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Portable Cooling at the Point of Use

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Laboratory workers have traditionally relied on water, ice, dry ice, and liquid nitrogen for portable cooling. While laboratory chillers will never completely replace these techniques, they provide advantages in portability and convenience.

Chiller applications fall into two basic categories based on the degree of temperature control required. Condensers, evaporators, temporary sample holding vessels, and diffusion pumps are generally forgiving of modest temperature fluctuations, whereas lasers, analytic instruments, and biological experiments require more precise control.

How they work

Lab chillers remove heat from one object and transfer it to another, usually by means of a liquid. Thermo Fisher Scientific defines chillers as “refrigerated recirculating liquid cooling system[s] consisting of a compressor, condenser, evaporator, pump, and temperature controller, all in one package.”

Chillers cool and maintain temperatures through one of three main methods. Compressor cycling, similar to thermostatic temperature control, maintains a desired temperature by turning the cooling engine on and off.

The main disadvantages are difficulty achieving precise temperature control and compressor wear. By adding a heater to the return loop, the compressor remains constantly on. While less stressful to the chiller mechanism, heater cycling is energy-intensive. Hot-gas bypass is a sort of compromise, providing relative energy-efficiency and long compressor life.

“Hot-gas bypass,” says Alan D’Ettorre, engineering manager at [Mokon](#) (Buffalo, NY), “fools’ chillers into thinking there’s a load on it when there is not,” which keeps the compressor running. For example, 36,000- BTU (British thermal units) chillers are rated to remove that quantity of heat, but an application may only require the removal of 12,000 BTUs. A hot-gas bypass forces the chiller compressor to remain on rather than initiate hundreds of start/stop cycles.

Regardless of the cooling method employed, chillers must release the heat they absorb through either an air- or water-cooled condenser. Because it releases heat to the atmosphere, aircooled

condensing works best with large rooms and small chillers. Large units in smallish rooms typically use the water-cooled method. Air-cooled chillers require less maintenance than water-cooled units, are simpler in construction, and consume slightly less power; water-cooled chiller condensers must be maintained periodically because of mineral buildup.

Chillers are technically not the same as circulators, although the terms are sometimes used interchangeably (and together). Circulators tend to be small, operate in a wide temperature range, and provide high temperature stability, although they have limited heat removal capability. Chillers are suitable for larger industrial applications and operate in a relatively narrow temperature range with modest ($\pm 0.5^{\circ}\text{C}$) stability, but provide much higher heat removal. A circulator's reservoir can be used as a circulating bath, while a chiller's cannot.

Choosing a chiller

Chillers are rated by the quantity of heat they can remove per unit of time, which depends on the heat characteristics of the application. Most lab managers will be put off by the calculations required for sizing a chiller. Luckily, vendors will perform the calculations provided the user knows the general parameters of heat removal required. A vendor can often help specify a chiller based solely on its intended application.

Chiller capacity is specified in tons, a misleading term that implies mass or weight. In this case, a ton is simply a measure of heat capacity in BTUs. Twelve thousand BTUs equal one "ton." Tabletop systems used mostly for laboratory processes are referred to as fractional chillers and are available in capacities of one-quarter to one-third ton (3,000 and 4,000 BTUs, respectively).

According to Cole-Parmer, choosing the right chiller often comes down to economics: "The optimum size needed is based on the amount of heat your application is generating, plus additional power to maintain temperature under varying loads. Normally the manufacturer of the device you are cooling will supply heat removal information."

Yet price is not the only factor. "Applications should determine chiller specifications," says Dennis Curtice, application engineer at [OptiTemp](#) (Traverse City, MI). "Most laboratory customers have unique applications and need equipment designed specifically for their needs." Factors to consider include ambient operating temperature, desired process temperature range, temperature control tolerance, process fluid type, process fluid pumping volume, process fluid supply pressure, and most important, the amount of heat to be dissipated from the process.

Chiller applications are not as sensitive to temperature fluctuations as those relying on ovens or freezers, and units are inexpensive compared with other lab equipment. Lab managers therefore enjoy a degree of flexibility in purchasing chillers and have the luxury of being able to overbuy in anticipation of future applications or expanded use.