TECHNICAL REPORT

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Hydraulic fluid power — Component cleanliness — Guidelines for achieving and controlling cleanliness of components from manufacture to installation

Transmissions hydrauliques — Propreté des composants — Lignes directrices pour obtenir et contrôler la propreté des composants de la fabrication à l'installation

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

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ISO/TR 10949 was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 6, *Contamination control*.

This second edition cancels and replaces the first edition (ISO/TR 10949:1996), which has been technically revised.

Introduction

In hydraulic fluid power systems, power is transmitted and controlled through a pressurized liquid within an enclosed circuit. Contaminants present in the circulating working liquid may degrade system performance. One method of reducing the amount of these contaminants within the system is to manufacture, package, ship, store and install components in ways that achieve and control the desired component cleanliness level.

Hydraulic fluid power — Component cleanliness — Guidelines for achieving and controlling cleanliness of components from manufacture to installation

1 Scope

This Technical Report gives guidelines for achieving, evaluating and controlling the cleanliness of hydraulic fluid power components from the time of their manufacture through to their installation in a hydraulic fluid power system.

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 4406, *Hydraulic fluid power — Fluids — Method for coding the level of contamination by solid particles*

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

ISO 18413:—[1)], *Hydraulic fluid power — Cleanliness of parts and components — Inspection document and principles related to contaminant collection, analysis, and data reporting*

3 Terms and definitions

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

3.1
component
part, assembly, or collection of parts that performs a function in a fluid power system

NOTE This definition differs from that in ISO 5598 because connectors, tubes and hoses are included here but are excluded from the definition in ISO 5598.

3.2
manufacturer
party that fabricates or assembles the component

NOTE The manufacturer and supplier may be the same person or company.

3.3
purchaser
party that stipulates the requirements of a machine, equipment, system, or component and judges whether the product satisfies those requirements

1) To be published.

3.4
supplier
party that contracts to provide the product(s) to satisfy the purchaser's requirements

NOTE The manufacturer and supplier may be the same person or company.

4 General principles

4.1 Component cleanliness during production

The manufacturer is responsible for providing components that meet the requirements either stated by the manufacturer or agreed upon with the purchaser. This includes achieving and evaluating, as necessary, appropriate levels of component cleanliness during the production process.

The required cleanliness level at the time of manufacturing release should be clearly stated in an inspection document drawn up in accordance with ISO 18413 and agreed upon between the manufacturer and purchaser.

The manufacturer is to exercise care at all steps of the production process to ensure that the required level of component cleanliness is achieved and controlled. More specifically, the manufacturer is responsible for the following:

— cleaning component parts prior to assembly, if this operation is needed to achieve the required cleanliness level;

— assembling components in an area having an overall level of contamination that will not significantly affect component cleanliness;

— flushing components, if this operation is needed to achieve the required cleanliness level;

— testing components with fluids that will not add significant contaminant to the product;

— evaluating component cleanliness by appropriate test methods;

— preparing components for packaging, including corrosion prevention, sealing of ports, etc.

4.2 Component cleanliness during packaging, storage and transport

The supplier and purchaser are to make an agreement about who is responsible for controlling component cleanliness during packaging, storage and transport to the purchaser. If the manufacturer and supplier are independent parties, their respective responsibilities should be mutually and explicitly agreed.

NOTE The supplier is generally not responsible for contamination that results from damage to either the components themselves or their packaging during transport.

The supplier (or other party that has agreed to take responsibility for ensuring component cleanliness) is to exercise care at all steps of the packaging, storage and transport processes to ensure that the required level of component cleanliness is maintained. More specifically, that responsibility includes the following:

— providing adequate packaging for component storage and shipment;

— using appropriate storage conditions;

— using appropriate shipping methods.

If deterioration in component cleanliness occurs between the time of release by the manufacturer and the time of receipt by the purchaser, then the supplier and purchaser should jointly investigate the cause and take corrective action.

4.3 Component cleanliness after receipt by the purchaser

The purchaser is responsible for controlling component cleanliness from receipt of the component through its installation in the assembled hydraulic fluid power system or resale of the component to another party.

