

EFFECT OF COOLANT TYPES ON GRINDING FORCE AND SURFACE ROUGHNESS IN SURFACE GRINDING 90CrSi STEEL

Luu Anh Tùng¹, Vũ Ngọc Pi^{1*}, Nguyễn Thị Thu², Bành Tiến Long³
¹College of Technology – TNU, ²Viet Duc Industrial College, Thái Nguyên,
³Ha Noi University of Science and Technology

SUMMARY

In grinding process, the temperature produced in the grinding zone is high. This is because the process can be described as a cutting operation of a large number of cutting edges with high cutting speeds. For that reason, selection of suitable grinding fluid as well as cooling regimes are the subject of numerous studies on grinding general and in surface grinding. This paper presents the results of studying the effects of various types of cooling lubricant to the quality of surface grinding of 90CrSi steel by Hai Duong grinding wheel. The experimental results show that the grinding forces and the surface roughness significantly reduced when applying suitable cooling regimes.

Keywords: *surface grinding, coolant, grinding force, surface roughness*

INTRODUCTION

Grinding process remove workpiece material by abrasion which can generate an extremely high amount of heat. That is the reason of high temperature, thermal damage to the workpiece and the reduction of the grinding accuracy. In grinding, the cooling lubricant can reduce the friction between the abrasive grain and the workpiece and between the bond and the workpiece [1]. Also, it can cool the contact zone and the workpiece surface by absorbing and transporting heat [1]. Therefore, there are many studies have been done on coolant and using it in grinding. T. Nguyen and L.C. Zhang have carried out a study on mechanisms of coolant penetration into the grinding zone associated with both the segmented and conventional grinding wheels [2]. The influence of high-pressure coolant jet on chip formation mode, grinding zone temperature and surface roughness in grinding AISI-1040 steel was studied by N. R. Dhar et al. [3]. There was also a study on development of technology to reduce the amount of coolant supply [4]. In addition, the use of different types of coolants such as synthetic oil, semi synthetic oil, straight

cutting oils and soluble oils was pointed by Hank Limper., Ken Cavanaugh [5]. The possibility of using anti bacterial additives to develop eco friendly coolants based on water was discussed by T. D. Lavanya and V. E. Annamalai [6].

From previous studies, it is learned that there are many studies on coolants and cooling process in grinding. However, there is lack of a research on the coolants for surface grinding of 90CrSi steel when using Hai Duong grinding wheels - a famous brand of grinding wheels in Vietnam.

This paper presents the results of studying the effects of various types of cooling lubricant to the quality of surface grinding of 90CrSi steel by Hai Duong grinding wheel. From the results of the research, it can be concluded that the grinding forces and the surface roughness significantly reduced when applying suitable cooling regimes.

EXPERIMENTAL APPARATUS

The setup of the experiment in order to investigate the effects of types of cooling lubricant on the quality of surface grinding of 90CrSi steel by Hai Duong grinding wheel was shown in Figure 1. The experimental conditions was described in Table 1. In the Table 1, v_{gw} is radial wheel speed (m/s); v_{fa} is

* Tel: 0974 905578, Email: ngocpivu@yahoo.com

axial feed speed (m/min); f_r is radial wheel feed (mm/double stroke). The coolants, the coolant volume flow rate and the concentration were used as the variables for the experiment. Grinding tests were conducted with the concentration and the flow

rate given for each type of coolant (see Table 1). Each experiment were performed three times in order to get the average result of three measurements of three components of cutting force and the surface roughness of workpiece.

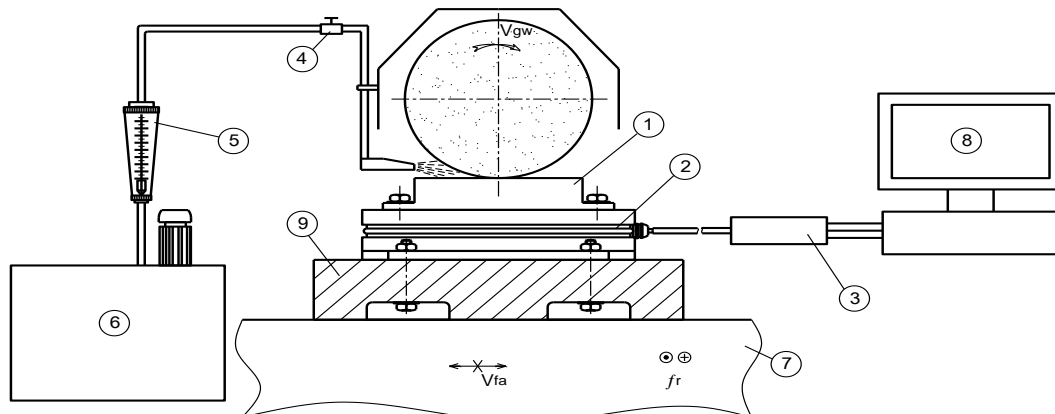


Fig. 1: Experimental setup

1-workpiece; 2-Kisler device; 3-signal converter; 4-flow adjustment valve; 5- Coolant volume flow rate measurement device; 6-coolant tank; 7-magnetic table; 8-computer with DasyLab; 9-fixtures

