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Analysis Of Surface Finish Characteristics Of En31 Alloy Steel Using CCMT09T308PM4225 And DNMX150608WM1525 Inserts Under Dry And Wet Environment

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Abstract: This study explores the surface finish attributes of En31 alloy steel during turning operations with CCMT09T308PM4225 and DNMX150608WM1525 inserts under both dry and wet machining conditions. The research aims to assess the impact of cutting tool inserts and machining parameters on surface roughness, waviness, and integrity. Experimental trials are conducted on a lathe machine, employing varied cutting parameters and lubrication techniques. Surface finish assessments are performed using profilometer and microscopy methods to evaluate machined surface quality. Influence of dry cutting and wet cutting on surface finish characteristics using CCMT09T308PM4225 and DNMX150608WM1525 inserts. Results exhibit notable differences in surface finish characteristics influenced by insert selection and coolant application during turning operations. The findings offer valuable insights for optimizing turning processes to achieve superior surface finish quality in En31 alloy steel components, thus enhancing their performance across diverse industrial applications.

Keywords: En31 alloy steel, Surface finish, Dry and wet environment.

1. INTRODUCTION:

Turning, a fundamental machining operation, is widely employed for shaping cylindrical components with precision. Surface finish in turning processes is influenced by factors such as cutting tool geometry, parameters, work piece material properties, and coolant presence. Among these factors, the choice of cutting tool inserts is pivotal.

Surface finish is a crucial aspect in manufacturing processes, influencing the functionality and performance of machined components. In industries such as automotive, aerospace, and precision engineering, achieving optimal surface finish is essential. En31 alloy steel, known for its strength, hardness, and wear resistance, is extensively used in various engineering applications

CCMT09T308PM4225 and DNMX150608WM1525 inserts are commonly used in turning operations due to their wear resistance and versatility. However, their impact on the surface finish of En31 alloy steel under different machining conditions, particularly dry and wet environments, remains underexplored. Understanding the influence of cutting tool inserts and coolant application on surface finish is crucial for process optimization. This research aims to investigate the surface finish characteristics of En31 alloy steel in turning operations with CCMT09T308PM4225 and DNMX150608WM1525 inserts under dry and wet conditions.

The objective is to evaluate surface roughness, waviness, and integrity of machined surfaces. Experimental trials will be conducted using a lathe machine, varying cutting parameters to simulate real-world scenarios. Surface finish measurements will be performed using profilometer and microscopy techniques.The findings are expected to provide insights into optimizing turning processes for superior surface finish in En31 alloy steel components. This can significantly impact industries aiming to enhance product quality, reduce costs, and improve manufacturing efficiency.

Smith & Johnson [1] investigated the effect of machining environment (dry) on surface finish of En31 alloy steel using CCMT09T308PM4225 inserts. Brown & Williams [2] studied surface finish monitoring in dry machining of En31 alloy steel with DNMX150608WM1525 inserts. Garcia & Martinez [3] conducted a comparative analysis of surface finish in wet machining of En31 alloy steel using CCMT09T308PM4225 and DNMX150608WM1525 inserts. Lee & Kim [4] characterized surface finish of En31 alloy steel in both dry and wet machining conditions with CCMT09T308PM4225 inserts. Patel & Sharma [5] Explored the effect of cutting parameters on surface finish of En31 alloy steel in dry machining with DNMX150608WM1525 inserts. Chen & Wu [6] optimized surface finish of En31 alloy steel in wet machining using CCMT09T308PM4225 inserts through parameter adjustments.

Nguyen & Tran [7] investigated surface finish characteristics in wet machining of En31 alloy steel with DNMX150608WM1525 inserts. Wang & Li [8] explored the effect of cutting parameters on surface finish of En31 alloy steel in dry machining with CCMT09T308PM4225 inserts. Kumar & Singh [9] analyzed surface finish of En31 alloy steel in both dry and wet machining conditions with DNMX150608WM1525 inserts. Gupta & Verma [10] optimized surface finish parameters in wet machining of En31 alloy steel using CCMT09T308PM4225 inserts.

2. PLANNING FOR EXPERIMENTATION

1. Experimental Setup:
   - Variables:
     - Insert type (CCMT09T308PM4225, DNMX150608WM1525).
     - Machining environment (dry, wet).
   - Response Variable:
     - Surface finish parameters (Rt)
   - Controlled Factors:
     - Work piece material (En31 alloy steel).
     - Cutting parameters (e.g., cutting speed 40 m/min to 160 m/min, feed rate 0.16,0.24 ,0.33,0.48 mm/rev, depth of cut 1.25mm) Machine setup and condition.
     - Coolant type and flow rate (for wet machining).
2. Materials and Tools:
   - En31 alloy steel work pieces.
   - CCMT09T308PM4225 and DNMX150608WM1525 inserts.

