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Water for Development By Nuclear Desalination

by Hycham Basta

As momentum builds against a Middle East war, the crying need for economic development in the region—which will necessarily entail dealing with its grave shortage of water—has put the LaRouche "Oasis Plan" squarely back onto the agenda. The International Conference on the Use of Nuclear Power in Desalinating Seawater, held at Marrakech, Morocco during Oct. 16-18, was a significant step toward realizing that plan.

With specialists attending from 35 countries, this three-day meeting was organized by the Association des Ingénieurs en Genie Atomique du Maroc (AIGAM), the World Water Council (Conseil Mondial de L'Eau—CME), and the World Council of Nuclear Workers (Conseil Mondial des Travailleurs du Nucléaire (WONUC). Industrialists, engineers, and researchers presented their work, notably on how nuclear power can be applied to desalinating seawater. Several of the speakers expressed the view that desalination through nuclear power has become a "viable, realistic option," given how serious the situation of water supplies has now become, worldwide.

According to Mekki-Berrada, the AIGAM's Chairman, desalination is a solution "both for the present moment, and for the future of mankind"; he added that nuclear power is an inexpensive, non-polluting, and accessible solution.

Why nuclear desalination? It is the solution for developing countries.

Desalination Against Underdevelopment

The Moroccan Secretary of State for Scientific Research pointed to how unevenly water resources are distributed over the globe, and described the policy of "vigilance and foresight" his country has adopted in this respect. Although the planet's water resources are gigantic, being estimated at 1.3 billion cubic kilometers, they are unevenly distributed. The oceans represent 97.41% of these reserves, while the rest is accounted for, essentially, by glaciers and rainfall. Only 0.4% of the world's 135,000 cubic kilometers of freshwater resources are, in fact, accessible.

Freshwater as such is still more unevenly distributed, since fewer than ten countries account for 60% of the world's water resources (particularly Brazil, Russia, China, and Canada). While resources are thus limited, demand has increased steadily, owing to progress, rising living standards, and demographic growth. But drinking water is, de facto, rationed—it is estimated that 1.4 billion human beings lack drinking water, and hundreds and thousands of women and children spend the day looking for water. This scarcity adversely affects food production, and condemns the inhabitants of arid areas to misery and underdevelopment.

There is a solution: Seawater can be desalinated. The industrial process has been mastered for some time, and indeed no longer presents any technical obstacles as such. The two commonest techniques are distillation, and reverse osmosis. In distillation, seawater is caused to evaporate, either through solar radiation, or by heating in a cauldron. Only the water molecules escape, leaving the salts and non-volatile substances behind, in the form of concentrated brine. To procure drinking water, all one need do then, is to condense the water vapour. With reverse osmosis, one first filters and disinfects seawater, so as to remove any particles in suspension, and micro-organisms. The ensuing brine is then driven under pressure through a semi-permeable membrane, which lets through the water molecules alone.

The major drawback to both systems, is that their cost in terms of energy is high, nor is the equipment notably efficient, as the quantity of energy required to heat, or compress seawater, is very large relative to the volume of freshwater put out at the other end. These methods for producing freshwater have accordingly been rather marginal. Only countries that suffer from a severe shortage of freshwater but are otherwise very wealthy, such as Kuwait or Saudi Arabia, have taken to desalinating seawater for drinking purposes.

As of today, world desalinating capacity stands at about 30 million cubic meters per day, with 10,000 desalinating stations, half of these being located in

Nuclear plants which desalinate seawater are already in use in several countries; this unit is under construction at the Kalpakkam Nuclear Power Plant in India. It will desalinate 6,300 cubic meters of water daily.

the Middle East. Although investment costs have tended to fall, they remain prohibitive nonetheless, roughly three to four times the cost of exploiting natural freshwater resources. To give only one example, the Persian Gulf states have already spent more than $100 billion to build and maintain desalinating plants, while in Libya, wheat is grown with desalinated water—but at eight times the world market price.

Nuclear Desalination: A Virtual Secret

To avoid future conflicts, not to speak of those that are already upon us, such as the Israeli-Palestinian clash over water supplies, we must move toward new and less costly solutions, particularly for the purposes of irrigation and recycling. Nuclear power could thus be an elegant approach to dealing with the stiff cost of traditional desalinating techniques. The technical feasibility of using nuclear energy for desalinating seawater has been shown by the plants now operating in Kazakstan and Japan—although the Western press has been remarkably quiet about this.

