Surface coatings for 3-piece freight bogie centre bearings

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10.0 Thesis Conclusions

The first objective of this thesis was to study the rim wall wear of un lubricated steel, and polyethylene centre bearing components. The wear depth rate of the AISI 1053 steel top centre was approximately twice that of the Hadfield steel centre bowl liner. The two most important findings of this section of work were that the worn Hadfield steel centre bowl liners showed significant near surface work hardening, and the wear mechanism for the AISI 1053 steel top centre was plastic strain accumulation in conjunction with low cycle fatigue.

An alternative material pair for the centre bearing was sought. Hadfield steel was retained as one of the bearing surfaces. Plasma nitrided AISI 4016 molybdenum steel and stellite 6 laser clad layers were studied as possible alternative centre bearing materials. The objectives of the second and third sections of work included to determine the optimum processing conditions of these materials. Samples were produced using four (4) different processing conditions. For plasma nitriding, the temperature was varied: 450, 500, 550 and 580 °C, whilst for laser cladding, the processing speed was varied: 600, 900, 1200 and 1500 mm/min. All other processing parameters were held constant. Subsequently, based upon the results of the materials characterisation of these samples, the optimum processing condition(s) for plasma nitriding and laser clad Stellite 6 layers were, at a temperature of 500 °C and at a processing speed of 600 to 900 mm/min, respectively.

Finally, in the last section of work, the reciprocating pin-on-plate wear test method is used to evaluate the friction and wear of the existing and alternative centre bearing material pairs. The existing material pairs tested were Hadfield pin - AISI 1053 steel
plate, Hadfield pin - untreated AISI 4016 steel plate, and HDPE pin – Hadfield steel plate, whilst the alternative material pairs tested were Hadfield pin - plasma nitrided AISI 4016 steel (500 °C) plate, and Hadfield pin – laser clad Stellite 6 (600 mm/min) plate. The wear test conditions provided a reasonable simulation of the rim wall operating conditions for the Hadfield steel pin – plasma nitrided AISI 4016 steel (500 °C) plate and Hadfield steel pin – laser clad Stellite 6 (600 mm/min) plate material pairs. The Hadfield steel pin – nitried AISI 4016 steel (500 °C) plate material pair performed best under these wear test conditions, however further research is required before it could be trialed as an alternative centre bearing material.
11.0 Recommendations for future work

The effect, if any, of impact loads on the rim wall wear of the centre bearing needs to be clarified. Reciprocating sliding friction and wear tests of the AISI 1053 steel - Hadfield steel existing material pair should be conducted using a large-scale flat-on-flat tribometer. Then, the surface and near surface cross-sectional microhardness and microstructure can be compared to the results included in this thesis.

In conjunction to this work, the rim wall load and sliding speed conditions during entry to and progression through the transition curve should be determined using real-life measurements, and/or a dynamic model, for centre bearing plate material pairs with different co-efficients of friction.

Once the loading conditions are accurately determined, a suitable friction and wear tribometer could be used to test Hadfield steel - plasma nitrided (500 ºC) AISI 4016 molybdenum steel, and self-mated stellite 6 material pairs. The Hadfield steel - plasma nitrided (500 ºC) AISI 4016 molybdenum steel material pair should be studied as nitrided and with the compound layer removed by grinding or polishing.