referred to an established scale, indicates the relative corrosivensss of the condensate. Accompanying such corrosion measurements, a careful chemical analysis should be made of the condensate, and the findings will serve as a basis for an intelligent study of the problem.

There are some indications that after a condensate containing carbon dioxide has dissolved some iron and thereby raised its *pH* value, its corrosive action is greatly reduced and the solution will remain comparatively inactive until admission of oxygen permits the precipitation of the dissolved iron as ferric oxide. The *pH* value of the condensate may be buffered to a fairly high value by the solution of iron and not correspond to the *pH* value to be expected in the unbuffered solution containing the same amount of carbon dioxide.

Corrosion, if found to exist, can be lessened or overcome by several means. If the steam supply is found to be definitely contaminated, proper chemical treatment of the water, followed by deaeration, is an obvious remedy. The leaks in the piping system, particularly in vacuum systems, should be stopped so far as is practicable.

Although inhibitors of various types have had considerable trial and experimentation and successes have been reported, the information as yet requires considerable study to be made satisfactorily useful. Among these inhibitors are oil, sodium silicate, sodium hydroxide, tannin, and various other organic compounds, some of which release ammonia gas. The best guidance to date in the use of such inhibitors is to compare the results found over a period of years in a similar installation operating under the same conditions.

In view of the fact that corrosion is most frequently found in the return lines from special equipment, which constitute a relatively small part of the total piping in a building, a simple solution of the corrosion problem may be to use non-corroding materials in those certain portions of the piping system, since the higher cost will usually be an unappreciable portion of the total. Brass and copper are undoubtedly less subject to this type of corrosion than the ferrous metals, and considerable attention is now being given to corrosion-resistant linings for ferrous pipe. Cast-iron pipe, sometimes alloyed with other metals, also deserves consideration.

Eighteen ferrous and non-ferrous metals and alloys were recently tested in a large air conditioning installation[4]. Observations were made in the wash water of the dehumidifier and in the air stream beyond the eliminator plates. The corrosion rates of all metals and alloys utilizing a dichromated-treated wash water were extremely low. Localized attack in the form of pitting was found to occur on steel in crevices or under solid accumulations. Just beyond the dehumidifier eliminator plates corrosive conditions were observed to be particularly severe and in such locations non-ferrous metals and alloys and stainless steels were most resistant. Alloy steels were found to be superior to mild steel.

[4]A.S.H.V.E. RESEARCH PAPER—Corrosion Tests in a Water-Recirculating Air Conditioning System, by W. Z. Friend (A.S.H.V.E. JOURNAL SECTION, *Heating, Piping and Air Conditioning*, March, 1942, p. 187).

Chapter 19

GRAVITY WARM AIR FURNACE SYSTEMS

Design Procedure, Estimating Heating Requirements, Leader Pipe Sizes, Proportioning Wall Stacks, Register Selections, Recirculating Ducts and Grilles, Furnace Return Connection, Furnace Capacity, Examples, Booster Fans

WARM air heating systems of the gravity type are described in this chapter[1], and those of the mechanical type are described in Chapter 20. In the gravity type, the motive head producing flow depends upon the difference in weight between the heated air leaving the top of the casing and the cooled air entering the bottom of the casing, while in the mechanical type a fan may supply all or part of the motive head. Booster fans are often used in conjunction with gravity-designed systems to increase air circulation.

In general, a warm-air furnace heating plant consists of a fuel-burning furnace or heater, enclosed in a casing of sheet metal or brick, which is placed in the basement of the building. The heated air, taken from the top or sides near the top of the furnace casing, is distributed to the various rooms of the building through sheet metal warm-air pipes. The warm-air pipes in the basement are known as leaders, and the vertical warm-air pipes which are run in the inside partitions of the building are called stacks. The heated air is finally discharged into the rooms through registers which are set in register boxes placed either in the floor or in the side wall, usually at or near the baseboard.

The air supply to the furnace may be taken (1) entirely from inside the building through one or more recirculating ducts, (2) entirely from outside the building, in which case no air is recirculated, or (3) through a combination of the inside and the outside air supply systems.

DESIGN PROCEDURE

The design of a furnace heating system involves the determination of the following items:

1. Heat loss in Btu from each room in the building.
2. Area and diameter in inches of warm-air pipes in basement (known as leaders).
3. Area and dimensions in inches of vertical pipes (known as wall stacks).
4. Free and gross area and dimensions in inches of warm-air registers.
5. Area and dimensions of recirculating or outside air ducts, in inches.
6. Free and gross area and dimensions in inches of recirculating registers.

[1]All figures and much of the engineering data which follow are from University of Illinois, *Engineering Experiment Station Bulletins* Nos. 141, 188, 189 and 246; Warm Air Furnaces and Heating Systems, by A. C. Willard, A. P. Kratz, V. S. Day, and S. Konzo. See also Standard Code Application Manual for Gravity Warm Air Heating Systems, published by the *National Warm Air Heating and Air Conditioning Association*, 145 Public Square, Cleveland, Ohio.