AIR IN PIPELINE - GANGA JAL PROJECT, AGRA

CLIENT : UTTAR PRADESH JAL NIGAM

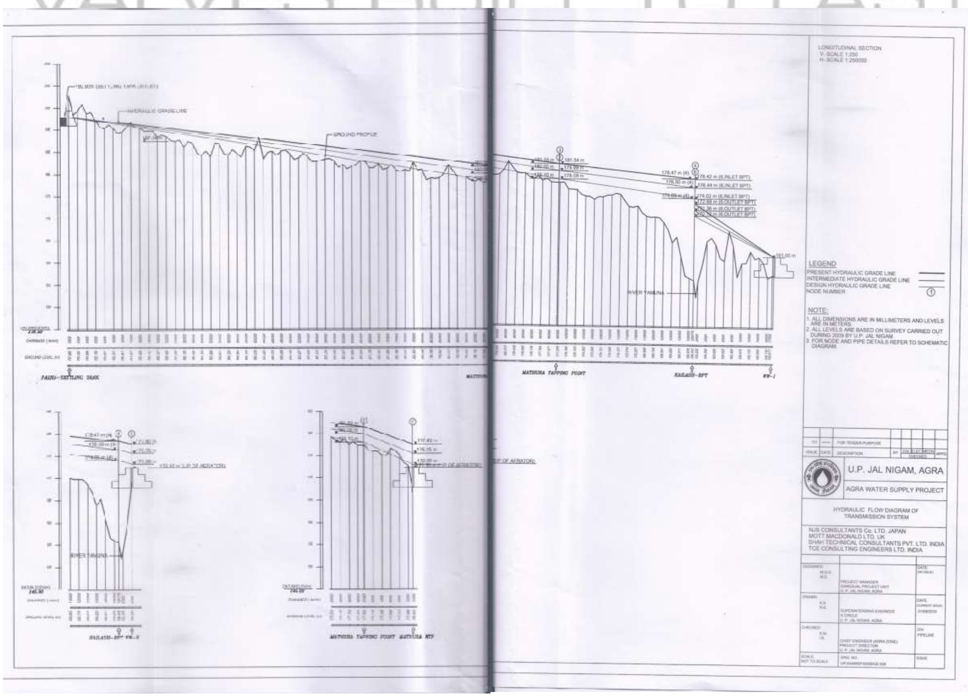
EQUIPMENT : AIR VACCUM VALVE

DATA

Pipe Size	V_c for Horizontal pipe	V_c for downward sloping pipe)	Proposed discharge (mld)	Corresponding velocity (m/s)
2100 Ø	2.20 m/s	2.90 m/s	183.5	0.61
2800 Ø	2.54 m/s	3.34 m/s	3423	0.64
1600 Ø	1.92 m/s	2.53 m/s	144	0.83
800 Ø	1.36 m/s	1.28 m/s	25	0.58

V_c = critical velocity when exceeded, air begins to move downstream with water flow

HYDRAULIC LINE DIAGRAM



CRITERIA FOR AIR BUBBLES / POCKET MOVEMENT

LONG CONDUITS have a L/D ratio > 20. Air bubbles collect at the conduit roof in distant air pockets, and will only be transported downstream when the flow has the capacity to remove or clear large air pockets in a downward sloping conduit. If the flow does not have this capacity then air pockets build up in size and eventually blow back upstream. Also, larger air pockets scale with the conduit dimension.

Air starts to move in a pipe line if the critical velocity is exceeded. For downwards slope, θ, higher than 5% (2.9°):

$$\frac{V_c}{\sqrt{gD}} = 1.509 \sqrt{\tan \theta}$$

g= 9.81 m/s² gravitational acceleration
D= Pipe dia in m
θ= Pipe slope (to horizontal plane) in degrees

Thus for a pipe Ø of 2100, 2800, 1600 and 800 mm corresponding critical flow velocity in downward sloping (higher than 5%) pipe line will be:

2100 Ø - 1.54 m/s
2800 Ø - 2.34 m/s
1600 Ø - 1.77 m/s
800 Ø - 1.25 m/s

Another experimental result gives the following equation for air flow in gravity mains:

$$\frac{V_c}{\sqrt{gD}} = 0.484 \quad \text{(for horizontal stretches)}$$

and

$$\frac{V_c}{\sqrt{gD}} = 0.638 \text{ (for downward sloping pipe)}$$

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INFERENCE

1. **Greater the pipe size more is the critical velocity beyond which air bubbles / pockets begin to travel with the flow.**

2. **Greater the downward slope, more is the critical velocity**.

