HYDRAULIC SHOCK

Hydraulic shock is the term used to describe the momentary pressure rise in a piping system which results when the liquid is started or stopped quickly. This pressure rise is caused by the momentum of the fluid; therefore, the pressure rise increases with the velocity of the liquid, the length of the system from the fluid source, or with an increase in the speed with which it is started or stopped. Examples of situations where hydraulic shock can occur are valves which are opened or closed quickly or pumps which start with an empty discharge line. Hydraulic shock can even occur if a high speed wall of liquid (as from a starting pump) hits a sudden change of direction in this piping, such as an elbow.

The pressure rise created by the hydraulic shock effect is added to whatever fluid pressure exists in the piping system and, although only momementary, this shock load can be enough to burst pipe and break fittings or valves.

A formula which closely predicts hydraulic shock effects is,

$p = v(((SG-1)/2)C + C)$

where p = maximum surge pressure, psi
v = fluid velocity in feet per second (Tables 6&7)
C = surge wave constant for water at 73°F
SG = specific gravity of liquid
If SG is 1, then p = VC

EXAMPLE 1

A 2" PVC schedule 80 pipe carries a fluid with a specific gravity of 1.2 at a rate of 30 gpm and at a line pressure of 160 psi. What would the surge pressure be if a valve were suddenly closed?

From table 5:

C = 24.2
p = (3.35)((1.2-1)/2 x 24.2 + 24.2)
p = (3.35) (26.6) = 90 psi

Total line pressure = 90 + 160 = 250 psi

Schedule 80 2" PVC from the chart on page 50 has a pressure rating of 400 psi at room temperature. Therefore, 2" schedule 80 PVC pipe is acceptable for this application.

TABLE 5
C-SURGE WAVE CONSTANT

1/4"	31.3	34.7	33.2	37.3	—	—
3/8"	29.3	32.7	31.0	34.7	—	—
1/2"	28.7	31.7	30.3	33.7	25.9	28.3
3/4"	26.3	29.8	27.8	31.6	23.1	25.2
1"	25.7	29.2	27.0	30.7	21.7	24.0
1-1/4"	23.2	27.0	24.5	28.6	19.8	—
1-1/2"	22.0	25.8	23.2	27.3	18.8	20.6
2"	20.2	24.2	21.3	25.3	17.3	19.0
2-1/2"	21.1	24.7	22.2	26.0	—	
3"	19.5	23.2	20.6	24.5	16.6	
4"	17.8	21.8	18.8	22.9	15.4	
6"	15.7	20.2	16.8	21.3		
8"	14.8	18.8	15.8	19.8		
10"	14.0	18.3	15.1	19.3		
12"	13.7	18.0	14.7	19.2		
14"	13.4	17.9	14.4	19.2		

Proper design when laying out a piping system will eliminate the possibility of hydraulic shock damage.

The following suggestions will help in avoiding problems:

- In a plastic piping system, a fluid velocity not exceeding 5 ft./sec. will minimize hydraulic shock effects, even with quickly closing valves, such as solenoid valves.
- Using actuated valves which have a specific closing time will eliminate the possibility of someone inadvertently slamming a valve open or closed too quickly. With pneumatic and airspring actuators, it may be necessary to place a valve in the air line to slow down the valve operation cycle.
- If possible, when starting a pump, partially close the valve in the discharge line to minimize the volume of liquid which is rapidly accelerating through the system. Once the pump is up to speed and the line completely full, the valve may be opened.
- A check valve installed near a pump in the discharge line will keep the line full and help prevent excessive hydraulic shock during pump start-up.