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Comparative Analysis between machining forces at different cutting parameters & study of overall performance of uncoated & CNT Coated tools

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Introduction : The cutting performances of tools depend on cutting force and thrust force. These have a lot of bearing on the chip appearance and the resulting surface finish. A reduced cutting force is beneficial, primarily because it demands less motor power of the cutting machine while a reduced thrust force helps by lowering the demands for machine stability. Many authors have shown that a TiN-coated tool yields lower forces than the conventional uncoated HSS tool. A number of papers have also reported an improved surface finish of the chips . However, this is of minor importance for the cutting performance, but is an indication of changed in the contact conditions between chip and tool. While TiC and Al203 appear to provide the most chemically stable screening layer between chip and tool, TiN appears to offer the lowest tool friction. This has been attributed to a lower chip surface strengthening action of nitrogen than carbon when the coating materials is decomposed in the presence of the austenitic surface of the chip. TiN and TiC coated tools give good surface finish on the work piece because the contact conditions between the tool and work piece cause smaller or fewer built-up edge (BUE) fragments which could be deposited on the cut surface, and also partly by the fact that the lower forces obtained do reduce tool vibrations, which lead to deterioration in the surface finish in the case of using conventional tools.

Key Words : Machining forces, cutting forces, feed forces and axial thrust, feed, depth cut and cutting speed etc.

Comparison Between Machining Forces i.e. Cutting Forces :

This paper include the comparison between machining forces i.e. cutting forces, feed forces and axial thrust acting on uncoated HSS tool and CNT coated HSS tool while machining EN8 carbon steel material rod on center lathe machine in dry conditions at different cutting parameters such feed, depth cut and cutting speed . This section also includes the discussion related to overall performance of uncoated and CNT coated tool.

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1. Experimental comparison between the forces acting on uncoated and coated tool at 0.072 mm/rev feed and 410 rpm cutting speed

Figure 1 shows that graphical representation of data related to forces acting on uncoated and coated tool while machining EN8 carbon steel on centre lathe. This section also includes that comparison between the forces acting on uncoated and coated tool at 0.072 rev/min feed, 410 rpm cutting speed and different values of depth of cut varies from 0.3176mm to 3.175 mm. This analysis revealed that at 0.072 mm/rev feed and 410 rpm speed component of cutting force and feed force acting on uncoated tool are slightly greater than that CNT coated tool but axial thrust force acting on uncoated HSS tool is much higher than that CNT coated tool at different depth of cut, which shows that CNT coated tool have high machinabilty than uncoated tool.

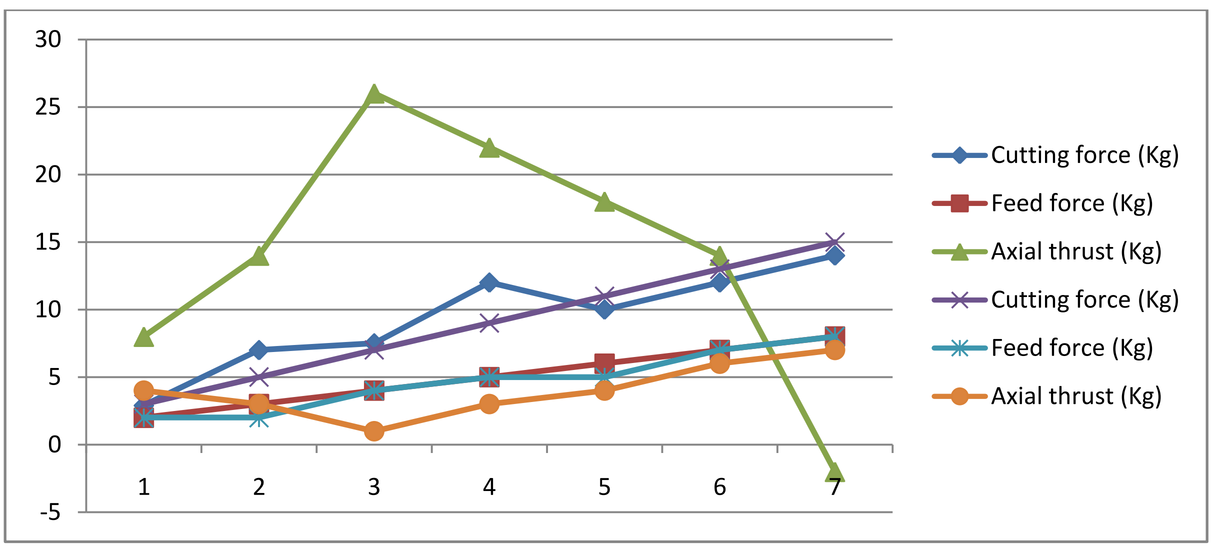

Fig. 1 Comparison between the forces acting on uncoated and coated tool at 0.072 mm/rev feed and 410 rpm cutting speed.