The purchaser is to exercise care at all steps of the receiving, unpacking and storage processes. More specifically, the purchaser is responsible for the following:

— taking care in unpacking;

— using appropriate storage methods;

— taking care that no significant contamination is added to the component after removing protective plugs, etc.

Care is also to be taken to install the component in the system in a way that does not add significant contamination.

5 Achieving component cleanliness

5.1 Cleaning of components

To ensure that an adequate standard of cleanliness of finished components is achieved, it is essential that all parts that make up a component meet the specified cleanliness level before assembly. Using clean parts for assembly of components is essential to ensure that no more than insignificant damage to the finished component occurs during flushing or performance testing.

Appropriate procedures are to be implemented for each part or component in order to remove such residues as chips, sand, filings, rust, weld spatter and slag, elastomers, sealants, water, aqueous products, chlorine, acid, detergent, etc.

When cleaning components, special care is to be taken to ensure that cored passages and deep holes are cleaned, and it should be remembered that items with designed sharp edges, such as grooved spools, can collect contamination from contact with human hands.

The cleaning procedure can be carried out as follows:

— shot blast, ultrasonically clean or chemically clean castings to remove casting sand and scale prior to machining, and then carefully deburr and wash the castings before assembly;

— remove manufacturing residues, burrs, fins, etc. by mechanical, ultrasonic or chemical means, etc.;

— remove cleaning residues using chemical means (e.g. filtered solvents), dry filtered compressed air, etc.;

— oven-dry or dry with dry, filtered compressed air.

5.2 Descriptions of commonly used cleaning methods

5.2.1 Shot blasting

Shot blasting removes surface contamination by impacting material designed to remove contamination while leaving the surface itself undamaged. Blasting may use sand, glass beads, carbon particles, metal balls or other materials generally recognized as applicable for this purpose. The type of cleaning desired and the

durability of the underlying surface are important considerations in the selection of the blasting material. Shot blasting is effective for removing contaminants such as casting sand and scale prior to machining. Care is to be taken to ensure that this cleaning method does not unintentionally or adversely alter the properties or the surface condition of the material.

5.2.2 Ultrasonic cleaning

Ultrasonic cleaning uses high frequency energy, transmitted through a liquid medium, to impart vibrational energy onto a surface and cause contamination to be removed from the surface. Because ultrasonic cleaning relies mainly on the effect of vapour bubbles imploding on the component surface, it is important that the bath and component temperature are correct for this action to be fully effective. Adequate time is therefore to be allowed for components to reach working temperature after immersion. The design of containers and spacing of components are also important; adequate flow paths are to be allowed for the ultrasonic waves to reach all parts of the components. It is recommended that the liquid in the bath be continuously filtered with an appropriate filter to avoid the build-up of contaminant.

5.2.3 Chemical cleaning

5.2.3.1 Health and safety

The use of chemicals, solvents and volatile liquids may present hazards to health. Instructions in the Material Safety Data Sheets and all applicable safety procedures are to be adhered to at all times. Personal protective equipment is to be worn wherever appropriate. Volatile liquids are to be kept away from heat and sources of ignition. All applicable regulations regarding use and disposal of solvents are to be followed.

5.2.3.2 Aqueous cleaning

Aqueous cleaning uses water in conjunction with detergents, acids, bases, heat and agitation, used alone or in combination. Water-based systems can be used to clean many types of material. Spray washing and dip tanks are often used for aqueous cleaning. Ultrasonic agitation is often used to improve the solvency of the water and detergent. When using a water-based cleaning system, it is important to minimize water usage and to select cleaning chemicals carefully for both cleaning efficiency and potential environmental effects. The cleaning liquid is to be maintained at an appropriate level of cleanliness by continuous filtration.

5.2.3.3 Semi-aqueous cleaning

Solvents are sometimes added to water to improve cleaning or to reduce costs. Depending on the solvent used, semi-aqueous cleaning may use the same methods as aqueous cleaning. Solvent flashpoint, air emissions, worker exposure and waste treatment and disposal are considerations when selecting a semi-aqueous cleaning method. The cleaning liquid is to be maintained at an appropriate level of cleanliness by continuous filtration.

