

Baths and Circulators

Heating and cooling have always been necessary in the lab. Reliable cooling and heating are used everywhere, from organic synthesis distillation towers to mass spectrometer vacuum diffusion pumps. Chemistry students are familiar with Bunsen burners, hot plates, and trips from the lab to the ice machine to prepare ice baths for experiments. For those who frequently need to heat in order to maintain a certain temperature or cool experiments to effect a reaction, baths and circulators are essential.

The simplest of baths are containers of water that are heated, analogous to cooking. Water provides a gentle method of transferring heat to a sample. For example, you would not want to hard-boil an egg by heating it directly with the flame. Heating water is a much gentler and more consistent way of transferring heat to an egg.

Yet, there is a great deal of room for technology even in something as simple as heating water. Integrating thermometers and electronic controls

allows temperatures to be set and maintained automatically, saving researchers time. However, water fails as a heating medium when temperatures above 100 °C are required (unless, of course, the lab is below sea level). Therefore, alternatives have been developed such as silicone oils and even sand. Another problem when heating a liquid is convection, which can cause nonuniform bath temperatures and, therefore, uneven heating. One improvement has been the ability to shake both the bath and the heated vessel at a range of temperatures. Shaking baths move the liquid around, creating more uniform heat transfer. Circulating baths also create more uniform heat transfer by using an impeller or other method to circulate the heated liquid. There are also some add-on products that provide stirring to noncirculating baths.

While heating samples is one of the main uses of baths, a possibly more important use is cooling, a more difficult task than heating. Cooling from room temperature requires either a continual supply of a lower-temperature liquid, such as tap water, or refrigeration. Circulators should not be confused with circulating baths. The latter, of course, basically stir containers of

liquids, whereas circulators can pump a heated or cooled liquid out of a storage reservoir to laboratory instruments. Circulators can be



A Julabo Presto sealed bath circulator.

quite a distance away from an instrument.

Many baths and circulators are constructed especially for cooling using internal refrigeration. Not all units have the compressor-based refrigerator. Some systems use electronic Peltier cooling. Some are made with both refrigeration and heating components for general purposes, and some can be used for extremely precise temperature control. Some product lines of baths, circulating baths, and circulators have digital controls that allow these devices to be incorporated into automated laboratory computer systems.

In addition to the chemical laboratory, these temperature control systems are used routinely in the semiconductor, environmental, and meteorological

fields. For instance, baths capable of precise high-temperature control are often used in electronics and materials science to study material properties, such as electrical resistance, at specific temperatures. In semiconductor manufacture, wafers are dipped in baths of liquid etchants that are held at precise temperatures.

Besides liquid baths, dry baths have arisen to meet the needs of the biological and pharmaceutical industries. Dry baths are not really baths at all. They are heating or cooling elements that act on solid blocks of materials such as aluminum. The blocks are created to fit specific types of containers so that heat is transferred between the block and the glassware. For example, test tubes would fit snugly in an aluminum block created for test tubes, allowing them to be heated at a controlled rate. According to Grant/Boekel, dry baths are used for biological applications such as restriction digests, denaturing DNA, melting agar, and studying coagulation.

Some companies also produce baths especially for biomedical research. Incubation baths made by Precision and VWR are precalibrated to hold temperatures necessary for fecal coliform determination tests, allowing untrained



A Lauda Ecoline stainless steel heating bath/circulator (left) and immersion circulator (right).

