Selection and Setup of Backpressure Regulators to Optimize Performance in Lubrication Oil Service

Keeping expensive turbomachinery online is often a key priority for most industrial facilities. Smooth, accurate control of a lubricating oil system is crucial to the overall longevity of rotating equipment and requires expertise. This document outlines some common issues seen in lubrication oil consoles and troubleshooting tips for startup and continuous operations.

Oil Console Operation

Lubrication oil consoles vary greatly in size and configuration but API 614 outlines a standard configuration commonly seen when turbomachinery is deemed critical with no spare. This means that the support system must always be in operation, since the process the turbomachinery is supporting would go offline with any equipment failure. Figure 1 details this skid configuration, which typically consists of a primary pump with a fully sized backup, that drives oil throughout the lubricating system.

The pumps create pressure by driving the oil from the reservoir throughout the system. Commonly, the pumps operate in a primary/auxiliary setup, where the primary pump drives the system pressure to desired conditions, with the auxiliary pump providing a backup in the event of primary pump downtime or maintenance. The auxiliary pump turns on when the system pressure drops below the optimal condition or it can be started manually by the user in order to turn off the primary pump (e.g. maintenance).

The pumps are protected by safety valves or PLVs, that vent to the oil reservoir. Ideally, these safety valves should not lift during standard operation. Due to the large swings in flow that result from pump switching, there is commonly a direct-operated backpressure regulator tied into the pump header that senses pressure changes and adjusts the flow accordingly.

The proper operation of turbomachinery bearings relies on clean lubricating oil appropriate for the application and efficient transfer of heat out of the bearing system. Because the system filter and heat exchanger typically see a considerable pressure drop, it is common for the backpressure regulator to use an external control line installed downstream of the intercooler and filter to keep constant, controlled pressure supplied to the downstream bearings and seals.

Finally, some lubricating oil consoles drive oil to multiple downstream systems such as shaft seals, bearings and control oil operations. Seal oil

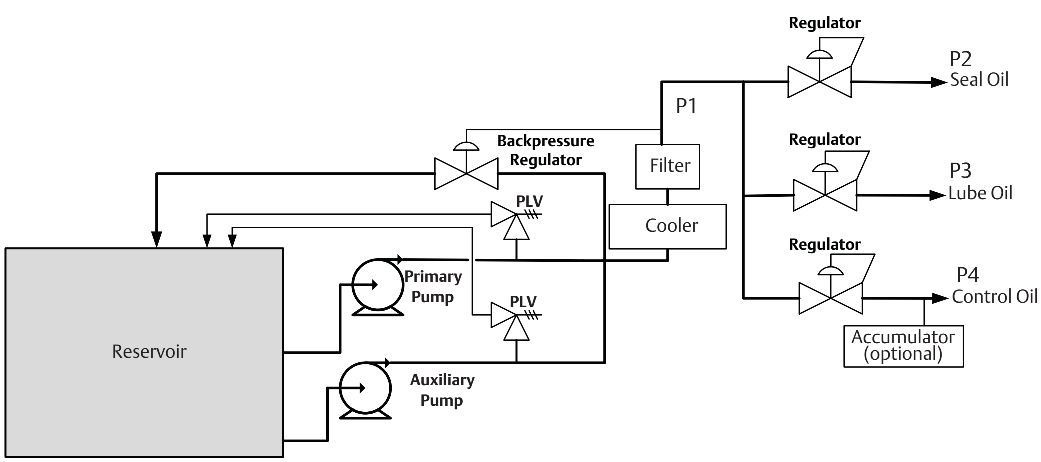

Figure 1. **API 614 Lubricating Oil Console Schematic**

applications often require differential pressure for operation (see the white paper Sizing Differential Pressure Regulators in Seal Oil Service for Turbomachinery). Bearing oil or lubricating oil, is commonly driven through the bearings at a stable pressure and utilizes a standard pressure reducing regulator. Control oil sometimes utilizes an accumulator to mitigate large flow or pressure swings, keeping constant oil pressure downstream to control equipment.

Troubleshooting Backpressure and Pressure Reducing Regulators

Turndown Requirements

Based on the 2-pump system commonly seen in lubricating oil consoles, flows can vary widely through the backpressure regulators. With one pump in operation, flow rates will be low through the regulator and with both pumps in operation, flow rates can increase to over 12 times the amount seen with one pump on. When selecting the appropriate backpressure regulator, one should use the buildup capacity information provided by the manufacturer to determine appropriate regulator size. Per API 614 standards, header pressure should be limited to a 25% maximum buildup pressure when both pumps are in operation and downstream demand is at the minimum expected value. Since the backpressure regulator is actually controlling the header pressure, it is important to consider the turndown characteristics of the backpressure regulator selected.

Turndown of a regulator at a basic level describes the minimum amount of flow through a regulator that can be accurately controlled. Typically, self-operated regulators have larger turndown ratios than pilot-operated regulators or control valves. Many backpressure regulators utilize different cage profiles to manage the turndown vs. high flow characteristics of a valve. Figure 2 details the flow rate vs. travel of different cage profiles and provides a visual representation of what happens inside the regulator as the travel increases.