5.2.3.4 Solvent cleaning

Solvents are used either in pure form or blended to remove coatings or degrease components. Solvents are used in hand wiping, spray washing, dip tanks and vapour degreasers. Solvent cleaning can be enhanced by agitation, ultrasonics and heat. Many once-common solvents have been largely replaced due to their toxic or ozone-depleting effects. The cleaning liquid is to be maintained at an appropriate level of cleanliness by continuous filtration.

5.2.4 Flushing

Flushing is used to remove contamination that may have been introduced during fabrication or assembly of components. The principle of flushing is to apply sufficient energy to dislodge contaminants and wash them away from the component for subsequent collection in a filter. The preferred procedure involves circulating a liquid of known cleanliness through the component under defined conditions of flow rate and temperature. The liquid used for flushing may be the service liquid or a liquid specially formulated for flushing and is to be compatible with the components and seals.

If the flushing liquid is not compatible with the liquid used in actual component operation, steps should be taken to ensure complete removal of the flushing liquid from the component.

5.3 Assembly of components

Components should be assembled as soon as possible after they have been cleaned, because even short storage periods of exposure to the atmosphere can allow corrosion to start or airborne dust to settle on the components. Components that are not required for immediate assembly should be adequately protected until assembly. The assembler's hands, tools and benches should be kept clean, and cleaning materials should be lint-free.

Assembly should be done in an area with a controlled environment that is consistent with the cleanliness requirements of the component. At a minimum, the assembly area should be well away from contaminant-generating operations such as grinding, welding and machining. Air jets used for cleaning in the vicinity of the assembly process should be avoided, because such air jets can project contaminant over many metres.

If adhesives or polytetrafluoroethylene (PTFE) tape are used during assembly, care should be taken to avoid their entrapment within the assembled component. If grease is used, it is important that it be kept clean; in addition, grease should be used sparingly as it may not be soluble in the system fluid and may cause filters to plug.

After assembly, all joint surfaces and ports should be covered unless the component is to be tested immediately (see 5.4). Cover plates and other closures should be at least as clean as the component. Closures that have been used for this purpose will probably be oily and should be cleaned before reuse.

If further cleaning of an assembled component is required, the component should be flushed, prior to testing, on a specifically designed flushing rig that is fitted with an appropriate filter. Production test rigs may be used for this purpose, as long as appropriate filtration is used and the conditions of flow rate and temperature are appropriate for flushing. The information on flushing in 5.2.4 applies.

5.4 Protecting cleaned components

It is important to remove moisture that may result in corrosion of component surfaces. Some of the methods of protecting cleaned components are listed in Table 1.

Table 1 — Methods of protecting cleaned components

Nature of protection	Cleaned components [a]
Pressed-on metallic plug or cap	T
Screwed cylindrical metallic plug with seal	R
Flanged plate with seal	R
Pressed-on plastic plug	T
Screwed male plastic plug	R
Self-cutting plastic plug	F
Anti-corrosive Kraft paper	T
Plastic packaging	R
Filling with clean compatible hydraulic fluid	R
Contact corrosion volatile inhibitor for spare parts	R by agreement
Vacuum-tight envelope [b]	R
Pressure-tight envelope [b]	R

[a] R = recommended; T = tolerated; F = forbidden.

[b] In addition to port plugs.

5.5 Testing of components

If function testing of the component is necessary, then the cleanliness level of the liquid in the test rig is to be as clean as or cleaner than the required cleanliness level of the component under test. This normally means fitting the test rig with appropriate filtration devices. Where the test process itself generates significant contaminant, it is recommended that an in-line filter be fitted to quickly remove contaminant so generated. This will minimize damage caused by its recirculation through the test rig.

6 Evaluating component cleanliness

As appropriate, the methods of contaminant collection, analysis and data reporting described in ISO 18413 should be used to evaluate the level of contaminant remaining in components or subassemblies. The inspection document prepared in accordance with ISO 18413 should make reference to the methods of contaminant collection, analysis and data reporting appropriate to the specified components. If a component is reassembled before packaging, storage or transport, the component is to pass through the final production stages (flushing or testing) to remove contaminant generated by the reassembly process.

