/TC 150, *Implants for surgery*.

Introduction

This International Standard is concerned with the extracorporeal circuit manufactured for single use and intended for use in conjunction with haemodialysers, haemofilters or haemoconcentrators. The requirements specified in this International Standard for the extracorporeal circuit will help to ensure safety and satisfactory function.

It was not found practicable to specify materials of construction nor to give test methods for biocompatibility, validation of sterility, non-pyrogenicity and certain performance characteristics of the extracorporeal circuit. This International Standard therefore requires only that materials will have been tested and that the methods and results are made available upon request.

The specifications for physical characteristics have been limited to those deemed necessary for safe and effective function of the device. A design standard is required for connectors to the blood ports of the haemodialyser, haemofilter or haemoconcentrator and to the blood access device to ensure the compatibility of the circuit and the corresponding device. These design and dimension specifications have been selected to minimize the risk of leakage of blood and the ingress of air. Connectors with either fixed or loose locking shells are permitted.

Attention is drawn to the work of Sub-committee 62D, *Electromedical equipment,* of the International Electrotechnical Commission (IEC) regarding the electrotechnical aspects of dialysis systems. There is no IEC publication dealing with haemofiltration or haemoconcentration systems.

This International Standard reflects the consensus of physicians, manufacturers and other interested parties for devices that are approved for clinical use. Conformance with the standard is voluntary and it does not supersede any national regulation.

Extracorporeal blood circuit for haemodialysers, haemofilters and haemoconcentrators

1 Scope

This International Standard specifies requirements for the extracorporeal blood circuit for single use which is to be used in conjunction with haemodialysers, haemofilters and haemoconcentrators.

Materials of construction and test methods for biocompatibility, validation of sterility, non-pyrogenicity and some performance characteristics are not specified; the rationale for these omissions is given in the Introduction.

This International Standard applies to the blood tubing and integral accessory tubing, including fluid and infusion tubings and tubing for attaching the extracorporeal blood circuit to pressure monitors.

This International Standard does not apply to haemodialysers, haemofilters, haemoconcentrators, vascular access devices, blood pumps, pressure monitors of the extracorporeal blood circuit, air detection devices, haemodialysis systems to prepare, maintain and monitor the dialysing fluid, and hardware used to perform haemofiltration or haemoconcentration.

NOTE — Requirements for haemodialysers, haemofilters and haemoconcentrators are specified in ISO 8637.

2 Normative references

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

ISO 472: 1979, *Plastics — Vocabulary*.

ISO 594-2 — [1], *Conical fittings with a 6 % (Luer) taper for syringes, needles and certain other medical equipment — Part 2: Lock fittings*.

ISO 8637 : 1989, *Haemodialysers, haemofilters and haemoconcentrators*.

1) To be published.

3 Definitions

For the purposes of this International Standard the following definitions apply.

3.1 arterial blood circuit: Portion of the extracorporeal blood pathway from the vascular access device of the patient to the blood inlet of the haemodialyser, haemofilter or haemoconcentrator.

3.2 non-pyrogenic: Free of pyrogenic materials within the limit of error of test methods for such determinations, as defined by the national regulatory agency of the country in which the device is to be marketed or, where available, an International Standard, and maintained in that state by suitable protection.

3.3 pump segment: Portion of the extracorporeal blood circuit that is acted upon by the blood pump.

3.4 sterile: Free from all living organisms within the limits of validation tests for sterility and maintained in that state by suitable protection.

3.5 venous blood circuit: Extracorporeal blood circuit from the outlet of the haemodialyser, haemofilter or haemoconcentrator, returning blood to the vascular access device of the patient.

4 Requirements

4.1 Good manufacturing practice

The extracorporeal circuit shall be manufactured in a clean environment and the fluid pathways shall be free of visible foreign material.

NOTE — Attention is drawn to the need to establish whether codes for good manufacturing practice exist in the country in which the device is produced and, if applicable, in the countries in which the device is to be marketed.

Testing shall be carried out in accordance with 5.1.

