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Study of the wear behavior of limestone impact crusher blow bar

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Abstract:
Wear is produced when two elements press against each other, such as apron liner, blow bars and crushing material. During this process, small materials from each element become detached, causing the surface to wear away. A primary factor in wear for crushing applications is abrasion. The blow bars on the rotor of an impact crusher wears faster because of the impact and rubbing with material during crushing. This contributes to about 60 % of the cost of wear parts in an impact crusher. This study is focus on wear analysis of rotor blow bars of a compound impact crusher used in limestone crushing. The wear rate on the blow bars were calculated using the measured length of the blow bar before and after crushing 100,000 tons of limestone. The blow bars are refilled and hard-faced to prolong it life span. However, wear analysis shows high wear toward the centre of the blow bar and this can be attributed to non-uniform feeding of the crusher. The wear rate was found to be 0.000160, at point A and E, 0.000172, at point B and D and 0.000194 mm/ton at point C. The blow bars wearing is due to trickle feed which gives uneven and excessive wear at the centre and reduces the life of the blow bar. The material feed rate was adjusted and uniform feed was maintained through the entire length of the blow bar. Rotor speed was checked and adjusted, cleaning was intensified in the chamberand discharge gap setting was adjusted to 50 mm. The wear on blow bar decreases to 0.000114 mm/ton of limestone crushed after the intervention with uniform and gentle radius profile on the blow bar.

Key Word:*Impact crusher; Blow bars; Wear; Wear rate*

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I. Introduction

Impact crusher use impact energy to crush materials. The crusher has a shaft that runs through the crushing chamber with a rotor that turns blow bars [1]. It uses the high-speed impacting force of the turning blow bars projections to break the material. The material is thrown to the impact plates for crushing and shot back to the blow bars again.This process is repeated until the materials are crushed to the required size and discharged through the discharging opening at the bottom of the crusher [2]. With impact crushing, the material breaks along its natural cleavage lines, resulting in a more cubical product at high reduction ratios [2, 3]. The gap between the impact rack and rotor support are adjusted to the size and shape of the end products. Figure 1 below shows a view of a hazemag impact crusher showing all the wear parts and other component.

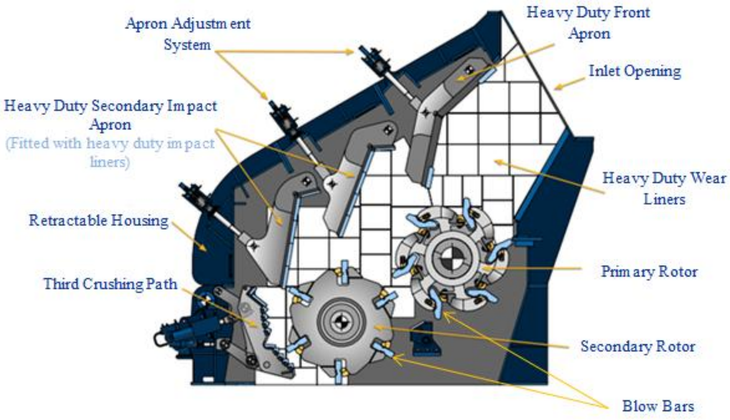


Figure 1: Compound impact crusher [3]

Wear on the crusher element

During material crushing in an impact crusher, wear is produced when the elements press against each other, such as liner, blow bars and crushing material. During this process, small materials from each element become detached, causing the surface to wear away [4]. The primary factor in wear for crushing applications is abrasion. Material fatigue is also a factor as the wear material is subjected to numerous pressure and impact stresses [3]. There are several factors that influence the wear behavior of in an impact crusher. Figure 2 below summarizes some of the factors that affect the wear lifetime of crusher wear parts [5].

