FTU 080

Fluid transfer unit with ICM 2.0 (In-line Contamination Monitor)
Contamination management

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HYDRAULIC FLUIDS

The fluid is the vector that transmits power, energy within an oleodynamic circuit. In addition to transmitting energy through the circuit, it also performs additional functions such as lubrication, protection and cooling of the surfaces. The classification of fluids used in hydraulic systems is coded in many regulatory references, different Standards.

The most popular classification criterion divides them into the following families:
- MINERAL OILS
  Commonly used oil deriving fluids.
- FIRE RESISTANT FLUIDS
  Fluids with intrinsic characteristics of incombustibility or high flash point.
- SYNTHETIC FLUIDS
  Modified chemical products to obtain specific optimized features.
- ECOLOGICAL FLUIDS
  Synthetic or vegetable origin fluids with high biodegradability characteristics.

The choice of fluid for an hydraulic system must take into account several parameters. These parameters can adversely affect the performance of an hydraulic system, causing delay in the controls, pump cavitation, excessive absorption, excessive temperature rise, efficiency reduction, increased drainage, wear, jam/block or air intake in the plant.

The main properties that characterize hydraulic fluids and affect their choice are:
- DYNAMIC VISCOSITY
  It identifies the fluid’s resistance to sliding due to the impact of the particles forming it.
- KINEMATIC VISCOSITY
  It is a widespread formal dimension in the hydraulic field. It is calculated with the ratio between the dynamic viscosity and the fluid density. Kinematic viscosity varies with temperature and pressure variations.
- VISCOSITY INDEX
  This value expresses the ability of a fluid to maintain viscosity when the temperature changes. A high viscosity index indicates the fluid’s ability to limit viscosity variations by varying the temperature.
- FILTERABILITY INDEX
  It is the value that indicates the ability of a fluid to cross the filter materials. A low filterability index could cause premature clogging of the filter material.
- WORKING TEMPERATURE
  Working temperature affects the fundamental characteristics of the fluid. As already seen, some fluid characteristics, such as cinematic viscosity, vary with the temperature variation.
  When choosing a hydraulic oil, must therefore be taken into account of the environmental conditions in which the machine will operate.
- COMPRESSIBILITY MODULE
  Every fluid subjected to a pressure contracts, increasing its density. The compressibility module identifies the increase in pressure required to cause a corresponding increase in density.
- HYDROLYTIC STABILITY
  It is the characteristic that prevents galvanic pairs that can cause wear in the plant/system.
- ANTIOXIDANT STABILITY AND WEAR PROTECTION
  These features translate into the capacity of a hydraulic oil to avoid corrosion of metal elements inside the system.
- HEAT TRANSFER CAPACITY
  It is the characteristic that indicates the capacity of hydraulic oil to exchange heat with the surfaces and then cool them.

FLUID CONTAMINATION

Whatever the nature and properties of fluids, they are inevitably subject to contamination. Fluid contamination can have two origins:
- INITIAL CONTAMINATION
  Caused by the introduction of contaminated fluid into the circuit, or by incorrect storage, transport or transfer operations.
- PROGRESSIVE CONTAMINATION
  Caused by factors related to the operation of the system, such as metal surface wear, sealing wear, oxidation or degradation of the fluid, the introduction of contaminants during maintenance, corrosion due to chemical or electrochemical action between fluid and components, cavitation.
  The contamination of hydraulic systems can be of different nature:
- SOLID CONTAMINATION
  For example rust, slag, metal particles, fibers, rubber particles, paint particles or additives
- LIQUID CONTAMINATION
  For example, the presence of water due to condensation or external infiltration or acids
- GASEOUS CONTAMINATION
  For example, the presence of air due to inadequate oil level in the tank, drainage in suction ducts, incorrect sizing of tubes or tanks.

EFFECTS OF CONTAMINATION ON HYDRAULIC COMPONENTS

Solid contamination is recognized as the main cause of malfunction, failure and early degradation in hydraulic systems. It is impossible to delete it completely, but it can be effectively controlled by appropriate devices.

Solid contamination mainly causes surface damage and component wear.
- **SURFACE EROSION**  
  Cause of leakage through mechanical seals, reduction of system performance, variation in adjustment of control components, failures.

- **ADHESION OF MOVING PARTS**  
  Cause of failure due to lack of lubrication.

