**Journal of Trends in the Development of Machinery and Associated Technology**
**Vol. 18, No. 1, 2014, ISSN 2303-4009 (online), p.p. 39-42**

# COLD AIR DRY MACHINING
# Part 1: EXPERIMENTAL SETUP

**Sabahudin Ekinović[1]**
**Edin Begović[1]**
**Belma Fakić[2]**
**Adisa Burić[2]**
**Aida Čeliković[1]**
**University of Zenica**
**[1)] Faculty of Mechanical Engineering**
**[2)] MI „Kemal Kapetanović“ Zenica**
**Bosnia and Herzegovina**

## ABSRACT
*Dry machining and near-dry machining were developed as an alternative to flood and internal high-pressure coolant supply to reduce metal working fluids consuption. In dry machining, compressed air introduces into the cutting zone, while near-dry machining supplies very small quantities of lubricant into the cutting zone. Both these techniques have been introduced with the aim to reduce the use traditional coolant and lubricant. One of the many dry machining techniques is the usage of cooled compressed air.*
*Experimental setup for dry machining with cold compressed air is presented in this paper. Machining tests were performed by turning of three grade of workpiece materijal; alloyed steel, aluminium bronze, and pure aluminium. Temperature of cold air and workpiece are measured, and chip morphology was analysed.*
**Keywords:** Cold Air Dry Turning, Steel, Aluminium Bronze, Pure Aluminium

## 1. INTRODUCTION
Nowadays the manufacturers in the field of metal working increasingly turning dry machining as one of the ways for future processing of materials. The development of environmental awareness and concern for human health, as well as increasingly stringent legislation, increasingly forcing industrial production that abandons the use of traditional techniques of cooling and lubrication in machining, and to turn the application of advanced production technologies. One of these is a dry machining [1,2,3,4]. Dry machining is ecological desirable process of metal removal that does not involve the use of wet cutting fluids. But, the mechanical and thermal loads on the cutting tool are increased. Therefore, cutting tool for dry machining applications can be designed in three different ways: by using new cutting tools material, by adapting new cutting tool geometries or by applaying special cutting tool coatings [4,5].
The main advantages of dry machining are [2,5,6,7]:
- absence of significant pollution of the atmosphere and water, which reduces the risk to the environment and human health,
- eliminating the costs of using coolants and lubricants (acquisition, adaptation, application and disposal),
- elimination of residual coolants and lubricants on the parts of the machine tool and the workpiece, thereby eliminating the cost of machine and workpiece cleaning,
- elimination of residual coolants and lubricants on the chip, thus reducing the costs of disposal of the chip.

Attracted the most attention today are three ways a dry machining: traditional compressed air dry machining, cryogenic machining, and cold air dry machining.
Employing compressed cold air for cooling in machining operations is a relatively new technique which has attracted many researchers [5,7]. A vortex tube is a device which produces cold (or chilled) and hot air from compressed air, Figure 1.
Compressed air, usually from 5.5 to 6.9 bar is introduced tangentially 1 into the vortex chamber 2. The air flow from the rotation of one million rev/min moving toward the exit of heated air 3, where it is discharged through the control valve 4.
The rest of the air, which is still circularly moving routed back through the central portion of the outer vortex. Internal air stream delivery kinetic energy in the form of heat to the outer stream and leaves the vortex tube as cold air 5.

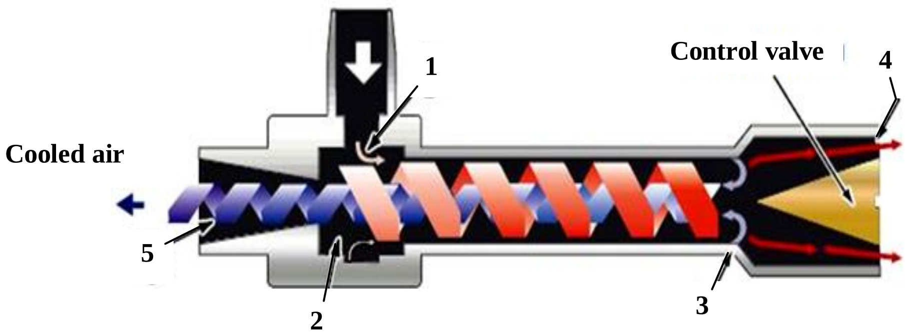


*Figure 1. The working principle of vortex tubes with parallel flow*

## 2. EXPERIMENTAL SETUP

Experimental investigations were carried out at the Laboratory for metal cutting and machine tools (Faculty of Mechanical Engineering, University of Zenica).
Machining tests were caried out on universal lathe. Workpiece materials were: alloyed steel Č.5432 (according to BAS standard), aluminum bronze Cu85.5Al10Fe2.5Mn2, and pure aluminium (99.5%).
Cutting conditions were:

- for alloyed steel: cutting speed v = 60 m/min, feed f = 0.098 mm/rev, depth of cut d = 0,5 mm,
- for aluminum bronze: cutting speed v = 85 m/min, feed f = 0.2 mm/rev, depth of cut d = 1,0 mm,
- for pure aluminium: cutting speed v = 70 m/min, feed f = 0.2 mm/rev, depth of cut d = 1,0 mm

For each workpiece material, three experiments were carried out: machining without the use of coolants and lubricants, cold air dry machining, and with a cooling of workpiece material before machining.
Thermovision camera was used to measure the temperature of the cutting zone. The measured temperatures of the cutting zone are shown in Figures 2, 3 and 4, for alloyed steel, aluminium bronze and pure aluminium, respectively.
At the same figures, the results of cutting force measurements are given, too, with the aim of analysis measured value of the cutting forces at different cooling regimes.

## 3. CONCLUSION

This paper represents the first part of the research concerning experimental setup for three ways of dry turning of different workpiece materijals: alloyed steel, aluminium bronze, and pure aluminium.
In the secont part, the SEM and metallographic examination of chip will be presented.

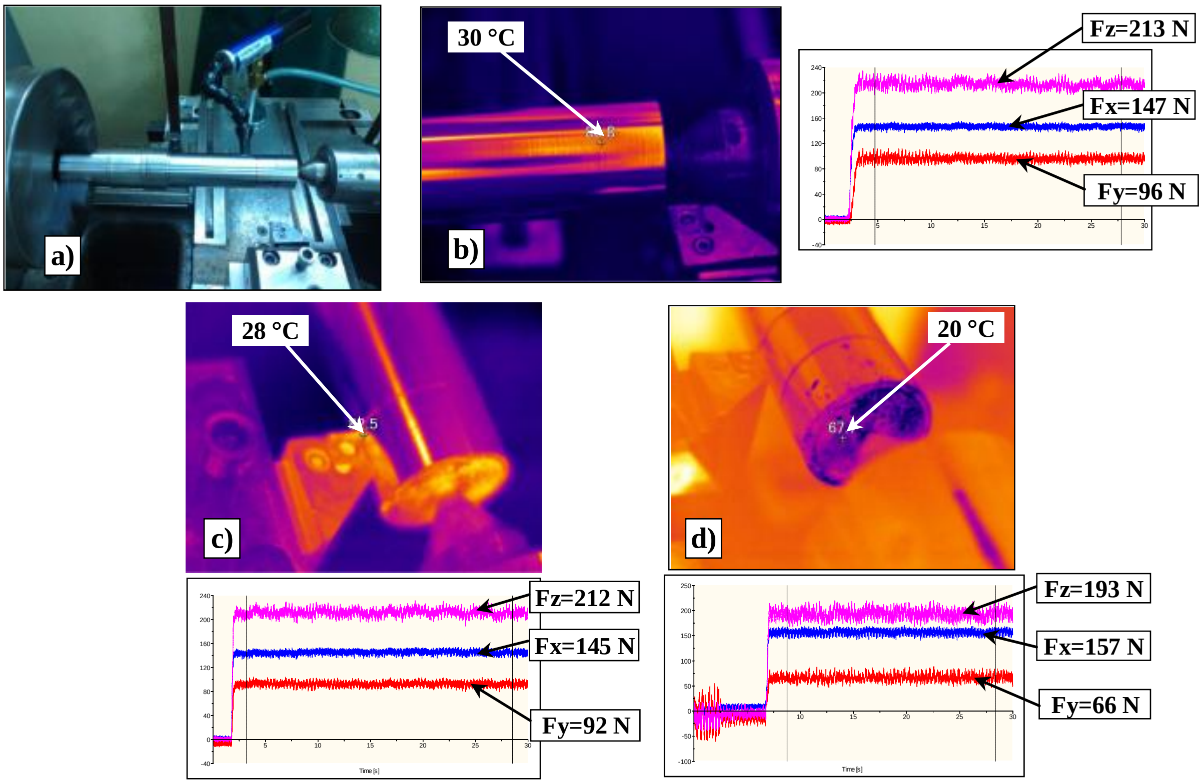


*Figure 2. Machining of alloyed steel Č.5432: a) experimental setup, b), c), d) thermovision camera measurement, b) machining without coolant and lubricant, c) cold air dry machining, d) cooling of workpiece*

