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Oxygen diffusion formula shows why problem is great

BY JOE FIEDRICH
Hydronic heating authority

THERE'S RECENT STRONG evidence that oxygen diffusion through the wall of permeable plastic tubing in "closed" radiant floor heating systems can cause serious problems in the system.

Significant corrosion and subsequent sludging problems were discovered recently in closed systems in Europe that employed O_2-permeable tubing.

Initially, the water in any closed loop hydronic heating system will become oxygen-poor water because the dissolved oxygen in the initial fresh water fill quickly reacts with iron components in the system. This causes a negligible amount of corrosion by-products.

Oxygen-depleted ("dead") water in an oxygen-tight, closed piping system is an effective and inexpensive heat transfer medium. Depleted of oxygen, the water does not corrode valves, pumps, boilers, expansion tanks, and other components.

There's some mechanical entry of additional oxygen whenever a vacuum is generated, usually during water temperature modulation and temperature setbacks. But properly sized and maintained expansion tanks are crucial and will practically eliminate mechanical oxygen sources by maintaining O_2 levels within the German DIN standard minimum requirement of 0.1 mg/l/day.

More oxygen finds its way into even properly designed closed loop systems via air vents, fittings, gaskets, etc., but the amount is small compared with the enormous amount that can enter through plastic and rubber tubing walls.

The average residential floor heating system constitutes 500 sq. ft. of tubing surface area. Depending on the molecular structure of the tubing material, the amount of oxygen that can permeate the surface of that much tubing can be hundreds of times greater than the amount of O_2 mechanically leaked into a copper pipe system.

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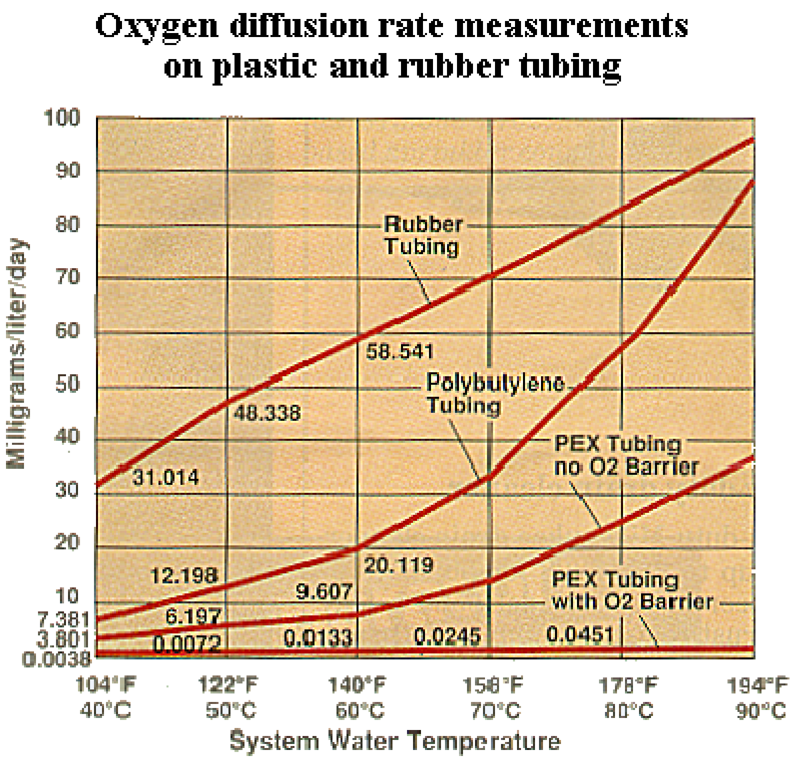
To understand why let's look closely at the measuring unit with which the amount of oxygen diffusion is calculated.

The measuring unit, according to DIN 4726, is milligrams of oxygen per liter of tubing water content per 24 hour period, absorbed at a given system water temperature. The key is to understand that this is a rate or time-dependent measurement unit, not an instantaneous measurement reading at any given point of the system.

That means that three factors in the measuring unit will quickly multiply the amount (mg) of oxygen to staggering numbers. The multiplication factors are:

1. Oxygen diffusion rate for a specific tubing material and operating water temperature (see diffusion rate graph).
2. Water content of the total tubing system (in liters).
3. Total time period system water circulating continuously through the tubing system during the heating season (in 24 hour periods).

Through multiplication of the above three factors, the amount of oxygen entering the pipe walls can be accurately calculated for any system. The degree of oxygen corrosion du to diffusion can vary greatly depending on the amount of tubing in a system, the material composition of all ferrous and nonferrous components, the system's operating water temperatures, and the operating time of the system per heating season.



Next month I'll explain the DIN standard in greater detail and talk about acceptable corrosion protection techniques. Until then, keep in mind that this is a debate that must be settled on the basis of scientific fact, not by claims and counterclaims.

The author is president of Stadler Corp. (tel. 781/275-3122), a Bedford, Mass.-based supplier of hydronic heating equipment