HIGH-TEMPERATURE MECHANICAL PROPERTIES OF 9CR OXIDE DISPERSION STRENGTHENED STEEL AS COMPARED WITH RAFM STEELS

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Reduced activation ferritic/martensitic steels (RAFMs) are considered as the primary candidates of blanket structural materials because of matured technology base and good resistance to neutron irradiation. However, RAFMs intrinsically allow operation at the temperature below about 550°C as the rapid decrease in yield and creep strength.

In order to increase the efficiency for fusion power production by achieving higher plant operation temperature, efforts need to be made for improving the high-temperature strength of RAFMs. An improved concept for this purpose is to use the oxide dispersion strengthened (ODS) steels, the advanced alloys based on the RAFMs.

In 2009, an advanced 9Cr-ODS steel was produced by mechanical alloying and delivered for studies under a cooperation program among Japanese universities and National Institute for Fusion Science. In this work, high-temperature mechanical properties of this 9Cr-ODS steel were systematically studied focusing on tensile and creep behavior. These properties were evaluated and compared with those of the normal RAFMs of JLF-1 and CLAM, Japanese and Chinese candidates, respectively. The longer-term creep behavior was predicted by Larson-Miller parameter. The mechanism of creep deformation will be discussed.

The present results showed that, the ODS steel has excellent tensile and creep strength, which can successfully increase the maximum operation temperature by about 100-150°C relative to RAFMs, as shown in Fig.1. Assuming an operation temperature at 550°C for 100,000 hrs, applied stress for ODS steel can be 280 MPa, which is twice larger than 140 MPa for RAFMs. Increasing the temperature to 700°C, the applied stress is about 120 MPa for ODS steel, which is only slight smaller than that for RAFMs at 550°C.

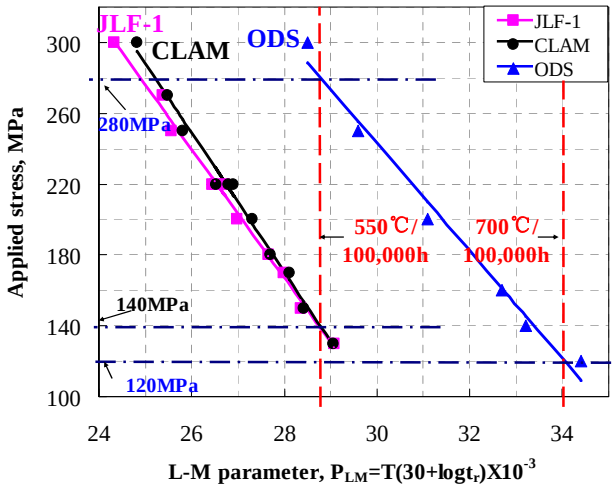

Figure 1: Stress vs. Larson-Miller parameter relationship for ODS, JLF-1 and CLAM steels