Coping with Excess Gas

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This article is the 12th in a series exploring refrigeration and heat pump concepts without using jargon. Last month we considered the effect of air or nitrogen in a condenser. Now, it's time to consider some effective—and not so effective—strategies for overcoming this problem.

Remember that the addition of extra gas in the condenser causes the compressor to work harder than it ought to. The extra gas is noncondensable. Within the limits of operation of the refrigeration system, we cannot make it cold enough to turn it to liquid. This means it remains stuck in the gassy part of the condenser, unable to drain out the bottom with the liquid refrigerant. The tactics for dealing with this pest are simple but require some lateral thinking.

The mixture of gases is allowed to flow into a separate side-chamber, which is made very cold, causing the refrigerant to condense and drain away as liquid. The low temperature in this side-chamber should be as cold as possible since the name of the game is to turn as much of the refrigerant gas to liquid as possible. The total pressure in the system should also be as high as possible during this process to give the condensable stuff as much chance as possible to escape. It is simply a case of making the ratio of pressures in the side-chamber as favorable as possible, which is done by simultaneously making the pressure high and the temperature low.

Using last month's example of R-134a with some nitrogen in it, the ratios show that if the total pressure is 212 psi (1462 kPa) absolute then the R-134a will condense at 122ºF (55°C) if it is 90% of the mixture. But, if the temperature is reduced to 0ºF (–18°C) then the R-134a portion of the total pressure will only be 10%. We have managed to turn a mixture that was only 10% nitrogen into one that is 90% nitrogen. However, the law of diminishing returns looms large: to increase the nitrogen content to 95% we would need to cool the mixture to –27.5ºF (–33°C), and to get up to 99% would require a temperature of –79ºF (–62°C) if the total pressure stays at 212 psia (1462 kPa).

Once the mixture has been lured into the side-chamber and chilled down to as low a temperature as possible, the nitrogen can be removed from the system, usually by blowing it to the atmosphere. Note that some refrigerant is always lost, too, and that some nitrogen is always left behind, so purging should be avoided completely if possible. It's always better to fix the leak than to have to deal with the consequences.

A purging system that doesn't pump the mixture up to high pressure or make it really cold will lose more refrigerant than it should, and will need to repeat the process more often. In a low temperature cold store or a freezer, a reasonable ratio can be achieved just using the suction pressure as the source of cooling, but in a chill store a small cooling unit running at a lower temperature than the compressor suction may be necessary to get to the right ratio to avoid excessive refrigerant loss.

Some people claim they can do a satisfactory job without a purger unit just by trapping the gas mixture in the condenser and running the fans to condense as much refrigerant as possible. This might just about work on a really cold winter's day if they get the pressure up absolutely as far as possible to start with, but who feels the need to purge in winter? At the height of summer, even with an evaporative condenser it is likely that the refrigerant proportion in the purged gas will not be lower than 50%. The real tragedy of this approach is that a decent purger can be homemade for a cold store for a few hundred dollars, including fully automatic controls. But, they are often not installed as a "cost-saving measure." Obviously that's a decision taken by someone who doesn't pay for the replacement refrigerant!

It is fair to say that chill jobs with the evaporator pressure well above atmospheric are less likely to suffer from air leaking into the system; on the other hand, they will still suffer from air left in after service, or nitrogen that was not removed after pressure testing. It is even possible to justify the installation of a purger on the basis of the time and cost savings achieved by not having to pull air out of small components after service, and not losing refrigerant during the subsequent "poor ratio" purging; a little joined-up thinking goes a long way in this case!

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