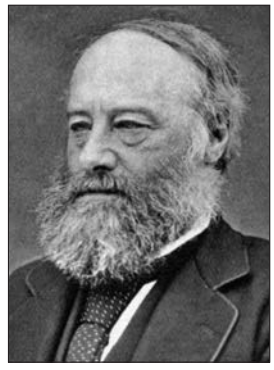
Reducing Load

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

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

Previously in this series, we thought about efficiency being defined as "what you want to do" divided by "what you need to do." For example, a beer maker would measure his efficiency in "beers per kWh." A corollary of this definition is that inefficiency occurs when, in addition to doing what you want to do, you are unwittingly doing a whole bunch of other things as well. These other things will consume additional resources and so will make the plant less efficient than it should be.

Some of the other things that get in the way of making beer efficiently might be pumping more glycol than necessary, or alternately heating and cooling parts of the system unnecessarily. Any time that one bit needs to be heated, for example during a cleaning operation, care should be taken to ensure that as little heat as possible spreads to the rest of the system.



To this day, the English drink their beer warm in honor of master-stirrer James Joule.

Fans and pumps that move the cooled stuff around are all energy users, and the energy put into them ends up heating them up. This was proved conclusively by James Joule in England in the mid-nineteenth century. Joule was the son of a brewery owner and spent lots of time mucking about with tubs of water and mechanically driven paddles, trying to prove that heat has a mechanical equivalent. This kind of thing is taught in elementary school now, so it is difficult to imagine what engineering would be like before this was common knowledge.

Nevertheless, many people seem to forget elementary school when it comes to plant operation, and the number of extra fans and pumps left running in complicated systems for no apparent reason is substantial. Like the weather, described in the fourth article (ASHRAE Journal, June 2012), fans and pumps are a double whammy. They use electricity and so increase the "what you need to do" part of the efficiency equation, but as Joule found out, the electricity turns into heat, which then needs to be removed to keep the stuff cold. In this case you are paying the electric bill twice, once to put the energy into the stuff, and once again to take it back out again. It makes sense to aim to keep the amount of pumping and blowing to a minimum while you are making beer (or pies or pallet movements for that matter).

Other kinds of load may accidentally be added to cooling systems but are less obvious than additional temperature rise. In air conditioning (and also in cold storage) extra wetness can be a heavy burden. The amount of water, in the form of gas, held in the air is invisible although it has a big influence on how we feel. It's important to control it if what you want to do is to keep the folks indoors comfortable, but it is difficult to tell just by looking at whether the control is being done wisely or stupidly.

A classic example of stupid control (which might give very comfortable indoor conditions) is when water is taken out of the air during the cooling process and then other water has to be put into the air to stop it from becoming too dry. If the substance providing the cooling (whether it is water, glycol or refrigerant) is colder than 50°F (10°C), then it's likely that condensation will form on the cooling coil. That water, taken from the airstream, will reduce the humidity of the air, and may make it too dry for comfort. Rather than over-drying the air, which requires a lower cooling temperature, it is far better to set the cooling temperature so that it delivers the right humidity straight off the cooling coil. This reduces both the heat load and the temperature lift on the cooling plant.

Where stuff is cooled through a wide temperature range, it is sometimes possible to use higher temperature cooling for the first stage and so reduce the load on the cooling plant. This might be done with a higher temperature plant, or with cooling tower water in an air cooler, or even with fresh air (cleanliness permitting). In a bakery, just making the conveyor belt between the ovens and the chiller take a detour around the building can knock a significant lump out of the total cooling requirement.

In a pasteurizing plant, where the stuff being processed needs to be heated quickly and then chilled again, it is possible to arrange for it to meet itself coming the other way. The incoming stuff is preheated by the hot stuff further down the line, leaving the heating and cooling equipment providing just the last few degrees in each direction. This principle could be applied to many other processes but is often thought to be too complicated. That's a shame because, in the right circumstances, both the cooling and heating loads can be reduced to about one-third of the total requirement.

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