AIR AND AIR VALVES IN PIPING – PART 1

Let’s start by learning what the sources for air in water-pipelines are

Although it’s normal to say “this pipe is empty,” what actually should be said is that the pipe does not contain any water. It’s actually “full” of AIR.

While the pipe is filling, the water that is being added must displace the air from the pipeline.

Example: A Class 6 250 mm PVC pipe has an internal diameter of about 235 mm, which means that for every 1000 of pipe run, 43,000 litres of water must enter the pipe in order to fill it. Likewise, if the pipe is being emptied (that is, filled with air), some 43,000 litres of water must be displaced.

In faulty installations, or when the level of the water source drops, it is possible for the suction or vacuum action of the pump to pull air into the piping.

In addition, there is air DISOLVED in the water, and when pressure and temperature conditions change, the air goes into the atmosphere.
What problems can the presence of air cause in pipe systems?

The first thing one should remember is that unlike water, air is capable of being compressed. That is, when pressure increases, the air reduces in volume. Air discharge can also trigger pressure instability and water-hammer.

Another unwanted effect of air in pipe systems is that it can accumulate at high spots, forming air pockets. Air pockets create a major hassle, especially in “flat” piping systems with little slope, or in low-velocity systems, where the flow of water is not capable of “carrying” the air.

The presence of air may increase the pumps’ energy consumption.

What problems can the presence of a vacuum cause in pipe systems?

When one say vacuum, one is actually referring to sub-atmospheric pressures. In case a pipe is being drained from water (whether this is done on a scheduled and controlled basis, or a rapid event such as in the case of a pipe burst), and air is not admitted to take its place, negative pressures that can cause pipe-collapse can occur.

This phenomenon is especially prevalent in plastic pipes, particularly those of lower classes (thin walls) and to large diameter, thin wall pipelines.
A collapsed pipe may or may not burst immediately, but it certainly weakens the pipe, especially at rubber gaskets that may be sucked into the pipeline when the pressure is sub-atmospheric and leak through when the pressure is restored. It’s likely that much of the leakage experienced with low-pressure rubber gaskets is caused by previous pipe collapses.

**What types of air valves are there?**

There are 3 types of air valves:
- Kinetic valves
- Automatic valves
- Combination valves

**KINETIC AIR-VALVES**

These are also called **anti-vacuum** valves.
They operate at low-pressure (a few wmc).
They are used for the release large volumes of air while the pipe is being filled with water and they admit large volumes of air into the pipeline to occupy the place of water when the pipeline is being drained.

The kinetic function is undoubtedly the main function of air-valves.
While the piping system is full of water and pressurized, the kinetic orifice is closed and does not operate; it is only active while the pipe is being filled with or drained from water.

Traditional kinetic valves have a hollow, ball-shaped float.
This traditional air valve design has the following characteristics:
- The kinetic orifice is often smaller in diameter than the nominal diameter of the flange.
- The hollow float may crush or deform, whether it is made of plastic or stainless steel. In such a case the float will not seal and the valve will leak water through. This is the part that most often needs to be replaced with this type of valves.
– In pressurized water pipes, over long periods of time, the float may stick to the rubber seat, which makes it difficult to re-open the valve and risk the system due to possible too high sub-atmospheric pressure (air will not be admitted into the line when drained).
– As the float is light, there is a risk of premature closure under low pressures.

AUTOMATIC AIR-VALVES
These are also called air-release valves. These valves operate at high pressure (several kg/cm²). This type of valves is capable of discharging small quantities of pressurized air from the pipe. This is a “maintenance” function. The orifice of the automatic valve is only used to release pressurized air. It can not replace the kinetic orifice in releasing or admitting large air volumes as it is too small for these functions.

Traditional design valves will have the following characteristics:
– They have a hollow, ball-shaped float, or similar.
– They usually have moving parts that are prone to getting stuck or wearing out.