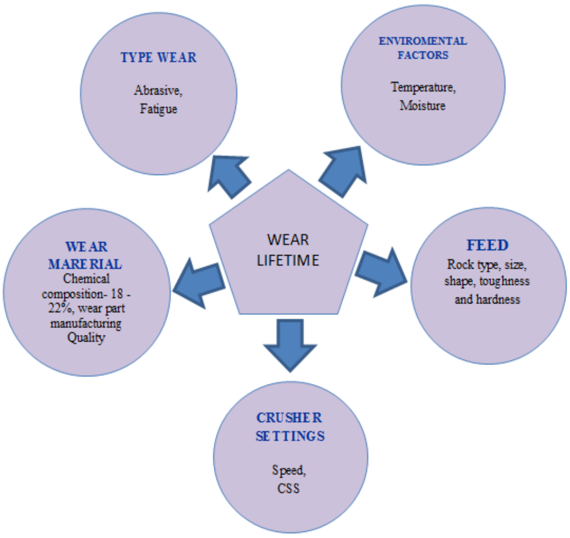


Figure 2 Factors that affect the wear lifetime of crusher wear parts [5].

The impact elements, blow bars, apron liners and side liners are made from wear resistant materials for long wear life. Figure 3 below shows wear comparison of the wear parts in an impact crusher irrespective of the factors shown in figure 2. The blow bars wears faster because of the impact and rubbing with material [4,5] (twice as fast as the apron liner plate and these contributes to about 60 % of the cost of wear parts).

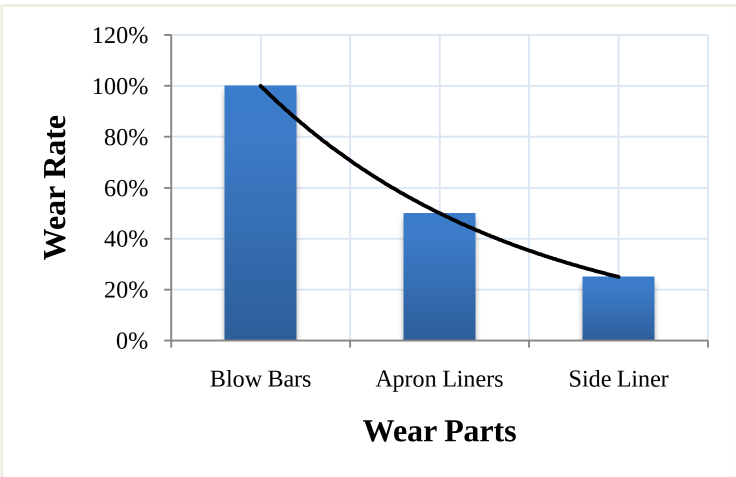


Figure 3 Wear comparisons of an impact wear parts [5].

Types of Blow bar wear

Material feed, rotor speed, moisture content, fineness content and crusher ratio are the major factors that influences the wear rate of blow bar aside the blow bar material [3,4]. Controlling these factors means reducing the wear rate on blow bars (optimizing the blow bar) and reduces the cost of wear part.

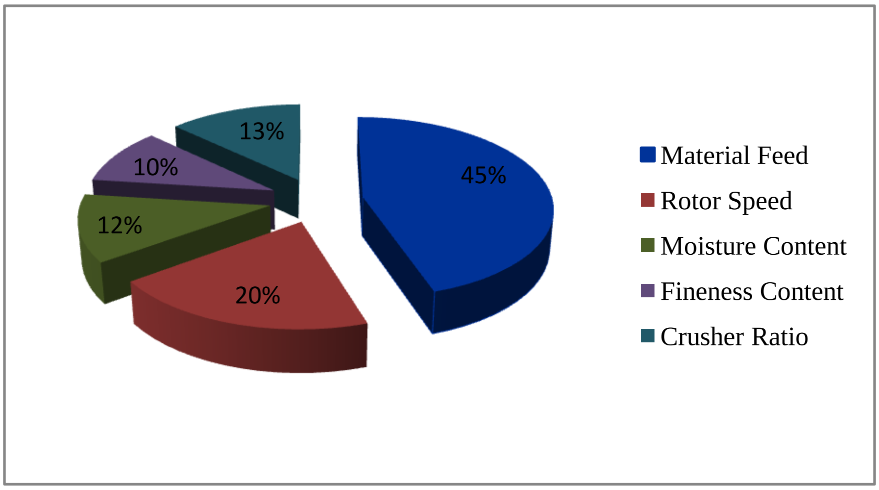


Figure 4 Blow bar wear factor considerations [4]

