Tool Wear Studies on EN24 Material

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Abstract:

This paper highlights the determination of the tool wear by turning operation using EN24 material. And by effecting of temperature generated at the tool tip. The heat generated at the tool chip interface dissipates the heat into the tool, which causes the rise in temperature at the tool tip. The temperature rise in cutting tool tends to soften it and causes loss of tool material in the cutting edge leading to its failure. In present study the three different cutting parameters are considered like transverse speed of the tool, rotary speed of the work piece and depth of cut. These different parameters are taken into account to so as to predict their effects on the tool wear. The temperature of the tool tip is observed using infrared thermometer. The challenges involved in measurement of wear of single point cutting tool are: the wear volume is very low in the order of cubic microns, wear is more than one dimension, and the wear is not exactly along uniform straight line. We address these challenges using image processing techniques that offer's superior ability visualization to take images of the tool. Using calibration grid wear is measured. These front and top view images are imported in to AUTO CAD. From these images solid models are designed and tool wear is computed as volume. We present the results of tool wear using high speed steel single point cutting tool machining EN24 work material in terms of factors mentioned above.

Keywords: HSS Tool, EN24 Work Material, Attrition Visualization MCVV01, Calibration Grid, AUTOCAD.

1. Introduction:

Tool wear describes the gradual failure of cutting tools due to regular operation. It is a term often associated with tipped tools, tool bits, or drill bits that are used with tools. The general effects of tool wear include: poor surface finish, increased cutting forces, increased cutting temperature's, decreased accuracy of the finished part, may lead to tool breakage and causes changes in tool geometry. In single point cutting tool wear various parameters involved in metal turning process are feed rate, depth of cut, cutting speed, rake angle, tool and work piece materials and tool nose radius. The major parameters affecting the temperature distribution in turning of HSS tool are the depth of cut, feed rate and cutting speed. By varying the depth of cut, tool transverse speed and work piece rotational speed the temperature and tool wear is measured. To observe the temperature various methods available like thermocouple method, infrared photographic technique, thermal radiation, thermo sensitive methods and thermocouple insert techniques etc. In this present study infrared thermometer is used to observe the temperature at different cuts of length. The image processing techniques those offer superior ability visualization to measure tool wear. With image processing device front and top view images are produced. With the help of images the 3d model is created in AUTOCAD software to measure tool wear.

1.1 Objectives of the Study:

Study of the tool wear effect in turning operation and temperature effect on tool.By taking images from imageprocessing device modeling 3d object in AUTOCAD and computing tool wear volume.

2. Literature Review:

Wear of the cutting tool is undesirable as it effects surface roughness of the work piece, consumes more power, and increases tool temperature leading to tool failure. We need to resharpen the cutting tool consuming more time. Many researches have work on these issues. Rathod, Mohd. Razik (1): suggested that cutting speed, feed rate, and depth of cut, in such a way so as to have the optimum temperature at the tool tip because of the heat generated, so that the minimum tool wear is encountered, and thus we could have the longest tool life and better machining economy. Safal, Amar and Chetan (2): studied the depth of cut increases, the Von-Mises stresses developed in the tool. It is the main reason for tool failure. Also, there is a sudden rise in temperature of the tool tip as the depth of cut is increased which softens the tool from the tip. It adds to the failure of the tool. Lakshmi Kumari, IrfanSadaq, Prasana Kumar (3) : observed that, as the cutting speed increases the temperature of tool increases up to certain speed and then approximately remains

