PROCEEDINGS

OF THE

SEVENTEENTH ANNUAL CONVENTION

OF

The National District Heating Association

HELD IN

NIAGARA FALLS, NEW YORK

June 1, 2, 3, 4, 1926

PUBLISHED BY THE ASSOCIATION

D. L. GASKILL, *Secretary.* H. R. WETHERELL, *Technical Secretary.*

APPENDIX

DESCRIPTION OF BY-PRODUCT SYSTEMS

EXHAUST HEATING IN KANSAS CITY

It should be now of interest to consider the progress being made in by-product plants. Before approaching a consideration of the more modern theories we are able to describe the exhaust heating system in operation in Kansas City, Missouri, calling attention to the objections, or rather, the questionable overall economy of this system, which has been in operation several years.

The Kansas City Power and Light Company have found many factors entering into the economic problem of operating a non-condensing turbo-generator in connection with a district heating system and as a result of several years' experience some of these factors may be outlined as follows:

The use of the word "economic" should be noted as referring to financial costs as well as benefits that cannot be measured in dollars and cents. There are no great physical obstacles that interfere with the operation of such machines as feeders to a large electric distribution network—even if the major source of power is some miles distant from the heating plant.

Off hand it would appear that the procedure is a source of comparatively cheap power and many authorities contend that the cost of power so produced is represented by the fuel required to furnish the heat utilized by the generating set. Actually there are a number of additional items that should be included, that add materially to the power costs. Before entering into a discussion of the costs to be expected it might be well to examine other features of the problem.

It should be remembered that almost without exception, wherever there is an opening for a non-condensing unit to serve a district heating system, there is a great adjacent demand for electric energy—perhaps a demand twenty to thirty times the capacity of the non-condensing unit. It follows then that the proposed unit has to compete with a more or less modern electric generating plant designed to produce electric energy at a minimum cost.

Here it may be stated that actual financial cost is not the final measure of the value of non-condensing generating capacity as the district adjacent to the heating plant may have electric load normally served from a larger plant but which load must be protected by standby equipment. The non-condensing plant furnishes an ideal solution to this problem. In one case a large hotel contract was obtained as an electric and heating customer only by providing emergency electric service direct from the heating generating plant in case of failure to the main source of electric energy. In emergencies the changeover has been made in considerably less than one minute.

The two curves (Figs. 11 and 12) are taken from the actual operation of a district heating system delivering to its customers between five and six hundred million pounds of steam per year. Last year 442,000,000 pounds of this steam were produced in a station equipped with electric generators and 8,149,900 kw. hrs. were generated. These two figures have been plotted against one another with a ratio of scales of fifty to one, as the turbo-generators require about fifty pounds of steam per kw. hr. It will be noticed that the steam curve is quantity delivered instead of water evaporated (which figure is not available) and that there is a marked departure from the electric energy that might be expected, particularly at the lighter loads. The actual steam required per kw. hr. figured on the steam delivered during the winter season was 54 pounds and when this is corrected to, pounds of steam generated in the station, per kw. hr. generated, the figure becomes perhaps, 65 pounds. This is due to the rapid falling off in turbine efficiency at light loads and to the fact that at very light loads the reducing valves are used to replace the turbines.

This diversity from expected economy must be borne in mind in considering the desirability of a non-condensing turbo-generator installation.

The curve showing the typical winter days operation, one warm and one cold, illustrates the variation to be expected in station output and emphasizes the fact that heating system generating equipment should not be considered as part of the main electric system generating equipment or even as normal standby equipment. The statement is emphasized by the fact that the heating system under discussion with non-condensing equipment rated at 5000 kw. and a maximum demand of 3400 kw. is operated in connection with an electric generating plant of 120,000 kw.

installed capacity and a demand in excess of 80,000 kw. There are no large electric generating plants successfully operated without reserve capacity far in excess of that of the connected heating plant so the total costs of the non-condensing electric generating plant must be charged against the electric power produced, together with labor and actual cost of heat.

An approximate outline of the methods of arriving at these costs, based largely on experience follows.

The turbines are guaranteed to have and tests probably would confirm a water rate averaging 50 pounds of steam per kw. hr. and an average removal of 80 B. t. u. per pound of steam or 4000 B. t. u. per kw. hr. This represents approximately 7% moisture in the exhaust (starting with 2% at the throttle).

Assuming a fuel cost of steam as generated at 40c per 1000 pounds, feed water temperature of 60°F. and boiler pressure of 150 pounds guage the heat in the high pressure steam costs approximately .036 cents per 1000 BTU. This 4000 BTU per kw. hr. represents a cost for fuel per kw. hr. of .144 cents. It may be said that the year's fuel cost for the 8,149,900 kw. hrs. generated was $8,503.50.

The 5000 K. W. generating plant with building and cable system represents a cost of $150,000.00. Fixed charges at 15% totals $22,500.00 per year.

Labor, supplies, etc., amount to $8000.00 per year. The total year's cost is then as follows:

Fuel	$ 8,503.50
Fixed charges	22,500.00
Labor, etc.	8,000.00
	$39,003.50

This checks out a cost per kw. hr. of 0.478 cents.

There are a number of large generating stations today that, figured on fuel costs as outlined above will put a kw. hr. on the switchboard for around .4 of a cent and due to the fact that the non-condensing plant is only a small part of the system capacity—in fact permits no reduction in the investment in the main plant there is a tendency to compare the total cost of power from a district heating plant with the larger plant's fuel costs.

In those cases where the non-condensing and condensing plants can be served from the same boiler plant these figures will be altered considerably in favor of the non-condensing plant and the bleeder type machine is desirable.

Fuel costs of steam alone have been used throughout this discussion —leaving out operating and fixed charges of boiler plants and no opinion is expressed as to whether such charges should be included. Such charges will show to the disadvantage of the non-condensing plant.

It is quite probable that as heating boiler plants are modernized and the advantages incident to higher boiler pressures are passed on to the non-condensing turbines or in places where the bulk of electric energy is not economically produced that the non-condensing turbo-generator can make a better financial showing.

PROPOSED EXHAUST HEATING SYSTEM IN DETROIT

In the Beacon Street heating plant of The Detroit Edison Company, now in the course of construction, there will be installed a turbine which will exhaust into the heating system and which is to be designed and operated in a somewhat novel fashion. Its installation marks, to a certain extent, a change in policy, for during the past several years the Detroit heating system has been supplied almost wholly with live steam direct from the boilers.

The distribution system in Detroit is a combination of three originally separate systems, two of which were designed and for a number of years operated as low pressure exhaust steam systems. The great increases in load, resulting from the tremendous growth of the city during the period between 1910 and 1920 rendered the distribution mains entirely inadequate to carry the quantities of steam required. To relieve this situation, a number of high pressure, high velocity feeders were installed from time to time in order to avoid the much more costly alternative of replacing major portions of the distribution network with larger pipes.