2. Experimental comparison between the forces acting on uncoated and coated tool at 0.1162 mm/rev feed and 420 rpm cutting speed

Figure 2 shows that graphical representation of data related to forces acting on uncoated and coated tool while machining EN8 carbon steel on centre lathe using Origin 15 graphing and

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analysis software. This section also includes that comparison between the forces acting on uncoated and coated tool at 0.1162 mm/rev feed, 420 rpm cutting speed and different values of depth of cut varies from 0.3176mm to 3.175 mm. This analysis revealed that at 0.1162 mm/rev feed and 420 rpm speed, the component of cutting force, feed force and axial thrust force acting on uncoated tool are slightly greater than that CNT coated tool at different depth of cut, which shows that CNT coated tool have high machinabilty than uncoated tool and ultimately it would have less wear and higher tool life.

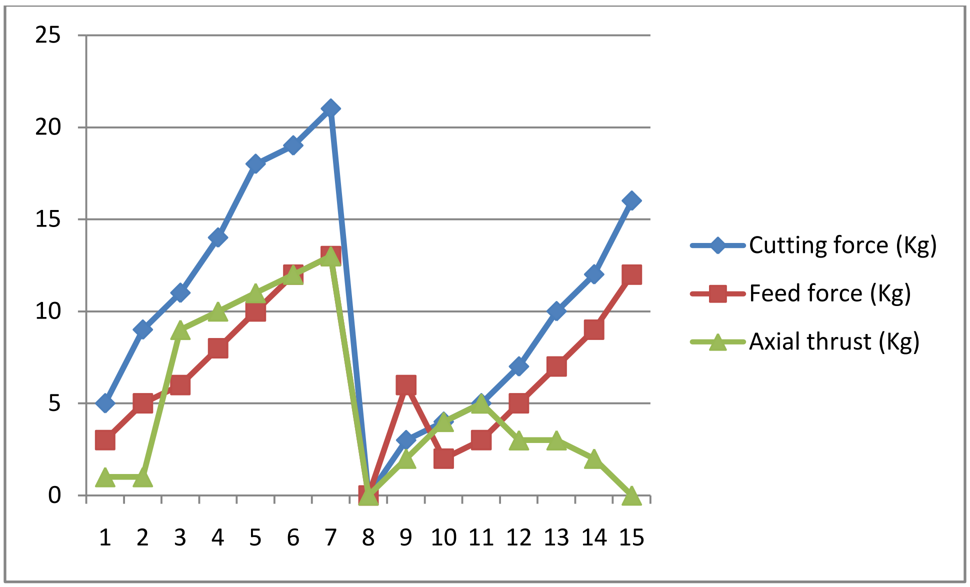

Fig. 2 Comparison between the forces acting on uncoated and coated tool at 0.1162 mm/rev feed and 420 rpm cutting speed.

3. Experimental comparison between the forces acting on uncoated and coated tool at 0.084 mm/rev feed and 640 rpm cutting speed

Figure 3 shows that graphical representation of data related to forces acting on uncoated and coated tool while machining EN8 carbon steel on centre lathe using Origin 15 graphing and analysis software. This section also includes that comparison between the forces acting on uncoated and coated tool at 0.084 rev/min feed, 640 rpm cutting speed and different values of depth of cut varies from 0.3176mm to 3.175 mm. This analysis revealed that at 0.084 mm/rev feed and 640 rpm speed, the component of cutting force, feed force and axial thrust force acting on uncoated tool are slightly greater than that CNT coated tool at different depth of cut, which shows that CNT coated tool have high

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machinabilty than uncoated tool and ultimately it would have less wear and higher tool life.

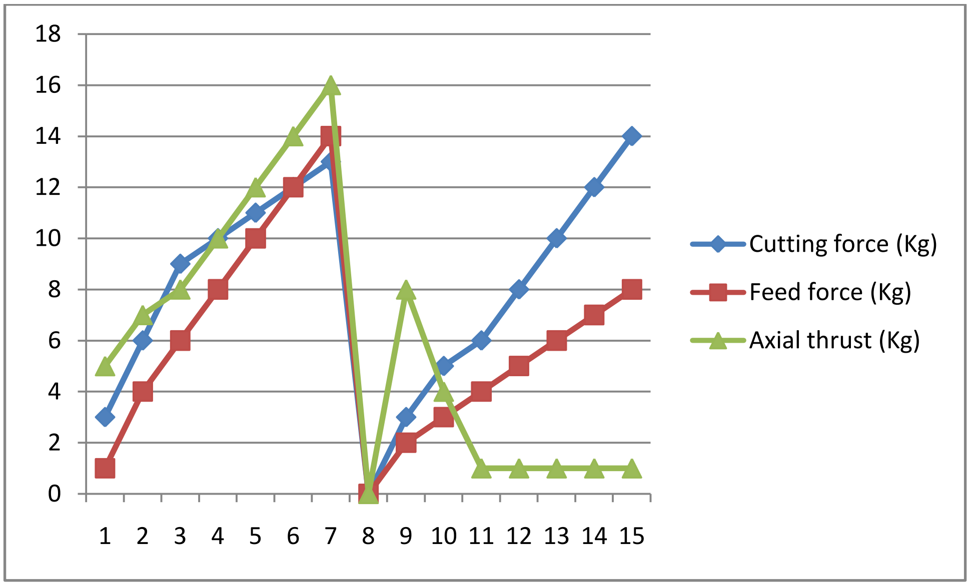

Fig.3 Comparison between the forces acting on uncoated and coated tool at 0.084 mm/rev feed and 640 rpm cutting speed