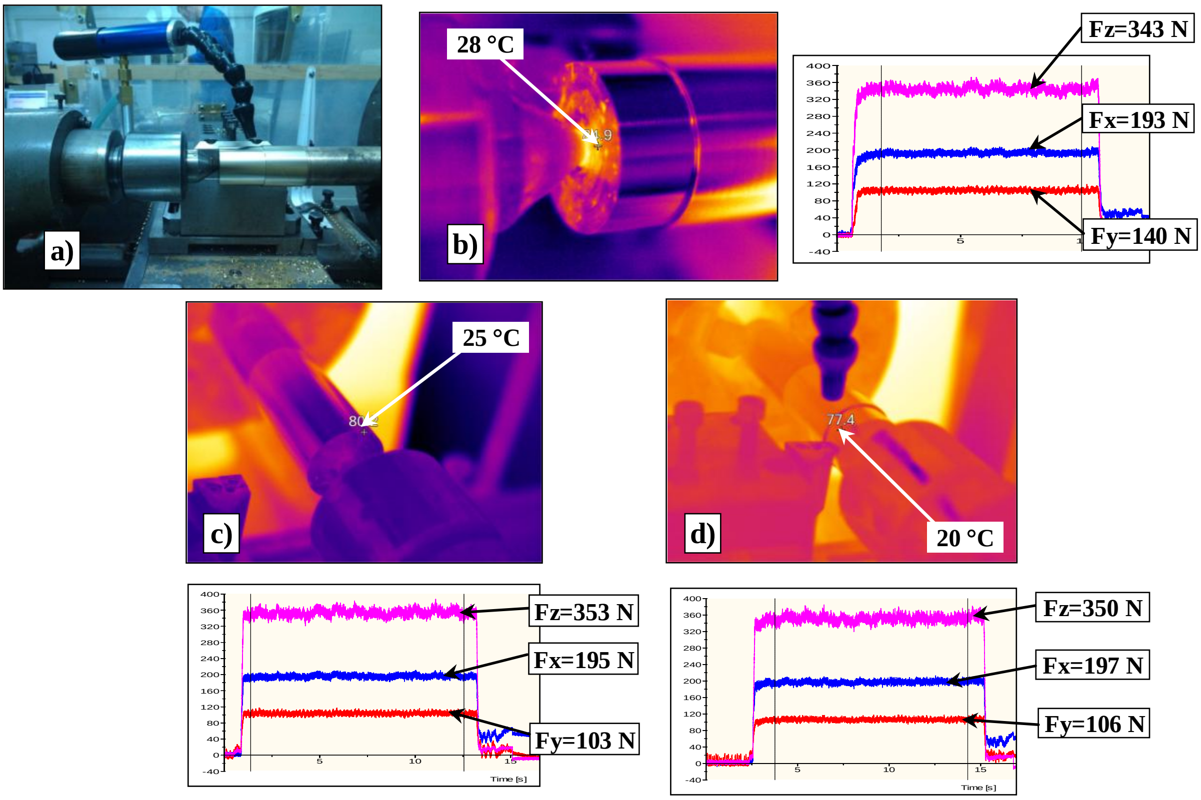


*Figure 3. Machining of aluminium bronze: a) experimental setup, b), c), d) thermovision camera measurement, b) machining without coolant and lubricant, c) cold air dry machining, d) cooling of workpiece*