4.2 Toxicology and biological compatibility

Samples of the device shall be tested for freedom from toxicity using, if available, the method specified in the relevant national standard and the results of such tests shall indicate freedom from biological hazard. If requested, details of the test method

and the results shall be made available by the manufacturer of the device.

NOTE — Attention is drawn to the need to establish whether national regulations or national standards governing toxicology and biocompatibility testing exist in the country in which the device is produced and, if applicable, in the countries in which the device is to be marketed.

Testing shall be carried out in accordance with 5.2.

4.3 Sterility

The fluid pathways of the device shall be supplied sterile.

NOTE — Attention is drawn to the need to establish whether national regulations or national standards governing sterility testing exist in the country in which the device is produced and, if applicable, in the countries in which the device is to be marketed.

Testing shall be carried out in accordance with 5.3.

4.4 Pyrogenicity

The blood pathway(s) of the device shall be non-pyrogenic. If requested, details of the test method(s) and the results shall be made available by the manufacturer of the device.

NOTE — Attention is drawn to the need to establish whether national regulations or national standards governing pyrogen testing exist in the country in which the device is produced and, if applicable, in the countries in which the device is to be marketed.

Testing shall be carried out in accordance with 5.4.

4.5 Residues from sterilization

After sterilization by the procedure recommended by the manufacturer, the device shall be tested for freedom from toxic residues that have adverse chemical, physical or biological effects on the blood or that result in release of clinically significant amounts of potentially toxic substances into the blood. If requested, details of the test methods and the results shall be made available by the manufacturer of the device.

NOTE — Attention is drawn to the need to establish whether national regulations or national standards governing testing for residues from sterilization exist in the country in which the device is produced and, if applicable, in the countries in which the device is to be marketed.

Testing shall be carried out in accordance with 5.5.

4.6 Mechanical characteristics

4.6.1 Structural integrity

Samples of the extracorporeal circuit shall be capable of withstanding

a) a pressure above atmospheric pressure at sea level that is 1,5 times the manufacturer's specified maximum pressure, and

b) a pressure 200 mmHg below atmospheric pressure (at sea level).

The pump segment shall be capable of withstanding a minimum of 24 h of use under worst-case conditions.

Testing shall be carried out in accordance with 5.6.1.

4.6.2 Connectors to haemodialyser, haemofilter or haemoconcentrator

The dimensions of the fitting for connection to the haemodialyser, haemofilter or haemoconcentrator shall be as given in figures 1 to 3.

The dimensions shall be checked in accordance with 5.6.2.

4.6.3 Connector to vascular access device

The fitting for connecting the extracorporeal circuit to a vascular access device shall be a male 6 % (Luer) taper lock fitting; this fitting shall be in accordance with ISO 594-2.

The fitting shall be checked in accordance with 5.6.3.

4.6.4 Connectors to ancillary components

All parts of the extracorporeal circuit intended for use with ancillary components, such as heparin lines and pressure transducer lines, shall terminate in a female 6 % (Luer) taper lock fitting; this fitting shall be in accordance with ISO 594-2.

The fittings shall be checked in accordance with 5.6.4.

4.6.5 Access ports

Where injection ports are incorporated into the extracorporeal circuit, they shall be capable of withstanding, without leakage, puncture by needle having at least an internal diameter of 0,8 mm (21 gauge). The injection ports shall be designed so as to minimize the risk of the needle piercing the tube completely and causing injury.

Testing shall be carried out in accordance with 5.6.5.

4.6.6 Colour coding

If the arterial extracorporeal blood circuit differs from the venous extracorporeal blood circuit, the arterial circuit shall be colour-coded **red** and the venous circuit shall be colour-coded **blue**. The coding shall be prominently displayed within 100 mm of the end of the tubing.

The colour coding shall be checked in accordance with 5.6.6.

4.7 Physical characteristics

4.7.1 Volume

The volume of the blood pathway of the venous and arterial extracorporeal circuits shall be equal to the manufacturer's stated values ±20 %.

Testing shall be in accordance with 5.7.1.

4.7.2 Pump segment

The length and internal diameter of the pump segment shall be equal to the manufacturer's stated values ± 5 %.

