

74075, 405/743-4337). Functional aspects are oriented toward performance and structural attributes of the cylinders and include such items as the following:

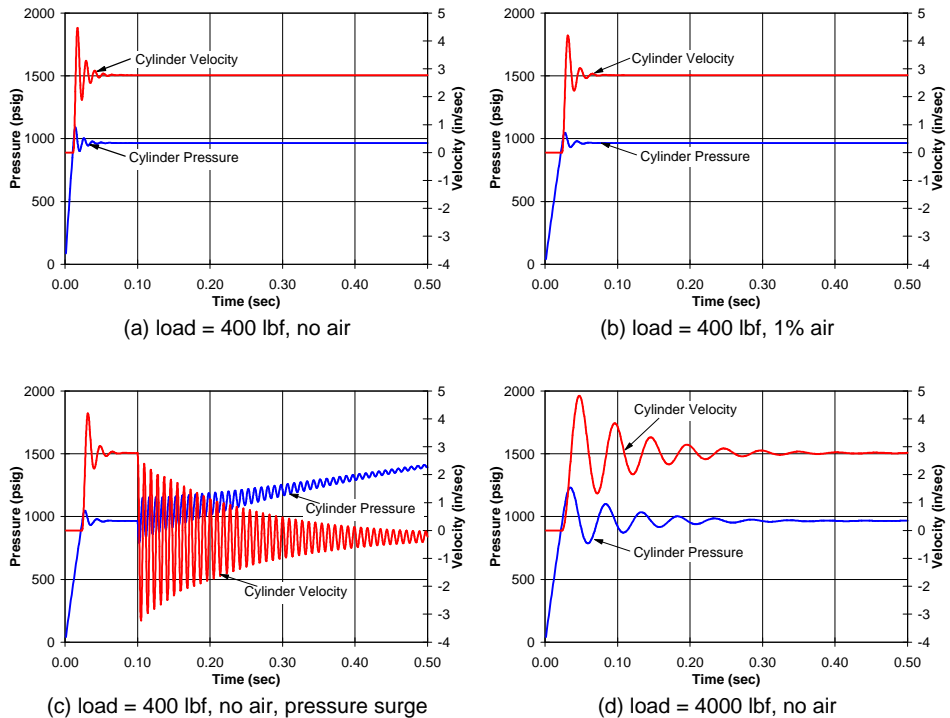


Figure 3-36. Cylinder Dynamics with Various Conditions.

- **Cylinder Configuration**—this assessment is concerned with the rod diameter, bore, stroke, mounting, load connection, and porting.
- **Position Hold, Piston Drift, and Rod Creep**—refers to the capability of a cylinder to hold or maintain a given rod position at extremes in operating pressure and stroke positions. (FES-C-P1)
- **Static Internal Leakage or Pressure Decay**—this assessment gives a relative indication of position holding and fluid sealing (pressure decay resistance) capability of the cylinder. (FES-C-P2)
- **Static Friction, Breakaway Friction or Packing Drag**—these are all critical features of a cylinder and reflect the inherent mechanical inefficiencies of a hydraulic cylinder. (FES-C-P3)
- **Cushioning Behavior**—reflects the capability of the cylinder to dampen and absorb external shocks as well as dissipate a specified amount of energy that is created by the load acting on the system or the fluid driving the cylinder rod. (FES-C-P4)

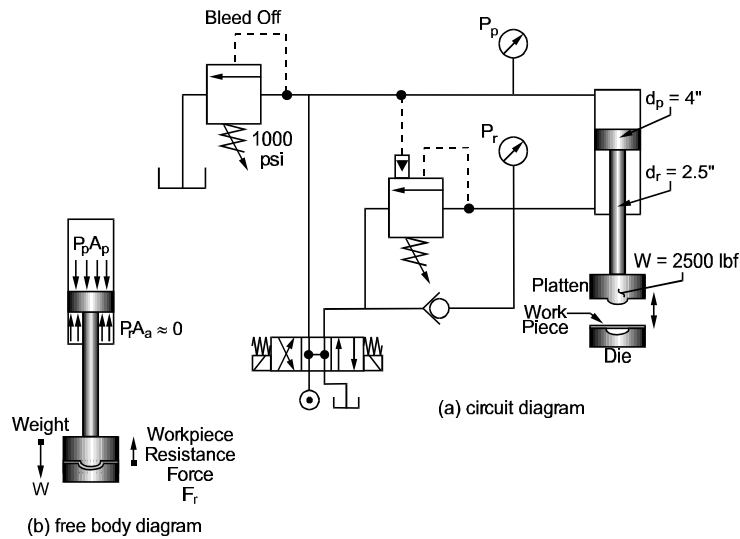


Figure 6-33. Hydraulic Press System with Over-center Counterbalance Valve.

