

Such conditions would be impossible with central station heating if the furnace designs at the station had been carefully made and the plant was operated intelligently.

Domestic heating apparatus needs attention in maintaining the fires, clearing out ashes, and cleaning and repairing the equipment before putting it into use each fall. These services are often not paid for in cash but are performed by the owner or one of his household. Yet there is a demand on such a person's time for this work. Then, again, there are also the many petty annoyances and irritations connected with the maintenance of the heating system which for comfort it is desirable to minimize or do away with entirely. Among such might be mentioned the fact that fires frequently go out when needed most, furnaces must be cleaned and fixed at the beginning of the season, coal gas escapes and is objectionable in the home or office and dust comes into the house from unloading coal and removing ashes and makes extra cleaning necessary. In apartment houses, the usually unsatisfactory janitor is practically eliminated when central heating service is supplied.

There is a tendency in such cases where individual furnaces are used to fire hard during the daylight and evening hours, and to bank the fires and allow the temperature of the building to drop during the night. This tends toward economy in fuel costs, although there is frequently a certain amount of physical comfort sacrificed for the sake of economy.

When hard coal is used, strict economy is practised. Storm windows and doors are put up after the first fall frost and from then on ventilation is sacrificed, while no space is heated that is not absolutely needed. This statement can be corroborated by any who have lived in rooming houses.

Many people follow the custom of purchasing the whole season's fuel supply during the summer months when coal is cheap. This often involves a certain degree of hardship as a comparatively heavy expenditure must be made at one time instead of having it spread out over a period of several months.

The Advantage of the Central Heating Plant.—Instead of providing individual heating furnaces in each building, a single building may be provided in a central location to accommodate the complete heat generating units for a given district, and heat can be transmitted to the different buildings by a system of underground pipes carrying hot water or steam. It is the purpose of this series of articles to discuss a number of phases of these central station heating systems in the light of personal experience and of the latest information available, especially with relation to conditions existing in Wisconsin.

When compared with individual heating plants, the central station systems have many points of superiority. Steam can be produced more economically in the large boilers in central plants than in small individual boilers. House heating boilers of 25 h.p. have shown efficiencies ranging from 40 to 50% under test conditions. Under average operating conditions such results would not be obtained continuously, and it is probable that the average operating efficiency is not far from 35%. Large sized boilers tested under actual daily operating conditions show efficiencies ranging from 60 to 80%, with an average of possibly 65%.

To illustrate some results that are actually obtained in a central heating plant of the best design, the boiler efficiencies obtained from three different tests of the

boilers of the Capitol Heating Station at Madison, Wis., are as follows: The first two tests were made on single 400 h.p. Stirling boilers fitted with Murphy stokers. Boiler efficiencies of 80.9 and 82.9% respectively at nearly full load rating were obtained from these tests. A year after the first tests, a trial was made on two boilers together, with less than half load on each, with a resulting boiler efficiency of 66.2%.

Other results of considerable interest are from tests made in 1911 by Messrs. Pugh and Watson, seniors in the College of Engineering, forming a portion of their work for the degree of Bachelor of Science in Mechanical Engineering. The tests were made on several of the 350 horse-power B. & W. boilers at the University heating station at Madison, Wis. Their object was to determine the efficiency of operation and the rate of evaporation of the various boilers under actual operating conditions. The boilers under test were fired by the regular crew in the same way as all the other boilers in the plant, so that the results represent average conditions of operation. These trials showed boiler efficiencies ranging from 64.6 to 77.3%, depending on the amount of scale on the heating surfaces and the particular type of furnace construction installed under the tested boiler.

It can thus be seen that there is a difference in efficiency under average operating conditions in favor of the central station of from 75 to 100%.

A table in Bulletin No. 40 of the Bureau of Mines gives the details of operation of fifty-seven central heating plants. In commenting on the costs of service, the authors state as follows: "A comparison of the prices charged by central stations as given in this table with the cost of fuel only for an ordinary house heating boiler shows that in many cases the cost of producing heat on the premises equals the price charged by the central stations. When heat is purchased the customer avoids the annoyance of having to supervise the operation of the heating plant as well as of the dust resulting from the delivery of fuel and the removal of ashes."

In the central station smoke can be almost entirely eliminated by the frequent firing of small quantities of coal on properly designed grates. Slack and other cheap grades of bituminous coal can be used instead of the more expensive grades supplied for household furnaces. It is also possible to install such sized boilers at the central station that those in service may operate at maximum economy at all times. It is therefore apparent that the central station can effect considerable savings over individual plants so far as boiler operation and coal are concerned.

The savings already mentioned are offset to some extent by the fact that the central heating system is expensive to install and thus a heavy overhead charge must be made on the service rendered to meet interest, maintenance and depreciation charges on such distribution apparatus. At the same time, an operating force must be employed at the central station.

When a prospective customer undertakes to compare central station charges for heating with the cost of his individual service he usually considers only his coal costs and neglects to allow for the interest, maintenance and depreciation charges on his own furnace equipment, which would be rarely less than about \$15, even in the smallest houses.

When central station heat is used, the fire risk on property is diminished and hence insurance rates are