- **DAMAGES DUE TO FATIGUE**  
  Cause of breakdowns and components breakdown.

- **MODIFICATION OF FLUID PROPERTIES**  
  (COMPRESSION MODULE, DENSITY, VISCOSITY)  
  Cause of system’s reduction of efficiency and of control.  
  It is easy to understand how a system without proper contamination management is subject to higher costs than a system that is provided.

- **MAINTENANCE**  
  Maintenance activities, spare parts, machine stop costs

- **ENERGY AND EFFICIENCY**  
  Efficiency and performance reduction due to friction, drainage, cavitation.

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### Measuring the Solid Contamination Level

The level of contamination of a system identifies the amount of contaminant contained in a fluid. This parameter refers to a unit volume of fluid. The level of contamination may be different at different points in the system. From the information in the previous paragraphs it is also apparent that the level of contamination is heavily influenced by the working conditions of the system, by its working years and by the environmental conditions.

What is the size of the contaminating particles that we must handle in our hydraulic circuit?

Liquid contamination mainly results in decay of lubrication performance and protection of fluid surfaces.

### Dissolved Water

- **INCREASING FLUID ACIDITY**  
  Cause of surface corrosion and premature fluid oxidation

- **GALVANIC COUPLE AT HIGH TEMPERATURES**  
  Cause of corrosion

### Free Water - Additional Effects

- **DECAY OF LUBRICANT PERFORMANCE**  
  Cause of rust and sludge formation, metal corrosion and increased solid contamination

- **BATTERY COLONY CREATION**  
  Cause of worsening in the filterability feature

- **ICE CREATION AT LOW TEMPERATURES**  
  Cause damage to the surface

- **ADDITIVE DEPLETION**  
  Free water retains polar additives

Gaseous contamination mainly results in decay of system performance.

- **CUSHION SUSPENSION**  
  Cause of increased noise and cavitation.

- **FLUID OXIDATION**  
  Cause of corrosion acceleration of metal parts.

Contamination level analysis is significant only if performed with a uniform and repeatable method, conducted with standard test methods and suitably calibrated equipment. To this end, ISO has issued a set of standards that allow tests to be conducted and express the measured values in the following ways.

- **GRAVIMETRIC LEVEL** - ISO 4405
  The level of contamination is defined by checking the weight of particles collected by a laboratory membrane. The membrane must be cleaned, dried and desiccated, with fluid and conditions defined by the Standard. The volume of fluid is filtered through the membrane by using a suitable suction system. The weight of the contaminant is determined by checking the weight of the membrane before and after the fluid filtration.
The level of contamination is defined by counting the number of particles of certain dimensions per unit of volume of fluid. Measurement is performed by Automatic Particle Counters (APC).

Following the count, the contamination classes are determined, corresponding to the number of particles detected in the unit of fluid. The most common classification methods follow ISO 4406 and SAE AS 4059 (Aerospace Sector) regulations. NAS 1638 is still used although obsolete.

Classification example according to ISO 4406
The International Standards Organisation standard ISO 4406 is the preferred method of quoting the number of solid contaminant particles in a sample.

The code is constructed from the combination of three scale numbers selected from the following table. The first number represents the number of particles that are larger than 4 μm(c). The second number represents the number of particles larger than 6 μm(c). The third scale number represents the number of particles in a millilitre sample of the fluid that are larger than 14 μm(c).

ISO 4406 - Allocation of Scale Numbers

<table>
<thead>
<tr>
<th>Class</th>
<th>Number of particles per ml</th>
</tr>
</thead>
<tbody>
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> 4 μm(c) = 350 particles
> 6 μm(c) = 100 particles
> 14 μm(c) = 25 particles

New ISO 4406 standard μm(c)
Old standard

ISO 4406 Cleanliness Code System
Microscope counting examines the particles differently to APCs and the code is given with two scale numbers only. These are at 5 μm and 15 μm equivalent to the 6 μm(c) and 14 μm(c) of APCs.
Classification example according to SAE AS4059 - Rev. E and SAE AS4059 - Rev. F

The code, prepared for the aerospace industry, is based on the size, quantity, and particle spacing in a 100 ml fluid sample. The contamination classes are defined by numeric codes, the size of the contaminant is identified by letters (A-F).

