Selection and Sizing of Air Release Valves

An Online Continuing Education Course for Engineers

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Selection and Sizing of Air Release Valves

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Free air can be found in most piping systems and fittings. Pipes considered empty before use are really full of air and the filling a pipeline requires that the air be pushed out by the water. Air entrapped in pipelines is an invisible culprit to many problems such as poor flow, water hammer problems, poor pressure control, damaged pumps and broken pipes. Control of air in the pipelines is thus very important.

Some of the hindrances, problems, and dangers attributed to the presence of air in pressurized pipeline systems are:

1. Inadequate supply of water. Air trapped in a pipeline can reduce or even completely stop the flow of water in the line. This is particularly a critical problem in pipelines that operate under very low heads or in long lengths.

2. Entrained air diminishes pump efficiency and cause energy losses;

3. Water Hammer, pulsations, dead heading… even can damage pipes and pump;

4. Corrosion and cavitation;

5. Inaccurate readings in meters and automatic metering valves. Serious damage to spinning internal parts of meters, metering valves may occur;

6. Physical danger to operators from air-blown flying parts and from very strong streams of high velocity, escaping air.

There are situations where air has to be taken in, primarily for efficient drainage, for vacuum protection, and/or for surge protection. Some of the problems and damages due to the absence of air, when and where it is needed, are:

1. Vacuum enhanced problems and damages;

2. Pipe or accessory collapse, due to sub-atmospheric (negative) pressures;

3. In some cases, the absence of air cushion can increase the damages of surge and slam phenomena.

Engineers have relied on various options such as concoctions of standpipes and various manual or automatic shutoff valves to deal with air - few worked well; some even created additional problems. The most efficient way to control air is by proper use of air valves that function by admitting large quantities of air when needed, and releasing air continuously in pressurized liquid conveyance systems.

How does air get into the system?

Air or gas gets into a pipeline in four primary sources:

1. First during filling. As the pipeline is filled, much of the air will be pushed downstream and released through hydrants, faucets, and other mechanical apparatus. If a means for air escape is not provided, air will be trapped at high points in the pipeline.

2. Second the air is forced into the system by pumps or drawn into the pipe under vacuum conditions;

3. Thirdly the water itself contains about 2% air by volume. The dissolved air will come out of solution with a rise in temperature or a drop in pressure which will occur at high points due to the increase in elevation;

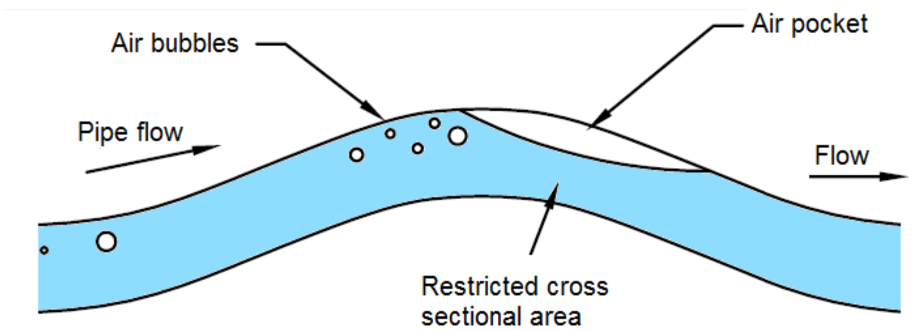
4. Four, when a pipeline is drained, air enters the line.

Effects of Trapped Air

Air in pipes is in the form of bubbles. These air bubbles will generally migrate to the high points of a system. Velocity of water flow will move the bubbles up slope. Figure below illustrates what happens when air bubbles are trapped at a high point in a pipeline.

If provisions are not made to remove this air from high points, pockets of air will collect and grow in size. Air pocket growth will then gradually reduce the effective liquid flow area, creating a throttling effect as would a partially closed valve. In severe cases the air can create an air block that stops water flow. The rapid movement of the air pockets can be the main problem causing sudden violent changes in velocity. The velocity of flow changes rapidly because of the fact that water is 800 times denser than air. When larger air pockets are suddenly vented the result can be dangerous explosive burst; followed by abrupt change of the water.

In addition to the flow restriction, a dislodged pocket of air can cause surges or water hammer. Water hammer can damage equipment or loosen fittings and cause leakage. Finally, corrosion in the pipe material is accelerated when exposed to the air pocket, which can result in premature failure of the pipeline.



No Air Release

Problem Areas

Air pockets are a frequent problem in very low flow, low pressure pipelines. When the velocity of water is very low, air bubbles do not get pushed out, even if the summit in the line is only one pipe diameter above the rest of the line. The air pockets also occur in the long pipelines operating under pressure (high head).

What is the solution?

The solution to air control can be either of the following:

1. Install an open air vent at summits to control the entry and exhausting of air.

2. Install hydrants at all summits in the line so the air can be vented manually.

3. For pressurized line, minimize the number of summits in the line by meandering the pipeline along the contour to avoid high points.