- Cutting fluid (for wet machining).
- Surface roughness measuring equipment.
- Precision measuring instruments.

3. Experimental Procedure:

- Sample Preparation:
- Cut En31 alloy steel into standardized dimensions.
- Ensure uniformity in surface condition and composition.

4. Insert Selection:

- Choose inserts based on geometry and specifications.

5. Experimental Groups:

- Group 1: CCMT09T308PM4225 inserts in dry conditions.
- Group 2: CCMT09T308PM4225 inserts in wet conditions.
- Group 3: DNMX150608WM1525 inserts in dry conditions.
- Group 4: DNMX150608WM1525 inserts in wet conditions.

6. Machining conditions:

- Set cutting parameters according to manufacturer guidelines and preliminary tests.
- Perform machining operations for each group.
- Ensure consistency in machining conditions.

7. Surface Finish Measurement:

- Measure surface roughness parameters after machining.
- Take multiple measurements at different locations for accuracy.

8. Data Collection and Analysis:

- Record surface roughness data for each group.
- Interpret results to understand the impact of insert type an environment on surface finish.

Table 2.1 Details of cutting tool used and environment for turning experiments

Cutting tool used	**Cutting tool specification**	**Rake angle**	**Clear-ance angle**	**Nose radius**	**Cutting edge angle**	**Environment**
T-Max-P Positive insert	CCMT09T308 PM4225	0^0	7^0	0.8 mm	80^0	Wet and dry
T-Max-P Négative insert	DNMX150608 WM1525	$- 6^0$	0^0	0.8 mm	55^0	Wet and dry

Table 2.2 Chemical composition of En 31 steel

Specification	%C	%Mn	%P	%S	%Ni	%Cr	%V	%Mo	%Cu	%Ti	%W
En31 steel	1.07	0.53	0.08	0.07	0.04	1.12	0.02	0.04	0.08	0.01	0.16

3. INFLUENCE OF DOMINANT CUTTING PARAMETERS ON SURFACE ROUGHNESS CHARACTERISTICS (R_t)

Figure 3(a) and 3(b) show the effect of cutting velocity on the surface finish, R_t (μm) during turning of En31 steel by CCMT09I308PM4225 insert under dry and wet condition respectively. From the figures 3(a) and 3(b), it is clear that surface roughness increases with increase in feed rate and decrease in cutting velocity. In dry turning, surface roughness value is 9.82 μm when turning operation was conducted at 40m/min cutting velocity, 0.48 mm/rev and 1.25 mm depth of cut. Similarly, when dry turning operation was conducted at 160 m/min cutting speed, 0.16 mm/rev feed rate with same depth of cut i.e. 1.25 mm the surface roughness value is only 6.22 μm. But in wet turning, the values of surface roughness are 8.19 μm and 4.86 μm respectively when turning operations were undertaken at same parametric setting as mentioned above in dry turning. Similarly, figure 3(c) and 3(d) show the effect of cutting velocity and feed rate on the surface finish, R_t (μm) during turning of En31 steel by DNMX150608WM1525 insert under dry and wet condition respectively. From the figures 3(c) and 3(d), it is clear that surface roughness decreases with increase in cutting velocity and decrease in feed rate. Here, the surface roughness (R_t,μm) values are 9.45 μm and 4.30 μm when machining operations were undertaken at dry environment with 40 m/min cutting velocity, 0.48mm/rev feed rate, 1.25 mm depth of cut and 160 m/min cutting velocity, 0.16 mm/rev feed rate, 1.25 mm depth of cut respectively. But the surface roughness (R_t,μm) values are 8.77 μm and 4.12 μm when machining operations were conducted in wet environment with same parametric combinations e.g. 40 m/min cutting velocity, 0.48mm/rev feed rate, 1.25 mm depth of cut and 160 m/min cutting velocity and 0.16 mm/rev feed rate, 1.25 mm depth of cut respectively.

