CHAPTER VI

CONCLUSION

The abrasive wear behavior of heat treated hypoeutectic 16 mass% Cr cast irons without and with Mo was investigated. After annealing, the cast irons were hardened at 1323 K and tempered at three level temperatures, before H_{Tmax} (B-H_{Tmax}), at H_{Tmax} and over H_{Tmax} (O-H_{Tmax}). The effects of hardness, matrix microstructure and volume fraction of retained austenite (V_γ) which varied Mo content and heat treatment conditions on wear behavior were clarify. The following conclusions have been draw from the experimental results and discussions.

6.1 Change in hardness of specimen by heat treatment condition

(1) In as-hardened state, the macro-hardness did not change but the micro-hardness increased gradually as Mo content increased.

(2) In tempered state, the macro-hardness curve showed a secondary hardening due to the precipitation of secondary carbides and the transformation of destabilized austenite into martensite. The degree of secondary hardening was greater in Mo specimen compared with Mo-free specimen. The micro-hardness curve showed the similar behavior to the macro-hardness curve.

6.2 Change in volume fraction of retained austenite (V_γ) of Specimen by heat treatment condition

(3) In as-hardened state, the V_γ increased gradually with an increase in Mo content.

(4) In tempered state, the V_γ in as-hardened state decreased remarkably as the tempering temperature increased and the V_γ value at the H_{Tmax} was less than 6%.

6.3 Behavior of abrasion wear

(5) The linear relationship was obtained between wear loss and wear distance. The highest wear resistance or the lowest R_W value was obtained in the H_{Tmax} specimen for Suga abrasion wear test and as-hardened specimen (As-H specimen) for Rubber wheel abrasion wear test. The lowest wear resistance or highest R_W value was obtained in O-H_{Tmax} specimen.

(6) At the same heat treatment condition, the R_W value in the Suga abrasion wear test was much larger than that of Rubber wheel abrasion wear test. The absolute wear rate per unit area (R_{WT}) of Suga abrasion wear test was ten times as large as that in Rubber wheel abrasion wear test.

(7) When the effect of Mo content was considered, the smallest R_W was obtained in 3% Mo specimen for Suga abrasion wear test and 1% Mo specimen for Rubber wheel abrasion wear test.

(8) The R_W of each specimen were increased proportionally with an increase in applied load in Suga abrasion wear test.

(9) The R_W decreased with an increase in the macro-hardness. The macro-hardness had more effect on Suga abrasion wear test than Rubber wheel abrasion wear test and the sensitivity was three times as large as that of Rubber wheel abrasion wear test.

(10) The smallest R_w appeared at certain amount of retained austenite, 15%V_γ for Suga abrasion wear test and at 10 to 15%V_γ for Rubber wheel abrasion wear test.

(11) The R_w was decreased with increasing Mo content and the V_γ at the minimum R_w shifts to high V_γ side in Suga abrasion wear test. In Rubber wheel abrasion wear test, however, the R_w did not show clear behavior.

(12) An increase in cooling rate by oil-quenching method leaded to improve the wear resistance due to the perfect hardening.

(13) The presence of M_2C carbides in 3% Mo specimen might reduce the wear resistance in Rubber wheel abrasion wear test.

6.4 Mechanism of abrasion wear

Suga abrasion wear test

(14) At the early state, the matrix was preferably cut off or worn and removed more than the eutectic carbides. Once this phenomenon continued to occur, cracks possibly prodeced in the eutectic carbides. Resultantly, spalling of carbides could take place.

(15) From the microphotograph, the matrix areas showed the fine area in the worn surface. It was also found that the eutectic carbides were worn by scratching and/or spalling and the area corresponded to the rougher area on the worn surface produced by grooving and tearing.

Rubber wheel abrasion wear test

(16) At beginning of wear the surface was quite smooth. When the test proceeded, the surface got uneven and worn by SiO_2 sands. At this point, the soft matrix was worn more than the hard carbide region. Then the eutectic carbides projected from the worn surface.

(17) The microphotograph displayed initiation of crack at the portion of the projection with eutectic structure and/or carbide itself. Then the crack propagates in the carbides and subsequently the projection would be removed by abrasive particles.