Annexure 6.7: Break Pressure Tank

Illustrative Example: To illustrate the application of the criteria developed, data on the water supply scheme of one city is considered.

Data: The gravity raw water main is from BPT to the aeration fountain. The gravity main is a pre-stressed concrete pipeline with of length 30,900 m and an internal diameter of 1,500 mm. The gravity main is in form of an inverted siphon as shown in Figure 6.5. Even after the stoppage of pumps, the pipeline remains full up to 396.0 m RL of aeration fountain.

The outlet of gravity main (elevation of destination) is in the form of a lip of aeration fountain kept at RL of 396 m. Computation is shown in Table 1.

Table 1: Computation of sizes of BPT

S. No.	Parameter	Formula	Immediate Stage	Ultimate Stage
1	*D = Diameter of pipe (mm)*	Data	1500	1500
2	L = Length of d/s gravity pipeline (m)	Data	30,900	30,900
3	Elv_D = Elevation of destination (Lip of aerator)	Data	396	396
4	A = Cross-sectional area of gravity pipe, (m2)	$A = \frac{\pi}{4} D^2$	1.767	1.767
5	HW C-value	Data	145	140
6	Q_{MLD} = Flow (MLD), Q_{MLD}	Data	110	150
7	Q = Flow (m^3/s)	$Q = \frac{Q_{MLD} * 1000}{(24 * 3600)}$	1.273	1.736
8	V_0 = Velocity in gravity pipe (m/s)	V_0=Q/A	0.720	0.982
9	hf = Frictional Head loss (m)	$hf = \frac{10.67L}{\left(C^{1.852} D^{4.87}\right)} Q^{1.852}$	7.111	13.478
10	H_f = Total Frictional Head loss + minor losses (m)	Hf = 1.1 (hf)	7.822	14.826
11	LSL of BPT	LSL of BPT = ElvD + Hf (of immediate stage)	396+7.822= 403.822 (Rounded 403.8)	
12	FSL of BPT	FSL of BPT = ElvD + Hf (of ultimate stage)		396+14.826 = 410.826 (Rounded 410.9)

S. No.	Parameter	Formula	Immediate Stage	Ultimate Stage
13	Bottom RL of BPT	LSL-0.5	403.822-0.5 = 403.322	
14	Top RL of BPT			410.826+3.5 = 414.3 m
15	F = Friction constant	$F = \frac{Hf}{(V_0)^2}$	15.070	15.361
16	A_T = Cross-sectional area of BPT(m^2)	$A_T = \frac{4AL}{F^2 V_0^{\,2} g}$	188.872	97.767
17	D_{BPT}= Diameter of BPT	$D_{BPT} = \left\{\frac{4A_T}{(\pi)}\right\}^{0.5}$	15.51 (Selected 10.0 m)	11.16 (Selected 10.0 m by reducing area by about 25%)
18	Volume of BPT	A_T × (FSL-Bottom RL)	550.10	550.10
19	Retention time (minutes)	Volume/Q	7.20	5.28

Conclusions:

i) From above Table A-1, the diameter of BPT is 10.0 m and retention time is 7.20 minutes in the immediate stage and 5.28 minutes in the ultimate stage.

Thus, though the length of gravity main is about 31 km and the pipe diameter is large i.e., 1500 mm, a very small BPT is adequate though, the downstream pipeline remains practically filled under no-flow conditions.

ii) Even though the BPT area, as per S. No.16, is reduced from 188.87 m^2 to 78.54 m^2, i.e., a reduction by 58.40%, the maximum WL attained in the immediate stage is 406.31 m as against steady state WL of 403.82 m (S. No.13). This shows that overshoot above steady state WL is marginal and much below FSL.

iii) The diameter of 11.16 m calculated for the ultimate stage is reduced to 10.0 m, thus reducing the cross-sectional area by 24.5%. On computation on basis of equations, WL rise above steady state WL (410.82 m) is just 0.10 m and thus very marginal compared to a safe margin of 3.0 m to be provided above FSL.

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