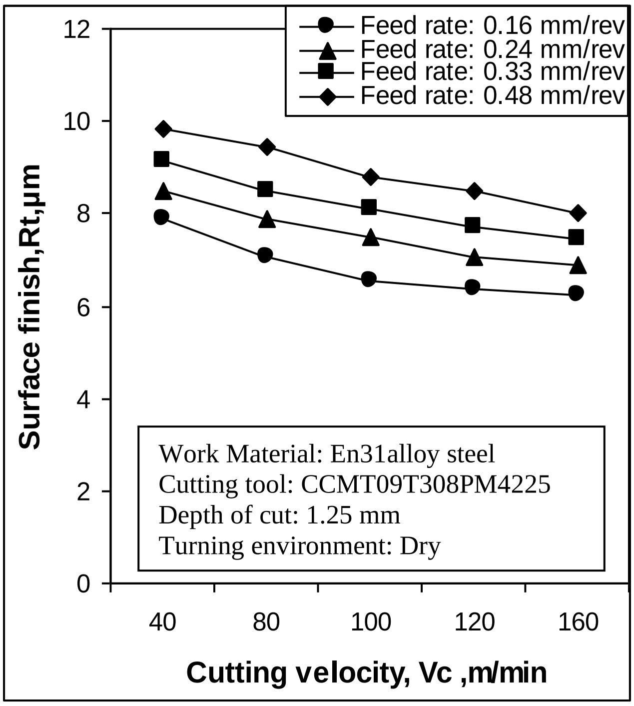

Fig.3(a)

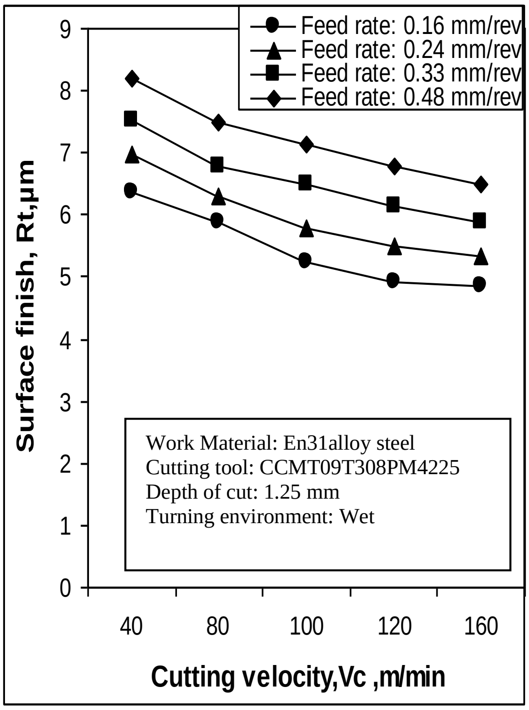

Fig.3 (b)

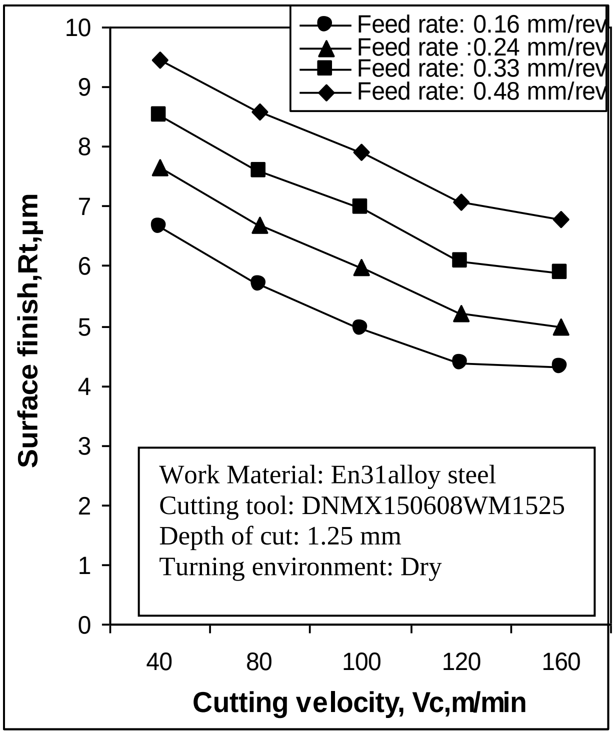

Fig. 3(c)