When a blow bar life is optimized, a gentle radius on the blow bar is formed, this shows the material feed in to the crusher is the correct size; the rotor penetration and rotor speed are correct, correct blow bar for the feed material is being used and machine parameter is correctly set up [6]. The profile of an optimized blow bar is shown in Figure 5 below

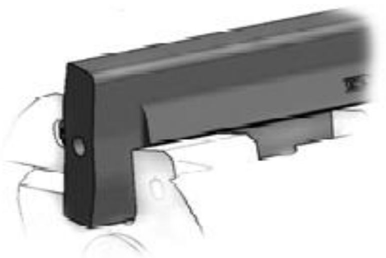


Figure 5 Optimized blow bar profile

If the rotor speed is too slow the risk of breakage on the blow bar increases due to excessive penetration on the blow bar. This means the blow bars are underutilized before changing and will lead to rotor wear which shortens it life span. On the other hand, If the rotor speed is too high, Wear rates will be excessive due to poor penetration. This means the top of the blow bar is worn down flat. This output reduces and creates lot of fines material. Figue 6a and b represent the pattern of excessive and over penetration on rotor blow bar [5, 7].

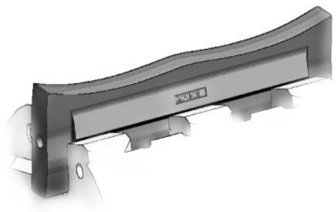
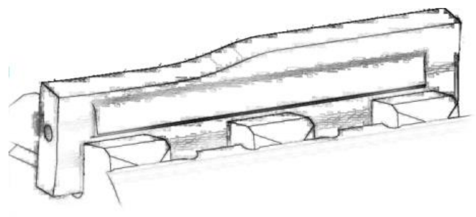
(a) Excessive penetration on blow bar (b) over penetration on blow bar

Figure 6 Blow bar wear due to in apocopate rotor speed

Another form of wear on the blow bars is the wearing of blow bar towards the centre is due to trickle feed which gives uneven and excessive wear at the centre and reduces the life of the blow bar. This type of wear can be address by increasing feed to the crusher.

Blow bar wearing excessively to one side is due to material falling to one side. [5, 8]

Excessive wear at both ends impact crushers problem wear on the sides of the blow bar this type of wear happens when there is high percentage of fines in the feed or overfeed causing fines to be pushed to outside [5, 9]. Crusher chamber contaminated with caked material can also cause friction wear on the blow bar. Figure 7a, b and c

(a) Blow bar wear to the centre (b) blow bar wear to one side

(c) Blow bar wear to both sides.
Figure 7 Blow bar wear due to poor material feed and build-up in the crusher.

Breaking of the blow bar is majorly attributed from foreign material loaded in the chamber. Either tooth from loading machines or fallen heavy duly impact plate. Blow bar can also break due to quality of blow bar material, wrong choice of blow bar or crushing hard materials [5, 8, 10]

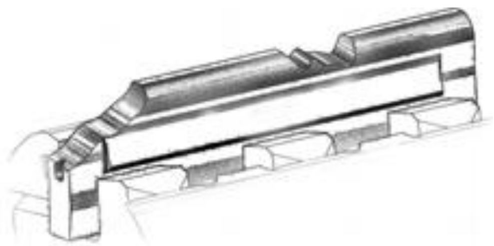


Figure 8. Wear pattern and damage on blow bar

II. Material and Methods

Materials

The material use for this study are:

i. Holmes Hazemagimpact crusher Model AP6. BRD. COMP
ii. Miller welding machine (Big blue 500 CC/DC)
iii. Refilling (build up)welding electrode
iv. Hard facing electrode
v. Depth vernier caliper 0 – 200 mm stainless steel for blow bar wears measurement.

