Accelerator production of neutrons as alternative to fast breeders; the perspective and problems.

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From the analysis of future global energy requirements it is clear that prior to the development to the large scale power production capability of abundant and environmentally attractive new energy sources from nuclear fusion and solar radiation, nuclear fission will be needed as back up source to coal, which is, after the exhaustion of liquid fuel, to remain the only conventional source capable of covering the energy consumption in the intervening period. Environmental effects, geographical distribution and other reasons can be given against the overdependence on coal.

There are, however, very few countries with such reserves of uranium as to be able to base their long term fission energy production on the inefficient thermal reactors of the light water type. The so-called fast breeder reactor, which is by almost two orders of magnitude more efficient user of uranium is being developed for many years now. Although it would solve the problem of uranium reserves, this reactor uses the high plutonium content fuel and is from safety point of view being met with increasing opposition, besides being technically and technologically complex. Its future is far from being clear. However, *there are alternatives.Considerations leading to entirely different approach started in early fifties, when the accelerator production of fissile materials was considered as an alternative to diffusion enrichment. A clear concept of using accelerator neutrons for better utilisation of fission fuel was presented by W.B. Lewis in 1968.*

The so-called accelerator breeder concept uses protons or deuterons accelerated to about 1000 MeV to produce neutrons by spallation and fission in U^{238} *and* Th^{232}. *Most of the neutrons are finally captured by these fertile materials to produce fissile* Pu^{239} *and* U^{233}. *Relative economical value of accelerator breeding depends essentially on the accelerator efficiency. Ten years back the concept was still thought of as a reserve way, should there be some unforeseen difficulties with breeder reactor. Meanwhile, further accelerator development has taken place, whilst the breeder prospects look less bright. A number of studies were undertaken in order to assess the present status of accelerator breeder. To this purpose several specific questions require further study and research pertaining to:*

- *Selection and determination of optimum beam energy and current; determination of neutron yields for various targets.*
- *Calculations of neutron production and transport and of distribution of produced fissile material in the target.*
- *Accelerator design, ion source development, cost and efficiency estimates.*
- *Target design; assessment of fuel cycles which claim to avoid reprocessing by production of fissile material in reaction fuel.*

As Yugoslavia is a country with only moderate coal reserves, and small reserves of uranium, the question, of uranium supply will soon be acute. Prior to the farreaching and questionable committment to fast breeder development the accelerator breeder concept should be evaluated. From the nature of this project it is clearly the task which requires the engagement of theoretical and experimental nuclear physicist with experience both in the low and high energy field.

References:

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