

be used, as direct current would cause electrolytic deterioration. Large boilers of this kind have electrodes immersed in the water where heat is generated directly. Electric steam boilers are useful in industrial plants which require limited amounts of steam for local processes, and for sterilizers, jacketed vessels and pressing machines which need a ready supply of steam. It sometimes is economical to shut down the main plant fuel burning boilers when the heating season ends, and to supply steam for summer needs with small electric steam boilers located close to the operation. In general, electric steam heating is confined to auxiliary or other limited applications. If the heating system is designed to use electricity exclusively, steam generating or distributing equipment is superfluous.

ELECTRIC WATER HEATING¹

Electric water heating, using an electric boiler in place of a fuel burning boiler, like electric steam heating, is generally confined to auxiliary or other limited applications. However, the use of insulated water storage tanks in which to store heat generated by electricity during off-peak hours at extremely low rates, is a development which may bring electric water heating systems into general use. This type of system, known as the off-peak hot water storage heating system, offers striking possibilities in the Southern and Pacific Coast States where the degree-day heating load is low and the Utilities have developed or are now developing large blocks of hydro-electric power which can be marketed at 1 cent per kwhr or less.

In this system of heating, the primary storage tank is simply a large, well-insulated, pressure type steel tank, equipped with immersion electric heating elements connected to line with automatic time switches, which also have automatic limit controls for temperature and pressure. The heating system installed in the home or other type building may be of the individual radiator type or fan-served indirect type, with provisions for the heating and humidification phases of an air conditioning system.

The following types of off-peak heating systems are used:

1. Hot water with gravity circulation.
2. Hot water with forced circulation.
3. Warm air utilizing forced circulation.
4. Unit heaters utilizing hot water as the heating medium.
5. Warm air utilizing stored heat in connection with waste heat.

The essential parts of all types of off-peak storage systems are:

1. Heavily insulated storage tank.
2. Immersion heating elements.
3. Automatic charging control.
4. Heat distributing system.
5. Automatic temperature control.

The insulated storage tank, the heating elements and the charging control are practically identical for all types of off-peak systems. Only

¹Performance Test of an Electric Hot Water Heating Boiler, by John James (A.S.H.V.E. JOURNAL SECTION, Heating, Piping and Air Conditioning, September, 1936).

the heat distributing system and the room temperature control differ to any extent.

The size of the storage tank is based upon the heat losses of the building, the heating schedule, the hours of heating from storage, and allowance for heating up. In new buildings and where openings permit, factory fabricated tanks are used. Otherwise, the tanks are welded at the final location.

In *hot water systems*, the storage tank supplies hot water to standard heating units (radiators or convectors) installed in the building. The water in the storage tank is heated to approximately 250 F. In the system using gravity circulation, the temperature of the hot water supplied to the heating units is varied by the action of a mixing valve under control of the room thermostat. In larger installations, the circulation is obtained by means of a pump under thermostatic control. In this case, the temperature of the water supplied to the heating units is regulated by mixing the proper amount of return water with the 250 F water from the storage tank through a suitable by-pass.

The *warm air system* makes use of extended heating surface and a plenum chamber assembly (*i.e.*, a central fan system) which is usually installed in the basement alongside the storage tank. The warm air supply ducts are run in the usual manner from the top of the plenum chamber to the registers in the rooms. The return air is brought back through cold air ducts to the inlet side of the fan or blower. Temperature regulation is obtained by thermostatic control of the blower and the valve admitting hot water to the heating units. Air cleaning and humidifying apparatus is readily incorporated in the system.

Unit heaters are used in connection with off-peak storage heating systems for industrial buildings. For sub-stations and certain types of industrial buildings, the electric storage heater is used to supply hot water to unit heaters placed in various parts of the building. Certain sections of the building, such as offices and rooms which are partitioned off from the larger areas, may be heated by ducts leading from indirect heating units supplied with hot water in parallel with the unit heaters.

Warm air supplied from off-peak storage is sometimes used in conjunction with a system designed to utilize waste heat. In this application, heating units are installed in the waste heat ducts, which supply waste heat from the losses of synchronous condensers and other apparatus. When the waste heat does not provide sufficient heating, the air temperature is boosted by supplying the proper amount of hot water from the storage tank to the heating units. Controls are provided, which not only make the entire operation automatic, but insure maximum recovery from the waste heat source.

ELECTRIC WATER HEATING FOR DOMESTIC SUPPLY²

Electric water heaters of the automatic storage type for domestic hot water supply are simple and reliable, and in many sections of the country very low electric rates have been established by the electric utilities to secure this load. In some districts, rate schedules divide the current

²Test Results of Electric Water Heaters, by C. G. Hillier (A.S.H.V.E. JOURNAL SECTION, Heating, Piping and Air Conditioning, November, 1936).