Technical paper

Air Admittance Valves (A.A.V.'s)

Active trap seal protection for high-rise drainage

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Abstract

Air Admittance Valves (A.A.V.s) are one way valves which allow air to enter the drainage system but do not allow air to escape through the valves. Their purpose is to limit the pressure fluctuations within the drainage system and to protect water trap seals. A.A.V.s are commonly used in multi-storey buildings as Group / Branch / Stack vents. The A.A.V.s are often preferred for this use as they are easy to install, use less space and provide ready access for maintenance cleaning of the waste pipe should a blockage occur. A.A.V.s provide better protection to the branch fixtures than an open vent as they sense the pressure fluctuation at the source (Point of Need (P.O.N.)) and equalize the system in less than 0.3 seconds, whereas the open vent method could take 1 second to equalize the system in a large building with a single flush. If there are multiple flushes, then the conventional passive system may never catch up with the demands of the system and lead to the depletion of the trap seals. When A.A.V.'s are used in a branch vent situation, the height of the building is not relevant as the A.A.V. is only venting the group of fixtures.

Context of this paper

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Research | Relevance | Design | **Solutions** | Materials | Installation | Terminology | Standards

Introduction

The traditional method, to protect water trap seals (for example P-traps) is to use pipe network (passive drainage venting) that will reach to atmosphere, usually at the top of the building.

One of the key purposes of the vents to atmosphere is to allow air to enter the pipes to reduce the pressure fluctuations within the network, so that water trap seals are maintained.

The issue with this practice, in high-rise and complex buildings, is the time that it takes for a system to respond due to the pipe period, from the P.O.N. to the vent at the top of the buildings.

The issue is even greater when there are multiple discharges on the same system within a very short period - 3-15 seconds.

A pipe period is defined as, the time taken t_p, for a transient travelling at acoustic velocity c, generated by a change of flow conditions to reach the system boundary (roof penetration) and return to its source 2L.

$$t_p = \frac{2L}{c}$$

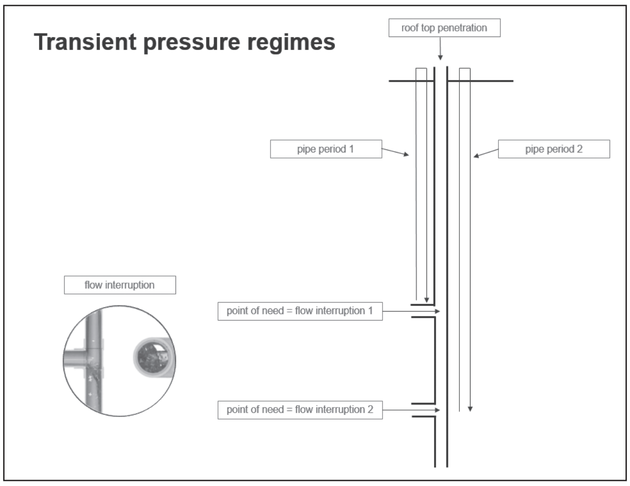

Figure 1.
Transient pressure regimes

One solution is the use of A.A.V.'s, to bring the air into the drainage system at the Point of Need (P.O.N). They provide the same function as the vent to atmosphere without the time delay, and are proven to provide better protection for the water traps seals than a vent pipe network, because of the faster reaction time.

Why is there a need to vent the drainage system?

If we do not protect the water trap seals smells and disease can enter into our living or surrounding spaces. Protection may be provided by using the passive venting but the requirements in codes have been based on research for lower buildings.

In high-rise and more complex buildings the vent lengths are greater by providing relief with A.A.V's at the P.O.N.; this reduces the response time and provides faster protection for the water trap seals.

The conventional thinking in drainage venting is to deal with the negative pressure. The established thinking is water trap seals are depleted due to siphonic action. The most common causes are "self siphonage" and "induced siphonage".

Self siphonage

A negative pressure transient occurs when there is a discharge of fixtures to which the trap seal is connected. This can have the effect of reducing the trap seal (or pulling the trap). This occurs ats the momentum acquired by the waste passes through the fixture and down the trap seal. This momentum is transferred directly into the trap seal and trap seal loss occurs. This is commonly known as 'self siphonage' and is not specifically related to high-rise.

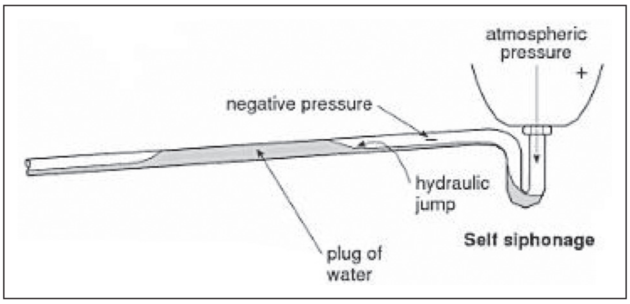

Figure 2.
Self siphonage

Induced siphonage

The most common, critical and also unknown aspects about trap seal depletion in multi-storey and high-rise buildings occurs when there is a pressure fluctuation caused by a discharge of another fixture in the system other than the fixture to which the trap is connected. This is called "induced siphonage". As the water falls down the pipe and passes the branch pipe connected to it, it draws air from it, thus creating a partial vacuum and sub-sequently siphonage of the trap can take place.

