# Teknisk rapport
# SIS-ISO/TR 10686:2013

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## Hydraulic fluid power – Method to relate the cleanliness of a hydraulic system to the cleanliness of the components and hydraulic fluid that make up the system (ISO/TR 10686:2013, IDT)

## Hydraulik – Metod för att relatera renheten hos ett hydraulsystem till renheten hos dess komponenter och vätskor (ISO/TR 10686:2013, IDT)

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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.

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The committee responsible for this document is ISO/TC 131, *Fluid power systems*, Subcommittee SC 6, *Contamination control*.

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# Introduction

The initial cleanliness level of a hydraulic system can affect its performance and useful life. Unless removed, particulate contaminants present after manufacture and assembly of a system can circulate through the system and cause damage to the system's components. To reduce the probability of such damage, the fluids and the internal surfaces of the hydraulic fluid power system and of its components should be cleaned to a specified level.

The final cleanliness level of the complete system can be theoretically predicted as the sum of the particulate contamination brought in by both the components that make up the system and the filling fluid.

As a reciprocal, the required cleanliness level of each individual component and of the filling fluid can be predicted from the required cleanliness level of the final system. This Technical Report explains the theoretical basis for such predictions.

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# Hydraulic fluid power — Method to relate the cleanliness of a hydraulic system to the cleanliness of the components and hydraulic fluid that make up the system

## 1 Scope

This Technical Report describes methods that can be used to:

— relate the cleanliness of a hydraulic system to the cleanliness of its components and the hydraulic fluid belonging to the system;

— estimate the final cleanliness level of an assembled hydraulic system filled with the hydraulic fluid, upon its release from the manufacturing area. The estimation of the final cleanliness level is based on the cleanliness level of each component in the system and on the cleanliness level of the filling fluid;

— calculate and manage cleanliness requirements of components and subassemblies that make up a system and of the fluid filling it so as to achieve a required cleanliness level (RCL) for the final system.

These methods can apply whatever the particle size considered and can also be used for other types than hydraulic fluid power.

## 2 Normative references

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

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

## 3 Terms and definitions

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

**3.1**
**wetted surface area**
*A*
surface area of the component or system that is exposed to the system liquid in normal operation, as agreed between parties

Note 1 to entry: Subscripts C or S are added to the symbol *A* when it refers to the wetted surface area of, respectively, a component or a system.

EXAMPLE Consider a hydraulic gear pump with two gears (see Figure 1). The wetted surface area can be calculated as the sum of the internal surfaces of the pump body (two plates and one flange with two ports) plus the external surface of the two gears.

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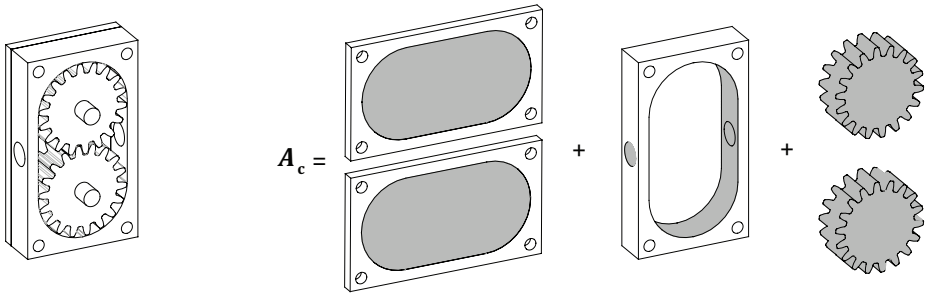


**Figure 1 — Wetted surface of an external gear hydraulic pump**

**3.2**
**wetted volume**
**contained volume**
*V*
volume of a component or system in which the system liquid is to be found in end-use operating conditions, as agreed between parties

Note 1 to entry: Subscripts C or S are added to the symbol *V* when it refers to the wetted volume of, respectively, a component or a system.

EXAMPLE Consider a hydraulic gear pump with two gears (see Figure 2). The wetted volume can be calculated as the volume of the body minus the volume of the two gears or measured as the filling volume of the complete pump.