Method

The wear rate measurement on blow bars start with a reference value after installation of new blow bar. The length of the blow bar was measured at five different points marked A, B, C, D and E as shown in the figure 9. After crushing 100, 000 tons of limestone, the crusher was stopped, cleaned, inspected and the length of the blow bars was measured before and after refilling (build up) and hard facing the blow bars. The blow bars wear rate are calculated according to equation 1 below

$$wear\ rate = \frac{l_1 - l_2}{Q_m} \qquad (1)$$

Were:
l_1 length of blow bar measured before crushing material in mm
l_2 length of blow bar measured after crushing material in mm
Q_m is the quantity of material crushed

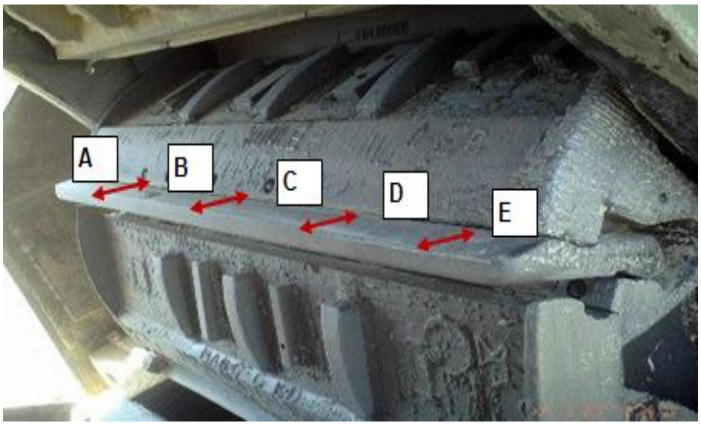


Figure 9 Blow bar measurement at different points

III. Result and discussion

The average wear rate of the six blow bars on the rotor measured at different point was found to be 0.000160, at point A and E, 0.000172, at point Band D and 0.000194 mm/ton at point C. This indicates high wear at the centre of the blow baras shown on the error bars in figure 10a to e. This happens due to trickle feed which gives uneven and excessive wear at the centre of the blow bar. The blow bars were refilled and hard faced to prolong it lifetime before reaching the action value were the blow bar reversal or replacement is recommended. If the blow bars are not reversed or changed after reaching its action values, crushing will be on the rotor thereby creating high wear and imbalance on the rotor which can lead to premature failure.

