Air Separation and Control

Water contains entrained air. If this air comes out of solution in a hydronic system, it causes two problems. First, it increases corrosion rates of metals within the system. In addition, air can form pockets at the top of pipes and heating units. These air pockets can actually restrict or block flow in a hydronic piping system.

Figure 1 below shows a solubility curve for air in water. Note that at a fixed pressure, increasing the temperature reduces the amount of air that can be dissolved.

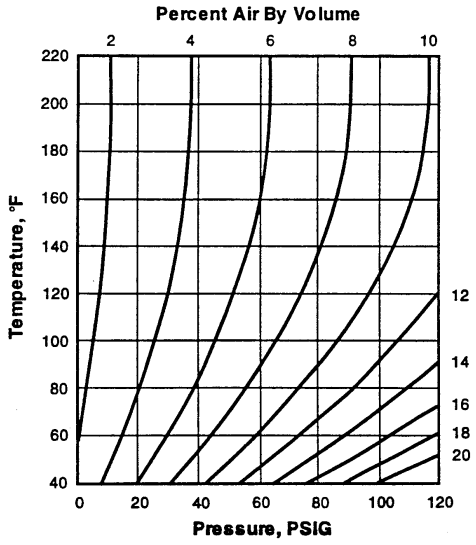


Figure 1, Curve for Air Solubility in Water

For example, at 40 PSIG and 40°F, the water can contain nearly 10% air by volume. At 40 PSIG and 200° F, the percentage decreases to just over 4%.
The conclusion is that as water is heated from the fill temperature to the operating temperature, a great deal of air is released. Therefore, the simple act of bringing the water to operating temperature could lead to corrosion and air pockets, both of which should be avoided.

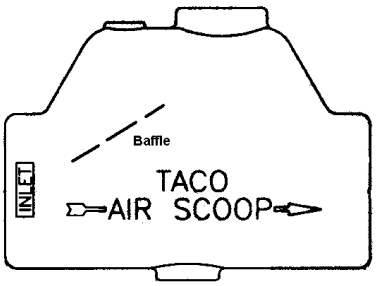
A method of removing this released air from the piping system is required. Enter the air separator. An air separator removes the air from the circulating fluid. Depending upon the type of expansion tank used in the system, the air separator is part of an *air control system*, or an *air separation system*. Both systems will be discussed later. For now, let's look at air separators in general.

Air Separator Types

Air Scoops

Air scoops are the simple and inexpensive. They are available in sizes from 1" (nominal pipe size) to 4". They utilize one-piece cast iron construction and work on two basic principles:

1. As fluid velocity decreases, air tends to separate from the water.
2. Air is lighter than water.



As the fluid flows through the piping, the lighter air tends to circulate at the top of the piping be on top. The internal baffle "peels" off this air and directs it toward the top of the scoop. Also, as the fluid enters the air scoop, it encounters an abrupt increase in cross-sectional area compared to the piping. This, of course, decreases the velocity. Note that the extra volume is all *above the pipe centerline*. The decrease in velocity allows the air to further separate. The added height gives the air a place to migrate, as it seeks "higher ground."

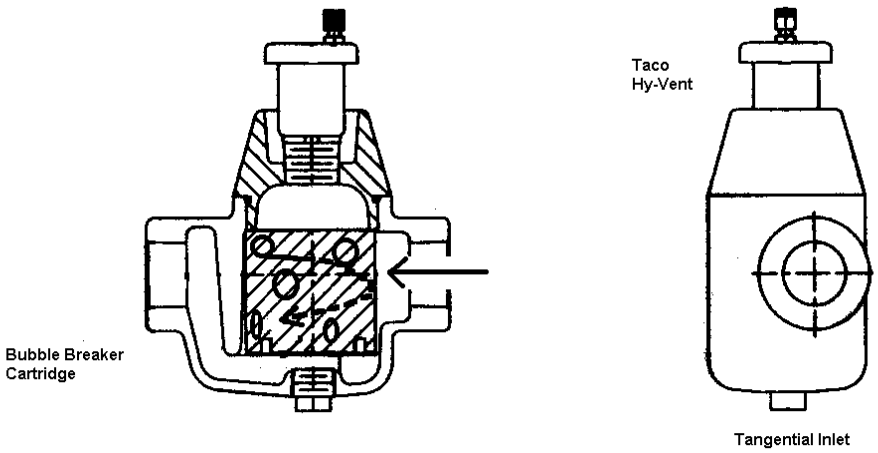
Note that the air separator is generally on the supply side of the boiler, the point of highest temperature, where the air solubility is lowest. The air separator is also on the suction side of the pump, where the system pressure is lowest.

