WHITE PAPER

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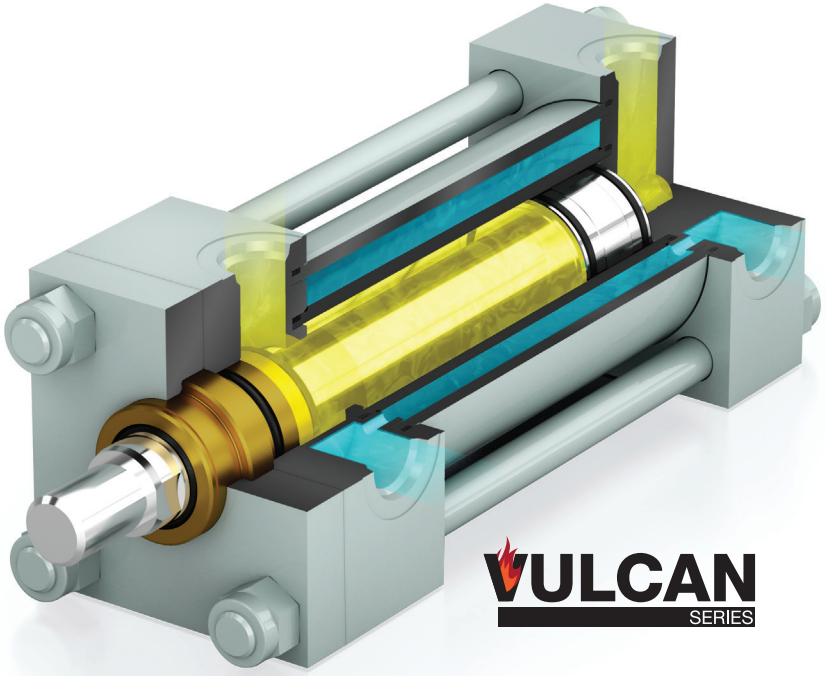
USING HYDRAULIC CYLINDERS IN HIGH TEMPERATURE ENVIRONMENTS



Hydraulic cylinders are typically designed to operate in environments below 180° F. But, if the application requires a hotter environment, what can you do?

This white paper will discuss causes of high temperature, issues related to high temperatures, standard non-cylinder temperature mitigation techniques, and high temperature cylinder solutions.

WHY IS MY SYSTEM HOT?

Every mechanical system generates heat as a result of movement. For example, if you rub your hands together, heat is generated. Or, if fluid is pushed through tight clearances, such as pipes and valves, heat is generated. If this heat is not dissipated, the system will heat up. Systems heat up because the mechanical energy generated is more than the heat that is dissipated.

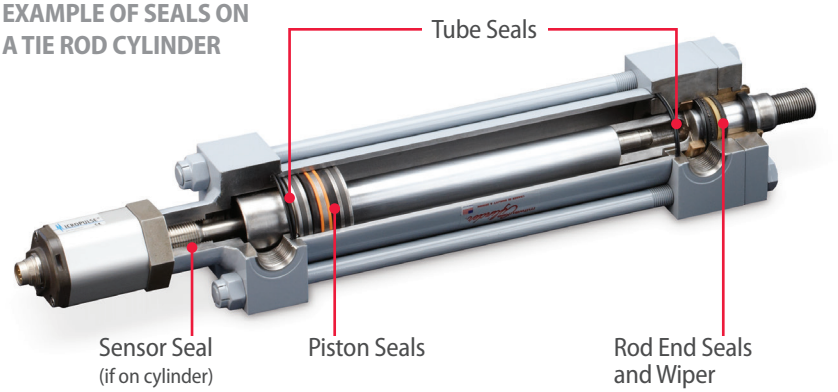
Movement within a system is one source of heat, but there is also the environment to consider. For instance, a hydraulic system located next to an object with excess heat such as a boiler, combustion engine, furnace, or rocket engine may have to absorb a lot of ambient energy. These conditions may require a hydraulic system to operate at higher temperatures than normal, and may need special systems to dissipate the heat or protect the hydraulics from the extreme environments.

WHY IS HIGH TEMPERATURE A PROBLEM?

First, let's consider the seals. Seals are designed to operate below specific temperatures. For example, most common seals require temperatures below 180° F. When seals are heated above their specifications several factors may change, such as the durometer, resistance to abrasion, tear resistance and lubricity. All of these scenarios may lead to seal failure. Seal failure not only means oil leaking past the seals, but it can also lead to contamination in a system and metal to metal contact with permanent damage to cylinder components.

Second, let's look at the hydraulic fluid. Hydraulic fluids tend to break down at a much faster rate at higher temperatures. As the oil breaks down, its viscosity, heat capacity and corrosion resistance are negatively affected, which results in friction, heat buildup and system contamination.

EXAMPLE OF SEALS ON A TIE ROD CYLINDER



HOW DO I KEEP MY TEMPERATURE WITHIN SPECIFICATIONS?

The first line of defense is a properly designed and operated hydraulic system. Hydraulic systems should be designed to accommodate the normal heat load generated within the system or environment. A properly sized oil cooler and reservoir tank can typically be used to dissipate heat at a rate designed to keep the hydraulic system within the required temperature range.