Hassan, Rizauddin (4): Tool wear is a time dependent process in which tool wear increases gradually with the cutting time. Nitin, Swati (5): Tool surface temperature and tool-workpiece interference temperature are increasing with increasing the depth of cut. Interference temperature is more increasing compare to tool surface temperature. Tool surface temperature is decreasing 10-15□c and Tool- workpiece interference temperature is decreasing 12-23□c using coolant so increasing the tool life by coolant. Tool weight loss is decreasing with increasing the depth of cut. Tool weight loss is decreasing when coolant used and increasing the tool life. Dinc, Lazoglua, Serpenguzel (6): The maximum tool–chip interface temperature increases with increasing cutting velocity, the maximum tool–chip interface temperature increases with increasing feed rate. The relationship between the maximum tool–chip interface temperature and the tool rake angle is not distinctive. Kapil Sharma, Dalgobind and S.S. Sen3 (7): The cutting force decreases as the tool rake angle increases. With increase in feed rate, this tends increase in cutting force. The increase in absolute value of negative tool rake angle and cutting speed these results in the decrement of tool chip friction. The tool tip temperature increases with an increase in cutting speed.

3. Experimental Work:

In this study EN24 material taken as work piece and tool is HSS. The work piece diameter Φ25mm length 350mm. The tool

constant. But the temperature of chip and work piece increases as cutting speed increases. Jaharah, Muhammad Rizal, MohdZaki, Che

shank cross section: 12.6mm x12.6mm and tool geometry is back rake angle:45°, side rake angle:7°, end relief angle:6°, side relief angle:8°,end cutting edge angle:18°, side cutting angle:16° and nose radius 0.8mm. The tests were performed based on various parameters like depth of cut (t), tool transverse speed (v) and work piece rotation speed (rpm).

Depth of cut (t) in mm	Length of cut (L) in mm	Tool velocity (v) in mm/min	Work piece rotation in rpm
0.5	300	28	306
1	300	28	200
1.5	300	28	200
0.5	300	42	460
1	300	42	306
1.5	300	42	306
0.5	300	64	700
1	300	64	460
1.5	300	64	460

Table 1: Various Parameters in Turning Operation

3.1 Tool Wear with Effect of Temperature:

Heat has critical influences on machining. To some extent, it can increase tool wear and then reduce tool life. In machining operations all most all of the mechanical energy converted into thermal energy. There are three zones at which heat is generated during cutting, they are: **Primary deformation zone-shear zone:** In the primary deformation zone, the heat generation is due to the plastic work done (plastic deformation) at shear plane. The high amount of heat generated in this area causes softening of the material and allowing the greater deformation. This region consumes about 70% of total energy applied. **Secondary deformation zone:** Heat generated by the secondary deformation due to the friction between the rake face and heated chip. About 20% of total energy

consumed in the secondary deformation zone. This energy used to overcome the friction. **Work tool interface:** In work tool interface, the heat generated by burnishing action due to the rubbing of tool flank and the machined surface. Heat generated in this region is very small as compared to another zone. Due to these heat effect the tool wear increase. The tool temperature is measured with the infrared thermo meter to study the temperature effect on tool wear at various conditions. Based on these tool wear is measured at different temperature's.

3.2 Tool Wear Image Capture Arrangement:-

In this device two slots are provided to keep the tool whose are horizontal and vertical slots. From the horizontal position front view image and from vertical position top view image is captured. All Images of the Tool and the Calibrated Grid (0.1mm) are captured at room temperature with fixed distance between Camera and Tool (25 mm).The below figure 1 shows image capture arrangement:
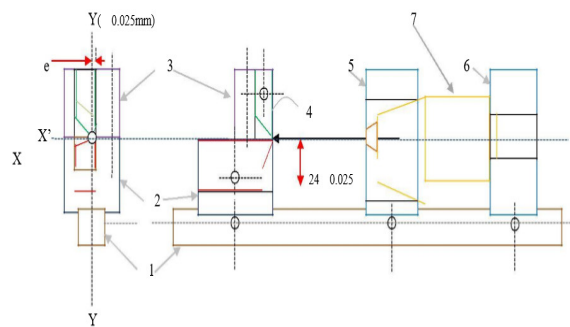