Table 1: Experimental conditions

Parameter	Values
Machine	Surface grinding machine MOTO – YOKOHAMA
Workpiece	90CrSi (HRC56-60)
Coolants	Caltex Aquatex 3180, AVANTIN 300, AVANTIN 361I, J.P WAY
Surface roughness device	Mittutoyo SJ-210
Force measurement device	Kisler 9250BA
Coolant volume flow rate measurement device	Z5615 - FLOWTECH
Grinding regime	$v_{gw} = 25$ (m/s); $v_{fa} = 8$ (m/min); $S_n = 8$ (mm/double stroke)
Coolant volume flow rate	5, 10, 15, 20, 25 (l/min).
Concentration (%)	Caltex Aquatex 3180: 3; 4; 5; 6; 7 ; AVANTIN 300: 2; 3; 3.5; 4; 5 AVANTIN 361I: 3; 4; 5; 6.5; 8 J. P. WAY: 1; 2; 3; 4; 5

RESULTS AND DISCUSSION

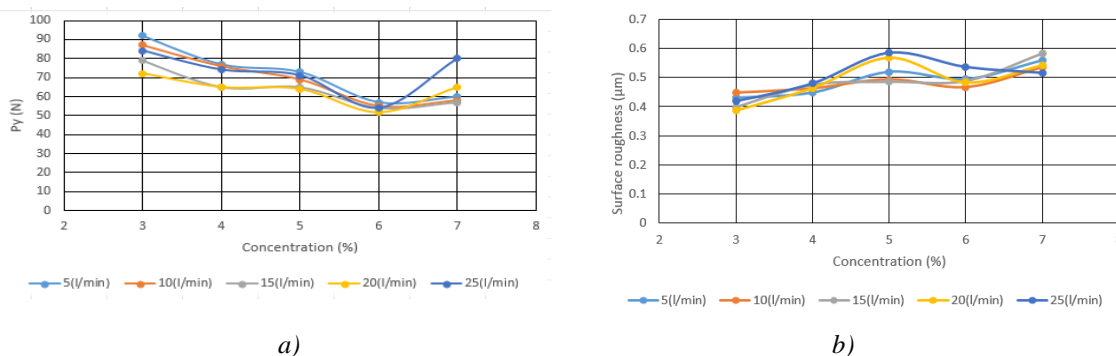


Fig. 2: Effects of the concentration and volume flow rate on P_y and R_a when using Caltex Aquatex 3180

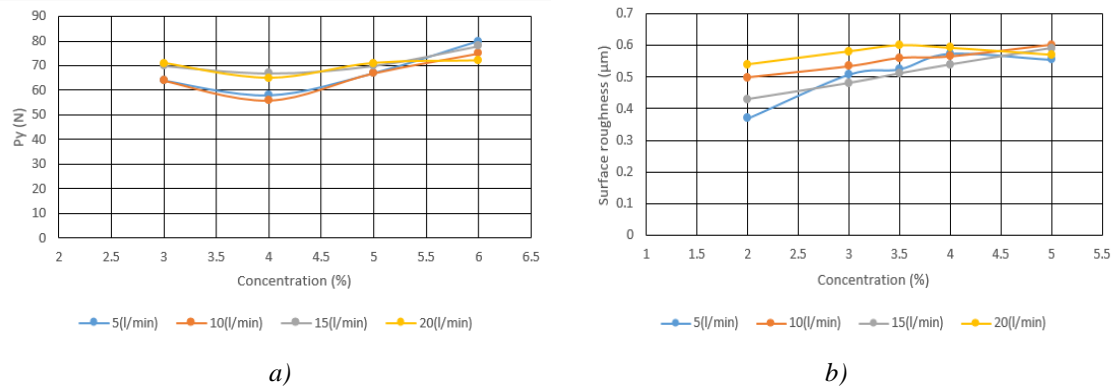


Fig. 3: Effects of the concentration and volume flow rate on P_y and R_a when using Avantin 300

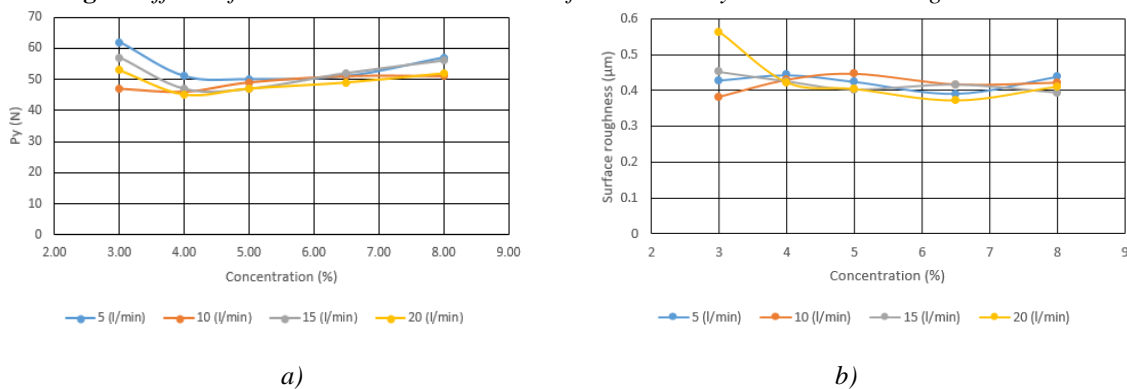


Fig. 4: Effects of the concentration and volume flow rate on P_y and R_a when using Avantin 361I

