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UTILIZATION OF SOLAR ENERGY

THE main sources from which energy is at present drawn are coal and oil, and it has been estimated that, at the present rate at which these resources are being exhausted, they are not likely to last much more than a few thousand years. A great deal of attention has therefore been paid to the possibility of obtaining power from such perennial sources as running water, the tides and solar energy. It is known that the earth receives a large amount of thermal energy in the form of solar radiation and although there has been much speculation as to the possibility of extracting useful work from this, the problem has not been critically examined in the past. A Committee was recently appointed by the Department of Scientific and Industrial Research of the United Kingdom to investigate this question and their report has recently been published.* According to this report, it seems unlikely that solar energy can be an important source of heat or power in the near future, though some applications may be possible in specially favourable circumstances.

Although the final conclusion of the Committee thus appears to be not encouraging, the report contains a large amount of valuable information, and it may be worthwhile mentioning some of those here.

Available Energy.—The amount of heat arriving from the sun at the outside of the earth's atmosphere varies only slightly, and is on the average 1·35 kw/m^2. The amount of energy reaching the ground near sea-level depends on the sun's altitude, the cloudiness and the state of the atmosphere. The maximum of direct radiation on a surface normal to the sun's rays on very clear days reaches 83 per cent. of the incident energy (1·12 kw/m^2) at Ouargla in Algeria. At Kew it is 70 per cent.; other stations give values between these. However, these maxima are rarely attained, and are only useful in estimating the maximum capacity of the plant necessary to make full use of the available energy. The use that can be made of this energy will now be considered.

* Report of the National Physical Laboratory Committee sponsored by the D.S.I.R., Great Britain.

Heating.—Solar water heaters have been on the market in the United States for many years but are used only on a limited scale. The reason is probably that the cost of water heating by other means is not high enough to make the capital expenditure on a solar heater and large storage tank in addition to the normal gas or oil heater seem worthwhile. It is possible that in England where fuel for private consumption is rationed, such heaters could be sold, but even here the competition from unrationed gas and electricity would probably be too severe. It seems unlikely that a campaign to encourage the sale of such heaters would result in a large enough saving of fuel to justify the capital cost. There is no prospect of substantial improvement of existing equipment by research and development.

In the tropics, hot water can be obtained for shower baths, etc., by very simple arrangements. The factor limiting the wide use of such installations is probably the absence in many places of piped water-supply and the lack of demand for hot water.

Cooking.—No one is likely to cook by solar energy if he can get gas, electricity, fuel oil, coal or wood. In some regions, however, none of these are freely available and it is possible that solar energy might find an application there. Cooking in itself does not consume much energy once the food has been brought up to the appropriate temperature. It might well be feasible to construct a solar stove which could satisfy part of the needs of the inhabitants of India, whose main meal is cooked at mid-day and generally consists of boiled rice or some kind of lentils. By designing a stove with suitable insulation to prevent excessive heat losses, it should be possible to reach and maintain temperatures of boiling water with 100 watts; this heat could be collected by a mirror of about 0·3 square metre.

A stove using a mirror and a pressure cooker has been built by the Indian National Physical Laboratory. There is no doubt that it is technically possible to cook food in this way, but it is not certain that the machine can be built at a price which an Indian villager can pay.

Refrigeration.—It seems impracticable to use solar energy directly as the sole source of power for a domestic refrigerator for preserving food, since its operation must be continuous. If another source of power is available the amount required is so small that it would not be worth using solar energy to save part of it. For areas where electric power is not available, refrigerators running on paraffin can be employed.

The use of solar energy for air-conditioning is more attractive, as it is not essential that the system runs continuously. There are well known refrigeration cycles in which heat is pumped out at the cold end and absorbed into the machine at the hot end so it would not be necessary to convert the heat into mechanical energy. It is difficult to estimate the amount of heat required without detailed consideration of design.

Power.—Owing to the intermittency of the supply, the direct use of solar energy for driving engines need not be considered for large power plants. There is, however, a number of purposes for which intermittent power as low as 1 kw would be useful. In particular, the economy of the Indian village might be profoundly affected by the availability of such prime movers for water pumping. Their use for driving the small looms employed in cottage industries has been suggested, but the intermittency of the supply makes it doubtful if they would be acceptable for this purpose. We are thus regretfully forced to the conclusion that orthodox heat engines driven directly by solar power are not an immediate practicable proposition.