The dimensions shall be checked in accordance with 5.7.2.

Dimensions in millimetres

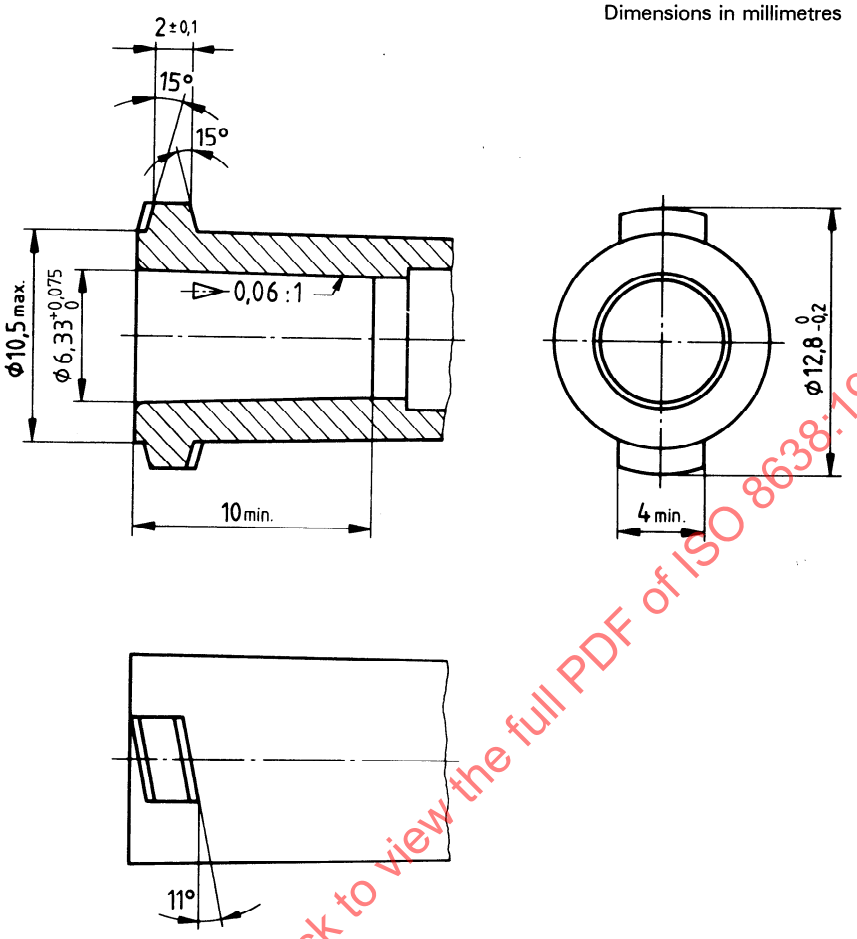


Figure 1 — Main fitting dimensions of extracorporeal circuit connector to blood ports of haemodialyser, haemofilter or haemoconcentrator