KEY TERMS: biotech, data handling, environmental, materials/nanotech, pharmaceutical, sample prep, synthesis

Table 1. Selected Bath and Circulator Manufacturers

Company	Website	Product
Ace Glass	www.aceglass.com	Instatherm oil baths
ARMALAB	www.armalab.com	Shaking water baths
Belco Glass	www.bellcoglass.com	Analog and digital water baths
Brinkmann Instruments	www.brinkmann.com	Lauda hot-water baths, circulators, immersion coolers, immersion circulators, recirculating chillers, and refrigeration circulators
Caron Products and Services	www.caronproducts.com	Huber-manufactured Polystat Baths, UC series Caron model 2050W bath/circulators, chillers, and Unistat circulators
Duratech	http://home.ntelos.net/~duratech/products.html	TCON 2000 dry bath system
Eberbach Corp.	www.eberbachlabtools.com	Shaking heating/cooling baths
Eppendorf	www.eppendorf.com	ThermoStat dry bath shaker
Fisher Scientific	www.fishersci.com	Hi-temp baths (>100 °C), Isotemp dry baths, water baths and circulators
FTS Systems	www.fts-systems.com	Recirculating chillers, immersion coolers, low-temperature baths
Gilson Company	www.globalgilson.com	Digital circulating and recirculating chillers, water baths, circulating water baths
Grant Instruments & Boekel Scientific	www.boekelsci.com www.grantlaboratory.com	Analog and digital dry baths and dry coolers
Hart Scientific	www.hartscientific.com	Range of liquid heating and cooling baths
Haskris	www.haskris.com	Water-cooled, air-cooled, and refrigerated-water recirculating systems; thermoelectric cooling system
IKA	www.ika.net	Cylindrical-shaped analog and digital heating baths
Jeio Tech	www.jeio-tech.com	Circulating, shaking, and water baths
Julabo	www.julabo.com	Immersion heaters, coolers, flow-through coolers; shaking, circulating, visco, and calibration water baths; heating, refrigerated, and combined circulators
Koehler Instrument Co.	www.koehlerinstrument.com	Constant-temperature water and circulating baths
Lab-Line Instruments	www.barnsteadthermolyne.com	Analog and digital shaking water baths, Aquabath line of water baths, modular dry baths, and DIGI-BLOCK electrothermal dry baths
Lindberg/Blue	www.lindbergbluem.com	Circulating and shaking/circulating water baths
Memmert	www.memmert.com	Water, oil baths
PCT Systems	www.pctsystems.com	Constant-temperature baths for semiconductor industries
Petrolab	www.petrolab.com	Heating circulators, high-precision baths/circulators, heating and cooling circulators, and low-temperature and constant-temperature viscosity baths
PolyScience	www.polyscience.com	Chillers, circulators, immersion circulators, water baths
Precision	www.precisionsci.com	Water, circulating, refrigerated circulating, and high-performance baths; Reciprocal, Dubnoff and shallow-form shaking baths; concentric-ring steaming baths
Science/Electronics, Inc.	www.se-one.com	Circulators, shaking baths, constant-temperature baths, dry-heaters, and low-temperature baths, and recirculators
Sheldon Manufacturing	www.shellab.com	Analog and digital water baths and circulators; fecal coliform incubation circulating baths; reciprocating water baths
Techne	www.techneusa.com	Circulators, circulation baths, water baths, refrigerated baths, and shaking baths
Thermo Electron	www.thermo.com	Haake Phoenix heating baths, Phoenix II refrigerated bath, C/DC series heating circulator baths, Neslab EX series heating bath/circulators, RTE series refrigerated bath/circulators, Forma circulators, immersion coolers, recirculating chillers
VWR	www.vwrsp.com	Immersion circulators, heated/refrigerated circulators, analog and digital water baths, shaking water baths, fecal coliform water baths
Yamato	www.yamato-usa.com	Heated circulating bath

users to incubate samples. Precision's model even comes with a free rubber duck to place in your bath.

Table 1 shows selected companies that offer baths

and circulators. Caron Products offers one of the smallest bath/circulators in the world, which takes up less than a square foot of bench space, and some manufacturers make

industrial equipment that can circulate many gallons per minute of cooling or heating fluid to serve the largest instruments. Regardless of size, or whether the need is for heat-

ing, cooling, or constant temperature, it's likely that a bath, circulating bath, or circulator is available to suit any lab's needs.

Michael J. Felton ♦