- b. The pressure required to extend the cylinder is determined by Eq. (6-13)

$$P_p = \frac{P_{cs} - P_c}{\gamma} = \frac{425 \text{ psi} - 326.5 \text{ psi}}{3} = 32.8 \text{ psi}$$

In SI units

$$P_p = \frac{29.26 \text{ bar} - 22.51 \text{ bar}}{3} = 2.251 \text{ bar}$$

- c. When the platen extends to the die, the pressure in the cap end of the cylinder, P_p , will begin to build up. As soon as P_p exceeds 32.8 psi (2.26 bar), the counterbalance valve will open and will reach its fully open position during the pressing operation. In other words, the pressure at the rod end, P_r , will be near zero during the pressing operation. Hence, the pressing force is

$$\begin{aligned} F_c &= (P_p A_p + W) - P_r A_a \\ &= [(1000 \text{ psi} \cdot 12.566 \text{ in}^2) + (2500 \cdot \text{lbf})] - (0 \text{ psi} \cdot 7.658 \text{ in}^2) \\ &= 15066 \cdot \text{lbf} \end{aligned}$$

In SI units

Example 6-7

Brake system probably is the most important system of a car. Figure 6-61 shows a brake system schematic. In operation, when the driver depresses the brake pedal and applies a force on the master cylinder piston, this force is transmitted through the hydraulic fluid and distributed to each wheel cylinder. Figure 6-62 illustrates a HyPneu circuit representing the braking system shown in Fig. 6-61. In the HyPneu circuit, a proportioning valve is used to control the rear brake pressure. In addition, a check valve is included to assure that any pressure build-up in the rear brake can be discharged back to the master cylinder. The wheel brakes are represented by a set of four single-rod-single-action cylinders. The braking force is simulated by a ramp force signal with respect to the caliper displacement.

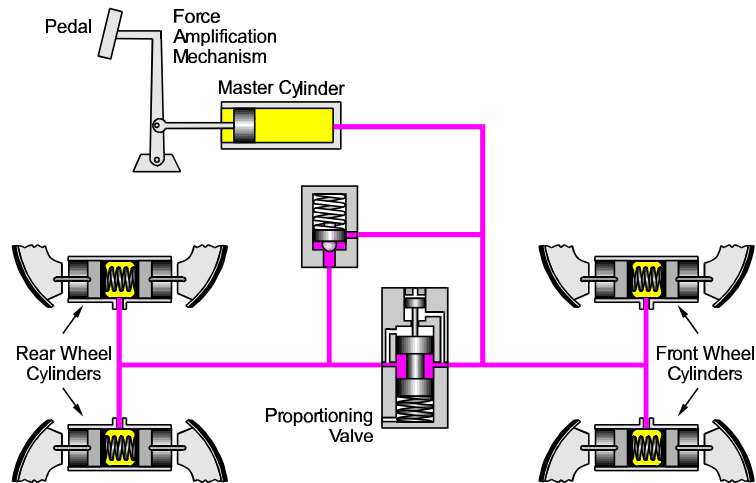


Figure 6-61. Schematic of a Simplified Brake System.

Discussion:

In the simulation, a force of 600 lbf (272.73 kgf) ramped up in 1 second is provided to the master cylinder. For this specific device, a steady state pressure at the outlet of the master cylinder is around 637 psi (43.94 bar). In the proportioning valve, the effective pressure area to the master cylinder line is $A_f = 0.049 \text{ in}^2$ (0.25" or 0.635 cm in diameter), and to the rear brake port is $A_r = 0.196 \text{ in}^2$ (0.5" or 1.27 cm in diameter). The valve is preset at 40 lbf (18.54 kgf) by a bias spring having a spring constant of $600 \text{ lbf}\cdot\text{in}^{-1}$ (107.15 $\text{kgf}\cdot\text{cm}^{-1}$). Assume the maximum stroke of

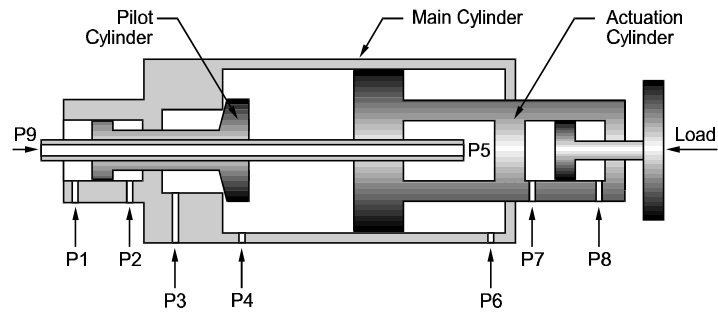


Figure 8-31. A Molding Clamping Unit.

