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# On The Use of Low Cost Sensors for Condition Monitoring Of Grinding Wheels

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**Abstract**— Grinding wheels are normally monitored by complex and costly equipment like acoustic emission sensors and grinding cycle monitors. In the present work, an attempt is made to utilize simple instruments like lux meter for condition monitoring of grinding wheels. As grinding progresses, the metal particles get clogged into the spaces between the abrasive cutting edges of the grinding wheel. This changes the reflectivity of the grinding wheel surface. This change can be captured by using a lux meter. The paper demonstrates the usage of simple lux meter for condition monitoring of grinding wheels.

**Keywords**— wheel clogging, wheel dressing, lux meter.

## I. INTRODUCTION

Grinding operation is considered to be one of the most important manufacturing processes and its complex nature leads to difficulties in measurement. Surface topography of the grinding wheel needs to be monitored continuously for quality production. There are three main mechanisms of wheel wear: attritious wear, grain fracture and bond fracture [1]. Attritious wear involve dulling of abrasive grains and plays an important role in improving the quality. This paper discusses on the use of low cost sensor to determine the wheel clogging, hence providing information to dress the wheel. The author [2] describes wheel condition monitoring using acoustic emission. Dressing is very important for quality performance of grinding wheel. The use of laser by M.J. Jackson [3] has been emphasized to dress and clean the chip stuck in the wheel.

## II. METHODS OF MEASUREMENT

In the past, researchers have come up with many methods to find out different parameters, but many have not taken the cost involved in it. A non-contact type white chromatic sensor has been used to determine the wheel topography [4]. A proper method of evaluating a grinding wheel has been described by M. K. Krueger et al [5]. A low cost method of measurement has been proposed to determine the wheel clogging and the need for dressing using sensors. These two parameters are vital in grinding performance and also for the quality of the product. Two methods which have been adopted are use of lux meter and carbon print.

### *A. Use Of Lux Meter*

Use of non-contact type sensor has been profound to measure the wheel clogging. The following procedure is adopted for measurement:

i. Four points A, B, C and D on wheel periphery are marked. (Fig 1 shows the wheel marking).
ii. Light from a laser source is made to fall on the grinding wheel surface.
iii. Next using a lux meter the reflected light from the wheel surface is captured and the light intensity is measured. (This intensity provides us the measure of wheel clogging).
iv. Now the wheel is stopped and the intensity is measured at the midpoint of the segment A, B, C, D.
v. The above steps are done for the following cases:
- After dressing
- After grinding


Fig.1. Wheel partition

### B. *Lux Meter*

Lux meter is device that is used to measure the light intensity. It consists of a photo detector and a display unit. The lux meter used is shown in fig 2. The specifications of the lux meter are shown in table I.

TABLE I
Lux Meter Specification

| Range | Resolution | Accuracy |
|---|---|---|
| 0-1,999 lux | 1 lux | ±(5%+2d) |
| 2,000-19,990 lux | 10 lux | ±(5%+2d) |
| 20,000-50,000 lux | 100 lux | ±(5%+2d) |


Fig. 2 Lux meter

### C. *Placement Of Lux Meter*

Placing a sensor is important to ensure repeatability in measurement. It is difficult to mount a sensor on a rotating tool [2]. Lux meter must be placed in a suitable position so that the sparks do not strike the photodetector and damage it.

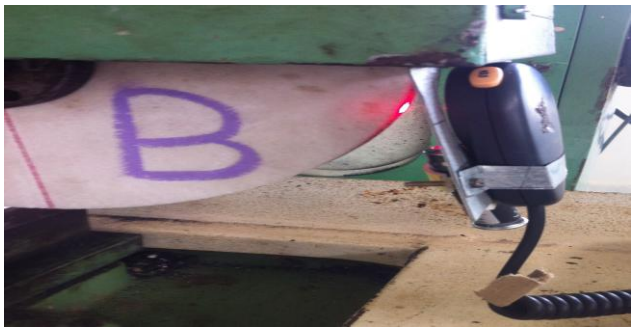


Fig. 3. Placement of sensor

Hence the sensor was placed in a direction opposite to that of the spark. A suitable clamp was fabricated to position the sensor without any modification in the machine seen in fig 3. Lux meter is built in with a photodetector (83*52*20.5) mm and a display unit, the device detects the light intensity that falls on the sensors. Fig 3 shows the placement of sensor in the surface grinding machine. The source is a red laser light of wavelength around 650nm with output less than 1mW.