4. Experimental comparison between the forces acting on uncoated and coated tool at 0.1162 mm/rev feed and 649 rpm cutting speed

Figure 4 shows that graphical representation of data related to forces acting on uncoated and coated tool while machining EN8 carbon steel on centre lathe using Origin 15 graphing and analysis software. This section also includes that comparison between the forces acting on uncoated and coated tool at 0.1162 rev/min feed, 649 rpm cutting speed and different values of depth of cut varies from 0.3176mm to 3.175 mm. This analysis revealed that at 0.1162 mm/rev feed and 649 rpm speed, the component of cutting force, feed force and axial thrust force acting on uncoated tool are slightly greater than that CNT coated tool at different depth of cut, which shows that CNT coated tool have high machinabilty than uncoated tool and ultimately it would have less wear and higher tool life.

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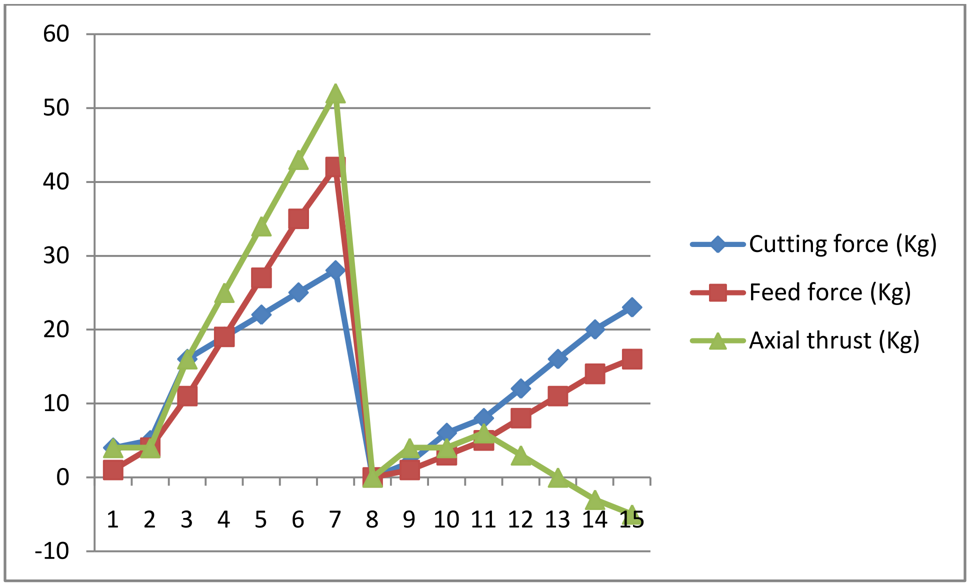

Fig. 4 comparison between the forces acting on uncoated and coated tool at 0.1162 mm/rev feed and 649 rpm cutting speed

Comparative analysis of forces acting on coated and uncoated tool for four for different cutting conditions of feed and speed as discussed above favored CNT coated tool as compared to uncoated HSS tool and it shows that CNT coated tool have greater performance than uncoated HSS tool at different cutting parameters.

Conclusion :

Experimental study concluded various results outcome with the use of MWCNT coated HSS tool and uncoated HSS tool such as all three forces acting on both tool i.e. coated and uncoated has been measured using dynamometer while machining of EN8 carbon steel rod at different cutting parameters such as depth of cut, feed rate and cutting speed & wear pattern on both coated and uncoated tool using SEM image are concluded and discussion on that results are discussed below:

A. As far as concern of cutting forces Coated HSS tools perform better than uncoated HSS tools. Average magnitudes of forces measured with coated HSS tool were lower than those obtained with uncoated HSS tools at different cutting conditions.

B. Results analysis shows that, the optimal value of both low depth of cut and low feed rate with high cutting speed is profitable to reduce machining force.

C. A cutting speed of 639 rpm in has been given the optimized magnitude of cutting forces in the experimental cutting parameters range. Cutting feed plays a direct effect on cutting force. With the increase in feed there is a direct increase in the cutting forces

D. This study revealed that cost of CNT coating on tool is lesser than the conventionally available coating material like AlTiN, TiC, TiCN etc.

E. The study of microscopic analysis of the worn surfaces of the cutting tools using SEM image revealed that wear of uncoated HSS tool is slightly greater than CNT coated HSS tool and ultimately coated tool have higher tool life than that of uncoated tool. The wear on cutting tool surface increases almost linearly with increase in depth of cut, cutting speed and feed rate.

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