For the last 27 years, the BN-350 reactor at Aktau in Kazakstan has been producing almost 135 megawatts of electricity, as well as 80,000 cubic meters of drinking water per day. Some 60% of the energy thus produced has been used to produce heat to desalinate seawater. In Japan, ten or so desalinating stations, coupled with electricity-generating PWRs (pressurized water reactors), have been turning out between 1,000 and 3,000 cubic meters of drinking water per day.

The International Atomic Energy Agency (IAEA) Options Identification Programme for Demonstration of Nuclear Desalination, as well as the international symposium on nuclear desalination of seawater held in South Korea in 1997, have done much to encourage national and inter-regional programs for nuclear-powered desalination. The IAEA held a Cairo seminar in 2001, on the promise of small and medium-sized nuclear reactors to produce both electricity and drinking water.

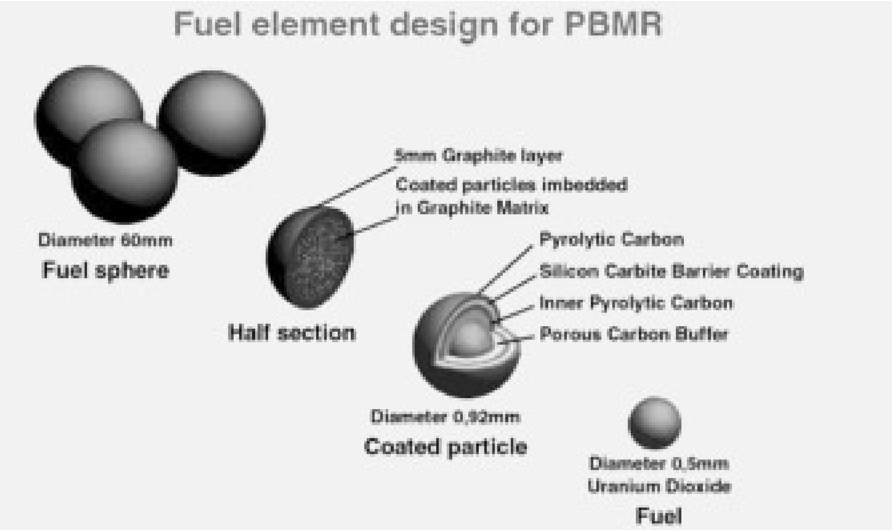
The Marrakech conference confirmed the great possibilities offered by nuclear power. The only real obstacle thrown up against desalination with nuclear energy is, in point of fact, the extremist anti-nuclear attitude harbored by certain circles. There are financial constraints; but nuclear-powered desalination has been accused of all sorts of ills by those who are putty in the hands of anti-nuclear grouplets. Industrialists have become increasingly reluctant to push for nuclear power.

International organizations like the IAEA or the WWC and other sponsors of the Marrakech conference, do enjoy broader credibility to deal with the freshwater shortage.

The PBMR: The Answer?

Although at the present time—and all the more so since the Chernobyl disaster—the general public may be fairly skeptical as to the widespread use of nuclear power in generating energy (for heating, electricity, etc.), a new nuclear concept is currently being developed in South Africa: the Pebble Bed Modular Reactor (PBMR). In 1993, the South African energy agency ESKOM, anticipating rising energy demand in the early 21st Century, as well as a drop in its ability to generate cheap electricity, promoted research into a new generation of high-temperature reactors. These had been developed by Germany in the mid-1980s. In 1996, ESKOM bought a licence for building such reactors, thereafter improving many of their elements.

Dr. Nicholls, CEO of PBMR Ltd, indicated at the Marrakech conference that although desalination had always been a secondary consideration in the original development of the PBMR design, discussions with other potential customers have led to an evaluation of the merit of the PBMR for desalination: “This evaluation has been very positive. The PBMR size (400 megawatts thermal and 165-plus megawatts electrical power) linked to its Brayton cycle, leads to a good desalination product.” He explained that linking the PBMR with a reverse osmosis (RO) plant would not require any additional circuit, and that with power consumption for the desalination process of only 13.8 MW out of the total 165 MW output, such a plant could produce about 77,760 cubic meters of water



The Pebble-Bed Modular Reactor’s fuel consists of self-contained and shielded pellets a fraction of an inch in diameter. A kernel of uranium fissile fuel is coated with its graphite moderator, then surrounded by layers of carbon compounds which contain the products of the fission reaction within the fuel kernel. Only the heat escapes.

daily. Dr. Nicholls added that the total maintenance cost (including membrane replacements for the reverse osmosis) would be 2.25% of capital cost per annum. He concluded that "the PBMR is very well suited to combined desalination and electrical production, without impacting the fundamental design."