Table 1 - Class for differential measurement

<table>
<thead>
<tr>
<th>Class</th>
<th>Measurement (µm)</th>
<th>6-14 µm</th>
<th>14-21 µm</th>
<th>21-38 µm</th>
<th>38-70 µm</th>
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- CLASSES OF CONTAMINATION ACCORDING TO NAS 1638 (January 1964)

The NAS system was originally developed in 1964 to define contamination classes for the contamination contained within aircraft components. The application of this standard was extended to industrial hydraulic systems simply because nothing else existed at the time. The coding system defines the maximum numbers permitted of 100 ml volume at various size intervals (differential counts) rather than using cumulative counts as in ISO 4406. Although there is no guidance given in the standard on how to quote the levels, most industrial users quote a single code which is the highest recorded in all sizes and this convention is used on MP Filtri APC’s.

The contamination classes are defined by a number (from 00 to 12) which indicates the maximum number of particles per 100 ml, counted on a differential basis, in a given size bracket.

Size Range Classes (in microns)

<table>
<thead>
<tr>
<th>Maximum Contamination Limits per 100 ml</th>
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<td>Class</td>
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<tr>
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<tr>
<td>12</td>
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</table>

- CUMULATIVE DISTRIBUTION OF THE PARTICLES SIZE - ISO 4407

The level of contamination is defined by counting the number of particles collected by a laboratory membrane unit per fluid unit. The measurement is done by a microscope. The membrane must be cleaned, dried and desiccated, with fluid and conditions defined by the Standard. The fluid volume is filtered through the membrane, using a suitable suction system. The level of contamination is identified by dividing the membrane into predefined number of areas and by counting the contaminant particles using a suitable laboratory microscope.

- CLEANLINESS CODE COMPARISON

Although ISO 4406 standard is being used extensively within the hydraulics industry other standards are occasionally required and a comparison may be requested. The table below gives a very general comparison but often no direct comparison is possible due to the different classes and sizes involved.

<table>
<thead>
<tr>
<th>ISO 4406</th>
<th>SAE AS4059 Table 2</th>
<th>SAE AS4059 Table 1</th>
<th>NAS 1638</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 4 µm(c)</td>
<td>&gt; 4 µm(c)</td>
<td>4-6</td>
<td>5-15</td>
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5) RECOMMENDED CONTAMINATION CLASSES

The table below, gives a selection of maximum contamination levels that are typically issued by component manufacturer. These relate to the use of the correct viscosity mineral fluid. An even cleaner level may be needed if the operation is severe, such as high frequency fluctuations in loading, high temperature or high failure risk.

<table>
<thead>
<tr>
<th>Component Type</th>
<th>ISO 4406</th>
<th>SAE AS4059 Table 2</th>
<th>SAE AS4059 Table 1</th>
<th>NAS 1638</th>
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<td>•</td>
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<td>Piston pumps</td>
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<td>10(c)</td>
<td>10(c)</td>
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<tr>
<td>with variable flow rate</td>
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<td>Vane pumps</td>
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<td>with fixed flow rate</td>
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<td>Vane pumps</td>
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<td>•</td>
</tr>
<tr>
<td>Check valve</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Directional valves</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Flow regulating valves</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Proportional valves</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Servo-valves</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Flat bearings</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Ball bearings</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
</tbody>
</table>

For other comparison photographs for contamination classes see the “Fluid Condition and Filtration Handbook”.
WATER IN HYDRAULIC AND LUBRICATING FLUIDS

Water Content

In mineral oils and non-aqueous resistant fluids, water is undesirable. Mineral oil usually has a water content of 50-300 ppm (@40°C) which it can support without adverse consequences. Once the water content exceeds about 300 ppm, the oil starts to appear hazy. Above this level, there is a danger of free water accumulating in the system in areas of low flow. This can lead to corrosion and accelerated wear. Similarly, fire resistant fluids have a natural water which may be different to mineral oil.

Saturation Levels

Since the effects of free (also emulsified) water are more harmful than those of dissolved water, water levels should remain well below the saturation point. However, even water in solution can cause damage and therefore every reasonable effort should be made to keep saturation levels as low as possible. There is no such thing as too little water. As a guideline, we recommend maintaining saturation levels below 50% in all equipment.

