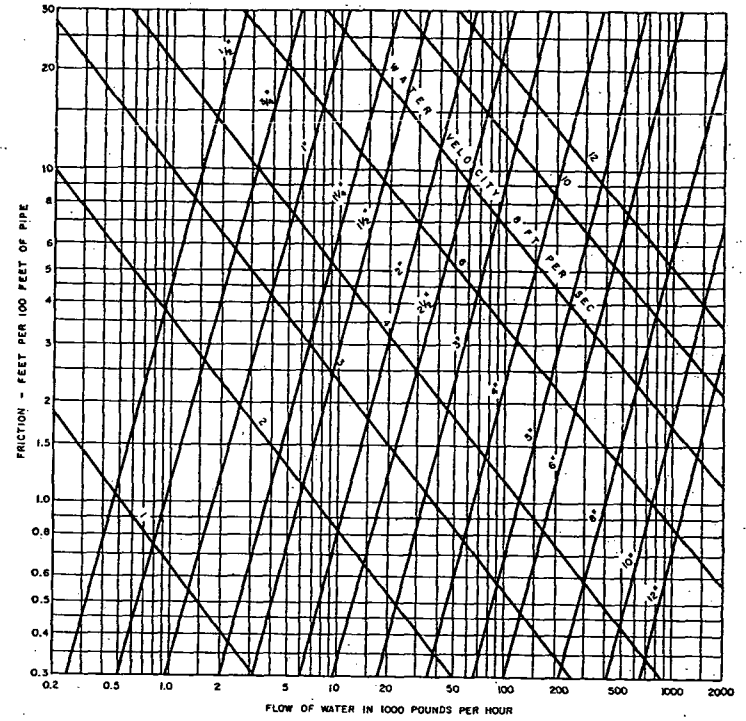


Fig. 11 .... Friction Loss for Water in Commercial Steel Pipe (Schedule 40)

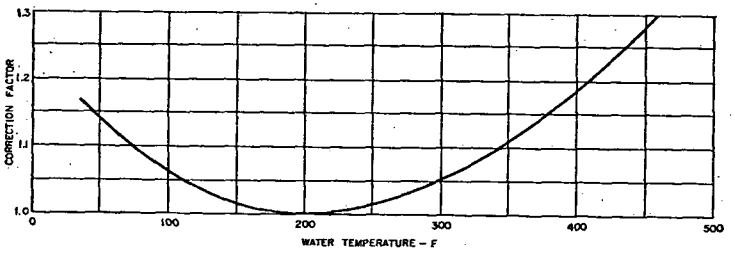


Fig. 12 .... Correction of Fig. 11 for Water Temperature

180 F or 200 to 250 F) depending upon how close they are to the occupants and upon the pressure for which they are designed. The water velocity through the heating equipment affects its capacity. This must be taken into account in selecting the equipment because, if a large water-temperature drop is used, the rate of circulation is reduced and consequently the velocity of flow may be reduced sufficiently to lower appreciably the rate of heat transfer.

Convectors, specially designed to provide low surface temperatures, are now available to operate with water temperatures in the 300–400 F range.

The high temperatures of these systems make them ideally suited for direct use in radiant panel surfaces. Since radiant output is a fourth-power function of the surface temperature, the surface area requirements are materially reduced over low temperature water systems. The surfaces may be flat panels consisting of a steel tube, usually ⅜ or ½ in., welded to sheet steel turned up at the edges for stiffening. Several variations of this are available. Steel pipe may also be used with an aluminum, or similar, reflector to reflect the heat downward and to prevent smudging of the surfaces above the pipe.

TEMPERATURE CONTROL

On steam-pressurized cycles, the basic control of the firing rate to the generator should be from the temperature of the water leaving the generator. A master pressure control operating from the steam pressure in the expansion vessel should be incorporated as a high limit override. Inert-gas-pressurized systems should be controlled from the generator discharge temperature.

Combustion controls are discussed in detail in Chapter 42 of the 1961 Guide And Data Book.

