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Reciprocating wear of WC-6 wt.% Co alloys in synthetic mine water

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Abstract

The focus in this study was to conduct an investigation on the corrosive wear behaviour of WC-6 wt.% Co hardmetals used for drilling in a mining environment. The wear behaviour was characterised by sliding the WC-6 wt.% Co buttons against 3CR12 stainless steel and mild steel, in a ball-on-flat configuration (ASTM G133) in synthetic mine water, with distilled water as a reference solution, and identifying the wear mechanisms. Standard potentio-dynamic corrosion tests were conducted to determine the corrosion behaviour. The WC-6 wt.% Co experienced higher wear rates when sliding against 304L stainless steel than mild steel. The dimensional wear rate coefficient indicated that the WC-6 wt.% Co/3CR12 sliding system was 52% more severe than the WC-6wt.% Co/mild steel system. Discolouration of both the WC-6 wt.% Co and the steel counterfaces were noted as evidence of chemical reactions during sliding. The wear mechanism of the steel counterfaces was severe plastic deformation, followed by groove formation caused by ploughing. The wear mechanism of the WC-6 wt.% Co was characterized by the removal of the cobalt binder matrix, followed by micro-cracking of the exposed WC grains. Adhesion of the steels to the WC-6 wt.% Co buttons was confirmed by EDS analysis. The corrosion rate of WC-6 wt.% Co was found to be 40% more in synthetic mine water when compared to the distilled water reference solution and indicated pseudo passivation behavior. Synthetic mine water showed an aggressive corrosive-wear synergism in the carbide-steel sliding systems, which led to a reduction in life of the materials.