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China pioneers ‘cheap, safe' nuclear reactors

By Mure Dickie

The icy draft whistling through the entrance hall of Tsinghua University's 10-megawatt high-temperature reactor building offers a sharp contrast to the technology humming away unseen behind its walls.

But Chinese nuclear researcher Xu Yuanhui shows no sign of letting the chill of a winter day in north-west Beijing cool his enthusiasm as he introduces a visitor to the science that drives the world's only operational “pebble bed” nuclear reactor.

The warmth of Prof Xu's zeal is understandable. **Pebble bed technology** is a hot topic in nuclear circles, as a consortium including Tsinghua University and leading Chinese power company Huaneng draw up plans to use it for the first time in a commercially-operated power station.

Although just a fifth the size of a standard nuclear power station, the 195MW plant, which backers hope will begin generating power in 2010, could have implications far beyond China.

High-temperature gas-cooled reactors (HTGRs) have for decades offered the theoretical promise of cheap, safe and easily scalable nuclear power and China's bold try at making them work will be closely watched by governments and energy companies around the world.

“If it succeeds, we can then spread this technology both at home and to the whole world,” said Wang Yingsu, a Huaneng official leading the utility's preparations to build the reactor in China's eastern province of Shandong.

At the heart of the pebble bed HTGR's appeal is its claim to “inherent safety” unmatched by the light- water reactors that are the nuclear industry's mainstay.

With a small core and uranium fuel dispersed among tens or hundreds of thousands of carefully engineered billiard ball-sized graphic spheres, the pebble bed reactor is designed to ensure that a meltdown is physically impossible.

In tests, researchers at Tsinghua's Institute of Nuclear and New Energy Technology have actually switched off all its safety systems a move that would be suicidal madness in an ordinary reactor and watched the reactor cool down on its own.

Such demonstrations can help to reassure critics of nuclear power, says Mr Wang.

“Currently in nuclear power stations around the world, it is very difficult to unify both safety and economy if you emphasise economy then there may be a certain loss of safety and if you emphasise safety then it may be a bit less economic,” he said.

“This technology embodies the two features together: safety and economy.”

Built-in safety also means HTGRs should be able to dispense with the hugely expensive containment buildings required by conventional reactors, allowing modular designs that could be built largely in factories and assembled on site.

Pebble bed reactors should also not need regular breaks for refuelling since the fuel spheres are constantly rotated through the core and can be easily individually replaced.

And by using inert helium gas heated to 700°C or more, HTGRs can generate electricity more efficiently than those that rely on cooler and corrosive water. It also makes them a potentially ideal source for the high-temperature process that can be used to produce hydrogen widely seen as the environmentally conscious fuel of the future.

There is no doubting the scale of China's need for more energy options as the country burns ever more coal and imported oil to feed its rapid economic growth.

Beijing is already planning to build the equivalent of 27 new conventional nuclear reactors over the next 15 years but even if that ambitious target is met, nuclear power is still expected to account for only 4-5 per cent of total capacity, up from 1.7 per cent now.

Pebble beds also give Beijing the chance to be a world leader. Germany pioneered the approach, but shut its last prototype reactor in 1989. Meanwhile, progress on a planned South African reactor remains in doubt.

Backers of pebble bed HTGRs still face substantial hurdles, however. Scaling up Tsinghua's technology from under 10 MW to 195 MW is a considerable challenge. The initial cost of the Shandong plant will be around $1,500 (€1,170, £805) per kilowatt similar to that of a standard nuclear plant, since safety savings will rely on later regulatory approval.

Critics also say that safety cannot be assumed. Some warn that an accidental fire could cause deadly radioactive leaks. The lack of a containment vessel could make HTGRs a target for terrorist or military attack. And spent radioactive fuel spheres will still be hazardous for many generations.

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China to pioneer ‘pebble bed’ N-reactor

By Mure Dickie in Beijing

China is poised to develop the world's first commercially operated “pebble bed” nuclear reactor after a Chinese energy consortium chose a site in the eastern province of Shandong to build a 195MW gas-cooled power plant.

An official representing the consortium, led by Huaneng, one of China's biggest power producers, said the proposed reactor could start producing electricity within five years.

If successfully commercialised, the pebble bed reactor would be the first radically new reactor design for several decades. It would push China to the forefront of development of a technology that researchers claim offers a new “meltdown-proof” alternative to standard water-cooled nuclear power stations.

China and South Africa have led efforts to develop “pebble bed” reactors, so called because they are fuelled by small graphite spheres the size of billiard balls, with uranium cores. The reactor's proponents say its small core and the dispersal of its fuel among hundreds of thousands of spheres prevents a meltdown.

Advocates of “modular” pebble bed reactors argue they offer the hope of cheap, safe and easily expandable nuclear power stations a potent appeal for China, which is struggling to meet huge growth in energy demand while avoiding environmental disaster.

Pebble bed reactors are small, which suits remote and rural areas and makes them easy to expand.

The reactor's supporters also argue that the technology is secure from proliferation. The low-enriched uranium fuel consists of half-millimetre-sized particles of uranium dioxide encased in graphite and silicon carbide, which in turn is encased in a graphite ball. Experts say it is expensive and difficult to process such spent fuel. Plans for a rival pilot plant near Cape Town, developed by Eskom, the South African power utility, US-based Exelon and British Nuclear Fuels, have been stalled by environmental challenges.

The Institute of Nuclear and New Energy Technology at Beijing's Tsinghua University, which has links with the Massachusetts Institute of Technology, operates the world's only test pebble bed reactor outside Beijing and is providing the technology for the planned power station.

The Chinese consortium, which includes Huaneng, Tsinghua and China Nuclear Engineering and Construction (CNEC), has identified the city of Weihai on Shandong's northeastern coast as their preferred site for the plant and is preparing to apply for government approval.

Huaneng, one of China's biggest electricity generators, plans to take a 50 per cent stake in the joint venture that will build the plant. CNEC would own 35 per cent and Tsinghua 5 per cent. The remaining 10 per cent may be offered to other investors.

South Africa's President Thabo Mbeki had said his country was seeking co-operation with China for the development of the nuclear technology. The Eskom-led joint venture was hoping to build its test commercial pebble bed reactor within 10 years.