In the water-tube generators most commonly used for HTW applications, the flow of water makes the pass through the generator in a matter of seconds. The temperature controller must have a rapid response to maintain a reasonably uniform leaving water temperature. It is rarely required that this temperature be held closer than plus or minus 5 F deg, but greater swings may occur if the location of the sensing element and the controller itself do not sense and react quickly enough. Simplicity of control is recommended. Due to the rapid response through the generator, some form of modulation of combustion rate is necessary on all systems having a capacity of over a few million Btuh. In the smaller size range this can take the form of high-low firing. In large systems, particularly those used for central heating applications, full modulation of the combustion rate is desirable through at least 20 percent of full capacity. On-off burner control is generally not used in steam-pressurized cycles since the system loses pressurization during the *off* cycle, which can cause flashing and cavitation at the HTW pumps.

All generators should have separate safety controls to shut down the combustion apparatus on high system pressure or high water temperature. HTW generators require a minumum water flow at all times to insure against tube failure. Means should be provided to measure the flow and to stop combustion if flow falls below the minimum value recommended by the generator manufacturer. For inert-gas-pressurized cycles, a low pressure safety control should be included to shut down the combustion system in the event of loss of pressurization. Fig. 13 shows the basic schematic control diagram for a HTW generator.

For large central distribution systems, it may be desirable to provide flow sensing means to shut down the combustion apparatus in the event of a line break. Further protection can be attained in such cases if automatically closing flow valves are installed in the main distribution system to seal off the line to prevent loss of water. An automatically controlled bypass valve at the central plant would then assure continuous flow within the central plant equipment during the period of time required to shut down and cool off the generators. Such line breaks on underground distribution systems are remote possibilities, and this protection would normally be considered only on extensive or special systems.

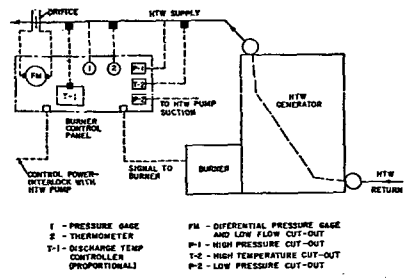


Fig. 13 .... Control Diagram for High-Temperature Water Generator

Valve selection and sizing are very important because of the relatively high temperature drops and smaller flows encountered in high-temperature water systems. To obtain good control, the valve must be sized so that it is effective over its full range of stem travel. It is recommended that the valve size be selected on the basis of a pressure drop at full flow equal to approximately 50 percent of the pressure difference between supply and return mains at the location of the equipment served. The pressure drop across the valve must not be sufficient to result in a downstream pressure below the saturation pressure at the temperature existing at any point or flashing into steam will result. A valve with equal percentage flow characteristics is desirable. Sometimes two small valves are used rather than one large valve to improve the controllability of the system. Stainless steel trim is recommended, and all valve body materials and packing should be suitable for the high temperatures and pressures encountered. The valve should have a close-off rating at least equal to the maximum head produced by the circulating pump. Generally, two-way valves are more desirable than the three-way type because of the equal percentage flow characteristics and the smaller capacities available in two-way valves. Single-seated valves are recommended in preference to double-seated valves since the latter do not provide tight closing.

Control valves preferably should be located in the return lines from heat transfer units in order to reduce the valve operating temperature and to prevent the high-temperature water from flashing to steam at the lower discharge pressure. Sometimes valves are located as low as practicable to increase the static head at the valve and further minimize the possibility of flashing. This problem is minimized in systems pressurized by inert gas, since a greater difference is maintained between the system and saturation pressures.

A typical application is the control of the temperature of water leaving a heat exchanger in which high-temperature water is used as the heating medium. The temperature measuring element should be located where it can best detect changes and thus prevent overheating of the outlet water and possible flashing. When the measuring element is located in the leaving water, there must be a continuous flow through the exchanger and past the element. If the water leaving the exchanger is used for space heating, the set point of the thermostat in this water (which controls the temperature of the leaving water by controlling the inlet temperature to the exchanger) can be readjusted in accordance with outdoor temperature.