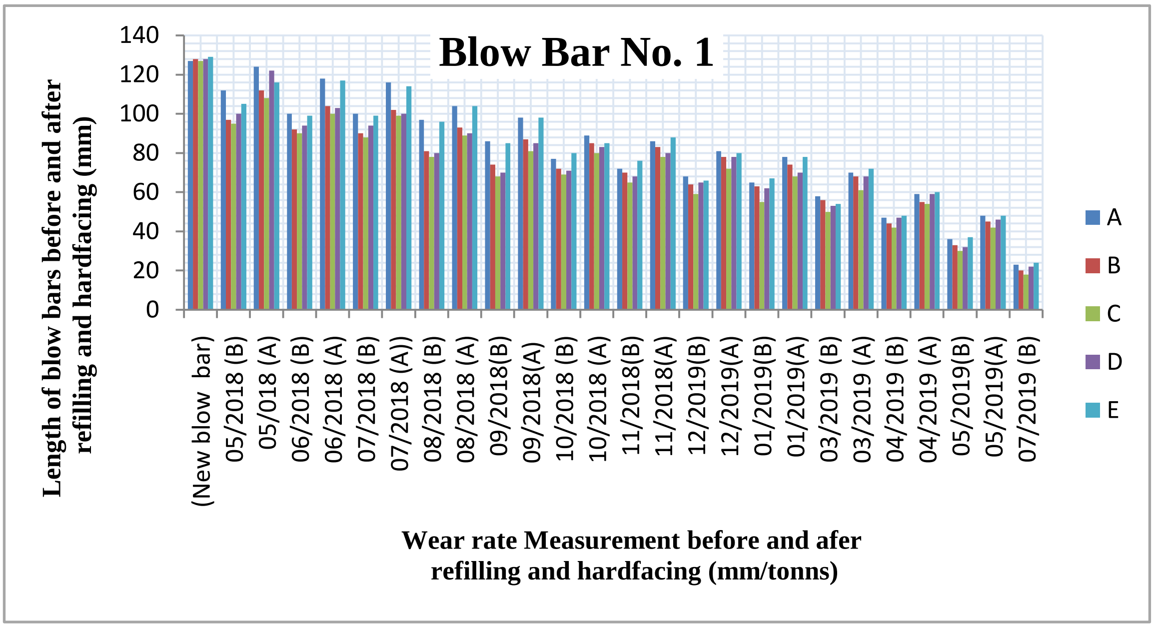


Figure 8a Wear rateof No. 1 blow bar before and after refilling and hard facing at point A, B, C, D and E

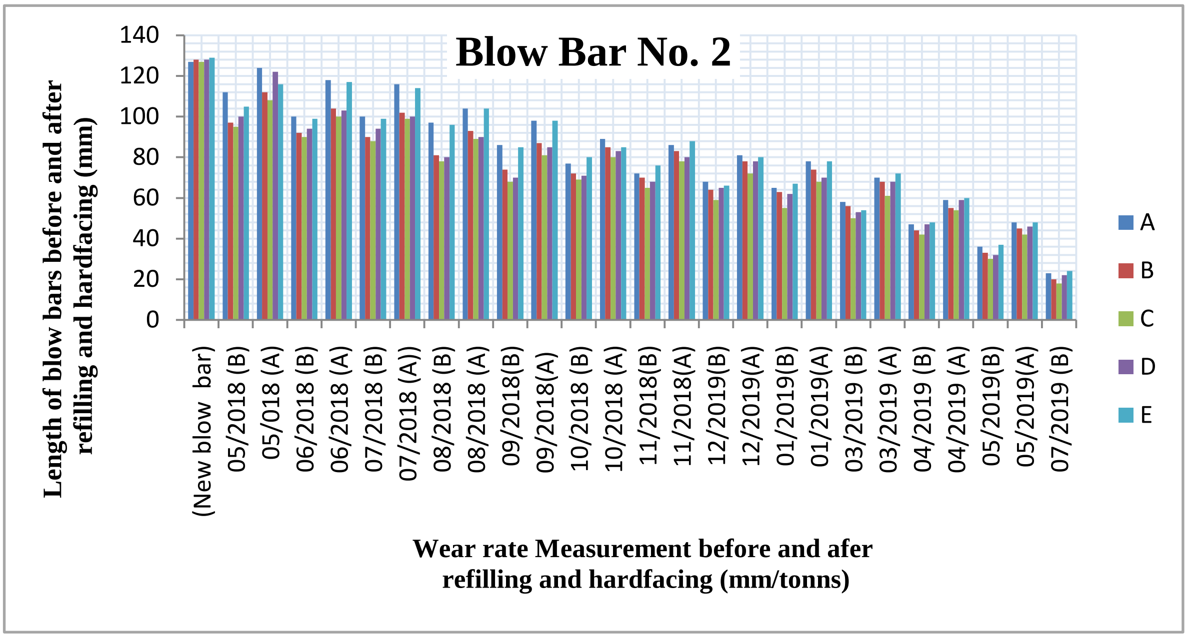


Figure 8b Wear rate of No. 2 blow bar before and after refilling and hard facing at point A, B, C, D and E