Figure 1: Image Capture Arrangement

1) Base
2) Tool holder (tool in horizontal position)
3) Tool holder (tool in vertical position)
4) Camera holder (front)

5) Camera holder (rear)
6) Camera

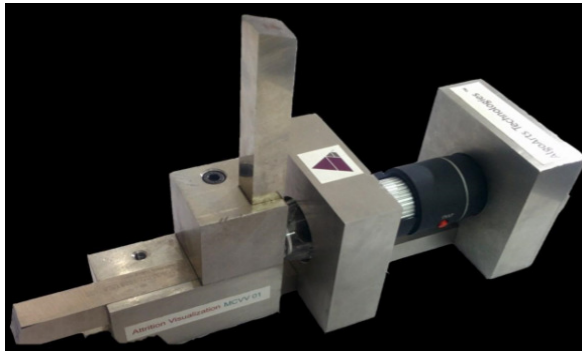The camera software was installed in computer. Obtain Image of the Calibrated Grid using the camera software.

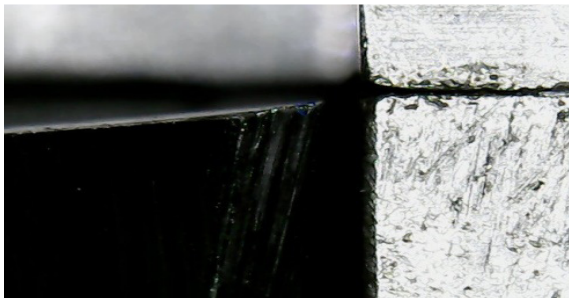**Figure 2: Attrition Visualization MCVV01 Device**

Figure 3: Front view before operation

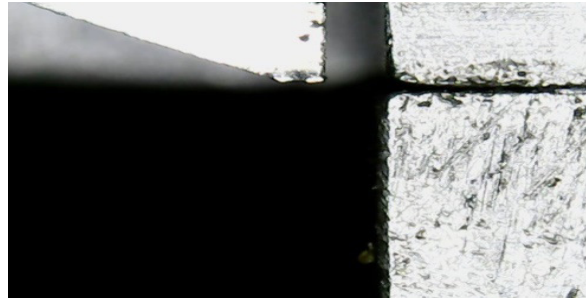**Figure 4: Front view after operation**
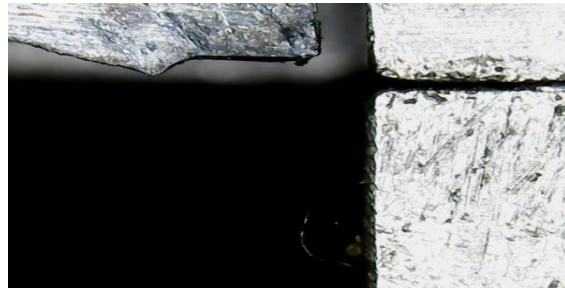