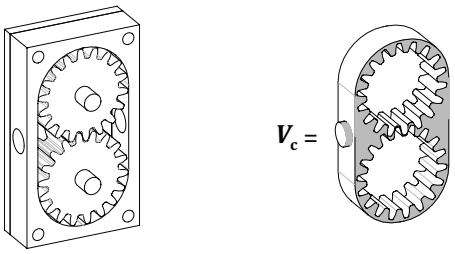


**Figure 2 — Wetted volume of an external gear hydraulic pump**

## 4 Symbols and units

The symbols and units related to the cleanliness of fluids, systems and components used in this Technical Report are given in Table 1.

**Table 1 — Symbols and units**

| Symbol | Description or explanation | Unit |
|---|---|---|
| $N_A$ | Number of particles of a given size introduced during assembly | number of particles |
| $N_C$ | Number of particles of a given size in a component | number of particles |
| $N_{Ci}$ | Number of particles of a given size in component *i* | number of particles |
| $N_S$ | Number of particles of a given size in an empty system (without fluid) | number of particles |
| $N_F$ | Number of particles of a given size in a fluid used to fill system | number of particles |
| $N_{SF}$ | Number of particles of a given size in a system filled with system fluid | number of particles |
| $N_X$ | Number of particles of a given size in an item *X* | number of particles |
| a If the relevant particle sizes are those covered in ISO 4406 [i.e. 4 µm(c), 6 µm(c), 14 µm(c) for automatic counting, 5 µm or 15 µm for microscopic counting], the cleanliness level can be expressed using the code system specified in ISO 4406. | | |

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**Table 1** *(continued)*

| Symbol | Description or explanation | Unit |
|---|---|---|
| $A_C$ | Wetted surface area of a component | $cm^2$ |
| $A_S$ | Wetted surface area of an empty system (without fluid) | $cm^2$ |
| $V_C$ | Wetted volume of a component | $cm^3$ or ml |
| $V_{Ci}$ | Wetted volume of component *i* | $cm^3$ or ml |
| $V_S$ | Wetted volume of an empty system (without fluid) | $cm^3$ or ml |
| $V_F$ | Volume of fluid used to fill system | $cm^3$ or ml |
| $V_{SF}$ | Wetted volume of a system upon its release from the manufacturing area | $cm^3$ or ml |
| $V_X$ | Wetted volume of an item | $cm^3$ or ml |
| $C_C$ | Cleanliness level of a component – $N_C$ / $V_C$ | number of particles per $cm^3$ or ml |
| $C_{Ci}$ | Cleanliness level of component *i* | number of particles per $cm^3$ or ml |
| $C_S$ | Cleanliness level of an empty system (without fluid) – $N_S$ / $V_S$ | number of particles per $cm^3$ or ml |
| $C_F$ | Cleanliness level of fluid used to fill system – $N_F$ / $V_F$ | number of particles per $cm^3$ or ml [a] |
| $C_{SF}$ | Cleanliness level of a system upon its release from the manufacturing area – $N_{SF}$ / $V_{SF}$ | number of particles per $cm^3$ or ml |

a If the relevant particle sizes are those covered in ISO 4406 [i.e. 4 µm(c), 6 µm(c), 14 µm(c) for automatic counting, 5 µm or 15 µm for microscopic counting], the cleanliness level can be expressed using the code system specified in ISO 4406.

# 5 Basic considerations

## 5.1 Particulate contamination

### 5.1.1 Basic principles

The physical and chemical principles that explain the presence and the behaviour of particulate contaminants in a hydraulic system are numerous and complex. This subclause covers some basic principles on which this Technical Report's approach to cleanliness is based.

### 5.1.2 Homogeneity of distribution of contamination in the system

In the absence of a system or flushing filter when the system is operated for the first time and stabilized, particulate contaminants are considered to be distributed homogeneously in the whole system, i.e. particulate contamination is in the fluid everywhere in the components and the system and on the wetted surfaces of the components. This assumes that all of the fluid and all the surfaces on which it flows are at the same cleanliness level.

### 5.1.3 Actual location of contaminants in items and fluid

Particulate contaminants are either deposited on the surface area of the components or suspended in the hydraulic fluid (see Figure 3). Even if particles are deposited on the entire surface of a component, only those deposited on the wetted surface are taken into consideration because they are the only ones likely to move into the fluid and potentially to damage the system.