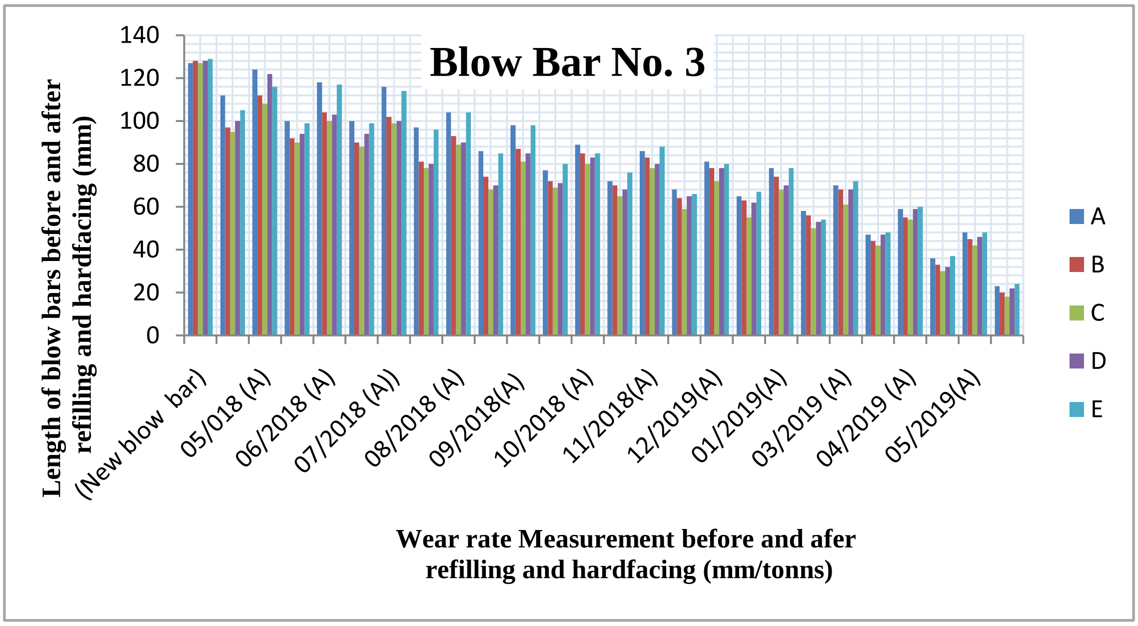


Figure 8c Wear rate of No. 3 blow bar before and after refilling and hard facing at point A, B, C, D and E

