Deccan Herald, Tuesday, December 09, 2008, pp. 3

Pic: NASA

Are we talking moonshine?

It will take a long time before helium-3 can actually be mined from the moon. For now, all talk of transporting bulk quantities of helium-3 and solving power generation problems on earth is moonshine, says C Sivaram

In the 1960s and 70s, both the US and Russia launched several missions to the moon, culminating in the Apollo-manned moon landings. Twelve astronauts spent several hours on the moon bringing back substantial masses of moon rocks. However after these spectacular successes, interest in moon missions waned considerably and missions to Mars, Venus and the other outer planets were dominant for the next two decades.

The main reason for renewed interest has been the realisation that the moon's surface can be tapped as a source for minerals, metals and potential energy sources. Suggestions have been made that by mid-21st century, man should be able to mine the moon and recover rare minerals and metals fast being depleted on earth (like magnesium, titanium, etc) as well as tap helium-3, which is a potential nuclear energy source. The moon is estimated to have at least one million tons of helium-3, which is envisaged by many nuclear power experts to be an important source of the future. This gas is rare on earth. Even for the Chandrayaan mission (which in close orbit around the moon would with its cameras and sensors be looking for Radon-222, as well as several metals like magnesium, titanium, calcium, thorium, etc.), an ISRO statement states, "one area which is seemingly seriously considered is the mining of helium-3 and bringing it to earth for use in nuclear fusion reactors to generate electricity!"

Power of helium-3

It has been estimated that around fifty tons of helium-3 is enough to generate the total power requirement of a country like the US for one year! (One gram of helium-3 undergoing fusion is expected to generate something like a hundred thousand kilowatt hours!) Although the exact quantity of helium-3 present on the moon is not known, it is expected to be about a million tons, if mined all over the surface up to a depth of one metre below.

An important source for the lunar helium-3 is the solar wind (which is rich in this isotope) and continually impinges onto the lunar surface (the moon having no magnetic field the wind charged particles are not deflected).

This is the one reason why it is rare on earth. Apart from the fact that there is no actual evidence so far for any helium-3 on the moon, the whole idea of generating vast amounts of nuclear power by incinerating helium-3 nuclei in a fusion reactor is based on misconceptions.

At all the current fusion test reactor experiments such as the International Test Experimental Reactor (ITER) in France, the fusion fuel used is a mixture of deuterium and tritium (D and T) nuclei, which are isotopes of hydrogen. Helium-3 is not used at all. Even the so-called hydrogen bomb (or thermonuclear device) uses no hydrogen, but only these heavier isotopes, D and T.

The D-T reaction is the most rapid of the reactions among the hydrogen isotopes and can be triggered at even below hundred million degrees. However, this reaction produces a helium-4 nucleus (an alpha particle) and a high-energy neutron which carries the bulk of the reaction energy. This neutron makes the walls of the fusion tokamak reactor radioactive and so is as 'dirty' as conventional nuclear fission reactors based on uranium or plutonium.

The net result of bringing helium-3 all the way from the moon and burning it in a nuclear fusion reactor on earth is to effectively end up with the same old D-T fusion process with its contaminating neutrons. Helium-3 enthusiasts claimed would be avoided and clean nuclear power would be provided! It has been suggested that two helium-3 nuclei can be fused to produce D nucleus and energy. But on earth, this twin nuclear fusion would need a billion or two billion degrees. Even ITER cannot generate energy from D-T. It is only by 2030 that one can hope for a commercial reactor based on only D-T.

For now, transporting bulk quantities of helium-3 and solving power generation problems on earth is just moonshine. Much like what Rutherford famously remarked. "Anyone who expects a source of power from the transformation of the atom," he famously declared, "is talking moonshine."

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