Production of Fuel.—The use of solar energy to produce fuel which is subsequently used in an engine is attractive, as it avoids the consequences of the intermittency of sunlight and allows the energy to be used in applications requiring the continuous production of power. The efficiency of the utilization of sunlight by growing plants is remarkable. *Eucalyptus globulus* in India gives 2·4 kilograms of wood per year per square metre (9·4 tons/acre year). The wood has a calorific value of $2 \cdot 1 \times 10^4$ joules/gm. (5,000 cal./gm.). The rate of storage of energy in the wood of an Indian eucalyptus forest is therefore 1·6 w/m^2 or 0·8 per cent. of the energy reaching the ground.

An estimate can be made of the possibilities of the wood fired steam engine for irrigation. If it is assumed that the land to be irrigated requires during the year the equivalent of 0·5 m of water to be raised from a depth of 10 m, it can be shown that the amount of land required for growing fuel for the engine is about 1/50 of the area to be irrigated. The value assumed for yield is what would be obtained under good conditions and is substantially greater than would be expected from peasant holdings. Even if a factor of 5 is allowed on account of optimistic assumptions, the project still seems practicable.

Distillation of Water.—There is scope for the solar distillation of water for drinking purposes in certain tropical areas. On the assumption that an average of 0·15 kw/m^2 of radiant energy is available, the evaporation by direct distillation at 100° C. would be approximately 5 kilograms per square metre of heat surface per day. Distillation at pressures below atmospheric would not reduce the heat required per kilogram of water, but the efficiency of heat collection would be greater because of the lower temperature. Considerable improvements have been made recently by introducing black dyes into the solution to increase the proportion of the heat absorbed.

There is great scope for a combination of solar heater and thermal pump. This system would enable almost complete recovery of the latent heat of condensation and would greatly increase the output for a given size of plant.

Conclusions.—It appears therefore that, there is, at present, no way in which the use of solar energy can make a large contribution to our sources of power. However, energy for domestic hot water heating can in favourable circumstances be obtained and there is scope in certain tropical areas for the distillation of water using a combination of solar heater and thermal pump. It is desirable that a cooking stove, utilizing solar energy and suitable for large-scale production, should be designed for use in a country like India. The development of air-conditioning equipment driven by solar power is worth consideration as is the design of a flat-plate collector for driving a small engine. Perhaps the most profitable way of utilizing solar energy is through the media of plants, and it would therefore be worthwhile to investigate the design of a small steam engine of high efficiency using wood or other plant material as fuel.

CENTRAL ELECTRO-CHEMICAL RESEARCH INSTITUTE, KARAIKUDI

THE Central Electro-Chemical Research Institute which was formally declared open by Dr. S. Radhakrishnan, Vice-President of India, on 14th January, 1953, is the tenth institution belonging to the network created by the Council of Scientific and Industrial Research, under the direction of Dr. S. S. Bhatnagar. Created for the rationalisation of industry, this network has been able to win the substantial support of Indian industrialists. The emergence of the Institute was largely made possible by the gesture of Dr. Alagappa Chettiar who offered a donation of Rs. 15 lakhs and a free gift of 300 acres of land for the Institute.

The Institute will have a number of major divisions dealing with electro-metallurgy and electric furnace products, electrolytic cells, electro-deposition and allied processes, electrochemistry of gases, etc. Besides the usual laboratory services and general chemical measuring instruments, etc., certain special work facilities and equipment such as liquid air plant, X-ray diffraction equipment, spectrographic and metallographic equipment, a constant temperature room, micro-analysis apparatus, electrolytic cells for special purposes—for fluorine for example—apparatus for repair and standardisation of precision instruments, are also intended to be provided. Provision has already been made for a general workshop, a lecture theatre and a well-equipped library. Space provision has also been made for accommodating a Museum or to be more appropriate, an Exhibition of products and equipment of interest to electro-chemists.

LADY TATA MEMORIAL TRUST SCIENTIFIC RESEARCH SCHOLARSHIPS, 1953-54

THE Trustees of the Lady Tata Memorial Trust are offering six scholarships of Rs. 250 each per month for the year 1953-54 commencing from 1st July, 1953. Applicants must be of Indian nationality and Graduates in Medicine or Science of a recognised University. The scholarships are tenable in India only and the holders must undertake to work whole-time under the direction of a scientist of standing in a recognised research Institute or Laboratory on a subject of scientific investigation that must have a bearing either directly or indirectly on the alleviation of human suffering from disease. Applications must conform to the instructions drawn up by the Trustees. Candidates can obtain these instructions and other information they desire from the Secretary, the Lady Tata Memorial Trust, Bombay House, Bruce Street, Fort, Bombay 1. The last date for receipt of applications is 15th March, 1953.