CHAPTER 5

Conclusions and Recommendations

5.1 Conclusions

SPB was conducted using the thermo-mechanically treated DSS (superplastic DSS) under different temperature (K) ranging from 1223 K to 1323 K and strain from 0.2 to 0.6. The kinetic of the process was also determined. The results are summarized as follows:

(a) A boronized layer with a uniform, smooth and dense morphology, identified as FeB, Fe_2B, CrB, CrB_4 and Ni_3B formed on the surface of boronized specimens.

(b) Boronized layer thickness and surface hardness in the range of 10.7 µm to 29.0 µm and 302.7 Hv to 1687.7 Hv were obtained respectively for the SPB process.

(c) The boronized layer thickness (17.3 µm) and surface hardness (1252.5 Hv) were obtained after SPB for 50 minutes under 1223 K, which are almost similar to that of CB (19 µm, 1250 Hv) at the same temperature for 60 minutes.

(d) The activation energy of the SPB and CB process was 111 KJ mol^{-1} and 192.1 KJ mol^{-1} respectively. SPB reduced the energy required for boron atoms to diffuse into DSS.

(e) SPB method consumed less boronizing powder compared to CB method. The boronizing powder consumed and pack thickness for SPB was only 10 g and 5 mm as compared to 37.7 g and 13 mm for conventional process. SPB is more economical to be used in application that only required boronizing one site surface of specimen.

5.2 Recommendations

Some considerations were suggested to further investigate and develop this new surface hardening technology as follows:

- Look into more microstructure characterization methods to evaluate the boron content of boronized samples such as chemical analysis with EPMA (electron probe micro-analyzer).
- Carry out mechanical testing such as wear and corrosion resistance to study the surface hardness of the boronized samples.
- Investigate the effect and phenomenon of superplasticity using liquid or gaseous as boronizing medium.
- Develop the true optimized boronizing processes in the present work through statistical and mathematical techniques. Apply statistical optimization procedures and response surface methodology (RSM) to evaluate the effects of several process variables and their interactions on response variables.
- Study the application of the produced material and its potential applications in the industry.