Reducing Leakage

By Andy Pearson, Ph.D., C.Eng., Member ASHRAE

This article is the fifth in a series exploring refrigeration and heat pump concepts without using jargon.

System designers go to great lengths to ensure their equipment is capable of dealing with the sorts of variation in load that were described in the June column. This includes the changes in the amount of working fluid that is contained in the cooling part of the circuit. If the cooling requirement is large then lots of liquid will be boiling and most of the space in the cooler will be taken up with gas. However, when the load reduces and the boiling is less vigorous then more of the space is filled with liquid, which has to come from somewhere else in the system. This is why systems need a tank with a lot of liquid in it, so that the plant doesn't fail to perform when the load is light and more liquid is required in the cooler.

This leads to two specific difficulties for the operator of the system. First, it is very difficult to say what is the right liquid level in the tank because that depends on what is happening in the rest of the system. Second, if some of the working fluid leaks out of the system its disappearance might not be immediately obvious. However, just at the time it is most needed it will not be there, and the system is likely to misfire in one way or another. A shortage of working fluid might cause the system to run less efficiently than it should or to stop working altogether.

Some people are more passionate about leakage reduction than others.

Leakage of working fluid causes many other problems. The fluid might be toxic, or flammable, or smelly or perhaps harmful to the environment in some less obvious way. Even if it is non-toxic it might suffocate people who are working near the leak or who walk into a room in which the oxygen has been displaced by colorless, odorless refrigerant. If a system is "short of gas" then someone has to purchase some more, someone has to get in their truck and drive to the site and someone has to return the empty cylinders once the job is done. However, if the leak isn't found and fixed then they will be back next month, and the month after, and the month after that. In some countries "topping up" a system that is known to be leaking is illegal and carries a heavy fine if convicted.

Leaks are therefore bad news and should not be allowed to happen. The good news is that most of them can be prevented, with a bit of care, some forward planning and a dose of common sense. Most leaks come from broken pipes, worn or faulty seals and loose fittings. Pipes can be broken by the effects of excessive vibration, either through fatigue failure, through abrasion of the pipe against another object or through work-hardening. Pipes also fail due to corrosion, particularly under insulation if the vapor seal is not maintained. Many of these causes can be eliminated at the design stage of the system by using suitable materials, ensuring adequate clearances around pipes and avoiding screwed fittings wherever possible.

For small diameter pipes stainless steel is a much more durable material than copper, and is not significantly more expensive when the total cost of the system is considered. Anyone who says they care about leaks but is still using copper gage lines on their plant is not credible.

Maintenance also has a big part to play in the reduction of leaks, including checking that the vapor seal on insulated pipe is in good order. Inspection of uninsulated pipe for signs of wear and corrosion—and treating them as soon as they are found—is probably the single most effective anti-leak measure. Spotting and eliminating excessive vibration is another key element of ongoing leakage prevention.

In this case it is useful to take benchmark vibration readings from time to time because gradual increases might not be noticed in a day-to-day inspection routine. It's also important to take the readings under a variety of operating conditions, particularly because vibration levels might be higher on part load than full load, especially if the system is speed controlled.

Ultimately, the key to leakage reduction lies in your mental attitude. If you lived in the superintendant's house at the hydroelectric plant in the lee of the Hoover Dam, you would be passionate about leakage prevention. There are two tricks that help keep plants in a leak-free condition. The first is to tell yourself that there is definitely a leak and your job is to find it. It is amazing what a difference this makes in comparison to wondering whether the system is leaking or not. The second trick, when a leak has duly been found and repaired, is to tell yourself that the system is still leaking, and you still have to find the leak. Developing this kind of passion could save thousands of dollars over the life of the plant.

Andy Pearson, Ph.D., C.Eng., is group engineering director at Star Refrigeration in Glasgow, U.K. ■