

SELECTION OF FILTER RATING FOR LUBRICATION SYSTEMS

1. INTRODUCTION

Solid particle contamination of the lubricant supplied to the moving components of a machine can cause damage. The contaminant particles can either directly damage components such as hydrodynamic bearings, rolling bearings and gears or accumulate in sufficient quantity to cause malfunctioning of the machine.

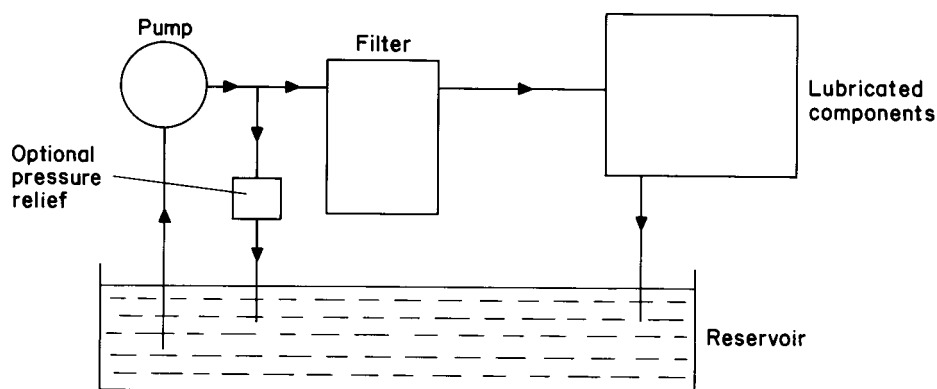
To ensure reliable operation and an adequate machine life the degree of contamination of the lubricant must be limited. This is usually achieved by incorporating some form of filtration in the lubrication system.

This Item is intended to assist in the selection of filters for lubricant circulation systems and provides a means of estimating an appropriate filter rating (filter “stopping power”). Other factors such as permeability, “dirt holding” capacity and the filter medium can influence the choice of filter and in all cases the manufacturers should be consulted.

Hydraulic systems, particularly high pressure systems with very fine clearances, require special consideration and are outside the scope of this Item.

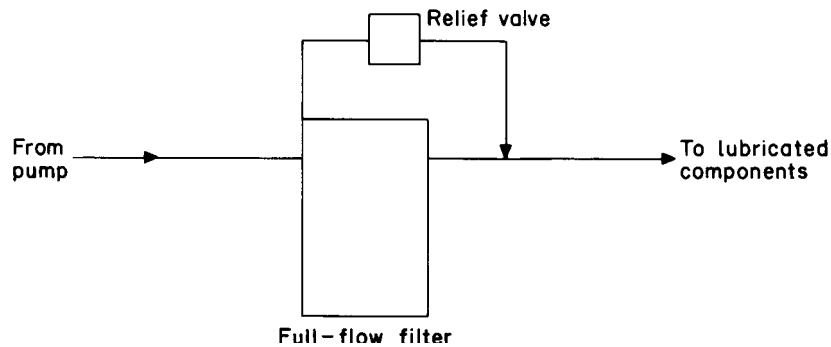
2. THE LUBRICATION SYSTEM

In a typical lubricant circulation system the lubricant is drawn from a reservoir by a pump, flows under pressure to the moving components of the machine, and is then returned to the reservoir. Filters may be incorporated at various locations within the system. This Item, however, deals only with the selection of full-flow filters (often called in-line filters), where the total lubricant flow to the machine passes through the filter. This is illustrated in Sketch 2.1. The optional pressure relief valve prevents the pump and the filter from being damaged by an excessive system pressure.



Sketch 2.1 Full-flow filtration

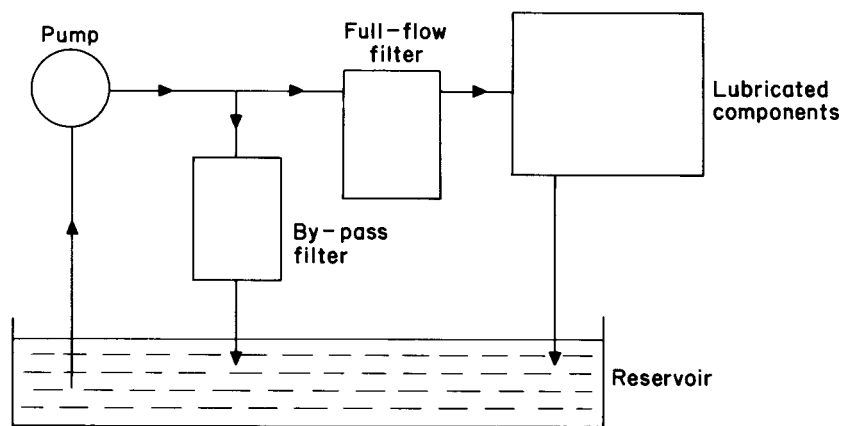
Full-flow filtration is primarily concerned with stopping those particles large enough to damage directly the component of a machine. A pressure relief across the filter (see Sketch 2.2) is often incorporated to prevent oil starvation when the filter resistance becomes excessive. Its use, however, should be avoided when complete protection from dirt is required. In this case a differential pressure operated warning device should be fitted to indicate when maintenance is required. Duplicate filters with isolating valves may be incorporated to allow the maintenance to be carried out on line.