3. Increasing velocities in large trunk mains also imply greater friction losses. Consequently therefore, lower velocities of 1 to 1.5 m/s are chosen which inhibit movement of air bubbles / pockets along with the flow of water. And it is on account of this that spacing of air release, air intake valves on such mains are more dense.
4. For the proposed system in terms of pipe line size (dia) and the carrying capacity of water (mld) the corresponding water velocities are considerably lower than the critical or threshold velocities and therefore there is just no way for air bubbles / pockets to be purged out hydraulically i.e. along with water flow.

5. Arising out of 4) above the system needs careful scrutiny in terms of ventilation and possibly a fairly dense regime of valves for air discharge and suction.

LARGE ORIFICE AIR VALVES

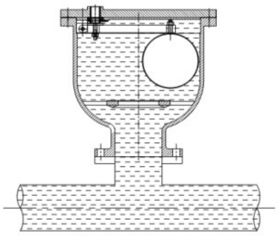
- "A large orifice air valve, when used as an alternative for a one-way surge tank (or discharge tank) should be placed as near as possible to and just downstream from the pump check valve?

- "Depending on the longitudinal profile and the positioning of the shut off valves or non-return valves in the line, a large orifice air valve should be provided to prevent sub-atmospheric pressures in the line when it is drained. **To ensure the flexible and effective operation of the pipe line, shut-off valves are normally provided at intervals of between 1500 and 3000 m (or more).** The result is that the spacing of large orifice air valves is more or less the same due to the requirement that one should be able to drain off any section between shut-off valves."

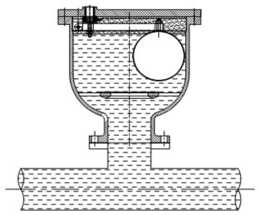
- "The results of surge analyses indicate where sub-atmospheric pressures might occur and it is suggested that large orifice air valves should be provided wherever the pressure drops below 6.0 m absolute".

SMALL ORIFICE AIR VALVES

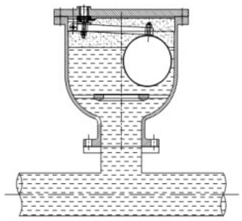
Small orifice air valves release air while the pipeline is in operation and so the emphasis for the design of such valves is to provide a collection chamber underneath the valve from where the air can be captured temporarily and then released through the air valve.



1. PIPE LINE UNDER HYDRAULIC PRESSURE



2. AIR ACCUMULATING IN CHARGED PIPE LINE



3. HIGH PRESSURE AIR DISLODGES FLOAT AND ESCAPES

PIPELINE PROFILE

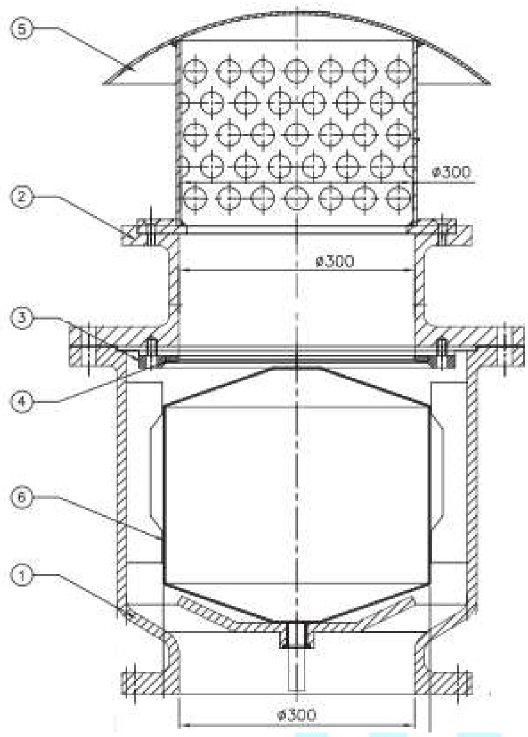
With regard to the pipeline profile, **current design practice manuals** such as Pont de Musson 1994 (from company St. Gobain) **suggest that pipes should be laid at minimum slopes of 1:250 (for downward slope) and 1:500 (for upward slope).** Minimum downward slopes of 1:300 are also used in practice. **The slope of 1:500 has been suggested as the shallowest gradient that can be constructed with no risk of a backfall**, which would otherwise prevent the pipe from draining. It is therefore more of a maintenance requirement than a hydraulic consideration.