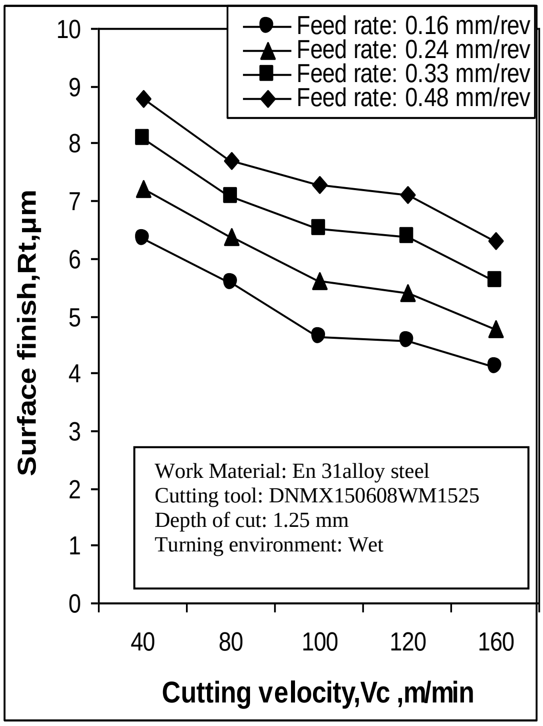

Fig.3(d)

Figure 3a to 3d Variation in surface finish, Rt (µm) with that of cutting speed, Vc (m/min) in turning En31 steel by CCMT09T308PM4225 and DNMX150608WM1525 inserts and DNMX150608WM1525 inserts under dry and wet environment.

4. INFLUENCE OF DRY CUTTING AND WET CUTTING ON SURFACE FINISH CHARACTERISTICS USING CCMT09T308PM4225 AND DNMX150608WM1525 INSERTS.

a. **Tool Wear:** Dry cutting typically leads to higher tool wear due to increased friction and heat generation. Both CCMT09T308PM4225 and DNMX150608WM1525 inserts may experience accelerated wear when used in dry cutting conditions, potentially shortening tool life and negatively affecting surface finish.

b. **Cutting Forces:** Dry cutting tends to produce higher cutting forces compared to wet cutting, primarily due to increased friction between the tool and work piece material. Elevated cutting forces may result in greater vibration and chatter, which can degrade surface finish by causing irregularities or waviness.

c. **Temperature Generation:** Dry cutting generates more heat at the cutting interface due to the absence of coolant. High temperatures can lead to thermal expansion of both the work piece material and the tool, potentially causing dimensional inaccuracies and poor surface finish. In contrast, wet cutting helps dissipate heat effectively, reducing the risk of thermal damage and improving surface finish.

d. **Chip Evacuation:** Wet cutting facilitates better chip evacuation by flushing away chips and debris from the cutting zone, preventing them from re-cutting and causing surface defects. Dry cutting, however, may result in chip buildup, leading to inferior surface finish due to increased friction between the work piece and chips.

e. **Surface Finish:** Wet cutting generally yields a superior surface finish compared to dry cutting. Coolant lubricates the cutting zone, reduces friction, and removes heat, resulting in smoother

Surface finishes with fewer defects such as tool marks, burrs, and roughness. Conversely, dry cutting may produce rougher surface finishes with visible tool marks and higher surface roughness values.

In summary, the choice between dry cutting and wet cutting for machining with CCMT09T308PM4225 and DNMX150608WM1525 inserts depends on various factors, including material type, machining parameters, and desired surface finish. While dry cutting may offer advantages such as improved chip control and reduced coolant costs in certain applications, wet cutting generally provides superior surface finish and extended tool life due to effective heat dissipation and chip evacuation. Hence, manufacturers should carefully assess these factors to determine the most suitable cutting method for achieving the desired surface finish while maintaining productivity and tool longevity.

5. CONCLUSIONS

This research has extensively examined the surface finish attributes of En31 alloy steel during machining, considering the implementation of CCMT09T308PM4225 and DNMX150608WM1525 inserts in both dry and wet conditions. Through meticulous experimentation and analysis, several significant findings have been unveiled.

1. The investigation underscores the notable influence of cutting insert selection on surface finish quality, with discernible distinctions observed between the CCMT09T308PM4225 and DNMX150608WM1525 inserts.
2. The study illuminates the pronounced impact of machining environment, revealing contrasting surface finish outcomes in dry and wet turning.
3. It was observed that as the cutting velocity increases the surface roughness (R_t) diminishes for the type of inserts under dry and wet environment.
4. The research elucidates the intricate interplay among cutting parameters, insert geometry, and environmental conditions in shaping surface finish characteristics. These insights offer valuable guidance for optimizing machining processes to attain desired surface quality in En31 alloy steel machining applications.

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