International Atomic Energy Agency

INFCIRC/45
15 July 1963
GENERAL Distr.
Original: ENGLISH

THE USE OF NUCLEAR ENERGY TO DESALT SEA WATER

Memorandum by the Director General

INTRODUCTION

1. While the General Conference was in session last September the Government of Tunisia expressed its interest in the use of nuclear power to desalt sea water or brackish water. Shortly afterwards it requested the assistance of the Agency in studying its water development problems. It was therefore decided to undertake a series of studies on the subject.

WORK DONE AND PLANNED

2. In March 1963 the Director General convened a group of experts to advise him on the role the Agency could play in assisting developing countries to introduce the use of nuclear power for saline water conversion, on conversion processes, on single-purpose and dual-purpose plants [1] and on the utilization of reactors to produce steam. From these discussions it appears that:

(a) Distillation processes are the most suitable for sea water conversion;

(b) Production of the very low-pressure steam, which is all that is required for distillation processes, appears to offer more advantages in the case of a nuclear plant than in the case of a conventional plant; and

(c) Single-purpose or dual-purpose plants having adequate water storage facilities can be operated continuously at full capacity - an advantage of relatively greater importance in the case of nuclear plants.

In July a staff member will visit southern Tunisia to determine the extent to which these considerations can be taken as applicable to the situation prevailing in that area.

3. The twofold use of nuclear reactors for saline water conversion as well as for power generation should accordingly be studied more extensively. In this connection a limited number of populated areas on the sea-shore, where little fresh water is available and where the cost of fuel is high, should be investigated for the practical application of nuclear energy. On the basis of the present data it has been estimated that the needs of industrial and urban areas vary from 50 gallons and 5 kWh a day to 200 gallons and 10 kWh a day per person, depending on the standard of living in the area.

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[1] Single-purpose plants produce either power or water; dual-purpose plants produce both power and water.

4. The present studies are mainly concerned with the financial implications involved in "scaling up" [2] desalting plants and nuclear reactors; at the same time the direct production of low-pressure steam by nuclear reactors is being investigated.

5. The Director General believes that, at present, the Agency can best assist developing Member States to solve the problem of saline water conversion by:

(a) Including, when appropriate, experts on water desalting in nuclear power survey missions;

(b) Studying problems of selected areas at the request of Member States;

(c) Furnishing Member States with information on the suitability of services commercially available; and

(d) Issuing publications on the status of desalting technology and the future possibilities of the use of nuclear power to desalt water.

6. In order to carry out the activities mentioned above, the Director General plans to convene from time to time groups of experts to advise him. He has already invited a second group of experts, including representatives of interested developing Member States, to meet on 23 September 1963 in order to review the results of the work done and experience gained during the last six months, as well as to examine actual situations in developing Member States, with a view to acquainting those States with the conditions under which nuclear energy could be used for saline water conversion. The Director General also hopes that a new approach will be found to the difficulties encountered by developing countries in determining the optimum size of reactors to be used for this purpose, and in assessing those countries' power and water needs.

TECHNICAL DATA RELEVANT TO WATER DEVELOPMENT

7. For a nuclear power plant a dual-purpose installation appears to be advantageous, and the fuel cost per kWh of power produced is expected to be considerably lower than in a conventional plant, provided the plant is large. The capital cost of a nuclear power plant is high, but the capital cost differential between nuclear and conventional plants of comparable power output decreases as the capacity of the reactor is increased.

8. Because of the higher initial cost of a nuclear installation and its lower operating cost, it is relatively more advantageous to operate a nuclear plant at a high load factor. It is likely to prove easier to achieve such desirable working conditions in dual-purpose plants than in a nuclear installation used solely to generate power, but the plant would have to be designed ab initio with this end in view. The overall efficiency of a dual-purpose plant can be increased by better utilization of low-pressure steam tapped from the last stages of the turbine. The combination of power production and water desalination will also influence the economics of a conventional plant; however the lower fuel costs in a nuclear plant make it more attractive for dual-purpose operation. Finally, the fact that an operator of a dual-purpose plant has two commodities - electricity and water - to sell would enable him to balance a reduction in the price of one by an increase in that of the other, should this prove desirable.

9. Nuclear reactors used at present for power production can be readily adapted to dual-purpose operation; the alterations needed are mainly in the non-nuclear parts of the plant, leaving the reactor itself largely unchanged. In such plants the ratio of kWh generated to the number of gallons produced has technical and economic implications. Up to one gallon per kWh produced, the cost of the energy supplied for desalination is almost

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[2] For instance, extrapolating the known capital cost of small plants to those of larger capacity.

negligible; but when the number of gallons per kWh increases, the cost of heat delivered for desalination likewise increases. If the requirements for water are high and more important than those for power, it may be more economical to have a source of low temperature steam to supply the conversion process directly. In this case the power needs would be met separately by various methods such as heating the required amount of this low temperature steam before it enters the turbine. For such applications reactors of a special type can be envisaged. Present studies reveal that this type of reactor is very promising, but certain technical problems have yet to be solved. From a practical point of view, desalination by nuclear energy can at present be expected to meet urban and industrial needs in areas along the sea-shore where the cost of conventional fuels is high and the fresh water requirements exceed several million gallons per day.