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Improvement of Surface Profile of Different Materials by Hot Air in Turning Process

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Abstract

In order to develop the quality of the machining product, the best way is to improve the surface roughness. A lot of research is going to improve the surface quality of the machined parts. Among different studies, one of the key concepts is to use the correct cutting fluid for the machining process. Moreover, if the cutting fluid is environment friendly, then it will more acceptable to everyone.
In this study, hot air is used as an alternative approach for hot machining processes. Initially Hot air is used to heat the work-piece for easy machining and chip removal process. Hot air is kept at a fixed temperature and is applied to three different materials (Brass, Aluminum and Stainless Steel) during turning operation keeping the other process parameters same. Surface roughness for different machined surfaces of different materials has been measured and comparison has been made accordingly. It has been observed that surface roughness for all the three materials are significantly improved compared to normal dry cutting machining process. This method may be used as an effective method for the improvement of surface quality during turning operations of different materials.

Keywords: Hot air, Surface roughness, turning operation.

1. Introduction

Surface roughness indicates the component of surface texture. The surface irregularities of a component or material may be intentionally created by machining, but they can also be created by a wide range of factors such as tool wobbling caused by motor vibration during machining, the quality of the tool edge, and the nature of the machined material. The form and size of irregularities vary, and are superimposed in multiple layers, so differences in those irregularities impact the quality and functions of the surface. The results of these irregularities can control the performance of the end product in aspects such as friction, durability, operating noise, energy consumption, and airtightness.
The surface quality is an important parameter to evaluate the productivity of machine tools and also machine components. Achieving the desired quality of surface is of great importance for the functional behavior of the mechanical parts [1]. Now a day’s in manufacturing industry, special attention is given to dimensional accuracy and surface finish. So measuring and characterizing the surface finish can be reified as the predictor of the machining performance [2]. Turning is the primary operation in most of the production process in the industry. The turning operation meets the critical feature that requires specific surface finish. The operators working on lathe use their own experience and machining guidelines to achieve the best desire surface finish. Due to inadequate knowledge and surrounding factor may cause high production costs and low quality. So, the proper selection of cutting tools and process parameters is very important in turning operation [3]. An experimental

investigation was conducted to determine the effects of cutting conditions and tool geometry on the surface roughness in the finish hard turning of the bearing steel by Sing et.al.[4]. The effect of cutting conditions on surface roughness in turning of free machining steel by ANN models was investigated by J. Paulo et. al. [5].Ranganathan et al. [6] presents results of surface roughness of the effect of hot turning (by mixture of liquid petroleum gas & oxygen gas) in stainless steel (316) under different cutting condition with a temperature range of 200°C to 600°C. Analysis of surface roughness by turning process using taguchi method was conducted by S. Thamizhmanii et.al. [7]. Patwari et al. proposed a new technique using the concept of voice activated mode generated ultrasonic smart waves and improved average surface roughness of the preheated machined surface of mild steel [8]. Patwari et al. introduced Investigation of surface parameters during hot air streaming turning process of mild steel [9]. An Experimental Investigation of Hot Machining with Induction to Improve Ti5553 Machinability was done by M. Baili et.al. [10].
The aim of the present investigation is to analyze the surface parameters of different materials (Brass, Aluminum and Stainless Steel) in the application of hot air which is an alternate manufacturing process. Here hot air preheats the job piece and eases the machining operation. Moreover, no health hazards like using coolants will occur here. A distinct comparison has been made to observe surface roughness of different material at a fixed feed rate (f), cutting speed (v), and depth of cut (d) under two different conditions dry and hot air. It has been found that surface roughness for different materials has improved by applying hot air compared to normal dry machining conditions.

2. Experimental Details

Figure 1 show the work flow diagram used in this experiment.