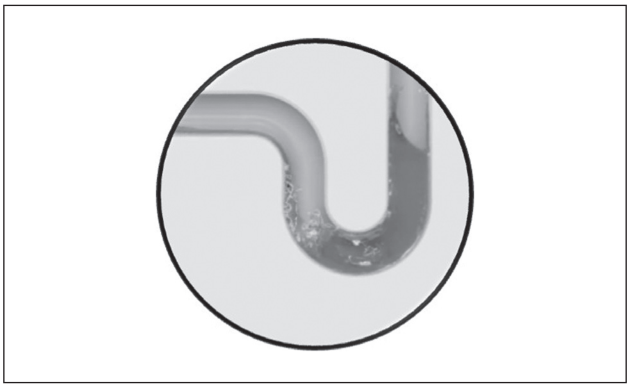

Figure 3.
Trap seal breach

How Air Admittance Valves work

The A.A.V.'s should open before -75 Pa, allowing air into the system and relieving the negative transient pressure.

This keeps the pressures in the system for discharges between 0 and -250 Pa. If the system goes above these pressures, this can lead to the depletion of the trap seals.

A.A.V.'s work by utilizing a reverse lift membrane. When there is water movement in the system the valve will open; when the movement of water stops, the A.A.V. will seal airtight by gravity.

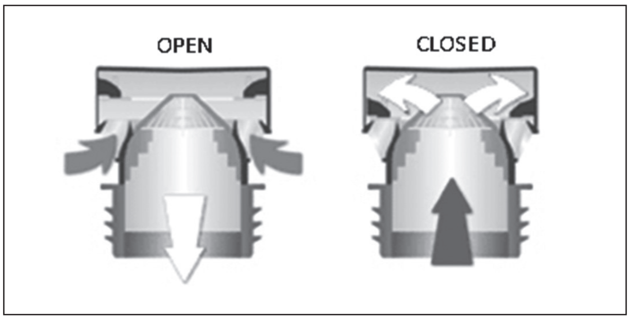

Figure 4.
A.A.V. operation

The valves open and admit fresh air when negative pressure occurs from the fixture discharge. This equalizes pressure within the system and so protects the trap seals. When the flow stops, the valve closes and seals airtight by gravity, preventing any transmission of foul air out through the A.A.V. or the fixture. A.A.V.s are tested for product approvals from -30Pa (lowest point a testing institute can accurately measure) through to -10KPa, so that the valves can be placed up to one meter below the flood level of the appliance.

Minium requirements for A.A.V.'s used in high-rise buildings

As there are many types of A.A.V.s on the market it should be noted that not each product is suited for use in high-rise building drainage. The criteria for A.A.V.s in high-rise buildings are stricter as the correct system operation to prevent any trap seal from breaching depends on the lifetime operational quality of all the A.A.V.s installed. The lifetime operational quality depends on the following 4 factors:

1. **Opening reaction time: the quicker the better**
   a. High-rise building drainage systems are subject to ongoing multi flushes, i.e. the continuously unsteady nature makes the system to constantly react to negative transients, as fast as possible.
   b. Reverse cone of the cap allows to neutralise any internal condensation that might affect the membrane opening ability.

2. **Zero maintenance**
   a. In high-rise buildings, the A.A.V.'s are often hidden in difficult accessible locations, therefore the less maintenance the better.
   b. Compact overall dimension.
   c. Double screen protection (internally and externally) against foreign material or insects.

3. **100% closing ability:**
   a. Dry membrane for consistent life time functioning, not depending on lubrication.
   b. 500K cycle endurance testing.
   c. Sealed design.

4. **Life time product warranty**
   a. ABS plastic + 100% silicone: the best material for durability.
   b. UV protection and anti mould protection.
   c. Meet most international product standards.
   d. External use and up to -40C (for stack A.A.V.'s).
   e. Full connection flexibility to any type of pipe material.

Conclusion

A.A.V.s have been available for use in the world market since the 1970s. They are included in many plumbing codes around the world. The definition within the EN 12056-2 for the purpose of vent pipes and air admittance valves is the same.

In more complex drainage systems with longer pipe networks and higher loadings, the ability to place an A.A.V. at the P.O.N means that the negative transients are reduced faster than the time a passive pipe network can respond and therefore the A.A.V.s as part of an active drainage venting solution provide greater protection to water trap seals and maintaining the barrier between the drainage system and the living space within the building.

It is also that the A.A.V. does not just open quickly, but it must be robust enough to withstand the greater loading pressures in high-rise and complex buildings. Therefore for A.A.V.s used in taller buildings should be tested up to a pressure of 10KPa, the upper tightness test within the EN 12380, the ASSE 1050 and the ASSE 1051, which are the main A.A.V. products standards in the world. It is also recommended that the A.A.V.s are third party tested and have third party approvals.

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1. Swaffield JA (2010). Transient Airflow in Building Drainage Systems, published by Spon Press

2. EN 12056:2000 *'Gravity Drainage Systems inside buildings Part 2: Sanitary Pipework, layout and calculations'*, British Standards Institute, London

3. Studor design guide 2012

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