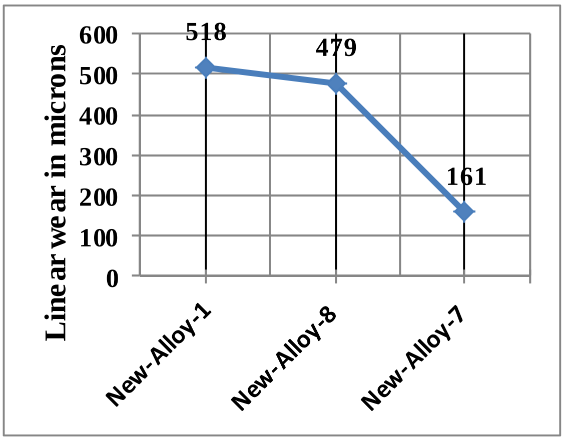


Figure 5: GCI, ACI, ACCI

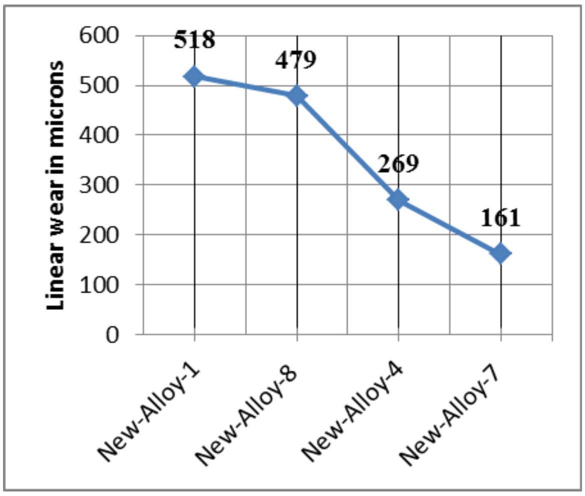
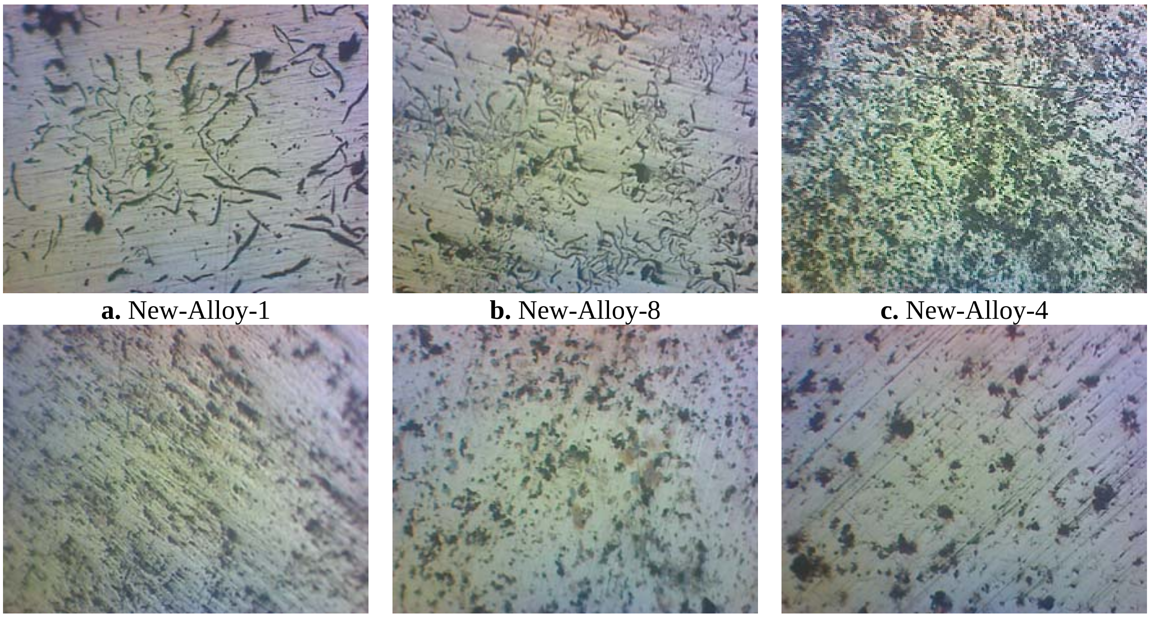


Figure 6: GCI, ACI, CCI, ACCI



a. New-Alloy-1 **b.** New-Alloy-8 **c.** New-Alloy-4

d. New-Alloy-6 **e.** New-Alloy-5 **f.** New-Alloy-7

Figure 8: Micrographs of GCI, ACI, CCI and ACCI- Magnification-100X

3.2 Microstructure

Figure 8a to Figure 8f is selected to analyze the microstructure of GCI, ACI, CCI and ACCI casted products at various conditions. Figure 8a shows the longer size graphite's with uniform and random distribution. Figure 8b shows the smaller size graphite's as compare to Figure 8a with rosette and random distribution. In Figure 8c, graphite distribution is not clear. From the image analyzer (Material plus) data, graphite flakes length are smaller than Figure 8a and Figure 8b.Pearrlite formation is dominated as compare to ferrite. Figure 8d, Figure 8.e and Figure 8f, graphite flakes are not clear as shown, but smaller compact graphite's with domination of pearlite and cementite. Due to this, machining was difficult near the chilled surface because of absence of prominent graphite.

