# Application under water column separation and return events

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Water column separation events occur at sudden water supply-demand differentials when the flow rate downstream from the point of separation is much higher than the flow rate upstream from this point. When a pump suddenly trips off, or when an in-line isolating valve is shut very quickly, water supply is stopped abruptly, while the down-stream water column separates, continuing to flow away from the pump or isolating valve. At pipe filling, when the rapidly advancing water column hits a closed valve or a dead end, it bounces back. At certain peaks, especially those close to the hydraulic grade line, column separation will occur, when supply is terminated, as the rising column slows down, while the descending column retains its flow, powered by gravity. Similar column separation events occur at peaks when, at time of low demand, there is an instantaneous peak water demand, such as at sudden fire demand.

If no fluid, such as air or water, replaces the withdrawing water column at column separation, a severe pressure drop, a down-surge, may result. This down-surge accelerates the returning water column, as it bounces back to the separation site.

Another phenomenon occurring at unprotected column separation is the formation of a vapor cavity. At the down-surge, if pressure drops below the vapor pressure of water, the tail end of the withdrawing water column turns to vapor that fills the remaining vacuum, thus, forming a vapor cavity.

When the accelerated returning water column slams against the pump, the isolating valve or the opposite water column, a pressure upsurge results. If the pressure drop at separation results in vapor cavity formation (down-surge), the subsequent upsurge at column return can be much more extreme and destructive. The reason for this is that, as pressure in the separation site rises at water column return, increasing to above vapor pressure, the vapor changes phase, back to liquid. At this transformation, called “vapor cavity collapse”, a great amount of energy is released. This energy augments that of the slam, resulting in a severe, and often-destructive surge.

Application of properly sized air valves can and will, in most cases, control the down-surge, thus, preventing the acceleration of the returning water columns. But, in some cases, when the air that prevented the down-surge is

re-discharged through the large orifice of the air valve at a high velocity, followed by the returning water column, the water column can slam the air valve float shut, causing a local surge. This surge can travel in the pipeline, causing problems.
This is where the “Non-Slam” air valve comes in.

1. When Column separation occurs, a large volume of air enters the pipeline, replacing the withdrawing water column and, thus, controlling the down-surge and preventing the formation of a vapor cavity. This protects the system from down-surge and destructive vacuum conditions, and prevents the acceleration of the returning water column.
2. At the first stage of water column return, air that replaced the withdrawing water columns is discharged through the large kinetic orifice of the air valve, at high flow rate, ensuring eventual evacuation of all the air.
3. During air discharge, at a predetermined differential pressure across the air valve, an aero-float throttling disc with a small kinetic orifice partially shuts the air valve’s large kinetic orifice, throttling the airflow through its small orifice. The remaining air pocket is depleted slowly, controlled by the throttling disc, slowing down the approaching water column and acting as a cushion and shock absorber, thus, preventing air slam and surge.
4. Air continues to exhaust through the throttling disc orifice, under control, until the water gently buoys the float, sealing the air valve.