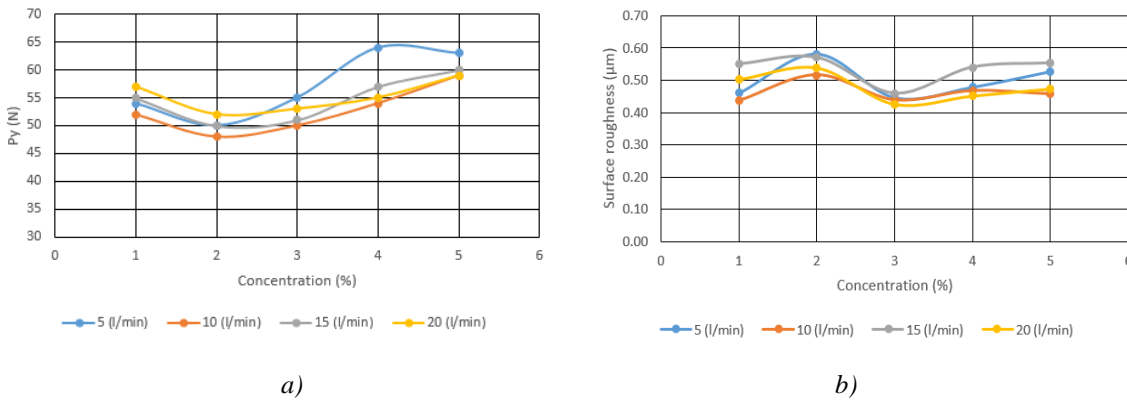


Fig. 5: Effects of the concentration and volume flow rate on P_y and R_a when using JPway.

When using the coolants mentioned, the effect of the concentration and the volume flow rate to grinding force components P_x and P_z is insignificant but a large influence on force component P_y (Fig. 2a, 3a and 4a). In addition, with each volume flow rate, there exists an optimum concentration at which minimal force P_y . Also, that optimum value depends on the volume flow rate (Fig. 2a, 3a and 4a). From the experimental results, the optimum concentration and optimum volume flow rate for each type of coolants were suggested as follows:

Table 2: Optimum parameters

Coolant	Concentration (%)	Volume flow rate (l/min)
Caltex Aquatex 3180	6	15
AVANTIN 300	4	10
AVANTIN 361I	3.5	5
J. P. WAY	2	10

From the results of using the above optimum regime for Aquatex 3180 Caltex oil at Private Enterprise Thai Ha, it is known that the grinding force can reduce 25% and the surface roughness can reduce 5.2% for comparing to the result when using the concentration of 5% - as recommended by the manufacturer).

CONCLUSIONS

- The effects of the concentration and volume flow rate with different coolants to the surface quality and the cutting force when surface grinding 90CrSi steel by Hai Duong grinding wheel were investigated.
- Optimum concentration and optimum volume flow rate for four type of coolants were proposed. Using this optimum values allows considerably reduce grinding forces and surface roughness of workpiece.

TÓM TẮT

ẢNH HƯỞNG CỦA DUNG DỊCH TRON NGUỘI ĐẾN LỰC CẮT VÀ CHẤT LƯỢNG BỀ MẶT KHI MÀI PHẪNG THÉP 90CrSi QUA TÔI

Luu Anh Tùng¹, Vũ Ngọc Pi^{1*}, Nguyễn Thị Thu², Bành Tiến Long³

¹Trường Đại học Kỹ thuật Công nghiệp - ĐH Thái Nguyên

²Trường Cao đẳng Công nghiệp Việt Đức, Thái Nguyên

³Trường Đại học Bách khoa Hà Nội

Trong gia công mài, nhiệt độ sinh ra trong vùng cắt cao do quá trình mài có thể coi là quá trình cắt bởi rất nhiều lưỡi cắt với vận tốc cao. Vì lý do đó, việc lựa chọn dung dịch và chế độ tron nguội là đối tượng của nhiều nghiên cứu về mài nói chung cũng như mài phẳng nói riêng. Bài báo này trình bày kết quả nghiên cứu ảnh hưởng của các loại dung dịch bôi trơn làm mát đến chất lượng bề mặt khi mài phẳng thép 9CrSi qua tôi bằng đá mài Hải Dương. Các kết quả nghiên cứu thực nghiệm cho thấy lực cắt và độ nhám bề mặt chi tiết khi mài giảm đáng kể khi áp dụng chế độ tron nguội hợp lý.

Từ khóa: Mài phẳng, tron nguội, lực cắt khi mài, độ nhám bề mặt

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* Tel: 0974 905578, Email: ngocpivu@yahoo.com

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