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ENGINEERING SERVICES

Hydraulic cylinder failure caused by the 'diesel effect'

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I was recently engaged by a client to conduct failure analysis on a large (and expensive) hydraulic cylinder off an excavator. This hydraulic cylinder had been changed-out due to leaking rod seals after achieving only half of its expected service life.

Inspection revealed that apart from the rod seals, which had failed as a result of the 'diesel effect', the other parts of the hydraulic cylinder were in serviceable condition.

What is the 'diesel effect'?

The diesel effect occurs in a hydraulic cylinder when air is drawn past the rod seals, mixes with the hydraulic fluid and explodes when pressurized.

How does this affect a hydraulic cylinder?

When a double-acting hydraulic cylinder retracts under the weight of its load, the volume of fluid being demanded by the rod side of the cylinder can exceed the volume of fluid being supplied by the pump.

When this happens, a negative pressure develops in the rod side of the hydraulic cylinder, which usually results in air being drawn into the cylinder past its rod seals. This occurs because most rod seals are designed keep high-pressure fluid in and are not designed to keep air out. The result of this is aeration - the mixing of air with the hydraulic fluid.

Aeration causes damage through loss of lubrication and overheating, and when a mixture of air and oil is compressed it can explode, damaging the hydraulic cylinder and burning its seals. As you have probably gathered, the term 'diesel effect' is a reference to the combustion process in a diesel engine.

In the example described above, the cause of the aeration was a faulty 'float' valve. The function of a float valve on a hydraulic excavator is to allow the boom or arm to be lowered rapidly under its own weight.

When activated, this valve connects the ports of the hydraulic cylinder together allowing it to retract under the weight of the boom or arm. The fluid displaced from the piston side of the cylinder is directed with priority to the rod side, before any excess volume is returned to the hydraulic reservoir. An orifice controls the speed with which the hydraulic cylinder retracts.

If this valve malfunctions or is set incorrectly, a negative pressure can develop on the rod side of the hydraulic cylinder, causing air to be drawn past the rod seals, leading to failure of the cylinder.

How can this type of failure be prevented?

This example highlights the importance of checking the operation and adjustment of circuit protection devices at regular intervals. As in this case, if the faulty float valve had been identified early enough, the failure of this hydraulic cylinder and the significant expense of its repair could have been prevented.

ABOUT THE AUTHOR: Brendan Casey has more than 25 years experience in the maintenance, repair and overhaul of mobile and industrial hydraulic equipment. For more information on reducing the operating cost and increasing the up-time of your hydraulic equipment, visit his web site:
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