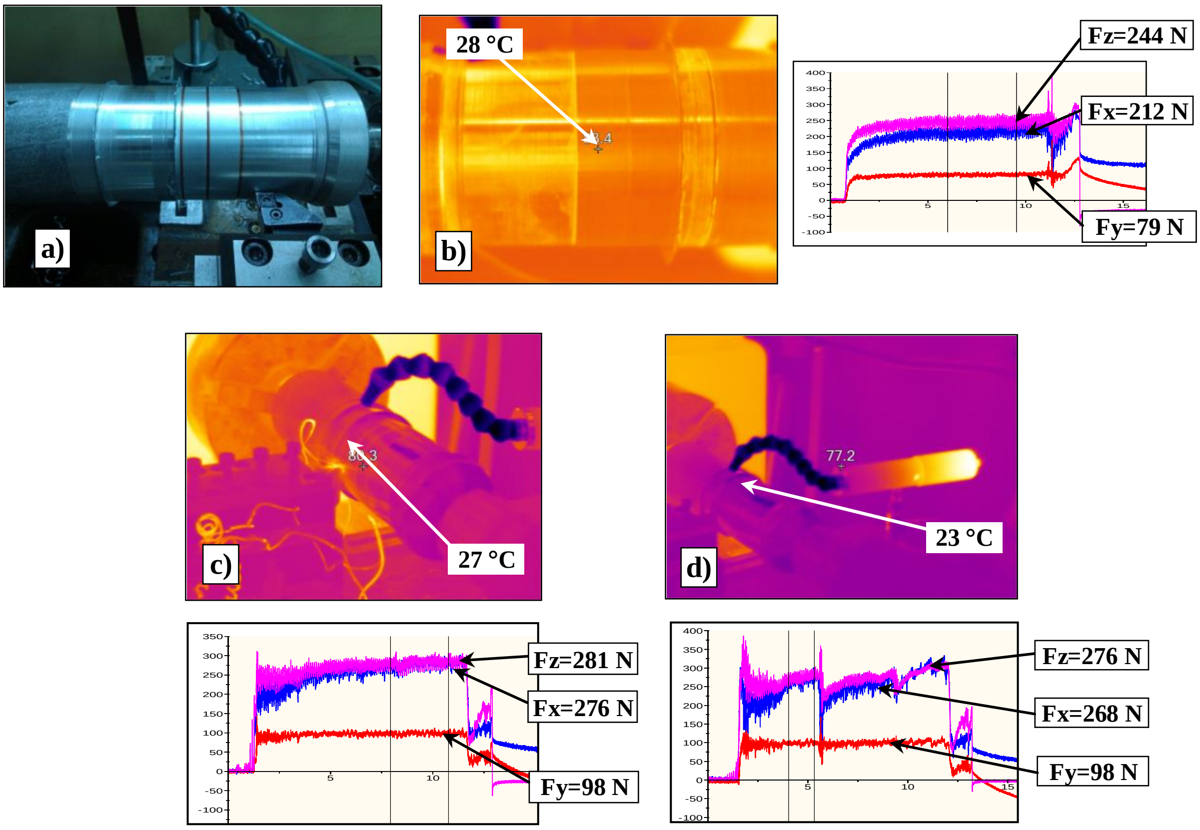


*Figure 4. Machining of pure aluminium: a) experimental setup, b), c), d) thermovision camera measurement, b) machining without coolant and lubricant, c) cold air dry machining, d) cooling of workpiece*

## 4. REFERENCES

[1] Kopač, J., Pusavec, F.: Concept of Sustainable Machining Processes, Proceedings of 13th International Research/Expert Conference „Trends in the Development of Machinery and Associated Technology“, TMT2009, Hammamet, Tunisia, 2009, pp.I-1-I-7.,

[2] Weinert, K., Inasaki, I., Sutherland, J.W., Wakabayashi, T.: Dry machining and minimum quantity lubrication, CIRP Annals, (53), No.2, 2004, 511-537,.

[3] Ekinović, S., Begović, E., Ekinović, E., Fakić, B.: Cutting Forces and Chip Shape in MQL Machining of Aluminium Bronze, Journal of Trends in the Development of Machinery and Associated Technology, Vol.17., No.1., 2013, pp. 17-20.,

[4] Jozić, S., Celent, L., Bajić, D.: Achievement of Green Manufacturing using Alternative Types of Cooling in Machining Processes, Proceedings of the 4th International Symposium on Sustainable Development, ISSD2013, GRE-1396, 2013. p.7.,

[5] Asthakov, V.P.: Tribology of Metal Cutting, Elsevier, London, 2006.

[6] Ekinović, S., Begović, E., Lušija, A.: MQL Machining – Oil on Water Droplet System, Proceedings of the 4th International Symposium on Sustainable Development, ISSD2013, GRE-1240, 2013. p.8.

[7] Kolcke, F., Eisenblaetter, G.: Dry cutting, CIRP Annals, (46), No.2, 1997, pp. 519-526.