4. Conclusions

The following inferences are made from the test results.

a. Variation in chill thickness:

New-Alloy-1 is dominated with graphite flake size of 4. Few graphite flakes size of 3 and 5 are also noticed. In New-Alloy-1 (No Chill), graphite flakes are clear and shows the microstructure similar to normal grey cast iron. Uniform and random distribution of graphite flakes leads to reduce the wear resistance (High wear of 518 microns). In New-Alloy-2, wear of 430 micron was measured. In New-Alloy-3, higher thickness MSC was used as compared to New-Alloy-2, hence wear is reduced from 430 to 410 microns. New-Alloy-4 (MSC-30X25 mm) shows the dominance in flake size of 6. Precipitation of carbon in iron to form iron carbide. Microstructure shows the formation of pearlite and cementite (High concentration of black zone- Fe_3C). This lead to decrease the linear wear (269 microns).

Graphite flake size number varies inversely with length of the flakes. Flake size number-3 is longer in length than flake size number-8 (1-2 inch –AFS and ATM). Higher the flake length leads to increase the wear. Concentration of pearlite and cementite (Figure 8c) decreases the wear.

Figure 4 clearly indicates that, higher the chill thickness leads to decrease the wear on the cast surfaces. Comparing the values of wear, there is a marginal difference in wear results between New-Alloy-2 and New-Alloy-3. It is clear from the experimental results that small MS chill thickness from 15 to 20 mm has not shown significant change in wear (430 to 410 microns). Using higher MS chill thickness of 30 mm resulted in reducing the wear to 269 microns.

33% increase in chill thickness (15-20mm) leads to reduce the wear by 5% (430 to 410 microns).
50% increase in chill thickness (20-30mm) leads to reduce the wear by 34% (410-269 microns).
100% increase in chill thickness (15-30mm) leads to reduce the wear by 37.5% (430-269 microns).

b. GCI, ACI and ACCI:
Addition of chromium (1.5%) and nickel (1.5%) without using chill has not shown any appreciable change in wear (518 to 479 microns). Combined effect of using chill and addition of above alloys leads to reduce the wear from 479 to 169 microns. Micrographs (Figure 8a and Figure 8b) shows longer graphite flakes leads to increase the wear. Whereas Figure 8f shows the concentration of pearlite/cementite which leads to reduce the wear drastically (High wear resistant).

c. GCI, ACI, CCI and ACCI:

- Using chill of 30mm thickness leads to reduce the wear (518 to 269 microns).
- Nickel addition (2.3%) with chilling effect leads to reduce wear (182 microns).
- Only addition of chromium (1%) and chill effect leads to higher wear resistance (131microns).
- Adding both chromium and nickel (1.5% each) with chill effect leads to increase the wear (169 microns).

Wear ratio **ACCI: CCI: ACI: GCI** is given as:

(182/ 169/ 131): 269: 479:518 microns.

By considering ACCI wear of 131 microns, the ratio can be written as **1: 2: 3.6: 3.9.**
It is understood from experimental results that wear is less with the combined effect of alloyed chilled casting. Only MSC effect leads to increase the wear by two times than ACCI.
Use of only alloys without MSC leads to increase the wear by 3.6 times than ACCI.
Present results concludes that addition of only chromium is preferred with MSC to increase the wear resistance (reduce wear).
Machining near to the chill end needs to have skill in selection of machine tool, tool material etc. It is observed by the micrographs and past results [15] that chilling effect is drastically decreases after 8-10mm from the chill end.

5. Scope for Future Work

MS chill thickness can be increase and tested for wear. Research can be extended by increasing %age addition of chromium with MS chill effect to increase wear resistance and optimize the same considering the economical factors.

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Acknowledgements

Thanks to the Management, HKBK College of Engineering, Bengaluru for providing laboratory facilities and giving encouragement. My profound gratitude to the fellow researchers and colleagues Dr. Sandeep Shastry, Pro Vice Chancellor, JAIN University, Dr. K. Venkatesh, Dean Engineering, JAIN University, Dr. K. Venkateswarlu, Principal Scientist, National Aeronautics Laboratory, Dr. S. G. Rakesh, Associate Dean, Amrita School of Engineering Dr. S. R. Nagaraja ,Chairman-ME , Amrita School of Engineering, Bengaluru, Dr. S. S. Kubsad, PG Coordinator, EPCE, Bangalore and Dr. Sayeed Ahmed Khan, Psychiatrist, Leicester hospital, Leicester, UK.

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