Paper ID: 40623
student

SPACE PROPULSION SYMPOSIUM (C4)
Joint Session on Advanced and Nuclear Power and Propulsion Systems (7-C3.5)

Author: Mr. Pierre EVELLIN
International Space University (ISU), France

Prof. Jean-Jacques Favier
International Space University (ISU), France
Mr. Robert Gevargiz
International Space University (ISU), France

COMPARISON OF NUCLEAR TECHNOLOGIES FOR THE DESIGN OF A 1MW TO 3MW COMPACT POWER PLANT FOR MULTIPLE SPACE USES.

Abstract

New Space put the emphasis on sending humans to the Moon, to Mars, in deep space or to low Earth orbit (LEO) space stations. Technologies are currently under development to achieve such a goal. Missions are designed, analogs are performed, rocket and propulsion are built and technologies are tested but one critical aspect seems to lack deep investigation: power supply. The efficiency of solar panel for long term bases is still open for debate because these kinds of installation would need several MW given some estimates. To go a step further, for large scale colonies, interstellar travel or large space stations, solar panels reach a limitation, even more where the effective time of sun exposure makes the yield drop significantly.

Nuclear power is a controversial candidate for supplying power during these types of missions. The ratio of power supplied is far greater than by solar arrays but the legal aspects, the public opinion and the necessity to refuel are going against this energy source. However, two technologies are competing. The first one is nuclear fission. Sub-technologies are investigated such as pressured water or boiling water reactor, thorium reactors, molten salt reactors or Rubbia reactor. The second one is the fusion technology. It has a great potential like suggested in the ICARUS project from The British Interplanetary Society.

A comparison between those two technologies is performed, highlighting the main challenges in the design of those reactors adapted to space that shall provide between 1MW and 3MW. Different aspects are analyzed: safety, efficiency, fuel management, weight, volume, existing technologies, economics, policy and ethics. On the one hand, the fission reactors appear to be technically more feasible but the legal and ethical constraints are very heavy, especially due to the fuel in classic fission. On the other hand, the fusion reactor is an uncertain bet given the unknown time needed to get a mature technology, for example, ITER expects promising results around 2060, but once this issue is solved, it is the most promising compact reactor because all the other issues are easily fixed.