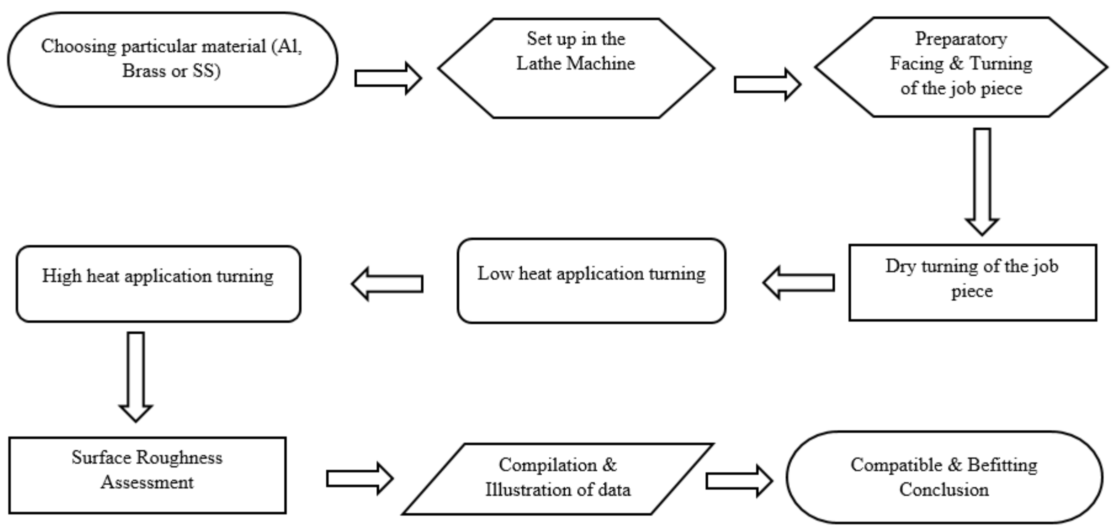


Fig.1. Flow Chart of the Working Procedure

In this research, a handful of experiments were done under dry and hot conditions at constant different process parameters, which is shown in Table 1.

Table 1. Process Parameters

Feed Rate (mm/rev)	**Depth of cut (mm)**	**Spindle Speed (rpm)**	**Cutting Speed (mm/min)**
0.95	0.75	220	21.77

Two different temperature of hot air at two different air velocities & two different switches has been used (Table 2). The process variables with their units (and notations) are listed below. Aluminum, Brass and Stainless Steel shafts were used as the work piece material. The total work piece length was 120 mm and diameter of the shaft was constant at 32 mm. Each experiment was carried out over 30 mm length with 10 mm gap after every experiment. Thus three experiments were done on each single piece. First experiment was done at dry condition and lastly by hot air in two conditions. Tungsten carbide coated insert was used in different experiments.

Table 2. Specification of Hot Air Gun

Hot Air	Air Velocity (m/sec)	Air Flow Rate (liter/sec)	Voltage (Volt)	Frequency (Hz)	Nozzle Diameter (mm)
Level 1	3.60	300	220-230	50	Outer = 23.3
Level 2	1.60	500			Inner = 20.1

To provide hot air, a hot air gun was used which is able to generate hot air at temperature 31°C to 205°C in 120s (Figure 2). The hot air gun is used to apply hot air with two different speed on different work-piece. A switch was there to generate several temperature. During the heating process the hot air gun was kept at an angle of 45^0 at a distance 2 inch from the work piece for the time of 1 minute and 40 seconds to get the maximum heating effects. The center lathe of model Gate Inc. model L-1/180 is used for machining. Figure 3 shows the schematic diagram of the experimental setup along with insert and Profilometer.

