

PUMP DISCHARGE NON RETURN VALVE, KRISHNA WSP, HYDERABAD

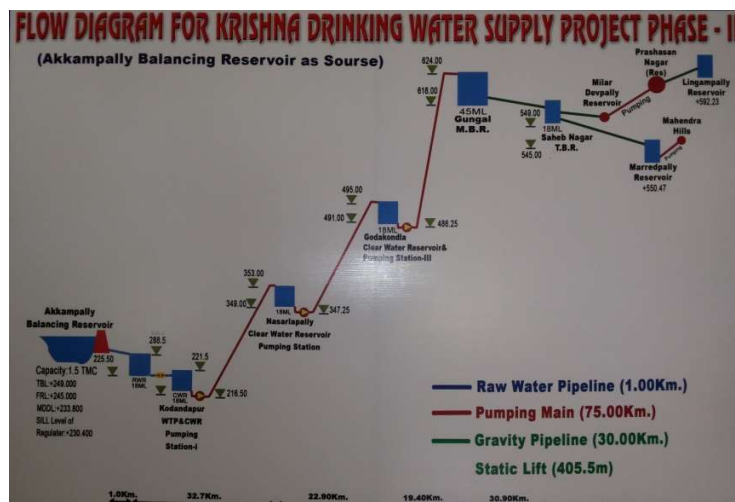


CLIENT : HYDERABAD WATER SUPPLY AND SEWERAGE BOARD

EQUIPMENT : Pump Discharge Non Return Valves

DATA

Pump Discharge (each)	: 2230 m ³ /h (v=2.19 m/s)
No. of active pumps	: 8
Size of delivery pipe/valve	: 600 mm
Max. Static Head (Nasarlapally to Godakondla)	: 148 mwc
Average pipe gradient	: 1 in 240/ 1 in 155/ 1 in 141
Trunk main	: 2200 mm
Discharge thru main	: 17,840 m ³ /h (v=1.3 m/s)



PROBLEM

Repeated failure of pump discharge non return valves irrespective of its type; standard swing check valves as per IS 5312, spring loaded dual plate check valves, slanted seat check valves - all failed after, ranging from 8 months to 2 years of operation in the given arduous duty condition as derived below:

The basis of all Surge Analysis is Joukowsky Equation:

$$\Delta p = \rho c \Delta v$$

where, ρ is the fluid mass density and c is celerity (approaching the speed of sound). Korteweg's (1878) formula defines, c for fluid contained in cylindrical pipes of circular cross-section:

$$K_e = \frac{K}{1 + \frac{DK}{tE}} \quad c = \sqrt{\frac{K_e}{\rho}}$$

where,

K is the bulk modulus of the liquid (Pa)

- ρ is the liquid density (kg m^{-3})
- D is the pipe diameter (m)
- t is the pipe wall thickness (m)
- E is the Young's Modulus of the pipe (Pa)
- c is the celerity (approaching the speed of sound) in the pipe (m s^{-1})
- Δv is the velocity of the liquid before the valve is shut (m s^{-1})
- ΔP is the maximum pressure (at the valve) generated by the valve closure (Pa)

Using the aforesaid, one could easily deduce the following:

- 1) For the large MS (assumed 12 thick) trunk main, the value of $C=884$ m/s and consequently on tripping of all pumps simultaneously, it would result in overpressure of the magnitude of 117 mwc (12 bar approx). By increasing the wall thickness of pipe from 12 to 18 mm, the value of C goes up and the overpressures are of the magnitude of 19 to 20 bar.
- 2) When all pumps are running and only one running pump trips, the magnitude of overpressures in a 12 thick 600 dia delivery pipe could be of 24 bar.

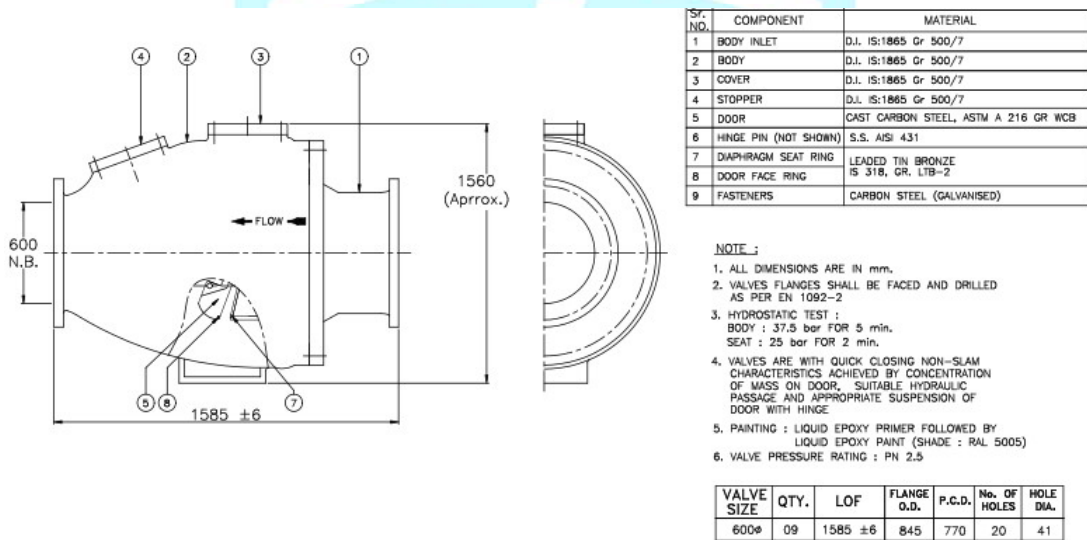
In reality however, owing to the presence of air in the pipe line (at least 1% by volume as dissolved air) water need not be treated as incompressible. As a result the magnitude of over pressures is lower than those stated in 1 and 2 above. Also, the surge protection device does help cushion and thus prevent excessive over pressures.

SUGGESTIONS

- All delivery side pump house valves be 25 bar rated with bodies tested to 1.5 times the rated pressure.
- NRVs where the doors are designed for closure before they get caught in the return flow the degree of slam is negligible. Dual plate check valve with spring assisted doors may qualify as quick return doors. Unfortunately the torsional springs used cease to deliver the requisite torque and like a door closure, is unable to close the door quickly or fully. Also, the elastomeric seat on the body has a short life. These valves are OK for small sizes, say 12" to 14" but for arduous duty like for this project, not suitable. And for larger sizes (Standard - American Petroleum institute API 594 - recommends upto 48" dia), it is money down the drain.
- Single door Recoil Check Valve - the doors are extremely heavy and the girth around the periphery of the body, considerably larger to give closure before flow reversal in the event of pump trip. These valves are immensely suitable for the pump house and the arduous duty.

SOLUTION ADOPTED BY HMWSSB

600 dia. Recoil Check Valve in Ductile Iron construction, 25 bar rated



Recoil of a gun - soon as the bullet is fired, the gunner (at least the firing arm) is thrown back in recoil almost instantaneously. Pretty much in the same way, as soon as the pump trips, the door proceeds to close, the last bit of travel slowed down due to the large girth (and therefore voluminous cavity) around the seat and the door closes finally without slamming. No external dampening or counter - weight used.

Manufactured and supplied since



These specially designed Recoil Check Valves are working extremely well to the utmost satisfaction of the HMWSSB engineers

VALVES BUILT TO LAST