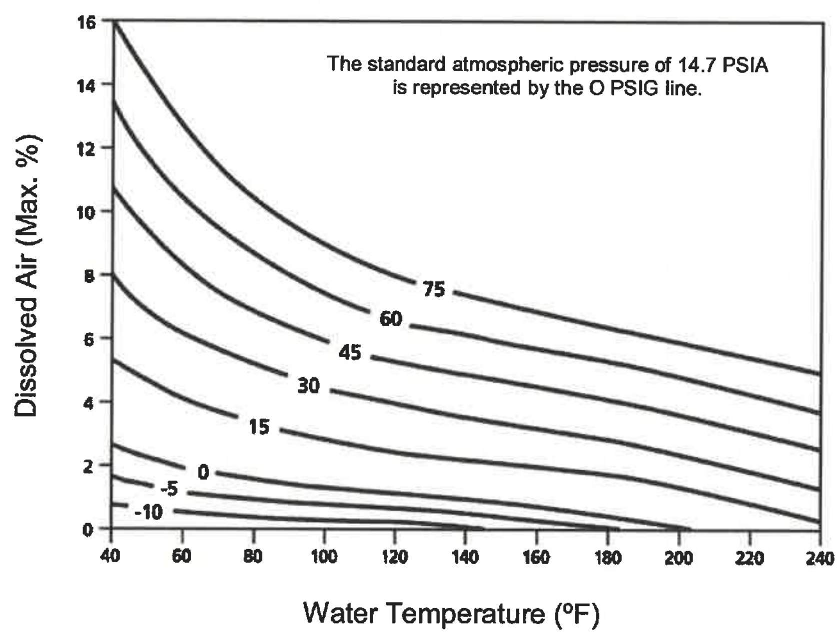
Gasses in Hydronic Systems

Air is present in system fluid in a variety of forms. The large visible air bubbles, or free air, that cannot escape from the system collect and create problems in curved piping, dead end risers, controlled zones, radiators, and radiant floor areas. Entrained air is present as tiny microbubbles that travel at the same speed as the water and are transported by the flow of the liquid. They can remain in the system as microbubbles or combine and become larger. Dissolved or absorbed air is always present in water to some degree, because water (H_2O) is part oxygen.

The solubility of gas in liquid depends on temperature and pressure. Figure B-1 shows the amount of air the water will absorb as a function of pressure and temperature. Note that as the water temperature increases, the percentage of dissolved air by volume decreases. For example, at atmospheric pressure (14.7 PSI) and 50°F, water will contain 2.3% air by volume under standard conditions. Once the water is heated to 195°F (without a change in pressure), however, it can only hold 0.3% air by volume. This means that during a temperature increase of 145°F, 100 gallons of water (comparable to a fresh-filled installation that is heated for the first time) will release 2 gallons of absorbed air.

Figure B-1

Solubility of Air in Water
As a function of temperature and pressure



The percentage of dissolved air by volume will also decrease along with a decrease in system pressure. For example, at 75 PSIG (comparable to the static pressure of a 170 foot high building) and a temperature of 50°F, water contains

14% air. When the water drops to atmospheric pressure (14.7 PSI), the percentage of air drops to 2.3%. That means that 100 gallons of water under the same conditions would release 11.7 gallons of dissolved air.

The composition and the origin of absorbed gasses vary widely. System water can contain carbon dioxide and atmospheric gasses such as nitrogen and oxygen. Hydrogen and methane can be present as a result of microbiological growth, electrolysis and chemical reactions.

Corrosion is the result of the chemical reaction between iron and oxygen as shown below:

$$Fe + 2H_2O > Fe(OH)_2 + H_2$$

$$3Fe(OH)_2 > Fe_3O_4 + H_2 + 2H_2O$$

As a result, the magnetite FE_3O_4 is formed. This magnetite, with the lasting presence of oxygen, will then be transformed to hematite, FE_2O_3, as described in the next equation.

$$Fe_3O_4 + O_2 > 6Fe_2O_3$$

Chemical reactions between system water and system metal, and electrolysis between dissimilar metals are not the only sources of absorbed gasses.

More common sources of air and system gasses include:

- Air diffusion through non-metallic tubing
- Undersized expansion tanks (which cause relief valves to pop and feed valves to feed)
- System fills or refills after repairs
- Seasonal draining of old style steel compression tanks
- Low or negative system pressure at top floors
- Bad plumbing joints and improper seals
- Improperly installed circulators

No hydronic system is completely airtight. Even a manually vented system cannot eliminate dissolved air. As the system operates, water constantly evaporates through valve stem packing, gaskets, mechanical seals, tiny fissures in the pipes and fittings, and dozens of other places. These leaks may go undetected, however, the build-up of mineral deposits on valve stems and gaskets proves that leaks are present. That white crust is evidence left behind by evaporating system water. During maintenance or repair, system water is unavoidably lost. And when water leaves a hydronic system, it must be made up with fresh feed water. Fresh water means more air, and more air means more problems. It is an endless cycle.

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