TYPICAL WATER SATURATION LEVEL FOR NEW OILS

Examples:
- Hydraulic oil @ 30°C = 200 ppm = 100% saturation
- Hydraulic oil @ 65°C = 500 ppm = 100% saturation

W - Water and Temperature Sensing

“W” option, in MP Filtri Contamination Monitoring Products, indicates water content as a percentage of saturation and oil temperature in degrees centigrade. 100% RH corresponds to the point at which free water can exist in the fluid. i.e. the fluid is no longer able to hold the water in a dissolved solution. The sensor can help provide early indication of costly failure due to free water, including but not exclusive to corrosion, metal surface fatigue e.g. bearing failure, reduced lubrication & load carrying characteristics.

Different oils have different saturation levels and therefore RH (relative humidity) % is the best and most practical measurement.

Water absorber

Water is present everywhere, during storage, handling and servicing. MP Filtri filter elements feature an absorbent media which protects hydraulic systems from both particulate and water contamination. MP Filtri’s filter element technology is available with inorganic microfiber media with a filtration rating 25 μm (therefore identified with media designation WA025, providing absolute filtration of solid particles to $\theta_{\text{cell}} = 1000$).

Absorbent media is made by water absorbent fibres which increase in size during the absorption process. Free water is thus bonded to the filter media and completely removed from the system (it cannot even be squeezed out).

By removing water from your fluid power system, you can prevent such key problems as:
- corrosion (metal etching)
- loss of lubricant power
- accelerated abrasive wear in hydraulic components
- valve-locking
- bearing fatigue
- viscosity variance (reduction in lubricating properties)
- additive precipitation and oil oxidation
- increase in acidity level
- increased electrical conductivity (loss of dielectric strength)
- slow/weak response of control systems

Product availability - UFM Series:
- UFM 041 - UFM 051 - UFM 091 - UFM 181 - UFM 919
FTU 080 Fluid Transfer unit suitable for filling, recirculation - via onboard 80L reservoir - and emptying of filtered hydraulic fluids and lubrication tanks.

The FTU can be utilised either as additional filtration to a system with a high incidence of contamination, or can be used as a standalone recirculating filtration circuit to clean fluid to a predetermined contamination level - monitored by the onboard ICM - prior to transfer of fluid to the system.

> Features & Benefits
- Compact size
- Easy to use
- Easy maintenance
- Reliable
- Absolute filtration
- In-line Contamination Monitor

Possible applications
- Low flow rate for filling of reservoirs
- Low-flow filtration for off-line tanks
- Pre filtration ability of fluid prior to filling of hydraulic system
### Technical data

<table>
<thead>
<tr>
<th>Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pump</strong></td>
<td>Gear pump</td>
</tr>
<tr>
<td><strong>Electric Motor</strong></td>
<td>0.75 kW 1400 rpm, 110/230 V single phase</td>
</tr>
<tr>
<td><strong>Flow (l/min)</strong></td>
<td>15 l/min</td>
</tr>
<tr>
<td><strong>Max. Operation Pressure</strong></td>
<td>3.5 bar</td>
</tr>
<tr>
<td><strong>Inlet</strong></td>
<td>Inlet (pump protection) filtration steel 250 μm strainer</td>
</tr>
<tr>
<td><strong>Viscosity</strong></td>
<td>150 cSt maximum fluid viscosity</td>
</tr>
<tr>
<td><strong>Suction Filter</strong></td>
<td>250 μm metal mesh strainers</td>
</tr>
<tr>
<td><strong>Bypass valve Δp set</strong></td>
<td>Rating 3.5 bar with bypass</td>
</tr>
<tr>
<td><strong>Filtration</strong></td>
<td>Water removal “spin-on” type, bypass set at 1.75 bar. In-line filtration 3 μm absolute Ø 1000 element bypass set at 3.0 bar.</td>
</tr>
<tr>
<td><strong>Filtration rating</strong></td>
<td>See designation order for cartridge and filter elements</td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td>Electrical Control Box</td>
</tr>
<tr>
<td><strong>Indicator</strong></td>
<td>Delivery line electric cut out switch</td>
</tr>
<tr>
<td><strong>Ambient Temperature</strong></td>
<td>From -10 °C to 80 °C</td>
</tr>
<tr>
<td><strong>Working temperature</strong></td>
<td>From 0 °C to 40 °C</td>
</tr>
<tr>
<td><strong>Protection Class</strong></td>
<td>IP55</td>
</tr>
<tr>
<td><strong>Seal</strong></td>
<td>NBR</td>
</tr>
<tr>
<td><strong>Fluid Compatibility</strong></td>
<td>Mineral oil compatible - please contact sales team for queries about other fluids</td>
</tr>
<tr>
<td><strong>Hoses</strong></td>
<td>Flexible hoses - SAE100R4 1” BSP swaged females 2mtr long hose</td>
</tr>
<tr>
<td><strong>Oil level</strong></td>
<td>Sight glass and filler with integrated electric float cut out switch</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>200 kg</td>
</tr>
<tr>
<td><strong>Mounting</strong></td>
<td>Heavy duty trolley and wheels</td>
</tr>
</tbody>
</table>

