Experience After 20,000 Operating Hours
The Mannheim Incinenerator

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There is so much interesting and valuable material in this paper that it almost seems that one should be satisfied and not, like Oliver Twist, "ask for more".

Furnace Gas Analysis

On page 101 and 102, Figures 18 and 19 show gas analysis in combustion chamber and in front of final superheater. Just where in the combustion chamber were these readings taken and to what do the numbers 11, 10, 9, 8, 7 refer on curve 18a and 19a? We assume the curves 18b and 19b show a tendency to change with time and would seem to indicate that the refuse material was reasonably uniform during the test run. Was this the case?

Furnace Design

As Mr. Hilsheimer has pointed out, stratification occurs with every type of stoker even when burning homogeneous solid fuel. So when a far less than homogeneous fuel, like refuse, is being burned, the mixing of the gases above the stoker is of great importance and the uniformity of the gas composition entering the superheater attests that considerable mixing does take place. It would be interesting to have Mr. Hilsheimer's comments on a similar unit design but with the Boiler, not the stoker, turned 180 deg, so that the rich gases would have to sweep across the second and third burning stokers before ascending into the combustion chamber (see Figure 1). Greater time for burning would be provided and the hot gas from the first and second stages would reflect heat down on to the last stage, where it is needed to maintain combustion of the slowest burning remnants of the refuse.

Hot Air

It is interesting to see that the design uses 465 F hot air for both undergrate and overfire air. This should materially speed ignition and burning as well as perhaps boil off fats and greases so that they burn on the grate instead of running through the grates where with cold air they congeal and restrict air openings in the grate surface. The author's comments on experience with 465 deg would be most interesting in view of the almost universal use of cold air in American practice.

Tube Cleaning

The method of mechanical vibration of heating surface to remove deposits has also been found the most efficacious method at a Power Station burning pulverized lignite in South Australia.

Thickness of Charge

It is noted that the charge depth has been reduced from 5 ft 3 in. to a little under 3 ft and what benefits are obtained from this change. The refuse sizing and handling equipment, which permits the use of so small an opening, eliminates the extreme difficulty
of avalanching and non-uniform air penetration of the bed. This would appear to be a necessity where good burn-out and complete combustion of the gases is a must.

DISCUSSION by Leo J. Cohan, Combustion Engineering, Inc., Windsor, Conn.

Mr. Hilsheimer is to be complimented on his review and forthright appraisal of his plant problems. Many persons, all too enthusiastically, recommend the application of heat recovery equipment without consideration of some of the socio-economic and engineering interfaces that are important factors in decision making.

Heat recovery is not without problems. However, sound economic trade offs can be realized when all factors are considered.

There is evidence in other publications and in test data that corrosion is temperature sensitive. However, the high fuel costs in Europe make high temperature steam cycles for incineration-steam generation more attractive that they might be in the U.S.

The authors summation of the steps taken to correct his plant problems is a credit to his thoroughness.

Reduction in bed thickness and its effect on air distribution is a step that might be considered in more plants utilizing mass burning.

Flow modeling and dimensional similitudes is a tool that the boiler industry has used for years. It is interesting to note how this technique was applied to the fire keys. Perhaps this valuable tool will be more widely used in design stages rather than after the fact.

Mr. Hilsheimer points out the importance of proper boiler design. In any design the fuel must be the governing factor, design standards which are applicable to fossil fuel fired units will not be applicable to refuse fired units. Critical factors are steam temperature, steam pressure, surface arrangement, tube spacing, and gas velocities.

It would be valuable information if the author had commented on how the plants current availability compares to other high temperature – high pressure units in Europe. In my opinion his plant would rate well. The high availability of the firing equipment is indeed important and since no mention is made of the combustible content of the residue, we can only assume that it is also up to high standards.

While the author comments that preparation of refuse would be difficult, he does make a very good case for it. Many of the problems that have occurred resulted, at least in part, from inadequate mixing of air and fuel. Preparation with proportionate surface enlargement would improve the combustion process.

DISCUSSION by W. M. Harrington, Jr., Whitman, Requardt & Associates, Baltimore, Md.

The same basic comments which were made for Mr. Nowak's paper also apply to this paper. In addition, Mr. Hilsheimer makes an important point in that all solid waste cannot be processed through refuse-fired boilers if the equipment is to be protected and if maintenance and operating difficulties are to be maintained at a reasonable level. The list of items set forth in his paper as being acceptable for incineration in the refuse boiler is impressive and points out the need for the totally integrated disposal system which utilizes more than one disposal method. In spite of the brayings of the self-appointed experts, there is no single all-encompassing method of resource utilization-recovery which can reasonably be expected to solve the solid waste problem in an area. When this fact has been ignored, the entrepreneur-sponsored process has almost always been doomed to failure.

It is also interesting to note that our European counterparts are more concerned with fixing the operating problems they encounter than in fixing the blame for the problems. In any advancing technology, it is necessary for designers to try different ideas which may require modification after an initial operating period. Unless the owner is willing to accept this fact of life, engineers will be forced to design anachronistic facilities because their operating difficulties have been accepted through repetition over the years. The European approach to the solution of operating problems is healthy and the European operators deserve a major portion of the credit for the technological advances that have been achieved in refuse-fired boilers because of this attitude.