Dimensions in millimetres

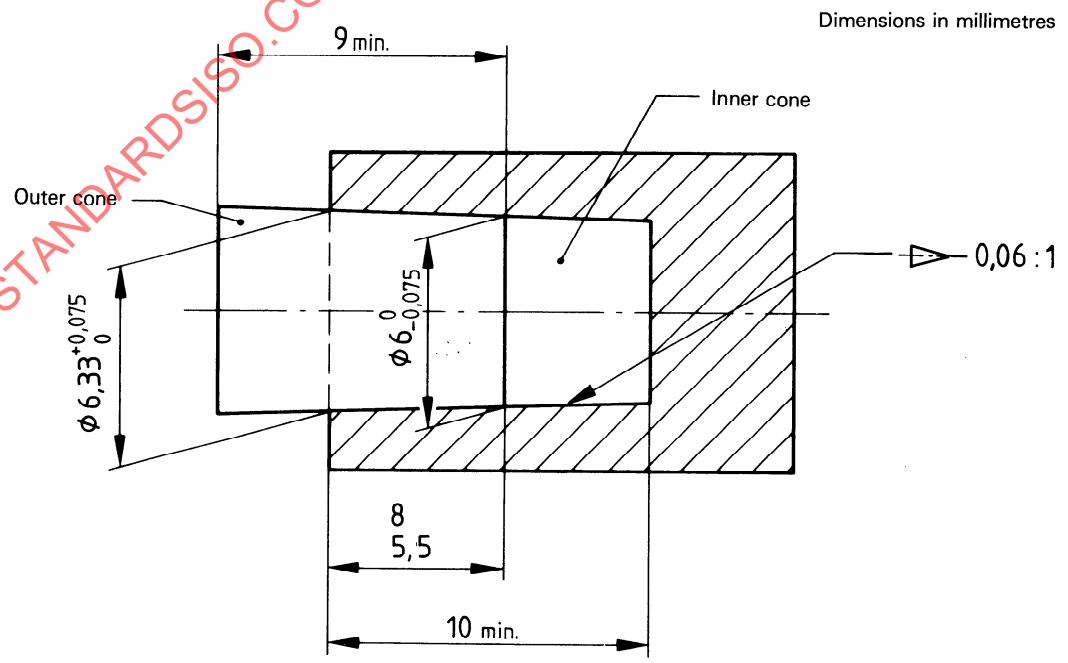


Figure 2 — Length of engagement of male and female cones of blood inlet and outlet connectors