In addition to a properly designed hydraulic system, it is critical to properly maintain the system in accordance with the system provider's instructions. For example, contamination can cause higher friction and quicker oil break down. Consequently, maintaining oil cleanliness via filtering, testing and periodic oil replacement is essential. It's important to always follow oil and system provider recommendations. *Note: Milwaukee Cylinder does offer hydraulic power units and can help in designing a system for your application.*

Operating a system within the design parameters is also a factor in controlling the heat generation within a system. It is quite common that operators push their systems, sometimes beyond initial design parameters. For example, if a system is

WHAT IF STANDARD TEMPERATURE MITIGATION DOES NOT WORK?

Typically, the first approach to handling higher temperatures is looking at the seal material. Seals can be made of various materials offering different properties. The most common seal materials used in the cylinder industry are nitrile or polyurethane based. These seals are typically rated from -20° F to 200° F. For higher temperature applications, ethylene propylene or Viton seals are available to operate to 350° F. For even higher temperatures, polytetrafluoroethylene (PTFE) based materials are available that can withstand up to 500° F.

It is important to note that seal material must be matched with the appropriate coolant type. A mismatch between seal materials and the coolant type can lead to premature failure of the seals.

Milwaukee Cylinder can recommend the correct seals for the temperature and coolant type.

SOLUTIONS FOR HIGH HEAT APPLICATIONS	
WATER COOLED OPTIONS:	HIGH HEAT
Cooling Water Bushing	
Cooling Water Jacket	
SEALS:	
PTFE based	
Fluorocarbon	
Nitrile	LOW HEAT

**Water cooled options are designed to your specific application*

designed to operate at X pressure or X RPM, but is routinely operated at X + Y pressure or X + Y RPM, this operation may cause a rise in system temperature. Operating procedures or design modifications may be required.

Other common techniques in managing system temperatures involve environmental considerations. Solutions include:

- Moving the heat source
- Insulation of the heat source or the hydraulic system
- Cooling ventilation

WATER-COOLED CYLINDER OPTIONS

Sometimes environments and other system requirements make it difficult to design a hydraulic system that can maintain the operation of a cylinder within seal and oil temperature specifications. In these situations, water-cooled cylinders should be considered. Water-cooled cylinder designs provide a source of cooling water that absorbs the ambient heat energy and moves this energy away from the cylinder, protecting the cylinder components from exposure to high temperatures.

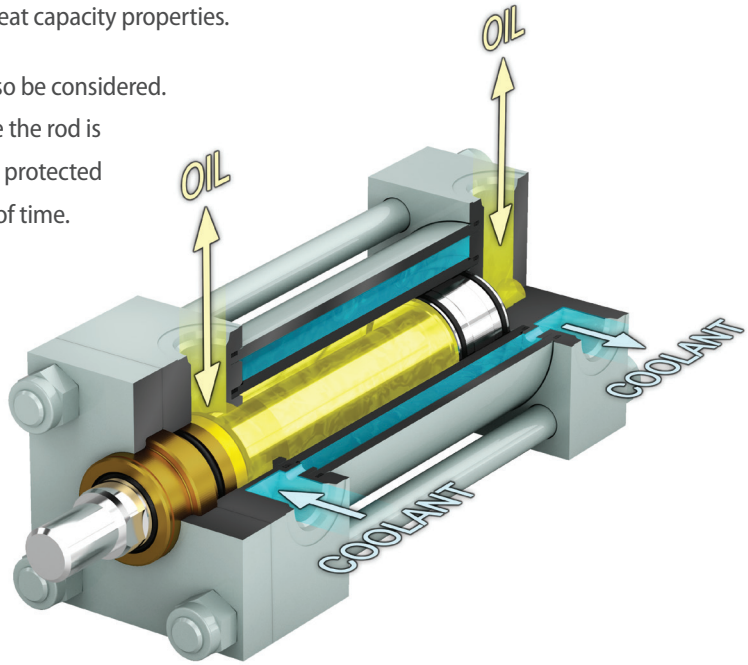
Water cooling can be used as a jacket for the cylinder itself, and/or can also be applied directly to the rod bearing/bushing, for direct seal cooling. When using this type of system, typically "water" would not be the coolant used, but instead an appropriate coolant would be selected for its corrosion and heat capacity properties.

In this type of system, the operation of the cylinder should also be considered. The designer must account for heat exposure to the rod while the rod is extended. Ideally, the rod should remain in its retracted state, protected by the water cooling, and then extend for only short periods of time. A reflective high-temperature boot could also be used in this scenario to help deflect radiant heat from being absorbed in the rod.

VULCAN SERIES

MILWAUKEE CYLINDER VULCAN SERIES

Milwaukee Cylinder offers its Vulcan series of high temperature cylinder solutions. With a wide range of high temperature seals, rod boots, water-cooled cylinders and water-cooled bearings, Milwaukee Cylinder can tailor a solution that best fits a customer's high temperature requirements. Milwaukee Cylinder's team of outside sales, customer service, and engineers are available to offer professional high temperature application support.



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For more information about Milwaukee Cylinder, visit www.milwaukeecylinder.com

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