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Utilization of Waste Heat

THE United States is favored with such an abundance of relatively cheap fuels that advances have been made in the efficiency of extraction and of utilization rather slowly. The added costs usually associated with improved efficiency in use have had to be balanced against savings in fuel costs. From this point of view, any real advance in the price of fuels has had a beneficial effect by stretching out reserves, but this has been canceled by the increased demand for energy required by our rising standard of living.

A large part of the high-grade chemical energy of fuels is wasted because of our inability to transform it directly to mechanical energy or to electric power, whereas we have learned to do this with the kinetic energy of falling water or even of the wind. The development of a practical low-cost fuel cell would of course make the transformation to electricity far more efficient. Until this is achieved, however, the use of some thermodynamic cycle substance, such as water, will be required to change fuel energy to mechanical energy. The discovery of a practical cycle substance approaching the Carnot cycle more closely than steam would help minimize the unnecessary part of this energy loss. The necessary part, which corresponds mainly to the heat of vaporization of the cycle substance, would still represent a loss unless it could be utilized—for example, by the integration of power plants with users of low-temperature heat.

When it is remembered that, at the most efficient steam-electric generating station, about half the fuel energy input to the boilers is discarded in the condenser water, it seems clear that if some low-temperature process can utilize this heat its economic value may be such as to make it profitable for the two industries to unite.

Such integration can be found in Europe, where fuel prices are high. A noteworthy example in this country is a brine concentration plant in Michigan, where fuel is burned in a high-temperature, high-pressure steam plant and the steam is expanded in turbogenerators to generate electricity, which is fed into the utility network. The low-temperature steam, which still contains the heat of vaporization after expansion, is fed to multiple-effect evaporators to concentrate the brine. Thus, in effect, the fuel costs for evaporation are nearly zero, and waste has been minimized.

Integration can also be made to serve directly through comfort heating, which simply involves the raising of external temperatures from a few degrees to 120°–150° F. The direct use of high-grade fuel for this purpose represents an unnecessary degradation of energy if other methods can be found. Acceptance of more efficient heating methods will, however, require added benefits such as summer cooling. The main challenge is to devise systems that provide for maximum comfort with the least expenditure of energy.

In the all-electric house that may eventually represent the ultimate in convenience, the heat rejected at the thermal generating station that supplies the electricity can furnish the heat required for the home if the rejected heat is properly circulated. Because of the higher temperature of the source as compared with natural heat sources, heat pumps, which are now two to three times the size required for cooling, need be made only large enough to cool the house in summer. Thus, costs would be minimized and energy waste avoided. Small open-cycle, gas-turbine power plants with a waste-heat boiler could be used. In this type of plant the capacity and the efficiency would increase as ambient temperatures fall.

There is thus every indication that integration of high- and low-temperature processes can accomplish a great deal to minimize waste of energy profitably.

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