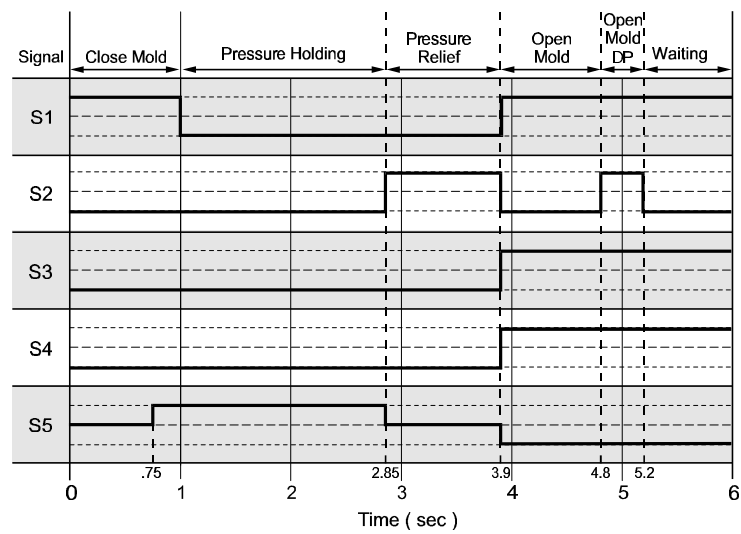
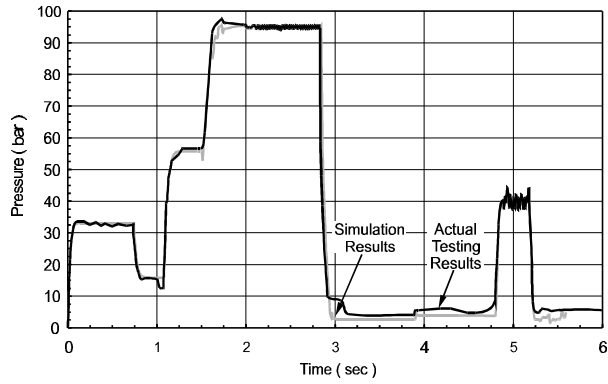
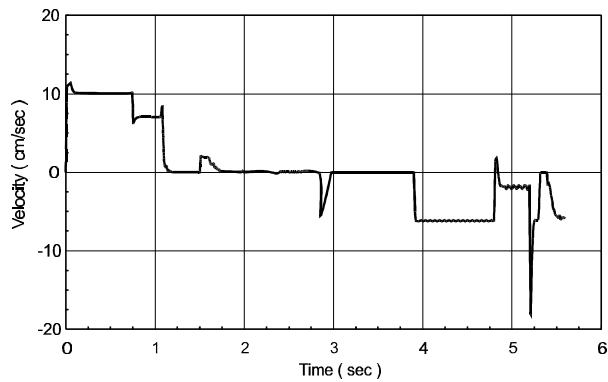


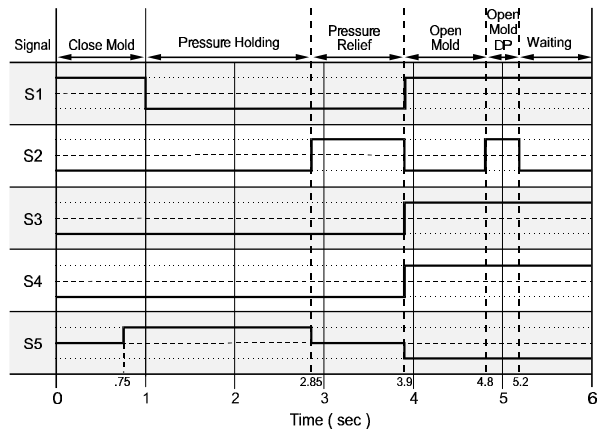
Figure 8-32. Work Cycle Time Diagram for Molding Clamping Unit.



(a) HyPneu Simulation Results vs. Actual Testing Data



(b) HyPneu Simulation Results of the Actuation Cylinder Velocity



(c) Work Cycle Time Diagram

Figure 8-33. Plastic Injection Process Pressure and Velocity Profiles.