Figure 5:Top view before operation

Figure 6: Top view after operation

3.3 Measuring Tool Wear using AUTO CAD:

Front and top view images are imported in to the AUTOCAD. The defaults units are changed into the millimeters. The default grid size also changed in to 0.1mm X 0.1mm. Grid image is imported in AUTOCAD and changed the scale of the image grid size to 0.1mm X 0.1mm. From these the image dimensions are fixed. Front and top view images are imported and changed their images size equal to grid image size as shown figure 7. On the imported views using line command removed shape has drawn. From the top and front views 3d models are created as shown figure 13. After creating the solid object using volume command tool wear volume is measured.
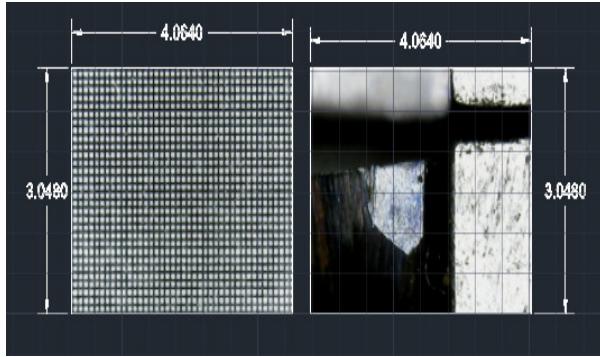
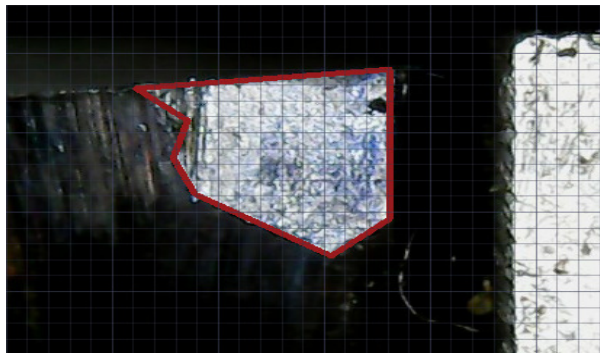**Figure 7: Image size is changed according to grid image size**
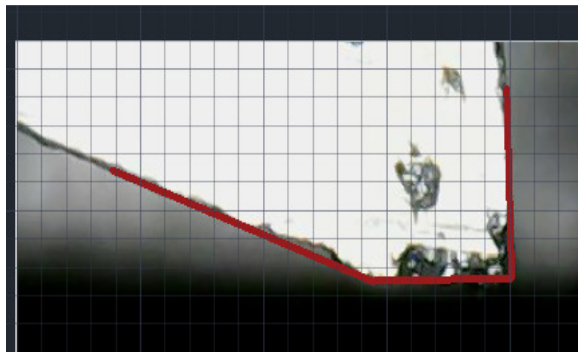

Figure 8: Front view after operation

Figure 9: Top view before operation
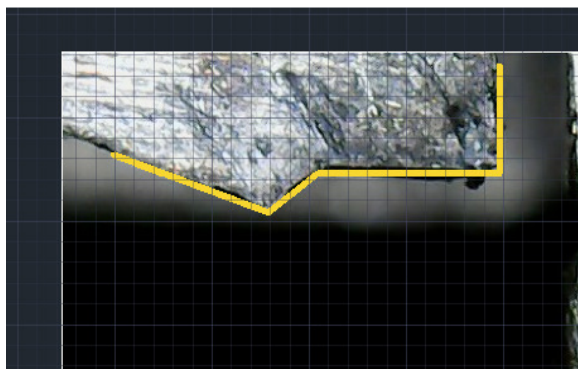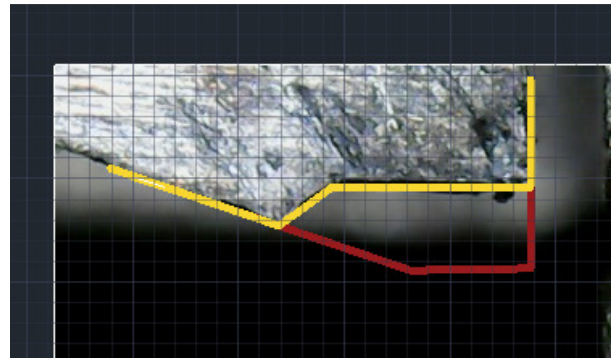