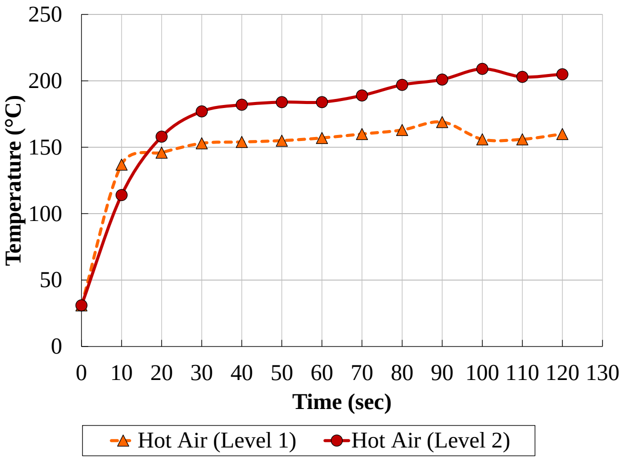


Fig.2. Change of temperature of the hot air

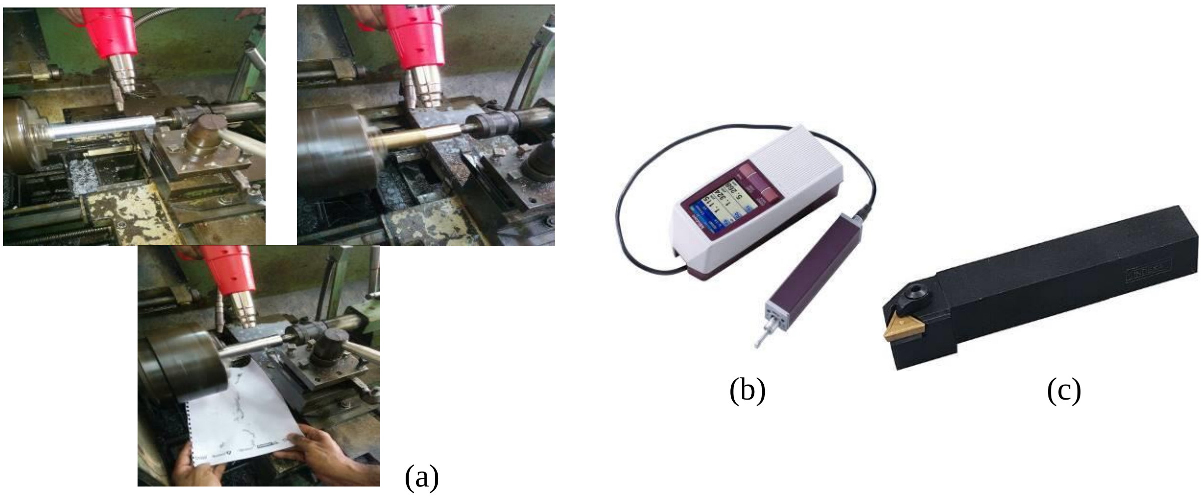


Fig.3. (a) Experimental set up (b) Profilometer (c) Carbide coated insert

3. Analysis of the Chips Formation

The chips produced during the machining operation were collected and presented below. Firstly, the chips for Aluminum are shown in Figure 4 (a)-(c). From left hand side serially the chips are for dry turning operation, turning operation using level 1 hot air and level 2 hot air. Initially the chips strands were continuous and closed winding. Gradually the strand windings were less compact. Secondly, the chips for Brass during machining operation are shown in Figure 4 (d)-(f). The chips were discontinuous type of regular shape & size. Gradually the shape and size of the chips decreased on application of several levels of hot air. Finally, the chips of stainless steel formatted during machining operation of dry turning, level1 hot air and level 2 hot air is shown in Figure 4 (g)-(i). At the beginning, chips were continuous but afterwards on the application of heat the chips became segmented type with a long strand winding.