Taco Vortech Separators

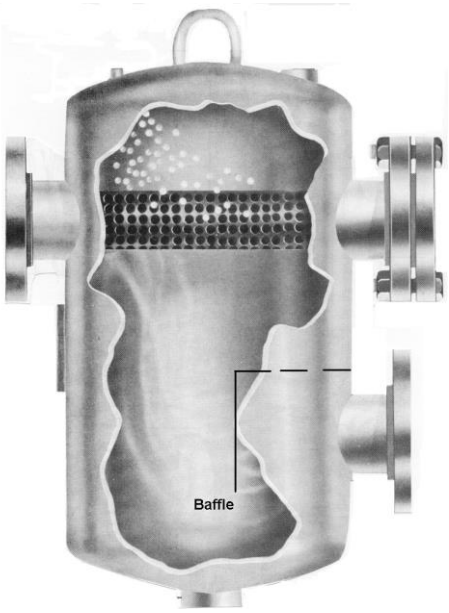
The Vortech separator provides an enhanced level of air separation compared to the scoop. It utilizes a tangential design to create a vortex of swirling water, similar to a tornado. It also uses a "Bubble Breaker Cartridge," which consists of a heavy spiral screen cylinder (bubbles collect readily on screens). The Vortech utilizes three phases of separation:

- Phase 1: Larger bubbles are immediately rise to the top and exit directly through a Taco Hy-Vent.
- Phase 2: Medium-sized bubbles enter the outer layer of the Bubble Breaker Cartridge, where they collect on the screen and then travel upward to the Hy-Vent.
- Phase 3: Smaller bubbles are forced by centrifugal action to the center of the cartridge where they combine with other small bubbles to form large bubbles, and travel to the inner vortex, then to the Hy-Vent.

Note also that as the water enters the Vortech, it is immediately forced downward, which aids in the separation process, as air tends to rise. The water exits the cartridge



through holes at the bottom of the cartridge, and exits on the side opposite the inlet. At this time Vortech units are available only in ¾" through 2" sizes. They can be used in air separation or air control systems.



Taco Commercial Air Separator

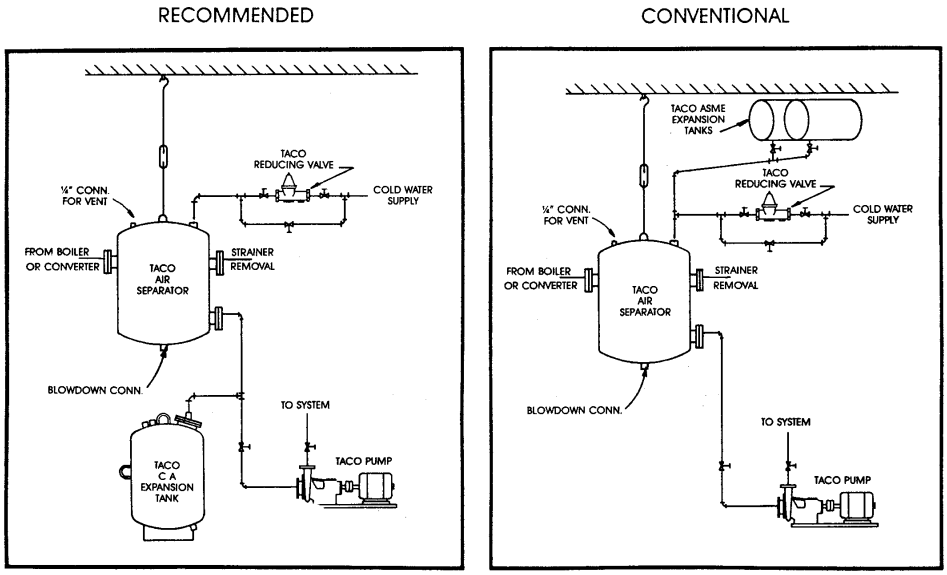
Commercial Air Separators

Commercial air separators are the most effective way to remove air. They are available as standard from 2" to 20" pipe size diameter, and in larger sizes upon special order. Taco commercial air separators are available without an integral strainer (the AC series) or with an integral system strainer (the AC-F) series. They use many of the same techniques to separate air that we have discussed already.