Figure 10: Top view after operation
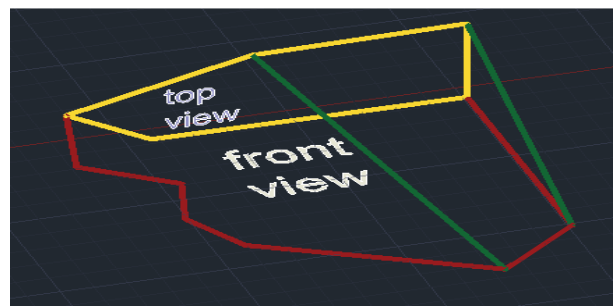

Figure 11: Top view after operation
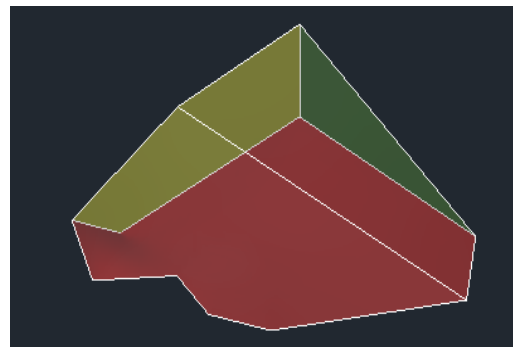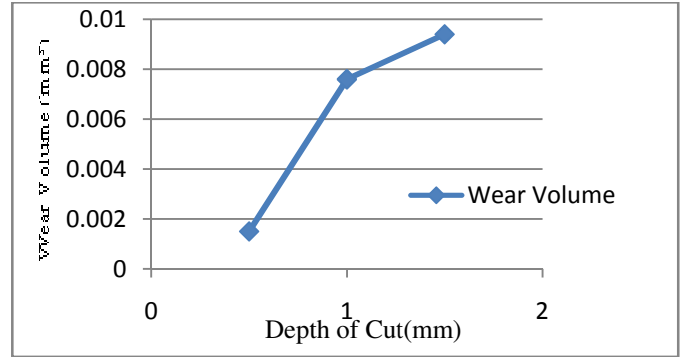

Figure 12: wireframe view

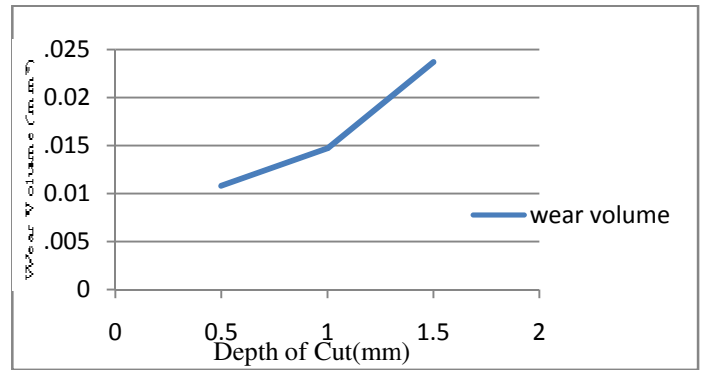**Figure 13: 3d model**

4. Results:

After performing the above operations the results are presented in the below table:

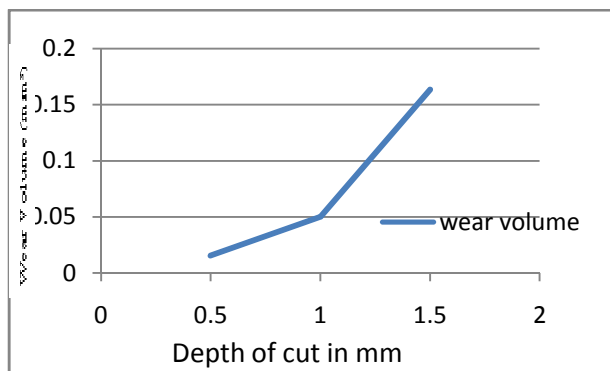| Depth of cut (t) in mm	Length of cut (L) in mm	Tool velocity (v) in mm/min	Work piece rotation in rpm	Temperature (T) in °c			Tool wear (Vw) in mm³
				At 10 mm	At 150 mm	At 300 mm	
0.5	300	18	200	30.2	48.1	55.1	0.0108
1	300	18	200	76.5	85.5	88.7	0.0147
1.5	300	18	200	81.2	120	130	0.0040
0.5	300	28	306	68.5	87.5	96.1	0.0015
1	300	28	306	73.9	94.4	142	0.0076
1.5	300	28	306	72.5	187.7	215	0.0094
0.5	300	42	460	78.9	80.2	99.8	0.0155
1	300	42	460	80.9	123.6	204	0.0545
1.5	300	42	460	155	305	320	0.1634