Dimensions in millimetres

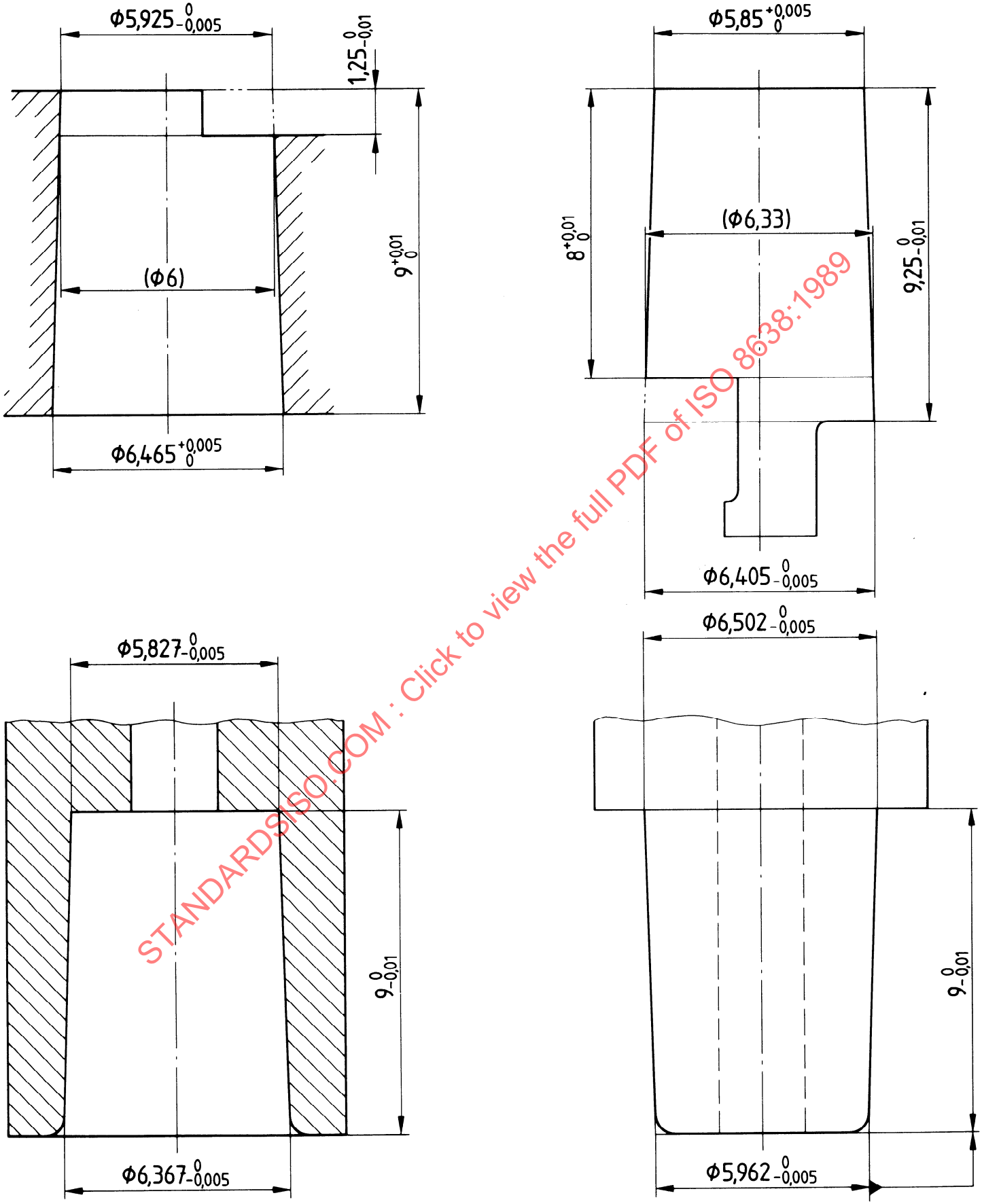


Figure 3 — Details of 6 % taper test fitting for connector to haemodialyser, haemofilter or haemoconcentrator blood port

5 Test methods

5.1 Good manufacturing practice

Compliance with the requirement specified in 4.1 shall be determined by inspection.

5.2 Toxicology and biological compatibility

The toxicology and biological compatibility of materials (of a device) which will come into contact with biological fluids shall be determined on samples of each new type of device prior to its marketing or after any change in the materials of construction of that type of device or after any change in the method of sterilization.

NOTE — Testing should be carried out using the method(s) specified in appropriate national regulations or national standards.

5.3 Sterility

The sterilization process shall be validated on samples of the finished device prior to marketing a new type of device, and, thereafter, the sterilization process shall be monitored for each batch.

5.4 Pyrogenicity

Testing for pyrogens shall be carried out on samples of each new type of device prior to marketing, and, thereafter, the manufacturer shall perform pyrogen testing at intervals shown to ensure non-pyrogenicity of the device.

5.5 Residues from sterilization

Samples of the finished device shall be tested for potentially toxic residues by recognized toxicological methods prior to marketing a new type of device, and, thereafter, the manufacturer shall test for toxic residues at intervals shown to ensure the safety of the device and after any change of materials of construction.

5.6 Mechanical characteristics

5.6.1 Structural integrity and access port leakage

The test described shall be carried out prior to marketing a new type of device; it is not intended to be a quality control test.

5.6.1.1 Principle

Subjection of the extracorporeal circuit to simulated use during which the access port is punctured. Subjection of the extracorporeal circuit to the specified pressures (see 4.6.1) above and below atmospheric pressure at sea level. Observation for leaks.

5.6.1.2 Reagents

5.6.1.2.1 Anticoagulated bovine or human plasma, with a protein mass concentration of 60 g/l ± 5 g/l for the perfusate during simulated use.

5.6.1.2.2 Distilled water, freshly boiled, for the subatmospheric test.

5.6.1.3 Apparatus

5.6.1.3.1 Blood pump, as recommended by the manufacturer, or, if the manufacturer does not recommend a blood pump, **an adjustable double roller blood pump** as commonly used for clinical haemodialysis, haemofiltraton or haemoconcentration. The rollers shall be just occlusive at the test pressure. Each roller shall be occlusive at the beginning, the middle and the end of the stroke.

5.6.1.3.2 Stainless steel or **plastic vessel** for the perfusate.

5.6.1.3.3 Heating device, capable of maintaining the perfusate at 37 °C ± 1 °C.

5.6.1.3.4 Jig, for puncturing the access port at the same location.

5.6.1.3.5 Needle, having the largest internal diameter recommended by the manufacturer or having an internal diameter of 0,8 mm (21 gauge), whichever is the larger.

5.6.1.3.6 Open or occluded steel reference connectors, as appropriate (the connectors for the blood access and ancillary tubing), which comply with the requirements specified in ISO 594-2. See figure 3.