COMBINATION AIR-VALVES
These are also called triple-function valves. The combination air valves have the kinetic and automatic functions are combined in a single unit.
– The discharge large volumes of air out of the system during pipeline filling stage, when the internal pressure is still low (a few mwc).
– They admit large volumes of air while the pipe is being drain of water and the internal pressure is lower than the atmospheric pressure.
– When the system is full with water and pressurized (several kg/cm²) they are capable of releasing small volumes of pressurized air out of the system.
In the traditional design:
- There is one body for the kinetic function, and on top of this there is a second valve body for the automatic function.

**Dorot air valves**

*DAV-MH-KA Combination valves*

- Compact design that combines the kinetic and automatic functions in a single body. Offers improved space utilization.
- Easy to install.
- The kinetic orifice section matches the nominal valve size in the DAV-MH model.
- Solid float (not hollow). No risk of deformation or dents, even under high pressure surges (rapid closure).
The float’s design reduces the risk for pre-mature closure, even at very high air-discharge velocities.

Maintenance can be performed without having to remove the valve body from the line.

It is possible to install a special Surge Arresting (‘SA’) device which will limit the kinetic air discharge flow without impeding the air intake capacity. This device can be added to any of the Dorot DAV-M models, without having to remove the valve from the service.

Available in 2 versions: MS = standard flow / MH = high flow.

Body, cover, and disc for kinetic seal made of high-grade ductile iron.

Internal shafts, guides, and fasteners made of stainless steel.

Main float and top float made of HDPE.

Internal seals made of EPDM.

Available in PN16, PN25 and PN40 versions

Available in sizes 2” to 12” / 50 to 300 mm.

Threaded (2” and 3” / 50mm and 80mm) and flanged connection.

Approved by WRAS and NSF for use with potable water systems

Design complies with AWWA C512 standard.
Operation Principle

KINETIK FUNCTION

PIPING SYSTEM FULL AND PRESSURIZED
Float unit at top point
No air enters or escapes

FLOATING OR EMPTYING THE PIPING SYSTEM
Float unit at low point
Air enters and escapes freely

INTEGRAL AUTOMATIC FUNCTION

How the DAV AUTOMATIC FUNCTION works:
- Because the piping system is full and pressurized, the top float keeps the kinetic orifice closed by the force of the internal pressure below.
- Air that accumulates in the valve's body, forces the water level down. The bottom float loses buoyancy, drops a few millimeters, thus opening the central orifice in the top float, allowing discharge of air.
- When the air is released, the water level rises, lifts the bottom float and closes the automatic discharge orifice.

1 Top float keeps the kinetic orifice closed
3 Automatic air release orifice open for a short time
2 Bottom flow drops for a short time
DAV-MH-KA combination valve aero-dynamic performance

The DAV-M family of air valves

<table>
<thead>
<tr>
<th>DAV METAL VALVES</th>
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<tbody>
<tr>
<td>DAV-MP-1A    metal valve – automatic – 1” \ 25 mm</td>
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<tr>
<td>DAV-MP-2KA   metal valve – combined (kinetic+ automatic) – 2” \ 50 mm</td>
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<tr>
<td>DAV-MS-K     metal valve – standard flow – kinetic – 2” to 12” \ 50 – 300 mm</td>
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Where should air valves be positioned?

AT THE DISCHARGE SIDE OF PUMPS

AT INTERMEDIATE HIGH POINTS
If there are 2 intermediate high points close to one another, select the highest one.

UPSTREAM AND DOWNSTREAM FROM CONTROL VALVES AND OTHER THROTTLED DEVICES
IN PLACES WHERE THERE IS A RISK OF PIPE COLLAPSE (e.g., tank discharges)

CHANGES IN SLOPE (uphill reduction)  
IN STEADY, PROLONGED SLOPE - EVERY 800 to 1000 METERS
This distance should be reduced in the following cases:
- If the pipe is very sensitive to collapse conditions or there is a high risk of negative pressures.
- Where large quantities of air can enter after the water source.
- In mountainous regions with relatively high differences in elevation.
- In low-pressure systems.

At distinct local high points, where too high discharge air-velocity may cause water-hammer, an SA (surge arrester) device should be added to the air valve.