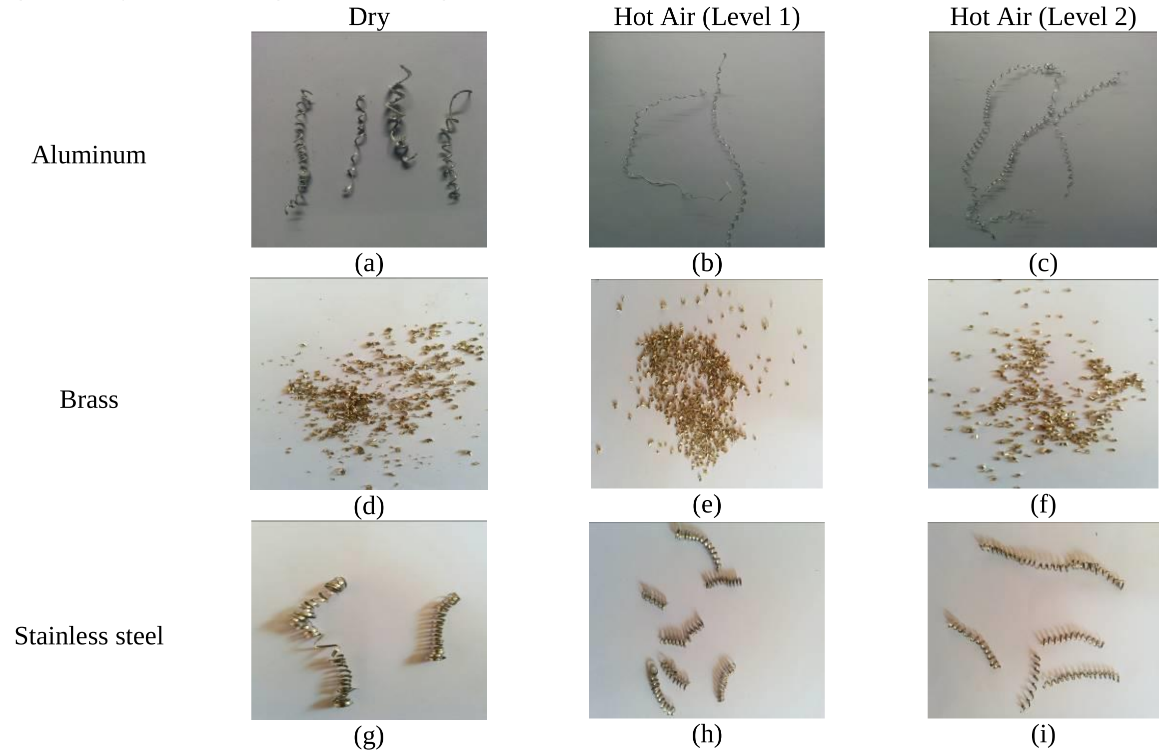


Fig.4. Cutting chips for different materials at different conditions

4. Results and discussion

It has been found that surface roughness for different materials has improved by applying hot air compared to normal dry machining conditions.

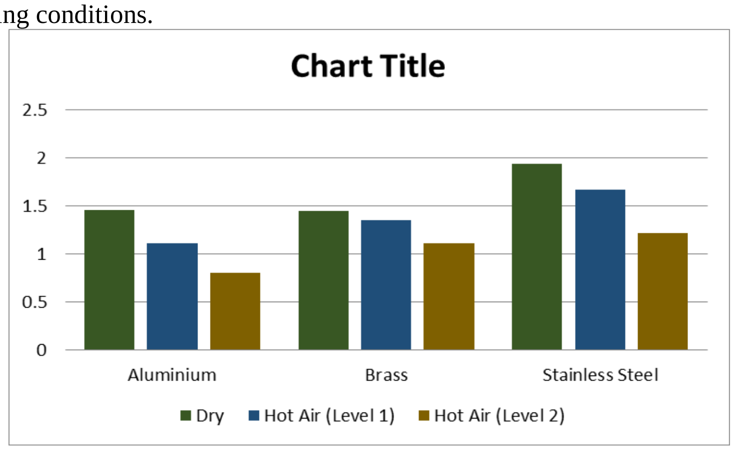
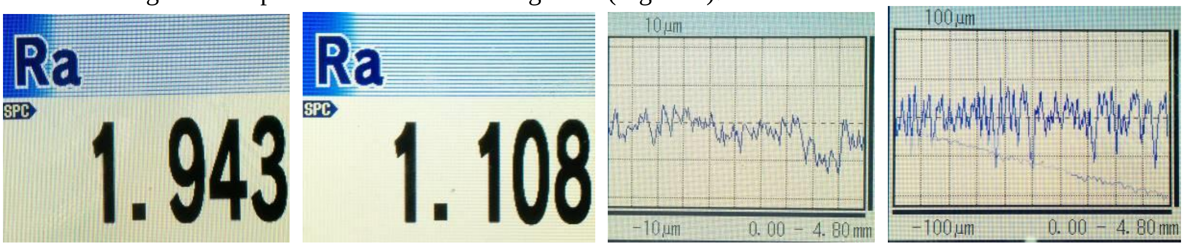


Fig.5. Effect of depth of cut on surface roughness

The Figure 5 depicts the results obtained for different experiments. From the graphical comparison for same feed and cutting speed on different materials illustration is made. It can be seen from this figure that with increase of hot air temperature the surface roughness progressively increases for these three types of materials.

It exposes that the preheating effect by hot air gun on different materials gives an excellent surface finish and cutting facility. It can be found on the application of preheating, the surface finish is fabulous compared to the conventional dry machining. Some of the surface roughness measurement values has been framed here which shows us the gradual improvement in surface roughness (Figure 6).