5.6.1.3.7 Blood port, complying with the requirements specified in clause 4.6.3 of ISO 8637 : 1989.

5.6.1.3.8 Tubing, to be attached to the blood port (unless it is occluded), and to the connectors to the blood access connector and to the ancillary tubing connector (5.6.1.3.6) that can withstand the test conditions.

5.6.1.3.9 Pressurized air source, capable of maintaining the extracorporeal circuit at the specified pressure above atmospheric pressure.

5.6.1.3.10 Suction device, capable of maintaining the specified pressure below atmospheric pressure.

5.6.1.3.11 Pressure gauges, accurate to ± 10 mmHg.

5.6.1.3.12 Vessel, filled with water, that will accommodate the extracorporeal circuit during the subatmospheric pressure test.

5.6.1.4 Sampling and preparation of test samples

A statistically significant sample of extracorporeal circuits drawn at random from the manufacturer's production which have passed all safety and quality control measures, where applicable, shall be used.

5.6.1.5 Procedure

5.6.1.5.1 Perform simulated dialysis by recirculating the plasma (5.6.1.2.1) at 37 °C ± 1 °C through the extracorporeal circuit at the manufacturer's recommended maximum pressure and flow rate.

After 15 min of perfusion, puncture the access ports, if any, six times in the same location with the needle (5.6.1.3.5).

Continue the perfusion for a total of 24 h.

5.6.1.5.2 Attach the connections of the extracorporeal circuit to appropriate fittings as shown in figure 4 and pressurize the extracorporeal circuit to a pressure 1,5 times the maximum operating pressure recommended by the manufacturer. Immerse the extracorporeal circuit in water at 37 °C ± 1 °C for 1 min, while maintaining the pressure inside the extracorporeal circuit constant.

After 30 s examine the circuit and the union of the connectors for the blood port, vascular access device and ancillary components for leakage of air indicated by a steady stream of bubbles.

5.6.1.5.3 Fill that part of the circuit and its connectors that may be exposed to a subatmospheric pressure with distilled water (5.6.1.2.2) and subject it to a pressure 200 mmHg below atmospheric pressure at sea level.

Examine the circuit for leakage of air as indicated by a steady stream of bubbles.

5.6.1.5.4 At the conclusion of the test, check that the pump segment is undamaged.

5.6.1.6 Expression of results

5.6.1.6.1 Test above atmospheric pressure (1,5 times maximum pressure)

An unsatisfactory test is shown if a steady stream of bubbles is seen after 30 s. See 5.6.1.5.2.

The results shall be recorded as "Pass" or "Fail".

5.6.1.6.2 Test at subatmospheric pressure

An unsatisfactory test is shown by the appearance of bubbles in the fluid pathway of the blood tubing.

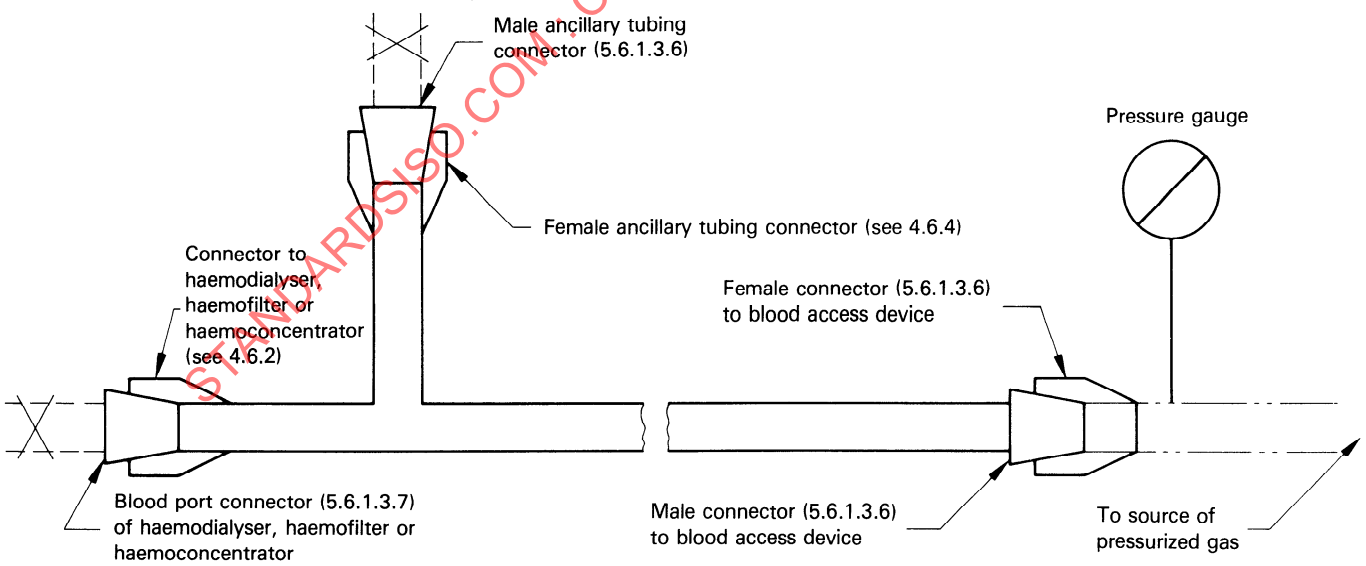
The results shall be recorded as "Pass" or "Fail".

