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Safety requirements for dry-cleaning machines —

Part 3: Machines using combustible solvents

Exigences de sécurité pour les machines de nettoyage à sec —

Partie 3: Machines utilisant des solvants combustibles

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Foreword

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

ISO 8230-3 was prepared by Technical Committee ISO/TC 72, *Textile machinery and accessories*, Subcommittee SC 5, *Industrial laundry and dry-cleaning machinery and accessories*.

This first edition of ISO 8230-3, together with ISO 8230-1:2008 and ISO 8230-2:2008, cancels and replaces ISO 8230:1997, of which it constitutes a technical revision.

ISO 8230 consists of the following parts, under the general title *Safety requirements for dry-cleaning machines*:

— *Part 1: Common safety requirements*

— *Part 2: Machines using perchloroethylene*

— *Part 3: Machines using combustible solvents*

Introduction

This document is a type-C standard as stated in ISO 12100.

The machinery concerned and the extent to which hazards, hazardous situations or hazardous events are covered are indicated in the Scope of this document.

When requirements of this type-C standard are different from those which are stated in type-A or -B standards, the requirements of this type-C standard take precedence over the requirements of the other standards for machines that have been designed and built according to the requirements of this type-C standard.

Safety requirements for dry-cleaning machines —

Part 3:
Machines using combustible solvents

1 Scope

This part of ISO 8230 specifies safety requirements for dry-cleaning machines that use a combustible solvent (CS), as defined in ISO 8230-1, as their cleaning medium.

It is applicable to such dry-cleaning machines, within the scope of ISO 8230-1, when they are used as intended and under conditions of misuse that are reasonably foreseeable by the manufacturer.

This part of ISO 8230, in conjunction with ISO 8230-1, deals with all significant hazards, significant hazardous situations and significant hazardous events that have been identified as being significant to the types of machines covered by this part of ISO 8230 and which require specific action by the designer or manufacturer to eliminate or reduce the risk.

It deals with the following significant hazards specific to the use of CS:

— hazards related to the entire dry-cleaning machine (electrical hazards, explosion hazards);

— hazards relating to the machine (combustible solvent emission, explosion hazards during the cleaning phase, explosion hazards during the drying phase);

— hazards relating to the distilling equipment (combustible solvent emission, explosion hazards).

This part of ISO 8230 applies to machines manufactured after the date of its issue.

2 Normative references

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

ISO 2719:2002, *Determination of flash point — Pensky-Martens closed cup method*

ISO 8230-1:2008, *Safety requirements for dry-cleaning machines — Part 1: Common safety requirements*

ISO 12100-1:2003, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology*

IEC 60204-1:2005, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

EN 13463-1:2001, *Non-electrical equipment for potentially explosive atmospheres — Part 1: Basic method and requirements*

EN 50104:2002, *Electrical apparatus for the detection and measurement of oxygen — Performance requirements and test methods* (amended by EN 50104:2002/A1:2004)

EN 60079-0:2006, *Electrical apparatus for potentially explosive atmospheres — General requirements*

EN 61779-1:2000, *Electrical apparatus for the detection and measurement of flammable gases — Part 1: General requirements and test methods* [1)]

EN 61779-4:2000, *Electrical apparatus for the detection and measurement of flammable gases — Part 4: Performance requirements for group II apparatus indicating a volume fraction up to 100 % lower explosive limit* [2)]

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100-1 and ISO 8230-1 and the following apply.

3.1
area of explosion
area of concentration of a combustible substance in the air where an explosion can occur

3.2
lower explosion limit
LEL
lower limit of the area of explosion

3.3
lower explosion point
LEP
temperature of a combustible liquid at which the concentration of the saturated vapour equals the lower explosion limit

NOTE If the lower explosion point is unknown, it can be assumed that the CS does not form any explosive vapour air mixtures if temperatures do not exceed 15 K below the flash point. During washing and spinning, the formation of mist is possible. With the operating conditions existing in the cage, the ignition energy required for droplet size and density is not reached by means of the ignition sources to be expected.

3.4
flash point
lowest temperature at which, under prescribed test conditions and in accordance with ISO 2719, a liquid releases combustible gas or combustible vapour in such quantities that a flame occurs immediately after contact with an effective ignition source

3.5
ignition temperature
lowest temperature of a hot surface, determined under prescribed test conditions, at which ignition of a combustible substance as gas air or vapour air mixture occurs

3.6
inert, verb
adding of inert substances to prevent the creation of an explosive gas atmosphere

1) IEC 61779-1:1998 modified.

2) IEC 61779-4:1998 modified.