HYDRAULIC CONSIDERATIONS

Minimum design flow velocities to ensure air movement are usually taken in the range of 1 to 2 m/s.

The requirement for a minimum downward slope is linked with the need to prevent pipes flowing more than 2/3 full during priming or re-priming to allow air to pass upstream to an open air valve. Some designers have quoted half full pipe as the condition to achieve the above.

OUR CONTRIBUTION TO THE SOLUTION



Sr.No.	COMPONENT	MATERIAL
1	BODY	CAST IRON IS 210 GR. FG 200
2	TOP COVER	CAST IRON IS 210 GR. FG 200
3	SEAL RETAINER	S.S. AISI 304
4	SEAL	BUNA N/EPDM
5	COWL	M.S.
6	FLOAT	STAINLESS STEEL ASTM A 240
7	FASTENERS (NOT SHOWN)	S.S. AISI 304

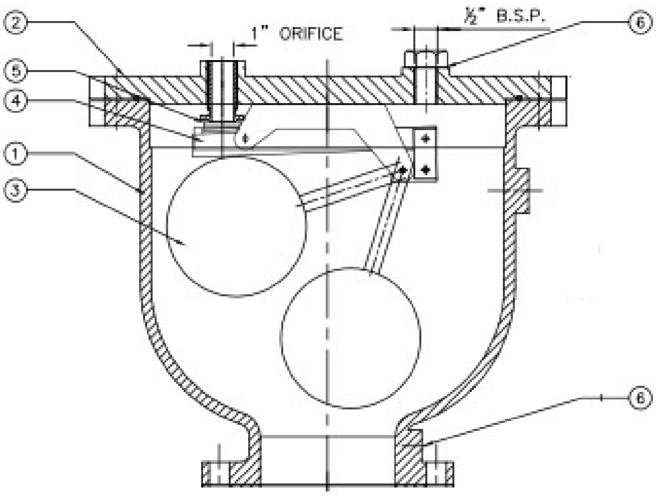
NOTE:

1) ALL DIMENSIONS ARE IN mm
2) VALVE FLANGES SHALL BE FACED & DRILLED AS PER IS:1538 TABLE 4 & 6

VALVE SIZE	FLANGE O.D.	P.C.D.	No. OF HOLES	HOLE DIA.
300ø	445	400	12	23

3) HYDROSTATIC TEST (CLOSED END METHOD)
   BODY : 9 Kg/sq.cm. FOR 5 min.
   SEAT : 6 Kg/sq.cm. FOR 2 min.
4) PAINTING : LIQUID EPOXY PRIMER FOLLOWED BY LIQUID EPOXY PAINT (SHADE : RAL 5005 BLUE) Min. DFT 250 Micron m.
5) VALVE GENERALLY AS PER AWWA C 512
6) PRESSURE RATING : PN 0.6
7) QUANTITY : 18 Nos.

AIR VACUUM VALVES
(300 dia.)



Sr.No.	COMPONENT	MATERIAL
1	BODY	CAST IRON IS 210 GR. FG 200
2	TOP COVER	CAST IRON IS 210 GR. FG 200
3	FLOAT	STAINLESS STEEL ASTM A 240
4	INTERNAL LINKAGES ARRAGEMENT	STAINLESS STEEL
5	SEAL	BUNA N/EPDM
6	DRAIN PLUG	Std.

NOTE:

1) ALL DIMENSIONS ARE IN mm
2) VALVE FLANGES SHALL BE FACED & DRILLED AS PER IS:1538 TABLE 4 & 6

VALVE SIZE	FLANGE O.D.	P.C.D.	No. OF HOLES	HOLE DIA.
150ø	285	240	08	23

3) HYDROSTATIC TEST (CLOSED END METHOD)
BODY : 9 Kg/sq.cm. FOR 5 min.
SEAT : 6 Kg/sq.cm. FOR 2 min.
ISV SHALL BE HYDROSTATICALLY TESTED FOR
BODY : 9 Kg/sq.cm. FOR 5 min
SEAT : 6 Kg/sq.cm. FOR 2 min.
4) PAINTING : LIQUID EPOXY PRIMER FOLLOWED BY LIQUID EPOXY PAINT (SHADE : RAL 5005 BLUE) Min. DFT 250 Micron m.
5) AIR VALVE GENERALLY AS PER AWWA C 512

AIR RELEASE VALVE (150 dia.)