5.6.1.6.3 If the pump segment was damaged, (see 5.6.1.5.4), the result shall be recorded as "Fail".

5.6.1.7 Test report

The test shall be recorded as satisfactory if all samples pass and unsatisfactory if any sample fails.

The size of the sample and the rationale for its statistical significance shall be given.



NOTE — Dotted lines represent tubing other than the extracorporeal blood circuit tubing used.

"X" across the tubing indicates that it is clamped (an occluded connector to the extracorporeal blood connector may also be used).

The break between two ends of the extracorporeal blood circuit represents other elements, such as a blood pump segment or a drip chamber.

Figure 4 — Diagram for testing structural integrity of extracorporeal circuit

5.6.2 Connectors to haemodialyser, haemofilter or haemoconcentrator

Compliance with the requirement specified in 4.6.2 shall be determined by inspection.

5.6.3 Connector to vascular access device

Compliance with the requirement specified in 4.6.3 shall be determined by inspection.

5.6.4 Connectors to ancillary components

Compliance with the requirement specified in 4.6.4 shall be determined by inspection.

5.6.5 Access ports

The integrity of the access port after it has been punctured by the needle (see 5.6.1.5.1) shall be tested in accordance with the method specified in 5.6.1.

Compliance with the requirements on disinfection and protection of the operator from being pricked by the needle shall be determined by inspection.

5.6.6 Colour coding

Compliance with the requirement specified in 4.6.6 shall be determined by inspection.

5.7 Physical characteristics

5.7.1 Volume

The test described is a referee test. Other tests may be used provided that the results are within ±5 % of the referee test. This test shall be carried out prior to marketing a new type of device; it is not intended to be a quality control test.

5.7.1.1 Principle

Volumetric measurement of the volume of water filling the blood pathway of the extracorporeal circuit.

5.7.1.2 Reagent

Tap water.

5.7.1.3 Apparatus

5.7.1.3.1 Graduated cylinder, capable of measuring the volume of the blood pathway to within ±2 %.

5.7.1.3.2 Clamps or occluded connectors to close off the ancillary tubings.

5.7.1.4 Sampling

A statistically significant sample of extracorporeal circuits drawn at random from the manufacturer's production which have passed all safety and quality control measures, where applicable, shall be used.

5.7.1.5 Procedure

Occlude ancillary tubings and fill the blood pathway with water. Drain the fluid as completely as possible into the graduated cylinder. Record the volume collected in the cylinder.

5.7.1.6 Expression of results

Calculate the volume collected, expressed in millilitres, as a percentage of the manufacturer's stated volume.

5.7.1.7 Test report

The test shall be reported as satisfactory if the result for each sample does not differ by more than 20 % from the manufacturer's stated volume.