3.7
inert gas
gas that does not react with the vapour generated by the complete evaporation of the CS or oxygen

3.8
limiting oxygen concentration
LOC
maximum oxygen concentration in a mixture of a combustible substance and air and an inert gas, in which an explosion will not occur, determined under specified test conditions

4 Safety requirements and/or protective measures

4.1 General

Dry-cleaning machines using CS shall comply with the safety requirements and/or protective measures of ISO 8230-1, in as far as these are not modified or completed by the requirements of this clause and other requirements of this part of ISO 8230.

4.2 Hazards related to the entire dry-cleaning machine

4.2.1 Electrical hazards

In addition to the requirements of ISO 8230-1:2008, 4.9, the electrical equipment of the dry-cleaning machine shall comply with the following:

— electric wires shall not be laid on floors or similar places where CS is liable to gather;

— all components made of conductive materials shall be connected to the protective bonding circuit.

4.2.2 Explosion protective measures

4.2.2.1 Display of malfunctions

Malfunctions in the field of explosion protection measures shall be displayed visually and signalled acoustically.

4.2.2.2 Measuring systems

4.2.2.2.1 General

NOTE It is assumed that with two independent systems whose failure is detected, leading to the cut-off of the machine, a failure of both systems at the same time is not to be expected.

The part of a control system of a dry-cleaning machine related to explosion protective measures shall be redundant or checked automatically so that failures cannot lead to an unsafe condition.

Control systems shall be safeguarded against involuntary maladjustment or manipulation, for example, by a fixed measuring sensor or limited possibility for adjustments. Manipulation shall be discernible.

Malfunctions shall be recognized automatically by the control before the dry-cleaning machine can go to an unsafe condition. At the same time, the machine shall stop automatically.

4.2.2.2.2 Concentration measuring instruments

Oxygen-measuring instruments shall be checked in accordance with EN 50104:2004, and CS measuring instruments shall be checked in accordance with EN 61779-1:2000 and EN 61779-4:2000.

The correct functioning of all concentration measuring systems shall be checked automatically during each working cycle. Faults shall entail the automatic stop of the dry-cleaning machine so that safe operating conditions are achieved.

NOTE 1 The air of the room can, for example, be used as test gas for oxygen measuring instruments.

Suction pipes for measuring gas shall be as short as possible.

The aperture where CS test gas is withdrawn shall be arranged in the area of maximum CS concentration during drying.

NOTE 2 As a rule, the highest CS concentration is between cage exit and drying condenser.

The suction pipes and measuring systems shall be arranged in such a manner that condensed CS cannot have an adverse effect on the results of the measurements.

EXAMPLE By heating the pipes.

4.3 Hazards related to the working cycle

4.3.1 Combustible solvent emission

4.3.1.1 Heating

The heating shall be interlocked such that the CS or air can be heated up to a temperature above the lower explosion point only when explosion protection measures are effective.

4.3.1.2 Sufficient drying

The drying temperatures and periods shall be selected and combined such that the CS is removed from the load. A sufficient degree of drying shall be controlled by a drying control system adjusted in accordance with the instruction handbook.

The occurrence of a technical failure that interrupts drying shall be clearly indicated visually or acoustically and shall cause the working cycle to stop.

It shall not be possible to withdraw the load from the dry-cleaning machine before drying is completed and the temperature in the outlet of the cage is below 50 °C.

4.3.1.3 Operation and maintenance of the water separator

Drainage for maintenance of the water separator and the associated tank shall be possible either via manual valves that close automatically when released or via a direct return circuit to the still or other reservoir.

The water outlet of the separator shall lead to a canister supplied with the dry-cleaning machine to avoid the loss of CS in case of failure. The capacity of the canister shall not be less than the maximum one day's production for which the machine is intended. The canister should be placed on the spillage safety tray.

It shall be possible to detect any presence of free CS in the contact water canister, e.g. by means of a sight glass.

A label on the tank shall indicate that the water contains CS (contact water). The wording of this label shall be reproduced in the instruction handbook.

NOTE National regulations may require specific contact water disposal.

4.3.2 Explosion protection measures during the cleaning phase

A temperature control device shall be provided that switches off the dry-cleaning machine and triggers a visual and acoustic alarm as soon as the CS temperature is more than 15 K below the flash point during the cleaning phase. Alternatively, one or the other of the following solutions can be applied:

a) the machine parts containing CS with temperature higher than 15 K below the flash point shall be evacuated to low pressure as defined in 4.3.3.2;

b) the whole interior of the machine shall be inerted in accordance with 4.3.3.5.

4.3.3 Explosion protection measures during the drying phase

4.3.3.1 General

One of the following explosion protection measures shall be taken.

4.3.3.2 Low pressure

4.3.3.2.1 General

This protection mode is based on keeping the pressure inside the dry-cleaning machine sufficiently low so that any pressure increase during an explosion will have no dangerous effect outside the machine, as far as the requirements of this clause are observed, with no additional safety measures being required.