A PBMR unit is comprised of two essential elements: the reactor—where thermal energy is generated by a nuclear reaction—and the energy-conversion unit, where thermal energy is converted into mechanical work, and then into electric energy, by a thermodynamic cycle and a generator. The PBMR reactor is a gigantic hollow steel cylinder, six meters in diameter and 20 meters high. Its cooling system is helium-based. For reaction control, a graphite cylindrical rod occupies the central axis of the steel tube, and moderates the chain reactions. The reactor's core (3.7 meters in diameter, 9 meters high), is located within the graphite rod itself.

The core's central part contains about 185,000 graphite spheres. The outer shell contains roughly 370,000 fuel spheres. Each such sphere, which resembles a billiard ball, is made up of uranium enriched with 8% U-235, surrounded by carbon or graphite. Gaseous helium filters through the central graphite rod and cools down the reactor core.

The second part of the PBMR is the energy-conversion unit. The heated helium which has recovered the reactor core's caloric energy is compressed during the so-called Brayton thermodynamic cycle.

The question is often posed as to why one should adopt this novel line in high-temperature reactors (HTRs), when there are already perfectly good standard reactors. It so happens that the PBMR is the standard-bearer for a new generation of advanced nuclear reactors. Seen from the vantage point of a developing country, these HTRs present several advantages relative to standard reactors.

First is the Pebble Bed's passive security system: helium is a remarkably stable and chemically inert cooling gas. The graphite used for the fuel spheres remains stable at temperatures of up to 2,800°C. This preserves the fuel elements' initial configuration throughout the chain reaction, and protects the reactor core from meltdown. Lastly, thanks to the carbon envelope surrounding the fuel particles, which serves to isolate radioactive radiation, radioactive waste can be stored far more easily, than in pressurized-water reactors, and it can be done on-site.

The second advantage is quick proliferation of power, with non-proliferation of the materials used in manufacturing atomic weapons; e.g., by extracting plutonium from the waste. The Western world is thus more likely to look favorably on the spread of nuclear power throughout the developing countries, with the HTR. Where a standard thermal, hydro-electric or nuclear power station takes at least eight years to build, leading to a risk of over-capacity, such HTRs can be built in two short years.

High-temperature reactors such as the PBMR also have greater operating flexibility: The modular concept allows mass-production, and new modules can be added on to the primary unit, so as to fine-tune supply to demand within the briefest of time-spans. This can be important during a cold spell for example, when demand soars.

The PBMR allows one to generate, free of charge, surplus thermal energy, which can be used to supply seawater desalinating plants. Compared to other energy generators, the PBMR is relatively cost-efficient: It works out at something like $1.3 million per megawatt, whereas, in South Africa, a thermal reactor costs $900,000, Although the gap would seem to be substantial, it dwindles in the long term, owing to the high cost of mining and moving coal. Lastly, use of PBMRs, relative to coal-burning reactors, would significantly reduce the greenhouse effect.

In addition to shareholder approval, approval to continue with the construction of a demonstration PBMR module is subject to a series of milestone reviews by the South African government, the successful completion of the environmental impact assessment process, and the issuing of a construction license by the National Nuclear Regulator. Assuming a favorable outcome of all these approval processes by March 2003, preliminary construction activities could commence by late 2004.

Energy Deregulation Has Failed in Ontario

by Richard Sanders

The credit ratings of Ontario's electrical distribution companies—formerly parts of Ontario Hydro—were downgraded on Jan. 31, 2002 by Dominion Bond Rating Service, "because," said Dominion analyst Nigel Heath, "of the restrictions put on them as a result of Bill 210, in particular the cap on the distribution rates that's been put in place." Canada's energy "privateers" had been hoping for an annual return of 9.88%, but because of the provincial government spending freeze, they will now earn 6.6%. In November 2002, following a growing consumer revolt over soaring electricity prices after the generating market was deregulated, Ontario Premier Ernie Eves capped retail hydro-electricity rates and distribution rates.

The downgrading will make it more difficult for the utility to raise badly needed funds, and threatens rate increases to the consumers, losses to the distributors, and/or bankruptcy.

How did what used to be the third-largest nuclear utility in the world—with about 15,000 MW installed capacity—end up in this dilemma? Ontario Hydro used to be Canada's largest crown corporation (essentially publicly owned), with