5.7.2 Pump segment

Compliance with the requirement specified in 4.7.2 shall be determined for each batch by inspecting a significant sample of pump segments from finished extracorporeal circuits that have passed all safety and quality control measures.

6 Packaging, marking and accompanying documentation

6.1 Packaging and marking

6.1.1 Unit containers

At least the following information shall be visible on or through the unit container:

a) the manufacturer's name and address;

b) the product name;

c) the manufacturer's identifying code for the device;

d) the lot number which will allow the manufacturing history of the device to be traced;

e) a statement of sterility and non-pyrogenicity, and whether the entire contents of the container or the fluid pathways only are sterile;

f) the month and year of sterilization, accurate to within 30 days of the actual date of sterilization;

g) a statement of single use;

NOTE — Symbol 1051 from ISO 7000 : 1989, i.e. ⊗, may also be used.

h) the statement "Read the instructions before use";

i) a prominent instruction to prepare the extracorporeal circuit for use as directed;

j) instructions and warnings regarding storage and handling.

6.1.2 Outer containers

At least the following information shall appear on the outer container:

a) the manufacturer's name and address;

b) the name and address of the distributor, if different from the information given under a);

c) the product name, description of contents and number of devices contained in the outer container;

d) the manufacturer's identifying code for the device;

e) the lot number which will allow the manufacturing history of the device to be traced;

f) a statement of sterility and non-pyrogenicity;

g) the month and year of sterilization, accurate to within 30 days of the actual date of sterilization;

h) instructions and warnings regarding handling and storage.

6.2 Documentation

6.2.1 Accompanying documents

At least the following information shall be supplied with each outer container:

a) the manufacturer's name and address;

b) the product name;

c) the manufacturer's identifying code for the device;

d) a statement of sterility and non-pyrogenicity and method of sterilization;

e) a statement of single use;

NOTE — Symbol 1051 from ISO 7000 : 1989, i.e. ⊗ , may also be used.

f) cautions and warnings, including, but not limited to, the following:

1) pressure and blood flow rate limitations,

2) a statement that the user ensures that the extracorporeal circuit is compatible with the device with which it is used, such as the air detector, the venous clamp, the blood pump and the pressure monitors, with particular emphasis on compatibility of the air detector,

3) a statement that if the extracorporeal circuit is attached to a blood gas exchanger circuit, it should be noted that the blood gas exchanger inlet line is to be colour-coded blue and the blood gas exchanger outlet line is to be colour-coded red;

g) instructions on how to prepare the extracorporeal circuit before use;

h) an explanation of the colour coding that is used to identify the arterial and venous lines;

i) instructions to read the reference documents before use, if they contain additional information.

6.2.2 Reference documents

At least the following information shall be provided to the user if it does not appear in the accompanying documents (see 6.2.1):

a) details of ancillary equipment required;

b) the total volume, in millilitres, of the blood pathway, assuming that the bubble traps are full;

c) the length and internal diameter of the blood pump segment;

d) a general description of the extracorporeal circuit;

e) details of the orientation of the connectors to the haemodialyser in relation to the dialysing fluid lines;

f) if monitor lines are included, an instruction that devices to prevent contamination of monitors by blood should be used unless these devices are part of the extracorporeal circuit;

g) a list of disinfectants for external application (e.g. when blood sampling) that are compatible with the components of the extracorporeal circuit and a warning that the compatibility of other disinfectants with the components of the extracorporeal circuit should be determined prior to clinical use;

h) the pressure at the inflow of the venous drip chamber when the venous extracorporeal circuit is perfused at 400 ml/min and 37 °C ± 1 °C with a 32 % (*V*/*V*) solution of glycerol and water respectively and with a pressure of 50 mmHg at the outflow of the venous extracorporeal circuit;

i) the direction of blood flow, if applicable;

j) the positioning of tubing connectors;

k) the recommended procedure for terminating the operational procedure, if applicable;

l) typical fluid circuit diagrams;

m) a statement that the following information is available to the user on request:

1) details of the test methods used to obtain the values used in disclosure of the physical characteristics *in vitro* and to establish biocompatibility (if applicable),