thereby prevent excessive weight loss, mold and slime growth, and moisture absorption by hygroscopic materials such as dried fruits.

Unit coolers, especially in the smaller sizes, are very similar in appearance to unit heaters. Copper, aluminum, or steel prime or finned-surface tubes are used. Propeller or centrifugal fans either blow or draw room air over the tubes. The fan and coil are generally enclosed in a casing provided with a drip pan. The motor horsepower requirements are a function of resistance due to coil construction and arrangement, and air volume required. Fin spacing is based principally on operating temperatures. For operation below 35 F, fin spacing is preferably not more than four to the inch. Above 35 F it may run as high as 8 fins per in., depending on room temperature and refrigerant temperature used. Both direct expansion refrigerants and brine are used successfully as cooling mediums.

Unit coolers may be arranged for either free or duct delivery. Face velocities vary, depending principally upon the intended application of the unit. In the larger sizes particularly, speed adjustment of the fan is generally provided to permit variation of the air delivery. While unit coolers are usually installed in the storage space, remote installation combined with appropriate duct work may be required by space or other considerations. Units are available for floor, wall, or ceiling mounting, thus providing an upward, downward, or horizontal discharge. Power, refrigerant, and drip pan connections are required, plus additional connections for defrosting, if necessary.

For storage temperatures below 35 F, some positive means of defrosting is mandatory. At 35 F or higher storage temperatures, cycling of the condensing unit with low pressure control with proper settings will provide automatic defrosting each cycle. At above 35 F design refrigerant temperatures, frost and ice formation will not normally occur.

Various methods of defrosting are used. In one method, hot gas is supplied to the interior of the tubes uniformly throughout the coil. The entire refrigerant circuit is thus contacted to obtain complete defrosting of all frosted surfaces. Electric defrosting generally involves the incorporation of heating elements within the construction of the coil, or the use of strip heaters in a dampered closed-air circuit. Warm water may be sprayed over the coil surface for defrosting. With storage temperatures above 32 F, defrosting may be accomplished by shutting down the refrigeration system and circulating the room air over the coil. In every case, defrosting requires a cessation of refrigeration on the unit being defrosted. Where continuous operation of the system is desired, a brine spray over the coil may be used unless it might damage the product in storage, or cause too much corrosion of room fittings, ducts, etc.

Ratings

As various means of expressing unit cooler capacity are utilized in the industry, different manufacturers suggest different methods of selection. The engineer should be aware of the conditions and factors which affect rating, selection, and performance of a cooler. These items are discussed in following paragraphs.

The refrigerating capacity of the unit may be either gross or net, the latter being less than the gross by an amount equal to the heat equivalent of the input to the unit cooler motor. In either case, the capacity should be given for a particular air volume. Air throw data are also valuable.

Dry or flooded rating conditions should be stated, as well as temperature level. The temperature level determines whether the coil surface is wetted or frosted, and it will also establish the refrigerant side pressure drop for any given load applied to a specific unit cooler. The refrigerant-side pressure drop increases as the evaporating temperature decreases, and thus temperature level exercises a significant effect on the average coil-surface temperature and the consequent condensing unit selection.

Coil capacity rating is usually expressed as total heat absorbed with no distinction between sensible and latent heat. The *rating* expresses the capacity in terms of Btu per (hour) (Fahrenheit degree temperature differential *between the refrigerant and the air*). The term *basic rating* may be used. This is the Btu per hour absorbed with one Fahrenheit degree differential between room air and evaporator refrigerant temperature. When the total load has been obtained from the load calculations, a temperature differential between the air and the refrigerant is selected. It is based on product classification previously discussed. The extent of dehumidification will be a function of this temperature differential. Moisture conditions in the storage space are dependent upon the correct selection of this temperature differential. It offers a quick and sufficiently accurate practical basis for coil selection. Where close control of relative humidity is desired, heating coils or electric heaters for re-heat may have to be added. The use of air conditioning psychrometric techniques is only required for accurate humidity control.

Cooling equipment is usually rated on the basis of the overall room-to-refrigerant temperature differential instead of using the intermediate average coil-surface temperature. If the tentatively selected unit cooler does not possess the proper capacity, it may be possible to adjust the fan speed to a new air volume. At the new air volume and the new overall differential, the cooler may be able to deliver the necessary cooling capacity. If not, the procedure must be repeated with another size of unit cooler, the final selection being based on the proper balance between unit cooler and the condensing unit to maintain the Btu per hour heat removal and temperature difference at design room temperature desired.

Procedures for rating and testing room coolers are given in an ASRE Standard[3] which establishes four groups of conditions (numbered I to IV) under which units may be rated. Many manufacturers establish and publish their ratings in accordance with this standard in which forced circulation air coolers are classified according to air side surface conditions as (1) dry coil, (2) sprayed coil, and (3) spray-no coil; or according to type of air delivery to room as (1) free delivery fan, or (2) pressure fan. Natural convection air coolers are classified according to type as (1) external baffle, (2) built-in-baffle, and (3) without baffle.

Arrangement and Operation

The refrigerant is usually supplied to the evaporator through a thermostatic expansion valve, thus obtaining dry expansion in the evaporator. In other designs, float-valve feeding is used as a means of metering the refrigerant into the evaporator. The refrigerant circuit in the coil may be of the continuous-flow type from inlet to outlet, or it may have means for internal recirculation of the refrigerant. The coils having the *dry-expansion* or *continuous flow from inlet-to-outlet* circuits may be of the upward feed or the downward feed arrangements. Upward flow is generally regarded as producing more refrigerant holding capacity and more effective use of the surface. However, with some refrigerants and in some systems, the downward-feed system has been found to produce better oil-return characteristics. Many direct-expansion installations use liquid-vapor heat ex-