(a) (b)

Fig.6. (a) Surface roughness data. (b) Graph of surface roughness

The application of heat was given at two stages. One for smaller hot air flow volume rate while the other is a bit larger rate. It is to mention that the diameter of the nozzle was kept constant. Finally from the above illustration it is very clear that the preheating effect on different materials while turning operation is an effective method for the improvement of surface roughness. Figure 7 shows the images of surface roughness at different conditions. It can be seen from Figure 7 that the quality of surface roughness gradually increases as the temperature of the hot air increases. Figure 7(c) shows that the smoothness of the surface for 0.75mm depth of cut and using level 2 hot air for Aluminum. On the other hand, figure 7(d) shows that the roughness of the surface for 0.75mm depth of cut at dry condition for Brass. For fixed conditions of depth of cut the surface using level 2 hot air shows better that other cooling method (Figure 7 (c), (f) and (i)).

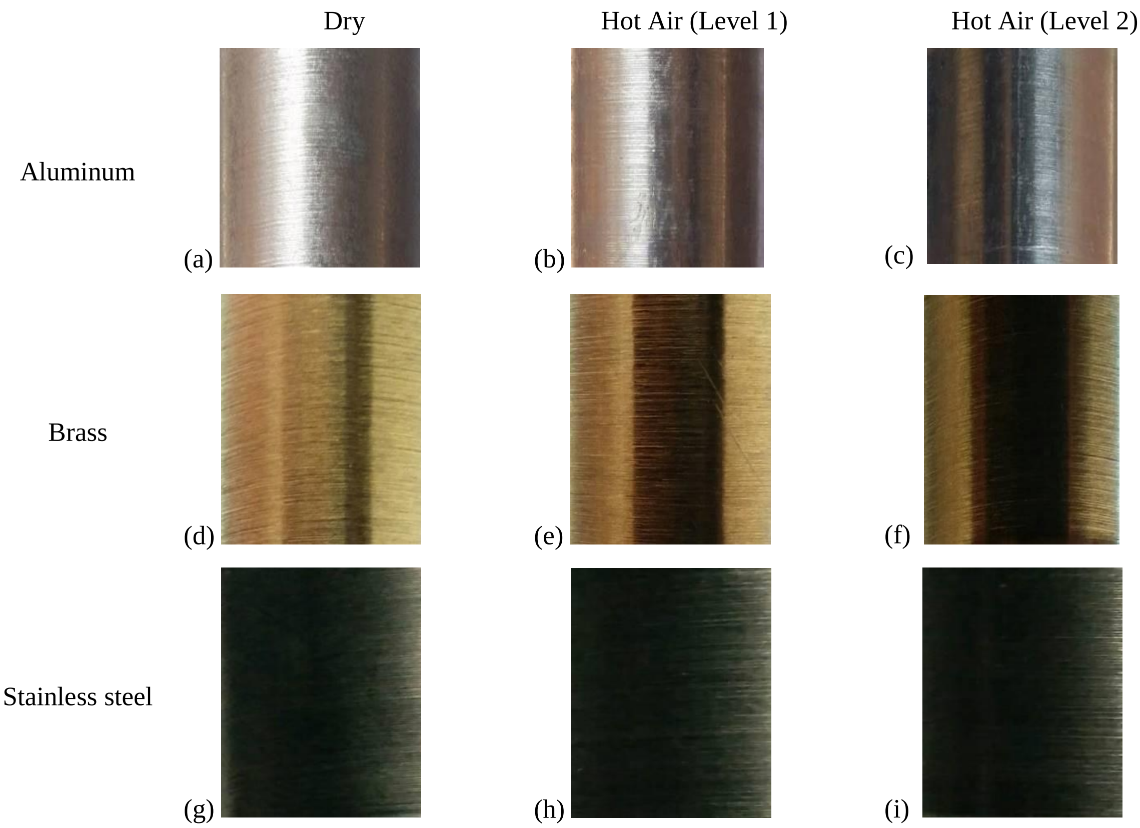


Fig.7. Images of surface for different depth of cut for cutting conditions (a, d and g) Dry; (b, e and h) Hot air level 1; (c, f and i) Hot air level 2;

5. Conclusion

The preheating effect with the help of hot air stream in improving the surface roughness during dry turning operation of preheated Aluminum, Brass and Stainless Steel is immense. Preheating effect expedites material removal rate from the surface of the material with ease breeding better surface finish than the traditional surface finish. The finest results have been achieved when level two hot air was applied where intensity of preheating plays an important role.

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