CHAPTER 8

SUMMARY AND SUGGESTIONS FOR FUTURE WORK

8.1 INTRODUCTION

This chapter of the thesis summarizes important observations and includes suggestions for future research.

8.2 SUMMARY

A detailed study was carried out to investigate the effect of hot-corrosion and surface modification on high-temperature erosion behavior of Type 446 stainless steel. Optimization of parameters using statistical modelling to minimize the erosion loss of the material was done. Effect of pre-hot corrosion on erosion behavior of Type 446 stainless steel was investigated in the 2SM environment at 550, 650 and, 750℃. Also, high-temperature erosion behaviour of surface-modified Type 446 stainless steel under hot corrosion conditions was studied. The major findings are concluded in the subsequent sections.

8.2.1 HIGH-TEMPERATURE EROSION

The erosion rate is seen to remain unchanged virtually up to 350℃ and follows a sharp increase up to 550℃ before stabilizing with moderate erosion rate at 650℃. Morphology of erosion is characterized by groove indentation, craters and plough marks. The fracture of embedded particles, the crests and plough marks are more intense with the increase in temperature. The erosion rate is inversely proportional to the angle of impact, due to lower resistance offered by the material to the shear force acting at a high velocity of impact. The oblique impact showed consistent ripples formed due to the plastic flow of material. These ripples changed to deranged scars for higher impact angles. The role of oxidation is insignificant between RT and 650℃.

8.2.2 MODELLING AND OPTIMIZATION

Optimization of erosion rate with variable input parameters reveals that "test temperature" is the most dominant factor for erosion rate followed by impact velocity and impact angle. The minimum erosion rate was achieved using the mathematical model at 350℃ test temperature, 55 m/s impact velocity, and 90º impact angle. The results are in accordance with the established theory of maximum wear rate with oblique impact and vice-versa. Validation of the mathematical model using ANN showed 9.12% variation when compared to measured values indicating the acceptability of predicted data

8.2.3 HOT CORROSION

The hot corroded samples exposed to 550℃ has a golden grey surface appearance with very little scaling, while at 650℃, the appearance is dark reddish-brown with spalling of the scale. The surface appears to be dim-grey in colour with heavy spalling of fragile scale when exposed to 750℃. Two salt mixture (75Na_2SO_4/25NaCl) deposited sample when exposed at 650 and 750℃ for 20 h, formed crevices/cracks and delamination of the weakly bonded layer due to evaporation of chlorides. Also, during the process of hot corrosion, the formation of pits/cracks led to degradation of the surface making the materials more susceptible to mechanical damage.

8.2.4 SURFACE MODIFICATION

Ultrafine grains near the surface region of Type 446 stainless steel resulting from ultrasonic shot peening was observed for different durations from 60 seconds to 180 seconds. The near-surface microstructure was examined using TEM and XRD and 52-65 nm grains were developed with no evidence of phase transformation in the surface. However, microchipping was observed in the sample when subjected to 180 seconds of USSP. The gradient microstructure formed can be distinguished from the top surface as equiaxed ultrafine grains and strain-free matrix. Surface roughness also increased with USSP duration. Microhardness of the USSPed samples increased and was found to gradually decrease from the surface towards the interior.

8.3 SUGGESTIONS FOR FUTURE WORK

The following suggestions are made for future work based on the present investigations:

a) Investigating the incubation time for the material under variable impingement velocity.
b) Examine the erosion wear as a function of discharge rate.
c) Enhancement in erosion resistance using thermal barrier coating.
d) Plastic deformation modelling of the surface under high velocity particle impact.
e) Effect of oxide scales, formed during high-temperature erosion, in protecting the erosion of the surface.