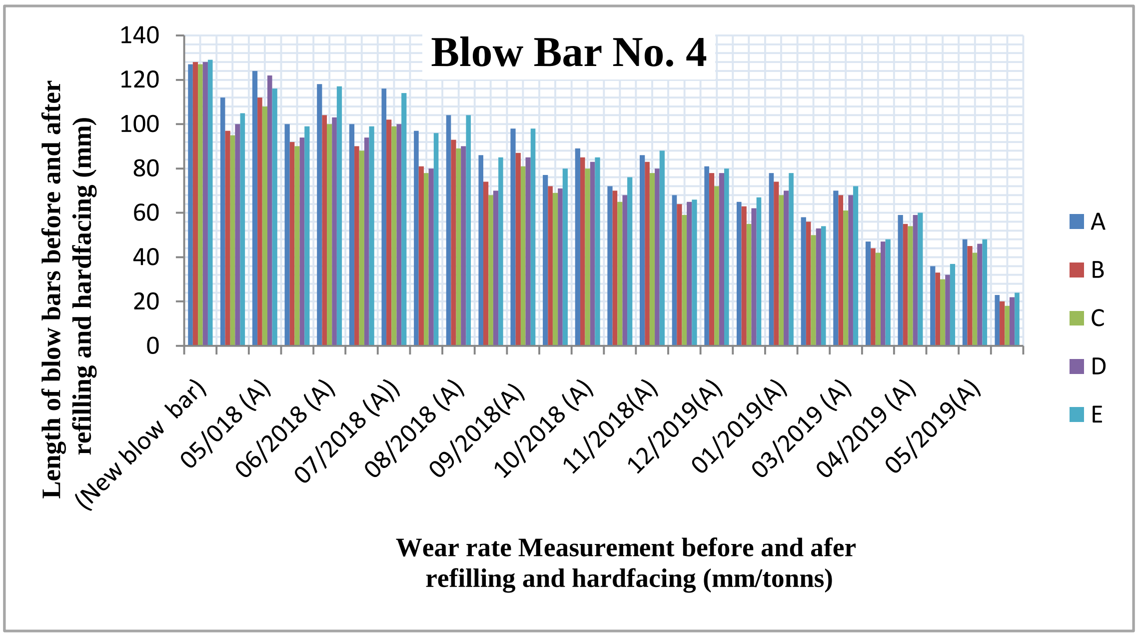


Figure 8d Wear rate of No. 4 blow bar before and after refilling and hard facing at point A, B, C, D and E

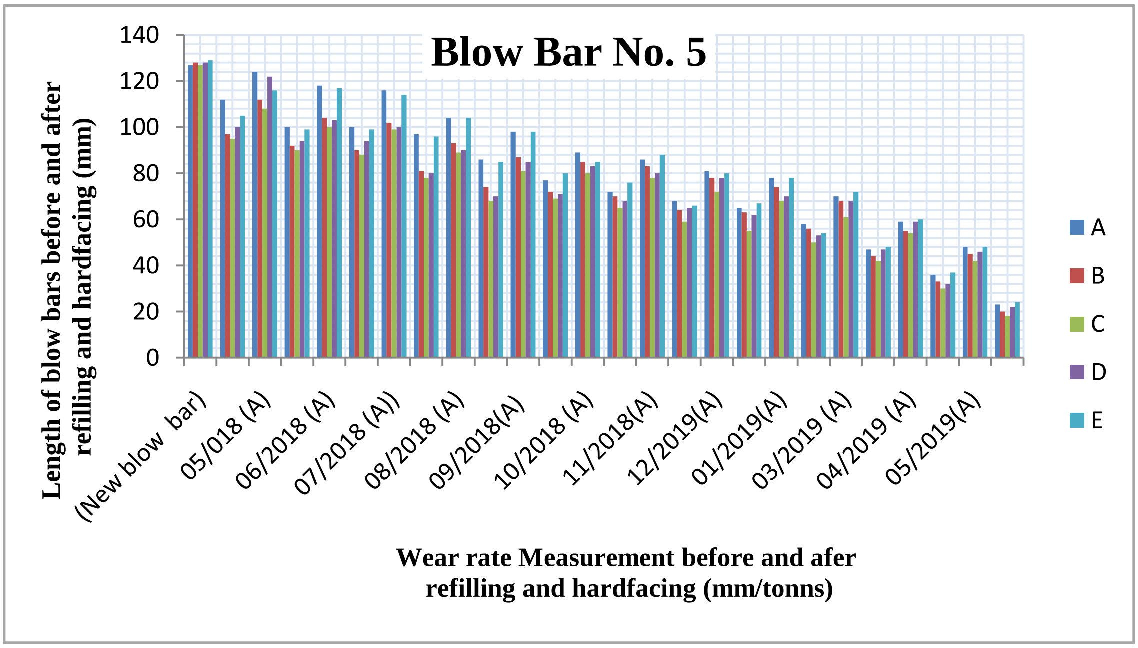


Figure 8e Wear rate of No. 5 blow bar before and after refilling and hard facing at point A, B, C, D and E