As the fluid enters the separator (upper left connection) it must pass through a perforated tube. This action causes some of the air to separate. Upon entering the main tank, the fluid velocity drops dramatically, because the cross sectional area of the tank is many times that of the piping. For example, the internal cross sectional area of a 4" O.D. steel pipe is 12.73 square inches. The cross sectional area of a Taco air separator, model AC-4 is 192 square inches. Therefore, pipeline velocity drops by a factor of 15. As discussed previously, dropping the velocity allows air to release from the fluid. The flow pattern in the commercial air separator is downward, past a downward-facing baffle, and

out thru the bottom right flanged connection. Being lighter than the fluid, the air resists the downward movement and the turn at the baffle, and rises to the top of the unit, where it collects. In an air separation system, the air is released by a Taco 409 high capacity air vent. In an air control system, it is piped to a plain steel expansion tank through a tank fitting. Taco also builds an air separator with a centrifugal action, the theory being that water, being heavier than air is slung to the outside and the air, being lighter, collects in the center. It has been shown that these are not more effective at full flow and when used in variable flow systems, they are not as effective as the style shown above.

The details below show proper piping of the commercial style air separators with both captive air tanks and plain steel tanks.

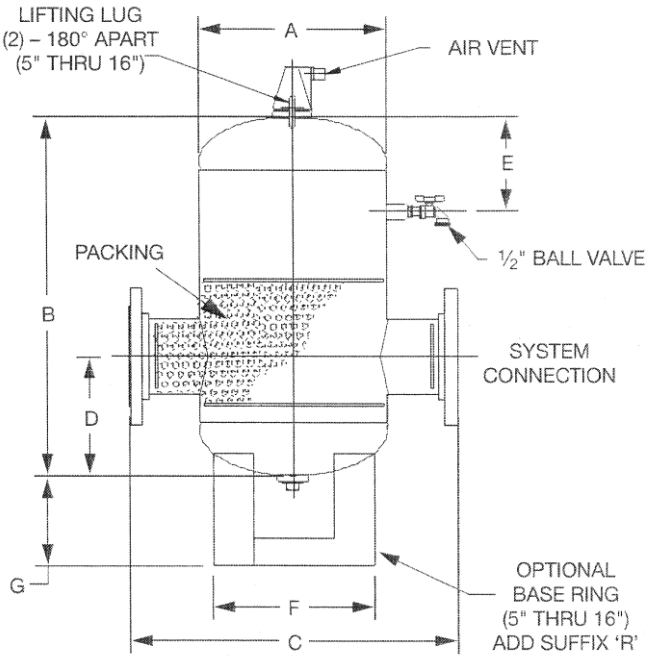


Commercial Air Separators in Air Elimination and Air Control Systems

Combination Air and Dirt Separators

A number of manufacturers now make combination air separators and dirt/scale separators, intended to keep systems free of air and dirt (See Taco 4900 Air/Dirt Separator for details). They are catching on but are still the exception rather than the norm. Testing shows that they are very effective at removing both air and dirt. A cleaner system benefits in many ways, from better heat transfer capability to fewer damaged

pump seals. The Taco 4900 air and dirt separator forces the system water to flow through a bed of pall rings, a form of packing. Pall rings are used in the chemical processing industry to remove particles and gasses from liquid. As the liquid finds a path thru the rings, the fluid's direction changes repeatedly, which causes the heavier particles to fall out. In addition, the fluid is exposed to many square feet of surface area. When this happens, the air that is entrained in the fluid forms bubbles on these surfaces. Because the fluid velocity is low in the large-diameter separators, the bubbles float to the top, rather than being carried along with the fluid flow. At the top of the separator, they are vented through a standard air vent.



FLANGED CONNECTIONS
4902A THROUGH 4916A

Air/dirt separators provide the best way to keep a system clean and air free. They are particularly useful when older systems are retrofitted, as they eliminate the scale and dirt that is set free by cutting into old piping.