For CS, the required low pressure shall be calculated on the basis of a pressure rise during an explosion of at least nine times the original pressure.

Solutions at a higher pressure level are acceptable when used in combination with additional measures such as control of temperature of condensation, air flow, etc.

4.3.3.2.2 Drum

The drum, including the loading door and its locking, the drying circuit and any valves isolating the drum from the dry-cleaning machine, shall be designed to withstand the pressure expected in the case of an explosion at low pressure prevailing in normal operation and where the explosion does not have dangerous effects outside the machine.

The drum shall be verified with 1,3 times the overpressure to be expected.

4.3.3.2.3 Vacuum pumps

Vacuum pump circuits shall be designed such that temperatures that are more than 15 K below the flash point cannot occur within them; alternatively, the temperatures in the circuits shall be monitored.

The evacuation pipes of vacuum pumps shall be designed such that evacuation of the exhaust gases to the open air is possible.

4.3.3.2.4 Pressure surveillance

The pressure level in the drum shall be continuously monitored. As soon as the operating pressure is exceeded, the heating shall be cut off automatically.

4.3.3.3 Limitation of CS concentration

The design of the dry-cleaning machine shall prevent the concentration of CS from reaching its lower explosion limit by means of one of the following.

— Permanent surveillance by measurement of the CS vapour concentration within the drum: the machine shall be switched off automatically and go to a safe condition if the maximum allowable concentration is exceeded.

— Controlling other parameters influencing the CS concentration (temperatures, air flow, etc.) if the CS vapour concentration is not permanently measured: the machine shall be switched off automatically and go to a safe condition if the maximum allowable concentration is exceeded (based on the relation between the controlled parameters and the CS concentration).

The maximum allowable concentration shall be considerably lower than the LEL.[3)]

4.3.3.4 Temperature limitation

The limitation of temperature is intended to prevent the reaching of the lower explosion point within the whole drying circuit.

Technical measures shall ensure that

a) nowhere in the drying circuit will the temperature of 15 K below the lower explosion point be reached during normal operation, and

b) if a temperature of 10 K below the lower explosion point is reached, the dry-cleaning machine will go into a safe condition.

4.3.3.5 Inerting

4.3.3.5.1 General

The inerting system shall ensure that the whole interior of the dry-cleaning machine is inerted before the temperature inside the machine reaches a level that is more than 15 K below the flash point.

The inerting process shall be set such that the concentration of oxygen remains significantly lower than the LOC of the used solvent.

NOTE The LOC value of CS depends on the type of solvent, the temperature of the air-vapour mixture and the experimental environment used for evaluation.

The cage drive shall be automatically switched off and the dry-cleaning machine shall go to a safe condition when the maximum concentration of oxygen during heating is exceeded.

The oxygen concentration shall be permanently checked by a control system.

The measurement point shall be placed such that the highest value is measured.

4.3.3.5.2 Inert gas

A monitoring device shall be provided that brings the dry-cleaning machine automatically to a safe condition if, before the start of the inerting process, the reservoir of inert gas does not contain the quantity of gas necessary for one such process.

The exhaust apertures for the gas displaced by inerting shall be designed such that evacuation to the open air is possible.

3) At the time of publication of this edition of ISO 8230, it was not possible to agree on a fixed percentage.

4.4 Hazards related to the distilling equipment

4.4.1 Combustible solvent emission

4.4.1.1 Operation

The coolant flow shall be interlocked with the heating of the still so as to stop heating when the coolant flow is reduced below a safe limit and to produce a visual and acoustical alarm. This can be achieved by a pressure sensor in the coolant service as a warning in combination with a sensor of the CS condensate temperature for stopping the heating, when the condensate temperature is more than 15 K below the flash point.

4.4.1.2 Water separator

The provisions of 4.3.1.3 apply.

4.4.2 Explosion protection measures

4.4.2.1 Still

Measuring devices and other equipment that can represent an effective ignition source inside the still shall be suitable for their use taking account of the assessment of the explosion hazards and according to the equipment categories defined in EN 60079-0 and EN 13463-1. If a valve is installed for breaking the vacuum, it shall have an interlocking provision such that it can only be opened if the temperature in the still is lower than 15 K below the flash point.

4.4.2.2 Heating

The heating of the still shall be interlocked such that the still can be heated to a temperature above the lower explosion point only when the pressure inside is reduced such that an explosion cannot cause the permissible overpressure to be exceeded or when the interior of the still is inerted.

The temperature of the heating surfaces in the interior of the still shall not exceed 80 % of the ignition temperature (measured in kelvin) of the CS used or the maximum threshold of thermal stability, whichever is the lesser.

4.4.2.3 Vacuum pumps

The provisions of 4.3.3.2.3 apply.