Table 2: Results
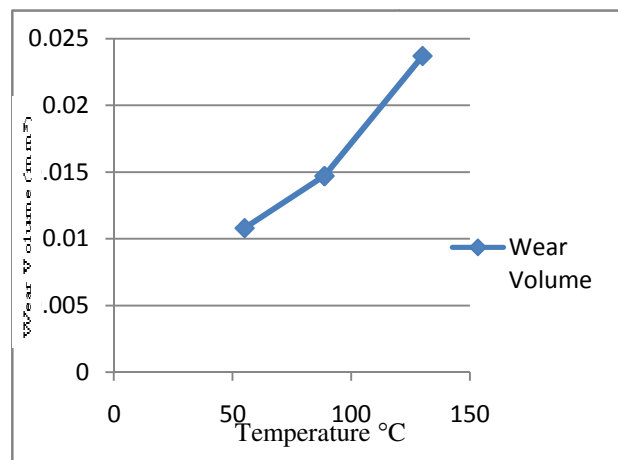

Graph 2 Depth of Cut Vs Wear Volume at Medium Speed
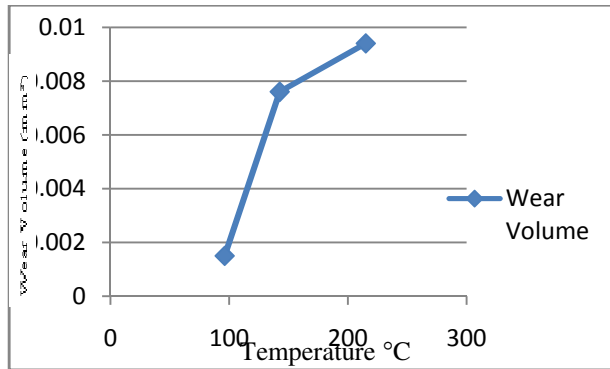

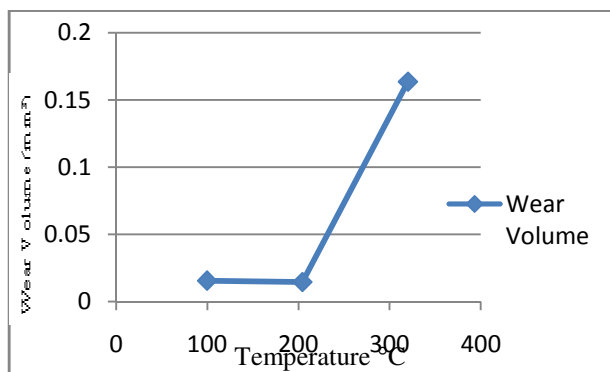Graph 3:depth of cut Vs wear volume at low speed

Graph 1 Depth of Cut Vs Wear Volume at High Speed Condition

Graph 4: temperature Vs tool wear at high speed

Graph 5: temperature Vs tool wear at medium speed

Graph 6: temperature Vs tool wear at low speed

Conclusion:

The above graphs 1,2,3 are the depth of cut Vs tool wear volume. The tool wear is increasing with increasing depth of cut.And graph 4,5,6 are the temperature Vs tool wear volume. In graph 6 the temperature is approximately constant up to 150mm length of the cut. And at the 300mm length the temperature is more. At low speeds the temperature at the tool tip less up to certain limit. If we maintain the low speeds the tool life will be increased. By increase the depth of cut tool wear is increases as well as temperature at tool tip also increases. At low speeds the temperature at tool tip less compared to the other speeds. It is observed that tool life will increase by maintaining low speeds.

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