Sketch 2.2 Pressure relief applied to full-flow filter

This Item does not deal with the following:

- (i) Filters intended to prevent the ingress of contamination from the environment through the oil reservoir vent (vent filters) or through the oil filler (filler filters).
- (ii) Filters intended to protect the pump from debris drawn from the reservoir (suction filters).
- (iii) Filters intended to prevent the return of wear debris to the reservoir (return line filters).
- (iv) Filters intended to provide bulk cleaning of the whole volume of lubricant (by-pass filters (see Sketch 2.3)).



Sketch 2.3 By-pass filter incorporated in system with a full-flow filter

With by-pass filtration only a portion of the total lubricant flow delivered by the pump passes through the filter and returns to the reservoir. A by-pass filter is generally of a finer rating than a full-flow filter to provide long term control of the contaminant level.

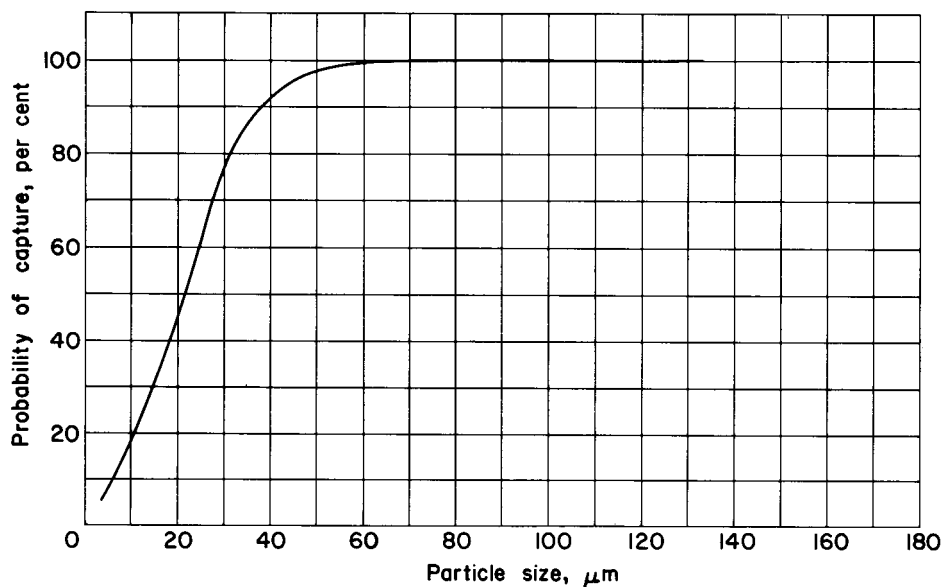
3. FILTER PERFORMANCE

The performance of a filter is dependent on many factors, some of which are associated with the design of the filter while others are associated with the nature of the contaminant, in particular particle size and shape, and the service environment of the filter. The measurement of filter performance is, therefore, difficult and is complicated by the following factors.

- (i) Contaminant particles have irregular shapes and this complicates the measurement of particle size.
- (ii) Various methods of measuring particle size are used and these can give different, often unrelated, results.
- (iii) Particle size distribution may be measured on a particle number or a particle weight (or volume) basis giving numerically different results.
- (iv) The particle size distribution of the test debris influences the test results and may not be the same as that of either the contaminant in service or the test debris used by other manufacturers.
- (v) A filter's ability to capture particles improves as particles accumulate both during testing and in service.
- (vi) Filter performance can be affected by the fluid in which the contaminant is suspended, the contaminant concentration, the temperature of the fluid, its pressure and its flow rate.

The designer should be aware of these factors in deciding the suitability of a filter. However, a filter rating suitable for most applications can be simply estimated using the guidance given in Section 5.

The fate of individual contaminant particles entering a given filter cannot be predicted with certainty and so statistical methods must be used to assess the performance of the filter. To be meaningful, any statement about the filter's performance must include both the probability of particles being captured and the size of those particles. A typical filter efficiency curve showing capture probability as a function of particle size is shown in Sketch 3.1.



Sketch 3.1 Typical filter efficiency curve