4.4.2.4 Cleaning of the still

If a drain valve is installed to empty the still in the event of breakdown or to reduce the oily residues prior to opening the cleaning door, it shall have an interlocking provision such that it can only be opened if the temperature in the still is lower than 15 K below the flash point.

4.4.2.5 Evacuation of residues

The evacuating device shall be interlocked such that it can only be opened when the still has cooled down to a temperature below 15 K below the flash point, unless the evacuation takes place with a closed system.

If the residues are evacuated at temperatures higher than 15 K below the flash point with a closed system, the connecting tubes between distilling equipment and collecting container shall have a conduction ability for electrostatic charges in accordance with of EN 13463-1:2001, 7.4.

4.4.2.6 Collecting container

If residues are evacuated with a closed system at temperatures above the lower explosion point, the collecting container shall be made of metal, including the cover. There shall be a safe electro-conductive connection between container and cover. Unless it is inerted, the interior of such a container shall be regarded as a place in which an explosive atmosphere is likely to occur occasionally in normal operation.

5 Verification of the safety requirements and/or protective measures

Verification of the safety requirements and/or protective measures, as well as requirements of Clause 6, shall be in accordance with ISO 8230-1 and Table 1.

Table 1 — Verification list

Subclause of this part of ISO 8230	Subject	Verification method
4.1	Hazards specified in ISO 8230-1	In accordance with ISO 8230-1
4.2	Entire dry-cleaning machine	
4.2.1	Electrical hazards	Design verification and visual inspection
4.2.2	Explosions protection measures	Design verification, inspection and testing
4.3	Working cycle	
4.3.1	Combustible solvent emission	Design verification, inspection, measurement and testing
4.3.2	Explosion protection during the cleaning phase	Design verification
4.3.3	Explosion protection during the drying phase	Design verification, inspection, measurement and testing
4.4	Hazards related to the distilling equipment	
4.4.1	Combustible solvent emission	Design verification, testing and inspection
4.4.2	Explosion protection measures	Design verification, measuring, testing and inspection
6.2	Signals and warning devices	Visual inspection
6.3	Instruction handbook	Visual inspection
6.4	Marking	Visual inspection

6 Information for use

6.1 General

All requirements specified in ISO 8230-1:2008, Clause 6, are applicable to the dry-cleaning machines working with CS. In addition, the provisions of 6.2 to 6.4, below, apply.

6.2 Signals and warning devices

A label on the collecting tank shall indicate that the water contains CS (contact water).

6.3 Instruction handbook

Dry-cleaning machines using CS as their cleaning medium involve some hazards that are very specific to this type of equipment and that need particular mention in the instruction handbook. These are as listed in Table 2 (see also Clause 4).

Table 2 — Special points to be included in the instruction handbook

Drying control system	A notice on how to adjust the drying control system.
Machine marking and warning notices	Details of the label on the water-collecting tank advising that the water in it contains CS.
Installation	Instructions on how to pipe away the exhaust gases of the vacuum pump without polluting the workroom, e.g. to the open air.
Installation	Instructions on how to pipe away the gas displaced by the inerting without polluting the workroom, e.g. to the open air.
Operator maintenance	A notice on how to connect the collecting container with the distilling equipment having conduction ability for electrostatic charges. Instruction on how to connect the collecting container with the cover having conduction ability for electrostatic charges.
Operation and maintenance of the water separator	Instructions as to the safe draining of the water collecting tank.

6.4 Marking

All requirements specified in ISO 8230-1:2008, 6.4, are applicable to dry-cleaning machines working with CS.

Table 3 presents an example of a machine plate (not including possible mandatory marking).

Table 3 — Example of machine plate

Manufacturer	Address
Machine type	Serial number
Year of manufacture	
Maximum dry load	kg
Maximum spinning speed	1/min
Permitted solvent	CS
Solvent total charge	l
Electrical supply	V phases Hz
Maximum power [a]	kW (... kVA)
Maximum current [b]	A
Maximum steam pressure range	bar (… MPa) [c]
Maximum coolant pressure range	bar (… MPa)
Maximum coolant temperature	°C
Compressed air pressure range	bar (… MPa)
IMPORTANT — Refer to the instruction handbook for maintenance and operation.	

[a] Maximum power draw during a working cycle.

[b] Full-load current as defined in IEC 60204-1:2005, 16.4.

[c] 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.

Bibliography

[1] ISO 12100-2:2003, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles*

[2] EN 1127-1:1997, *Explosive atmospheres — Explosion prevention and protection — Part 1: Basic concepts and methodology*

[3] EN 14756:2006, *Determination of the limiting oxygen concentration (LOC) for flammable gases and vapours*

[4] EN 50015 to EN 50039, *Electrical apparatus for potentially explosive atmospheres* (general title)

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