4. Often the velocity of the liquid will remove air bubbles if the pipeline slopes upward to lodge at a high point. But, if the pipeline is fairly flat or the pipeline slopes downward, the velocity may not be sufficient to keep the air pockets (bubbles) moving. Increasing the water velocity to the point the water "sweeps" out the air bubbles is critical.

5. Maintain the water pumping level well above the pump intake. This will avoid siphoning air along with the water into the pipeline.

6. Keep the bulk of the pipelines full if possible. Minimize refilling of the lines in order to avoid repeated trapping of air.

7. Lay pipe to grade in order to have fewer high points. Lay out the pipe so it is on either a constantly increasing or decreasing gradients. Experience indicates that minimum pipe diameter should be:

- 1¼ inch nominal diameter for gradients over 1.0 percent.
- 1½ inch nominal diameter for gradients from 0.5 to 1.0 percent.
- 2 inch nominal diameter for gradients from 0.2 to 0.5 percent.

For gradients less than 0.2 percent, gravity flow systems are not recommended and where pipe of minimum size will not deliver the required flow, the size should be increased.

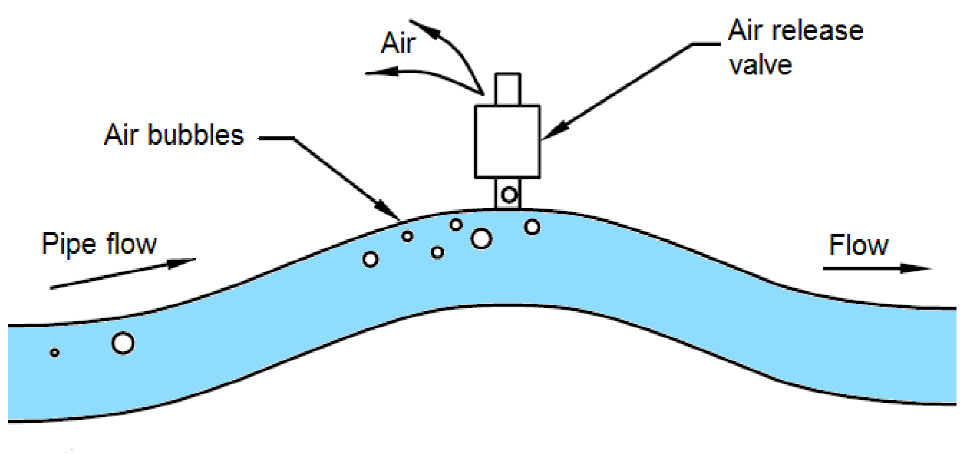
Today, most pipeline installations use a variety of automatic air valves at all points where air can collect along the pipeline.

What is an air valve?

Air valves are hydro-mechanical devices which automatically vent small pockets of air as they accumulate at high points in a system while the system is operating and pressurized.

An air release valve has a small venting orifice that releases air entrained in water under pressure. The air release valve is normally-open and closes as soon as liquid rises in the system and lifts a float within the valve. The valve allows the rising liquid to force out air that occurs naturally in a piping system. Once the liquid rises and reaches pressure, the air release valve remains sealed until the system is depressurized. Depending on the application, it should be mounted at high points in the piping system, as well as the tank.

Air valves can open against internal pressure, because the internal lever mechanism multiplies the float force to be greater than the internal pressure. This greater force opens the orifice whenever air pockets collect in the valve. The orifice size generally varies between 1/16” and 3/8” depending on valve design and working pressure.



With Air Release Valve

Air release valves should be installed with an isolation valve to facilitate removal from the pipeline (should the valve fail or require maintenance) without having to shut the pipeline down.

Types of Air Valves

Air valves in general are often misnamed as “Air release valves” or, less frequently, as “vacuum breakers”. Actually, there are three basic types of air valves which are standardized in American Water Works Association (AWWA) Standard C512: Air Valves for Waterworks Service. They are:

1. Automatic Air Release valves with small orifice
2. Air and Vacuum Release va
3. Com

Each of these ty ... tives.

AUTOMATIC AI

Air release valves ... utomatically release small pockets of accumu ... s under pressure exceeding atmospheric press ... pared to the Air and vacuum valves and ... lated air while the pipeline operates under pre ... 16” and 3/8” depending on valve design and w ... ailable.

How do they work

Air release valve has ... (1.6-mm) to 0.5-in (13-mm) and has a float ... the orifice upon sensing the air. In op ... the valve, they will displace the liquid within the v ... to the float. When the level of the liquid is lowered to where the ... buoyant, the float will drop. This motion opens the valve seat and permits the air which has accumulated in the upper portions of the valve body to be exhausted to atmosphere. While the system is flowing and under pressure, air release valves continually and automatically exhaust the small quantities of air that would otherwise collect at system high points. Air Release valve should be installed at high points or at grade changes within the pipeline.