POWER PLANT CONCEPTUAL DESIGN FOR FAST IGNITION HEAVY ION FUSION

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A conventional way of implementation of HIF energy is based on indirect target drive. This is motivated by large stopping ranges of heavy ions. A direct drive can be well adjusted to cylindrical targets. The concept of fast ignition heavy ion fusion (FIHIF) suggests a detonation burning of precompressed DT fuel as a basic scenario for target ignition. The cylindrical target composed of concentric massive shell and inner cylinder of fuel is driven by the two high power heavy ions beams of 100-GeV ions. The first beam of hollow tube geometry deposits its energy into the shell causing compression of fuel by imploding shell material. The second sharply focused beam impacts on the front end of the high density cord of fuel, thus initiating a detonation wave propagating along the cord. The compression beam of Pt^{+}_{192} ions is arranged by rotation of a single beam. The ignition beam of high power is composed of Pt ions of four different masses and plus/minus one charge states. The efficiency of the driver of RF linac type is evaluated as 0.25.

The energy released in the target microexplosion is partitioned in 546 MJ for neutrons, 187 MJ for debris and 17 MJ for X-rays. The X-ray pulse is characterized by very long duration of about 0.7 ms and by mean temperature of 30 eV. A wetted wall design is chosen for the reactor chamber. The chamber consists of the two adjacent sections: the upper section is the explosion section itself and the lower section is an expansion volume for the condensation of vapor on sprayed jets.

The response of the reactor chamber to the microexplosion is started by the X-ray impact. This results in evaporation of 5.4 kg of coolant from the liquid film at the first wall and generation of recoil pressure of 700 bar.

The neutron heating of the blanket is determined for a design, which is modeled by a multilayer cylinder. The energy deposition at the first wall is determined as 22 MJ/m^3 for liquid film and 20 MJ/m^3 for SiC porous structure. This should result in pressure pulse generation, the maximum amplitude of which is evaluated for isochoric heating as 400 bar that does not exceed the yield strength of silicon carbide. Tritium breeding ratio for the blanket is 1.05 and blanket multiplication factor is 1.1.

The energy conversion system consists of three loops. The maximum temperature of $Li_{17}Pb_{83}$ in the first loop is taken as 823 K. The inlet temperature in the reactor chamber is 623K. The initial steam pressure is taken as 180 bar. The efficiency of the steam cycle is equal to 0.417. The resulting net efficiency of the power plant is 0.37, providing the net power for one reactor chamber of 670 MW.