### D. *Carbon print*

Use of carbon print is a conventional method for measuring the wheel topography [6]. In this paper it is done by rolling the wheel on the butter paper beneath which the carbon sheet and paper is placed respectively. Fig 4 shows the wheel being rolled on the paper and the wheel surface being printed on the sheet.


Fig. 4 Method of carbon print

Butter paper is used so that the carbon paper does not stick to the wheel. The wheel rotates in the anti-clockwise direction as the cross sectional feed is provided to get the carbon print.

## III. EXPERIMENTAL SETUP

The experiment was carried on a surface grinding machine. The parameters used for the experiment is shown in the table II.

TABLE II
Experiment Condition

| | |
|---|---|
| **Work piece** | Mild steel (99*76*10)mm |
| **Depth of cut** | 0.03mm/pass |
| **Total no of passes** | 50 |
| **Spindle speed** | 2800rpm |
| **Electric motor** | 0.75hp |
| **Grinding wheel size** | 200*13*31.75mm |
| **Grinding wheel grade** | AA60K5V8 |
| **Diamond dresser with holder** | 0.5CR |

## IV. OBSERVATION

The lux value for every 5 passes is noted for each segment A, B, C, D. The lux value after every 5 passes is tabulated shown in table III.

TABLE III
Lux reading after dressing and every five passes of grinding

| | **Point A** | **Point B** | **Point C** | **Point D** | **Average** |
|---|---|---|---|---|---|
| after dressing | 347 | 345 | 392 | 373 | 364.25 |
| pass 5 | 340 | 349 | 371 | 361 | 355.25 |
| pass 10 | 322 | 327 | 367 | 357 | 343.25 |
| pass 15 | 323 | 323 | 370 | 352 | 342 |
| pass 20 | 328 | 328 | 360 | 338 | 338.5 |
| pass 25 | 316 | 301 | 358 | 330 | 326.25 |
| pass 30 | 305 | 299 | 405 | 309 | 329.5 |
| pass 35 | 307 | 254 | 305 | 295 | 290.25 |
| pass 40 | 183 | 166 | 275 | 245 | 217.25 |
| pass 45 | 148 | 126 | 216 | 231 | 180.25 |
| pass 50 | 136 | 128 | 126 | 209 | 149.75 |

After the lux meter reading is noted, carbon print for every 5 passes is taken. The fig 6 shows the carbon print for 5, 20, 35 and 50$^{th}$ pass

