LyondellBasell Technical Tip

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How the Hydraulic System of a Blow Molding Machine Works

Hydraulic oil travels through a maze of piping and valves in a blow molding machine. Knowing where it goes and just how it does what it does can be of help when certain problems arise.

Almost every moving part in a blow molding machine depends upon the hydraulic system, which uses oil as a working fluid to supply the force that enables the parts to move. Figure 1 shows schematically the principal parts of a hydraulic system.

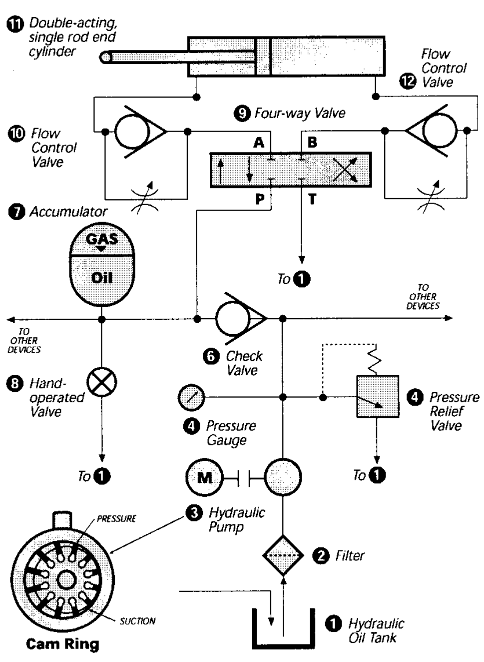

Figure 1

Hydraulic oil is stored in an open reservoir or tank (1). Every time the oil is withdrawn from the tank, it passes through a filter (2) containing a pack of fine mesh screens and usually a magnet. The screens remove any particles of dirt or other foreign matter and the magnet grabs any tramp iron that may get into the system. Periodic replacement of the screen pack is necessary; otherwise the meshes of the screens become clogged and seriously limit the free flow of oil.

A hydraulic pump draws oil from the tank and moves it to the points of use. The pump is usually a single-stage, centrifugal type that is driven by an electric motor (M). A cross-section of such a pump is shown in the small figure. Seen is a cam ring enclosing an off-center rotor. The latter contains a number of vanes that can slide radially within slots in the rotor and maintain contact with the ring wall through the action of centrifugal force. The vanes pick up a fixed volume of oil in the suction area and discharge a fixed volume through an outlet in the pressure area. The vanes impart a velocity head to the oil, which then converts to a pressure head as the oil encounters various points of resistance to its flow.

Since the vanes cannot make a perfect seal against the cam ring, there is a small amount of back flow called “slippage.” The higher the pressure in the system, the greater the amount of slippage. Slippage reduces the amount of oil pumped.

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A phenomenon called “cavitation” can occur in a pump if the operating speed is too high for the viscosity of the fluid being pumped. Bubbles form within the pump ahead of the pressure section; when the bubbles reach the pressure area, they rapidly collapse. The result is a high noise level, erosion of metal and eventually destruction of the pump.

Pressure in the system is indicated by a pressure gauge (4). The curved lines straddling the pipe represent a restriction or reduction of the inside diameter of the pipe. This restriction prevents sudden changes in the pressure system from violently slamming the needle about.

Because the hydraulic pump runs constantly, but the demand for the working fluid is intermittent, some method of relieving pressure is necessary. A press relief valve (5) opens and releases oil back to the oil reservoir whenever a specified maximum pressure is sensed. When the system pressure decreases because of a valve opening and calling for oil, the relief valve instantly closes to maintain the desired pressure level.

The flow of oil branches beyond the relief valve; in Figure 1, one branch is marked "to other devices." Flow out of this branch is controlled directly by the pump and the relief valve. Generally, no equipment is tied to this point, but the feature is available, if needed.

Oil flowing along the other leg of the branch moves through a check valve (6). This valve permits flow from right to left, as the valve is depicted, because it unseats the ball check. Oil pressure from left to right reseats the ball and stops the flow.

The flow of oil branches again, with one path leading to an accumulator (7). This is a storage device internally equipped with a piston or flexible bladder. The main purpose of the accumulator is to supplement flow from the pump when a large volume of oil is required within a short time interval. The gas side of the piston or bladder is precharged to a specified pressure with an inert gas, usually nitrogen. When oil is pumped into the other side, it compresses the gas until the gas pressure and oil pressures are equal.

The size of the accumulator and the gas precharge pressure are set so the accumulator supplies the additional oil needed during the high demand portion of the blow molding cycle: during mold opening, shot delivery and mold close. As much as two gallons of oil may be required within five seconds. Such a quantity could be supplied from a larger pump, but this would be costly and the pump would have little, if any work to do during the remainder of the blow molding cycle. The more practical and economic solution is to size the pump to supply about half the oil required with the accumulator sized to supply the remainder needed.

Another path leads to a point where other devices may be hooked into the hydraulic circuit, for example, the cylinders supplying power to open and close the molds. A hand-operated valve (8) is in another leg of the branch so that if a fitting must be disconnected, the oil under pressure in the accumulator can be discharged back to the oil tank instead of at the fitting being opened.

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Another branch in the oil line leads to a solenoid-piloted, two-positioned, four-way valve (9). When the inner position of this valve is shifted to the right, port P is connected to port A and port T is connected to port B. Pressurized oil then passes freely through the flow control valve (10) into the rod end of the double-acting, single-rod, end cylinder (11), forcing the piston to move to the right and expelling oil from the front of the piston at a controlled rate through the flow control valve (12) back to the oil tank. The rod end of the cylinder supplies the force to deliver shots. Each flow control valve consists of a check valve and a by-pass that can be adjusted to control the rate of flow, and thereby control speed at which the piston moves.

When the four-way valve is shifted to the left, then port P is connected to port B and port T is connected to port A. The oil flow is now opposite to that previously described and the piston is forced to travel to the left.

During the brief period between mold open and mold close, the four-way valve is parked in a neutral position, as it is drawn on the schematic, so that all four ports are closed off.

For more information about blow molding, contact your Equistar sales or technical service representative.

LyondellBasell Industries
P.O. Box 3646
Houston, TX 77252-3646
United States

www.LYB.com

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