Abstract

Tribological problems are of significance for several engineering components made of austenitic stainless steels used in sodium cooled fast breeder reactors (FBRs). Sliding, reciprocating and rotational motions as well as static contact between the mating components of Prototype Fast Breeder Reactor (PFBR) lead to adhesive wear, high friction coefficient and the tendency for self-welding. One of the commonly adopted solutions to overcome these problems is to provide a hard coating on the mating surfaces of the components. The primary focus of this investigation is to understand the tribological behaviour of Ni-Cr-B hardface coating in flowing sodium for efficient functioning of the PFBR.

Ni-Cr-B hardface coating, processed by gas tungsten arc welding, on 316LN stainless steel substrate has been used in this investigation. The chemistry, microstructural features, phase constituents, mechanical properties like hardness, and the nature of bonding between the coating and the substrate were examined prior to tribological studies. Tribological behaviour of Ni-Cr-B hardface coating has been investigated in liquid sodium at 823 K using an in-house designed and fabricated set-up, supplemented by similar tests in air for both substrate and the coating at room temperature. Ni-Cr-B hardface coating exhibits lower wear rate compared to 316LN stainless steel because of its considerably higher hardness than the substrate. The wear damage in Ni-Cr-B coating has been attributed to work hardening and surface delamination, unlike severe plastic deformation and fracture in 316LN stainless steel. The selected hardface coating indicates lower friction coefficient in flowing sodium than in air. This has been explained by the lubrication effect due to liquid sodium and the inference has been supported by surface damage analyses by SEM and confocal microscopy.

The major inferences from this investigation are: (i) friction coefficients and wear rates of Ni-Cr-B hardface coating in liquid sodium at 823 K are of magnitudes that are well within the design criteria for various components of PFBR, (ii) a high temperature pin-on-disc tribometer with design features suitable for testing in liquid sodium environment is successfully designed, fabricated, installed and tested in reactor grade flowing sodium and (iii) self-welding is unlikely to occur in the mating surfaces of Ni-Cr-B hardface coatings for reactor operation of 40 years.

Keywords: *austenitic stainless steel, fast breeder reactor, liquid sodium, wear, friction, self-welding, Ni-Cr-B hardface coating, pin-on-disc tribometer*