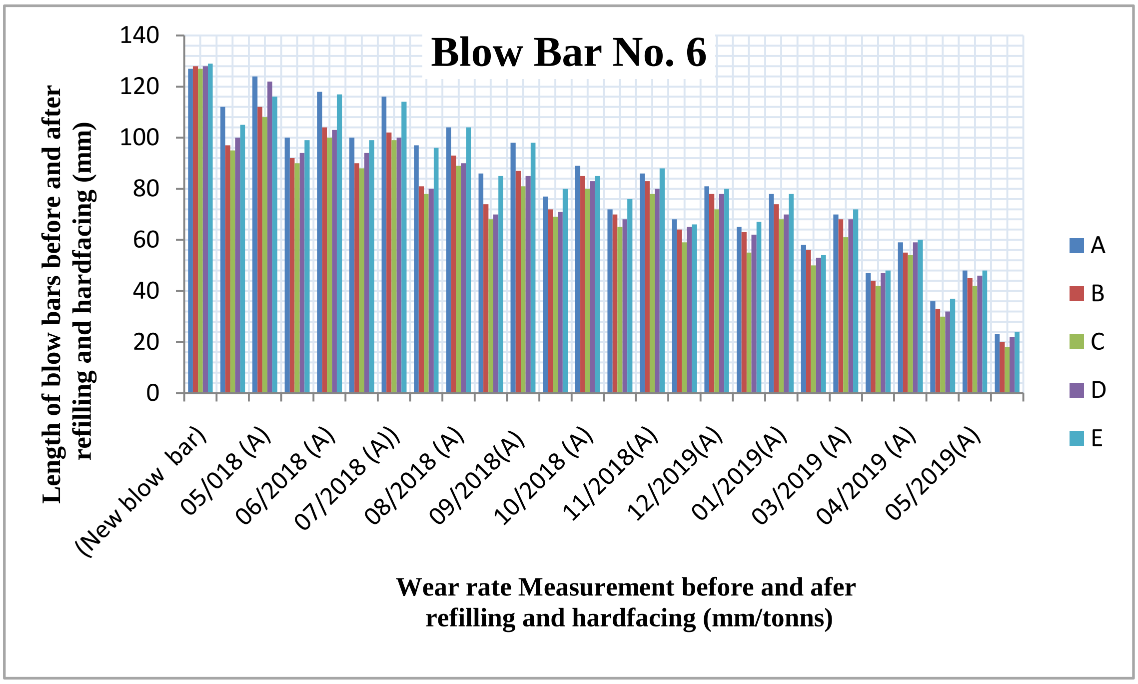


Figure 8f Wear rate of No. 6 blow bar before and after refilling and hard facing at point A, B, C, D and E

Based on the wear profile observed on the blow bars as shown on figure 10 a to e, it can be concluded that there is trickle feed to the crusher or material build up at the edges of the crusher inlet which gives uneven and excessive wear at the centre.The following measures were put in place to correct the high wear picked at the center of the blow bar.

- Uniform material feeding to the crusher was maintained
- Rotor speed checked and found to be within required speed
- Material moisture content adjusted to 10% on average and maintained,
- Discharge gap setting adjusted to 50 mm material size maximum [5, 11]
- Material build up at the crusher inlet were cleared and regular cleaning of the chamber was maintained.

After the above intervention, the length of the blow bar was measure after crushing 100,000 ton of limestone and 200,000 ton. The blow bars profile were observed and found to have worn uniformly at 0.000124 mm/ton on average at point A, B, C D and E. Also, a gentle radius was observed on the blow bar. This shows the material fed in to the crusher is the correct size; the rotor penetration and speed is correct, correct blow bar for the feed material is being used and machine parameter is correctly set up.

IV Conclusion

The wear rate of the rotor blow bar was optimized by ensuring that the material fed in to the crusher is the correct size, rotor penetration and speed is correct, correct blow bar for the feed material is being used and machine parameter (such as gap setting) is correctly set up. This established that any deviation from the wear parameter impact significantly on the wear rate and maintenance cost.

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