where the distance from the guard to the fan is more than 4 in., they shall not permit the passage of a cylindrical rod ¾ in. in diameter.

Motor Speed Classifications

A Constant-speed motor is one in which the speed remains practically constant with changes in load; e.g., a d-c shunt-wound motor or a-c squirrel-cage motor with low slip.

A Varying-speed motor is one in which the speed varies with the load, usually decreasing when the load increases; e.g., a d-c series motor or an induction motor with large slip.

An Adjustable-varying-speed motor is one in which the speed can be adjusted gradually, but when once adjusted for a given load will vary in considerable degree with change in load; e.g., a shunt-wound d-c motor adjusted by armature resistance control.

An Adjustable-speed motor is one in which the speed can be varied gradually over a considerable range, but when once adjusted remains practically unaffected by the load; e.g., a d-c shunt motor with field-resistance control. The standard ratings for open-type, adjustable-speed motors, having a speed range of 3 to 1 and greater are in accordance with the following:

(1) A standard continuous horsepower rating at 150 percent of minimum speed with a temperature rise of 40 C.

(2) The next higher standard continuous horsepower rating at 3 times minimum speed with a temperature rise of 40 C.

(3) Between 150 percent of minimum speed and 3 times minimum speed, the standard continuous horsepower rating with a temperature rise of 40 C will vary with the speed along a straight line connecting these two horsepower ratings. No further increase in horsepower is recognized above 3 times minimum speed.

(4) Below 150 percent of minimum speed the lower continuous horsepower rating (see preceding item 1) will apply with a temperature rise of 50 C.

Example: 20/25 hp, 400 to 1600 rpm. This motor may be rated 20 hp, 40 C at 600 rpm and 25 hp, 40 C from 1200 to 1600 rpm. Between 600 and 1200 rpm the rated horsepower increases directly with speed from 20 to 25 hp.

(5) Motors may also be rated 1 hour with temperature rise of 50 C with the higher horsepower rating (see preceding item 2) throughout the entire speed range.

Example: 20/25 hp, 400 to 1600 rpm. This motor may be rated 25 hp, 50 C 400/1600 rpm; 1 hour.

Mechanical Modifications

Vertical Mountings are available for such applications as pumps and agitators. This type of application may require a special umbrella-type hood to protect against dripping liquids.

Flanged Mountings are available for use where motors are built in as part of machines. Motors may also be supplied with flush plate mountings, suitable for close coupled pump and similar applications.

CHAPTER 46

RESIDENTIAL SUMMER AIR CONDITIONING

Consumer Requirements, Equipment Capacity Selection, Types of Equipment, Types of Systems, Gas Year-round Air Conditioners, Location of Cooling Equipment, Noise, Air Distribution Methods, Operating Costs, Effects on Future House Design

SUMMER air conditioning in residences has become a major factor in the air-conditioning field and has created a heavy interest among home-owners, builders, architects and business men. Residential cooling, particularly for the small home, received its initial impetus when equipment specifically designed for such purposes became available in the 1930's.

The first installations were made by using commercial and industrial methods as the estimating basis and did not prove as satisfactory as the installer or designer desired. Actually, the difference between estimating the residential summer air-conditioning and commercial summer air-conditioning loads is in the design temperature differences used, the type of internal load in the conditioned area, and the method of calculating equipment size.

CONSUMER REQUIREMENTS

Present practice is to design residential summer air conditioning on the basis of an 80 F indoor temperature. In using this basis it is assumed that the home owner will operate the system continuously with a thermostat setting of 75 or 76 F and thereby take advantage of the thermal storage in the house and household furnishings to reduce the peak temperatures. The preference of the individual home owner must, however, be considered in selecting the design indoor temperature and may require that a temperature lower than 80 F be selected. Analog computed studies and field investigations[1] have apparently demonstrated the adequacy of the 80 F indoor temperature as a basis for equipment selection procedure.

To ensure comfort, it is essential that the proposed operation and performance of the system be explained to the user in advance. Usually the greatest degree of comfort can be obtained by keeping the house closed and operating with a fixed thermostat setting throughout the cooling season. In some climates the opening of the house to utilize *night-air cooling* creates humidity difficulties that take several hours to overcome during the following day. The use of *night-air cooling* may lead to unsatisfactory conditions when the equipment is not turned on again sufficiently early the next day. It will also allow unfiltered air to enter the house thus reducing the cleanliness advantage of air conditioning.

EQUIPMENT CAPACITY SELECTION

There are two industry-accepted methods of calculating residential cooling loads. These are as given in Manual 11, *Summer Air Conditioning*, of the National Warm Air Heating and Air Conditioning Association and Standard 610-56, *Application Engineering Standard for Year-Round Residential Air-Conditioning* published by the Air Conditioning and Refrigeration Institute. Published procedures of reliable manufacturers when used in conjunction with their equipment are also adequate.

Both of the industry methods mentioned employ cooling load factors for the various components of the load that are averaged over a peak period of several hours and thereby make allowance for thermal storage effects. They avoid the possibility of pyramiding non-concurrent, instantaneous peak loads.

With most methods it is possible to select the desired design indoor-outdoor temperature difference, using 80 F or the user's preference for the indoor temperature, and the commonly used outdoor temperature for the area as listed in Chapter 13.

Design methods which average load conditions for a period in excess of 12 hr have not been accepted by the industry committees. Such methods require the introduction of factors that are not at present considered to be adequately substantiated by mathematical analysis or to be justified by the thermal storage effects of a typical residence.

The contractor should avoid any capacity selection procedure based on a rule of thumb such as *10 average windows or doors per ton or 500 sq ft of floor area per ton.* Insulation, glass areas, shading effects, and solar orientation must be given careful consideration by using an accurate, step-by-step procedure for estimating the load.

In residences, peak lighting loads will not usually occur during the period of greatest load from outdoor temperature and solar conditions. Unlike summer air conditioning in commercial or industrial establishments where internal heat producing sources may be a major portion of the load, internal loads in residences may generally be neglected except under the most unusual circumstances.

The heat and moisture introduced by a clothes dryer or water heater should be vented to outdoors. Heat introduced by the kitchen range should be discharged through an exhaust fan. These are major internal loads that must be taken into account if adequate venting is not to be provided.

The load calculation method presented in Chapter 13 is not recommended for residences where it has been found[2] to result in oversizing because internal loads that are generally a prime consideration in commercial applications are not generally significant in residences. Furthermore the method outlined in Chapter 13 gives an instantaneous peak load without consideration of residential usage and heat storage effects applied in the ARI and NWAH & ACA load calculation procedure. Oversizing is objectionable from at least two viewpoints: (1) it increases the capacity and consequently the