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R&D Status of Reduced Activation Ferritic/Martensitic Steel for CN TBM

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To provide structural material support for the design and fabrication of Chinese Helium-Cooled Ceramic tritium Breeder test blanket module (CN HCCB TBM) as well as for China demonstration (DEMO), a kind of Reduced Activation Ferritic/Martensitic (RAFM) steel named CLF-1 has been developed at Southwestern Institute of Physics (SWIP) in China since 2003.

With the cooperation among domestic institutes and factories, a lot of products have been produced, including 5 ton plates with different thickness from 2mm to 35mm, welding fillers and different size of tubes/pipes, which have totally fulfilled the needs for manufacturing small size mock-ups. Now a 1/3 size CN HCCB TBM has been successfully manufactured. Compared with other RAFM steels, the CLF-1 steel has similar physical properties and relatively higher tensile strength, especially the thermal creep properties. These advantages may be resulted from its fully martensitic microstructure with fine and dispersed tiny carbides.

According to the structure design of CN HCCB TBM, a detailed R&D program on various joining technologies is undergoing to support the design. Both electron beam welding (EB) and tungsten inert gas welding (TIG) showed that preheating was not necessary but a post-welding heat treatment is essential for sound joint. Currently these joining technologies are being applied for different size plates and for the joining of plates and pipes to make the joining techniques applicable for TBM manufacturing.

A neutron irradiation campaign has been started in the high flux engineering test reactor (HFETR) in China. In 2014 a target dose irradiation level will be about 1 dpa and the irradiation temperature is 300°C. The irradiation experiments are aiming to provide the basic irradiation database required for fusion blanket design, including the effects of neutron irradiation on the mechanical properties, microstructures and so on.

A qualification program of CLF-1 steel has been started at SWIP. In future, larger scale ingots of CLF-1 steel larger than 5 tons will be produced to provide material for the material qualification and TBM manufacturing on the required scale. Various properties including more neutron irradiation properties will be measured to sufficient data for specifying the design criteria.

Country or International Organisation

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