Andy Pearson

Staying Tight

BY ANDY PEARSON, C.ENG., FELLOW ASHRAE

In last month's column, we touched on the issue of "tightness" as it applies to refrigeration and air-conditioning systems. This introduced the rather odd term "technically tight," which is worth exploring in a little bit more detail. These thoughts have been rattling round my head for quite a few months now, so I hope you can bear with me while I try to sort them into some kind of logical order.

"Technically tight" means not leaking to a greater extent than the bounds of specification. The difficult question regarding refrigeration and air-conditioning systems is where that specified level should be set. There are multiple reasons why a system needs to be kept tight. Loss of charge will affect efficiency, performance and reliability in that order. Replacing charge can be expensive not only in the cost of refrigerant, but the travel and labor time charges for someone to go to the site and do the work. Leakage could also create an unsafe condition for people in the vicinity, whether they are working on the system, working on something else and have no knowledge of the system or are just passing by. Even if the refrigerant doesn't create an unsafe condition locally, the effect on the environment may give cause for concern.

Sammy liked to keep things tight.

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The two most significant factors in setting the required level of tightness are concern for local safety, particularly with flammable refrigerants, and concern for the environment, particularly with refrigerants with ozone depletion potential or high global warming potential. The level set for fluorinated gases (f-gases) is that there shall be no leakage when the system is tested with an instrument having a sensitivity better than 5 g (0.2 oz) per year of refrigerant. Compared to all of the other reasons for staying tight this is much more stringent than would otherwise be needed. For example a domestic unit containing 150 g (5.3 oz) of R-134a could probably lose 10% of its charge before efficiency would be seriously affected. If the unit has a 10 year life that would imply a leakage rate of 1.5 g (0.053 oz) per year, but a larger unit, say a water chiller containing 30 kg (1,058 oz) and having a 20 year life could lose 150 g (5.3 oz) per year for its entire life—the same as the full charge of the domestic unit—and not see a significant effect on efficiency or capacity.

The concept of a system being "durably technically tight" means that through good design, installation and ongoing maintenance it will remain technically tight throughout its working life. Small systems, like the domestic unit, are expected to do this without any maintenance, so it comes down solely to the design of the unit and the quality of construction. Larger systems require a maintenance program of some kind, so the loss of charge would be over the maintenance interval, not the whole life of the plant. For an ammonia system with 160 kg (5,644 oz) charge subjected to a monthly maintenance inspection this would mean that even with a loss of 192 000 g (6,773 oz) per year the system could be considered to be technically tight from the perspective of performance. However, if this equipment was in a machinery room of 250 m^3 (8,829 ft^3) with a ventilation rate of four air changes per hour (ach) the concentration of ammonia in the room* would never exceed the short term exposure limit of 25 ppm and would be more than 7,000 times below the lower flammable limit so it is hard to argue that the room would be unsafe.

Now if that ridiculous thought doesn't jolt you like an electric shock, as Sammy Davis, Jr. used to say, "you ain't got no switches." ■

*Say 250 m^3 (8829 ft^3) and four ach = ventilation rate of 1000 kg (2,205 lb) of air per hour. Leakage rate is equivalent to 16 kg (35.3 lb) ammonia in a month or 22 g (0.8 oz) per hour, so concentration is 22 ppm.

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