# Roll-off cleanliness

A paper by MP Filtri provides theoretical calculation of the appropriate flushing requirements for hydraulic systems, when a clean-up process after assembly is necessary to guarantee roll-off cleanliness. By **Geoff Grant**, MP Filtri's Global Product manager – CMP division

When it comes to hydraulic systems, it is desirable to assemble any component or system with clean parts in a controlled manufacturing environment. However, this may not always be possible and it is sometimes necessary for the entire hydraulic system to undergo a clean-up process after final assembly to reach the desired roll-off cleanliness level.

Experts estimate that 75% of hydraulic component and system failures are caused by contamination. Contamination causes premature wear and lost efficiency which can result in catastrophic failure. Typically, sources of contamination can be characterised as:

## BUILT-IN

Inadvertent contamination left in the system or a component during initial assembly or a system rebuild.

## GENERATED

Contaminants internally generated during system operation, or caused by wear, corrosion, agitation, oxidation or fluid degradation.

## INGESTED

Externally introduced contamination that enters a system from various openings such as breathers, worn cylinder wipers, improperly sealed access covers, and others.

This paper discusses built-in contamination, specifically particulate contaminants, and how to clean up the system following final assembly.

Particulate contaminants typically include weld splatter, dust, fibres, paint chips and other undesirable and potentially abrasive particles. Many of these particles are below the human visual threshold of 40 microns but can be still damaging to a system.

## ROLL-OFF CLEANLINESS

The main purpose of roll-off cleanliness is to minimise damage to the various system components in their infancy. To underscore the importance of establishing roll-off cleanliness standards, the International Organisation for Standardisation (ISO) is developing new standards outlining the cleaning of components and systems. One draft standard, ISO/WD 16431, describes "roll-off cleanliness of an assembled hydraulic system upon release from the production area." This title may change as the document is finalised, but it is obvious that the target is to provide the cleanest possible equipment to the customer.

## CLEANING METHODS

There are many ways to clean a system, and it is up to the manufacturing group of a company to decide which methods to use. The ultimate goal is to reach the desired cleanliness level at the most reasonable cost and minimum time interval. Some of the methods are:

1. Let the system run through its normal operating cycle and allow the system filters to clean the fluid. The system will operate at low pressure during the cleaning/flushing process. The main advantage of this method is simplicity. However, one disadvantage is that the system filters might not have sufficient dirt-holding capacity to last through one cleaning. Several element changes may be necessary to clean a dirty system. This method may also damage system components if the initial contamination level is too high.

2. Use a filter cart, sometimes referred to as filter buggy or kidney loop (following the idea of kidney dialysis). This mobile, self-contained unit filters the fluid off-line using its own pump, motor and filter. It is designed to operate at a low pressure, usually less than 100 psi. The best way to use this device is to attach its suction and return hoses to the reservoir with fluid fittings and let it run while the system is running at a low pressure. Oil returning to the reservoir from the return line will

**MP Filtri's mobile filtration unit UFM 181 with flow rates up to 180 l/min 10 bar.**

now be filtered through the filter cart. This off-line process supplements system filters and decreases cleanup time. This method may also damage system components though.

3 Design an off-line filter that can be attached to the system at system pressure. It can be connected to the system in such a way that it becomes the power supply. The equipment can be cycled using hydraulic power from the off-line system. The main system does not need to be run except to remove oil from the lines that are not in circulation. The cart flow is not required to be as large as the system flow. The idea is to cycle the system for flushing purposes but not necessarily as fast as normal operating speed. This method minimises damages to system components.

It must be pointed out that it is not economically feasible to remove all contaminants from a system. Most systems operate trouble-free with a small amount of contamination present. The amount of contamination that can be tolerated in a system depends upon the sensitivity of the most critical component. System reliability continues to improve, however, as ideal conditions are reached. This threshold for the contamination level is established by the component manufacturer and ultimately by the system builder.

## FILTER TYPES

The size and type of filter used are important in making calculations for cleaning a system. The analysis presented here makes use of the following assumptions:

1 Contaminants are uniformly distributed in the fluid.

2 During roll-off cleaning, no additional contaminants enter the system and no contamination ingresses.

3 The filter exhibits uniform efficiency throughout its working life.

4 The filter does not go into bypass. If it does, the element is replaced. In order to avoid filter element change during the roll-off cleanup, the filter must be adequately sized. It has been observed that contamination may inadvertently be added to the system during element changes.

Generally after a hydraulic system has reached the required cleanliness level, the system has been running for a significant time and at working temperature. The hydraulic media and the particulate contamination are homogeneous. When the hydraulic system is shut down though, the particles settle out in the reservoir, hydraulic components and system pipework. When the system is started again, particles and hydraulic media are not homogeneous and this can lead to initial high levels of contamination for a significant length of time until the hydraulic application is back up to temperature and the particles and hydraulic media are once again homogeneous.

## A HIGH QUALITY SYSTEM

Real applications will vary from this idealisation to some degree, but the variation is not expected to significantly affect the results. Proper roll-off cleanliness procedures protect equipment in its infancy and provide for fewer warranty claims. The end-customer is provided with a high-quality system with clean components that meet their initial use needs. Roll-off cleaning however, is only the starting point for trouble-free system operation.

The final responsibility in controlling contamination lies with the user. Users must maintain proper filtration and practice responsible contamination control in the system to keep the hydraulic fluid clean. **dpi**

https://bit.ly/3voWbs5