DISCUSSION by Robert K. Hampton

Mr. Hilsheimer is to be congratulated on his well illustrated and informative paper. It is hoped that it will be used as a broadly based effort to further the total knowledge of the industry and not be used as a basis for partisan gain.
I will concentrate my remarks on the residue handling portion of the paper.

There has been considerable debate on the difference between the residue conveyors used in Europe and those currently in general use in the United States. The European experience parallels that experienced in the United States over the past 30 years where early designs were often too light for the duty required. It was only when knowledgeable Consulting Engineers wrote strong specifications that real progress was made in the United States.

The early U.S. designs often had a life of six months or about 4000 hr in a plant operating 24 hr a day, six days a week before major repairs had to be made. The cost could vary between 10 to 20 percent of the total original conveyor cost, depending on the type and date of construction of the original conveyor. The designs used in the last 10 years have indicated a life of three to six years before any extensive repairs have had to be made. These are based on a plant operating 24 hr a day, six days a week or about 8000 hr per year. Thus 24,000 to 48,000 hr could be expected before extensive costs could be expected. This would be about 2 to 8 percent of original cost per year.

Few large scale installations of conveyors using rubber belts or metal aprons have been made in the United States. There have been some recent installations which after three or four years operation will show how well they can handle residue produced from refuse as collected in the United States. Low cost design, however, could still be a stumbling block to any real comparison.

As in most other areas of incinerator plant design, the operating experience during the next five years will give us many answers and hopefully reduce the amount of conjecture.

DISCUSSION by David J. Damiano, Chief Sanitation Engineer, City of Philadelphia, Pa.

The paper by H. Hilsheimer is a valuable contribution to the data bank of knowledge required for designers and operators of future facilities.

It is apparent that a valuable guide is furnished in establishing the type of technical information seriously needed in the United States in order to advance the technology of incineration. It is significant to note that in addition to planning, the very detailed analysis and composition of the refuse as a fuel was made on a monthly and weekly basis in order to insure the efficiency of operations. Also, the recommendation given to the importance of various refuse components as outlined in the agreement the author reproduced in his paper with the Chamber of Commerce newsletter is the type of progress required to bring incineration to a truly scientific process.

The instrumentation and testing on temperature profiles for the furnace and air flow measurements through the fuel bed are the types of in-depth investigations needed to establish design parameters. Performance of various components such as the furnace grates, boiler tubes and overall operation practices is essential to design and operation. The author is to be complimented on the comprehensiveness of his paper and it is our belief that valuable experience can be gained by encouraging this type of technical report and the mutual exchange of information with our counterparts in Europe as demonstrated by this paper.

AUTHOR'S CLOSURE

Furnace Gas Analysis

The points shown on Figures 18 and 19 on pages 101 and 102 are at the combustion chamber exit with a traverse taken across the chamber.

Yes, the refuse material was reasonably uniform during the test run.

Furnace Design

The layout suggested by Mr. Smith has been applied in Essen. This layout requires auxiliary fuel over the feed grate because there is not enough radiation to get good ignition. The requirement for auxiliary fuel is a disadvantage due to the cost of the auxiliary fuel. An advantage of this layout is that the corrosion problem is alleviated because combustion is completed before the gases are discharged to the boiler.

Hot Air

Hot air is not used to boil off fats and greases but rather to assist in the mixing of the combustion air and the furnace gases, raise furnace temperatures to decrease burning time, and lower flame tips. The minimum burning temperatures that must be maintained, by regulation, are 800 C to eliminate odors. At these temperatures, obnoxious organic odors break down and are burned.
AUTHOR'S REPLY to L. Cohan

The cost of fuel was not a basic consideration in the decision to use waste heat boilers in refuse burning facilities in Germany. Rather, we first decided to incinerate. Then in the development of burning systems, we decided to use waste heat boilers to cool the gases prior to passing them through air pollution control facilities. We then determined the best use for the steam produced.

As far as the author knows, Mannheim is the only refuse burning facility with high temperature and pressure boilers. The oil fired boilers are run for 8,000 hr between inspections. The refuse fired units are taken off the line every 1 to 2 months for cleaning. The availability of the oil fired units is about 95 percent while that of the refuse fired units is 80 percent ±. The availability of the refuse fired units has been improved by burning at a reduced rate. The availability of the refuse fired units in Stuttgart is about 60 percent due to the high loading of the units. When the third unit is completed in Stuttgart, the unit availability should improve.

The combustible in the residue at Mannheim is 3 to 5 percent as a yearly average. This is combustible, not putrescible. The maximum permissible putrescible in West Germany is 0.2 to 0.3 percent, although there is no officially accepted test.

Mixing, to the extent indicated in the paper, has been found helpful. The author doubts that, if it were carried much further it would be as helpful as the discussor implies. You would still be faced with the problem of mixing the prepared fuels, and maintaining the mix, to achieve a uniform feed to the furnace from the standpoint of burning conditions.