**Standard**: 

- CE
## FTU 080

### Mobile filtration units

<table>
<thead>
<tr>
<th>Mobile filtration unit</th>
<th>Designation &amp; Ordering code</th>
</tr>
</thead>
<tbody>
<tr>
<td>FTU</td>
<td>FTU 080</td>
</tr>
</tbody>
</table>

### FLUID TRANSFER UNIT FTU

<table>
<thead>
<tr>
<th>FLUID TRANSFER UNIT FTU</th>
<th>Configuration example</th>
</tr>
</thead>
<tbody>
<tr>
<td>FTU</td>
<td>FTU 1 1 15 2 1 M250 SL4305</td>
</tr>
</tbody>
</table>

- **Onboard reservoir**: 1 80 litres
- **In-line contamination monitor**: 1 With ICM
- **Flow rate**: 15 15 l/min
- **Motor power**: 0.75 kW, 1400 rpm
- **Vage**: 1 110 V - 50 Hz single phase; 2 240 V - 50 Hz single phase
- **Inlet filtration**: M250 250 μm suction strainer (internal of reservoir)
- **Outlet filtration**: SL4305 Single spin on plus LMP length 5

### Filteration element is not included and should be ordered separately.

### Outlet filtration options:


#### CARTRIDGE STANDARD LENGTH

<table>
<thead>
<tr>
<th>Inorganic microfibre</th>
<th>Wire mesh element</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 100 A01 A P01</td>
<td>CS 100 M25 A P01</td>
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<tr>
<td>CS 100 A03 A P01</td>
<td>CS 100 M60 A P01</td>
</tr>
<tr>
<td>CS 100 A06 A P01</td>
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<tr>
<td>CS 100 A10 A P01</td>
<td></td>
</tr>
<tr>
<td>CS 100 A25 A P01</td>
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</table>

#### CARTRIDGE EXTENDED LENGTH

<table>
<thead>
<tr>
<th>Inorganic microfibre</th>
<th>Wire mesh element</th>
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</thead>
<tbody>
<tr>
<td>CS 150 A01 A P01</td>
<td>CS 150 M25 A P01</td>
</tr>
<tr>
<td>CS 150 A03 A P01</td>
<td>CS 150 M60 A P01</td>
</tr>
<tr>
<td>CS 150 A06 A P01</td>
<td></td>
</tr>
<tr>
<td>CS 150 A10 A P01</td>
<td></td>
</tr>
<tr>
<td>CS 150 A25 A P01</td>
<td></td>
</tr>
</tbody>
</table>

#### LMP FILTER ELEMENT - LENGTH 5

<table>
<thead>
<tr>
<th>Inorganic microfibre</th>
<th>Wire mesh element</th>
</tr>
</thead>
<tbody>
<tr>
<td>CU 400 5 A03 A N P01</td>
<td></td>
</tr>
<tr>
<td>CU 400 5 A10 A N P01</td>
<td></td>
</tr>
<tr>
<td>CU 400 5 A16 A N P01</td>
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</tr>
<tr>
<td>CU 400 5 A25 A N P01</td>
<td></td>
</tr>
</tbody>
</table>

#### WATER REMOVAL - CARTRIDGE EXTENDED LENGTH

- Multi-Layer water absorber: CW150P10A
Dimensions

HYDRAULIC CIRCUIT

Transfer to on-board tank

On-board tank filtration

Transfer to external tank

External tank offline filtration