Due to the turndown requirement for backpressure applications, it is important to choose the cage profile that meets flow requirements while also providing the highest turndown ratio available. The order of cage progression typically is:

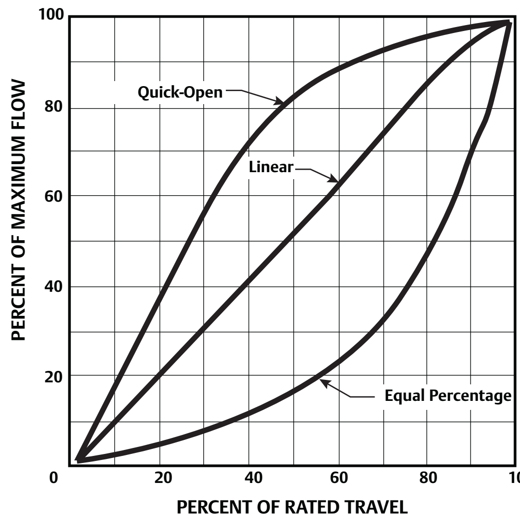

Figure 2. **Flow vs. Travel of Various Cage Styles**

1. Linear
2. Equal-Percentage
3. Quick-Open

When a backpressure regulator cannot meet low flow requirements, then the regulator typically exhibits instability. This usually is represented by wide pressure swings in the lubrication oil header pressure and can result in system vibration, safety valves opening or even high/low pressure alarms that can trip the entire system and result in costly downtimes.

Oversizing a backpressure regulator can also lead to system instability, because a higher turndown ratio is needed for larger regulators. When selecting a backpressure regulator, it is ideal to choose the smallest valve or trim size. When selecting trim or cage profiles, it is recommended to start with linear or equal percentage; only choose the quick-open profile when a higher flow demand is required.

In systems where only a pressure reducing valve is present, it is important to remember that inlet pressures to the regulator will vary due to the on/off actions of the pumps. In this case, sizing the pressure reducing valve for the worst case scenario is important to prevent pressure droop. The worst case condition would be the maximum system flow requirement with the lowest inlet pressure.

Controlling Pressures in Lubrication Oil Service

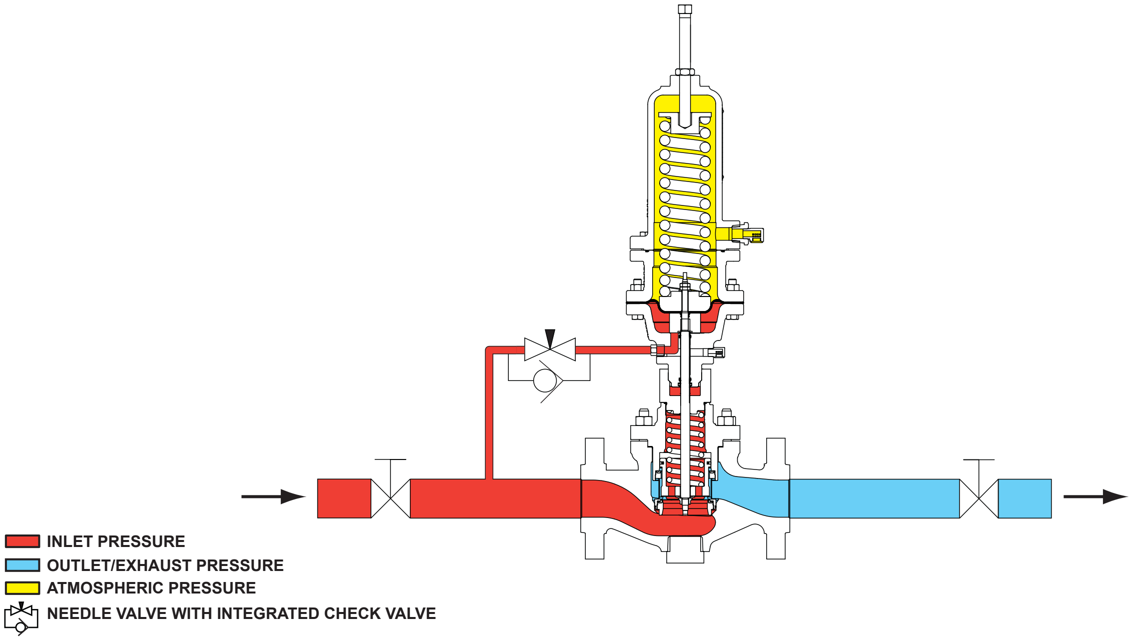

Figure 3. **Diagram of Needle Valve with Integrated Check Function**

Speed of Response Requirements

The 2-pump system also sees almost instantaneous pressure spikes when pumps are turned on and off. Due to the near instantaneous action and the incompressibility of liquids, system pressure is often characterized by sharp spikes or decreases in header pressure.

To mitigate this, it is recommended to utilize direct-operated backpressure or pressure reducing regulators that can respond rapidly to these pressure fluctuations. This means that when the header pressure changes, the regulator will make a quick position correction to match the demand requirement. However, the regulator will begin to interact with the pressure variation caused by the pump and this can lead to large unstable pressure swings, leading to system shutdowns or vibrations.

Sometimes a needle valve with an integrated check function is used to tune the regulator response speed. The needle valve is installed in the sensing line of the backpressure regulator and can be adjusted to either lower or raise the regulator speed of response. Limiting flow through the needle valve will slow the regulator speed of response, while opening the needle valve will increase speed of response. The needle valve should be accurately sized to ensure that the regulator will still respond quickly when the needle valve is in the wide-open position.

The integrated check function allows for full flow in the outbound direction from the regulator spring case. This is very useful in lubrication oil applications, as the sudden shutdown of one pump requires the regulator to immediately close to prevent a sudden loss of header pressure.

Figure 3 details the operation of the needle valve in the operational schematic of a backpressure regulator.

Summary

Consistent operational performance is key in turbomachinery support applications. By utilizing some of these troubleshooting methods, operators can ensure that their oil support systems stay online, which prevents machinery downtime and lost revenue due to repair and unplanned maintenance.

Emerson Process Management
Regulator Technologies, Inc.
3200 Emerson Way
McKinney, Texas 75070 USA
T: +1 800 558 5853
F: +1 972 542 6433
www.EmersonProcess.com/Regulators