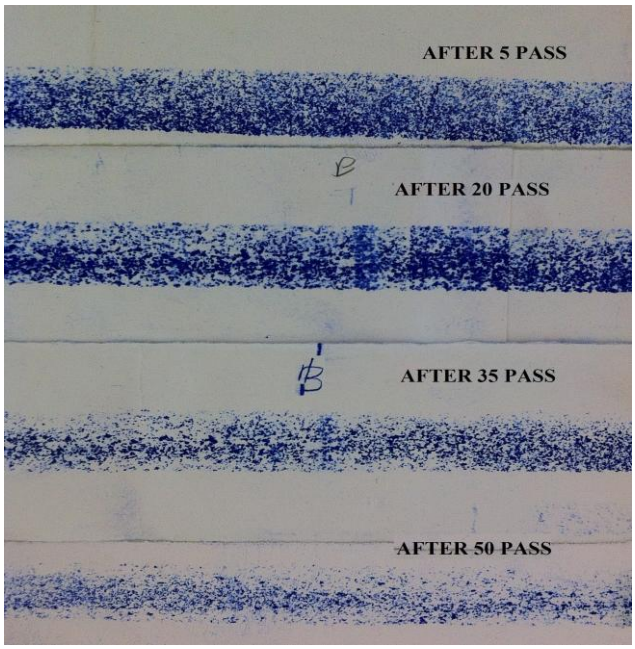


Fig. 5 Carbon print for different pass

## V. RESULTS AND DISCUSSION

The grinding result is summarized in terms of lux reading and carbon print.
From table III it is clear that as the number of passes is increased the light intensity decreases due to wheel clogging. Fig 6 indicates that after pass 35 there is a rapid decrease in lux reading indicating increase in clogging. This information can be useful, as an alarm signal for need for dressing.

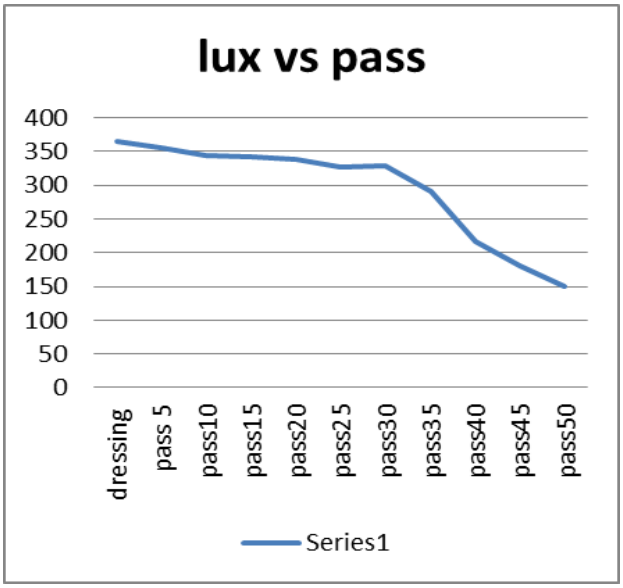


Fig. 6 A graph is plotted between lux and average pass.

As seen in the fig 6 during the initial stage of the pass the grains are sharp and get a clear print of the wheel topology and grains are placed at equally spaced, as the number of pass increases, there is a change in topology of the wheel, due to clogging. The wheel gets dull as a result

the grains are not printed properly with visible voids on the paper.
Comparing fig 5 & 6 the 35$^{th}$ pass where clogging is very high, the carbon print also shows a smeared appearance.

## VI. CONCLUSION

A study has been conducted to measure the wheel clogging and need for dressing, with the use of lux meter and the results are promising. The results show that lux meter can be used to measure the wheel clogging and notify the operator for the time for dressing. This can provide improvement in grinding performance.

## REFERENCES


[1]. K. Fathima, A. Senthil Kumar∗, M. Rahman, H.S. Lim," *A study on wear mechanism and wear reduction strategies in grinding wheels used for ELID grinding*", Wear 254 ,pp 1247–1255, 2003.

[2]. Ichiro Inasaki," *Application of acoustic emission sensor for monitoring machining processes*", Ultrasonics 36,pp 273-281,1998.

[3]. M.J. Jackson , A. Khangar , X. Chenc, G.M. Robinson , V.C. Venkatesh , N.B. Dahotre, *Laser cleaning and dressing of vitrified grinding wheels*, Journal of Materials Processing Technology 185, pp17–23,2007.

[4]. Abdalslam Darafon, AndrewWarkentin, RobertBauer," *Characterization of grinding wheel topography using a white chromatic sensor*" International Journal of Machine Tools & Manufacture 70, pp 22–31,2013.

[5]. M. K. Krueger, S. C. Yoon, D.Gong," *New Technology in Metalworking Fluids and Grinding Wheels Achieves Tenfold Improvement in Grinding Performance*", Coolants/Lubricants for Metal Cutting and Grinding Conference, 2000.

[6]. Brinksmeier, F. Werner," *Monitoring of Grinding Wheel Wear",* Annals of the CIRP Vol. 41, pp 373-376, 1992.