7 Controlling component cleanliness

7.1 General

Appropriate procedures are to be developed to control and maintain cleanliness throughout the complete production process, especially during transit between operations. The level of cleanliness maintained during the assembly of the component by the manufacturer can easily be compromised unless care is also exercised during subsequent operations, such as post-test handling, painting, packaging and shipping. Precautions are still essential at these points to ensure that contamination does not degrade the performance of a component such that it fails to meet the purchaser's expectations. In addition, topics such as training, the provision of appropriate procedures and control over the environment are equally important.

7.2 Training

Effective training at each step of the product production and delivery process is essential to minimize the introduction of contamination. Persons involved with the manufacture, assembly, testing, packaging, storage and inspection of fluid power components should be educated in the basics of contamination control. Training should include an appreciation of the effects of contamination, as well as instruction in performing specific tasks. If personnel do not understand the damaging effects of contamination, they may not follow the prescribed procedures.

7.3 Working environment

The workplace should be designed so that “dirty” processes such as machining, de-burring and subassembly welding and grinding are separated from the final component assembly process. If this is impractical, then effective extraction equipment should be used to promptly remove the generated contaminant.

Airborne contamination should be controlled to a level consistent with achieving the cleanliness requirements of the product being manufactured or assembled. The methods and frequency of cleaning of floors, benches and work areas will depend upon the amount of contamination generated and the cleanliness requirements of the product. Special clean areas should be used if the sensitivity of the component or process requires it.

If an environmental cleanliness level is not specified, monitoring the cleanliness of the part or component should be used to confirm its suitability.

7.4 Working procedures

Appropriate procedures for all aspects of production should be readily available and well understood. Procedures should be structured so as to limit the amount of contamination added to the product during one step of the production process and transferred to the next step of the production process. Procedures should be reviewed regularly to ensure their continued relevance and effectiveness.

7.5 Post-test handling

After test, drain the component in a clean area. If required, inhibit corrosion on inside surfaces of the component during transit and storage by adding a clean preservative fluid according to the manufacturer's instructions. Reseal all ports and carefully avoid the ingress of contaminant during this operation. Protect breather filters with clean plastic film and, where possible, bag the component, preferably in a bag with an airtight seal.

7.6 Painting

If the product is to be painted after test, check that all ports are still sealed before painting. Breathers should be protected from becoming blocked with paint. Moving parts, such as cylinder rods, which may provide a route for paint particles to enter the components, should also be shielded from paint.

7.7 Packaging

Components should be packaged to ensure that they are protected against both physical damage and the introduction of contaminants during storage and shipment.

7.8 Storage

Components should be stored in a clean, dry and secure area away from the production area.

7.9 Transport

Components should be shipped by methods that do not damage the component or introduce contaminant into the component.

8 Purchaser precautions

8.1 General

It is prudent for manufacturers and/or suppliers to warn purchasers about the detrimental effects that can result from allowing contaminants to be introduced into a component after receipt. This may be done by means such as:

— information in the product literature, such as instructions on application and recommended installation, start-up and maintenance procedures;

— information supplied with the product, such as a warning notice on the box or on a label attached to the component.

Such information might usefully refer to the standard or product cleanliness claimed by the manufacturer. For example: “During assembly, the parts in this component were carefully cleaned and the assembled component was tested using a fluid with a contamination code of *x*/*y*/*z* in accordance with ISO 4406. Do not remove any protection until immediately before the component is ready for installation. Clean and careful handling will help to prolong its working life.”

8.2 Storage

Components should be stored in such a manner as to maintain the cleanliness level achieved when the components were packaged.

8.3 Customization

If customization is necessary to adapt a standard component to a particular system, and customization is allowed by the manufacturer, such work should be carried out in clean conditions, and appropriate precautions observed to prevent contamination. The component should be left open only as long as necessary, in order to minimize the possibility of exposure to contaminants.

8.4 Inspection

In general, purchasers should not disassemble components, even on a percentage sample basis as part of their quality assurance programme. When disassembly is required, purchasers should be advised of all the procedures for correct reassembly, corrosion inhibition and packaging, and should be given instructions on how to avoid the introduction of contaminant. Purchasers should also be advised about any changes in the manufacturer's warranty that may result from their actions.

Bibliography

[1] ISO/TS 16431, *Hydraulic fluid power — Assembled systems — Verification of cleanliness*

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