The International Journal of
TRANSPORT &LOGISTICS
Medzinárodný časopis
DOPRAVA A LOGISTIKA

ISSN 1451-107X

THE IMPACT ANALYSIS OF CUTTING FLUIDS AEROSOLS ON THE WORKING ENVIRONMENT AND CONTAMINATION OF RESERVOIRS

Matúš Čuma [1], Jozef Zajac[2], Slawomir Luscinski[3]

[1] *Department of Manufacturing Technologies, Faculty of Manufacturing Technologies , Technical University in Kosice, Bayerova 1, 080 01 Prešov, +421 55 602 6350, e-mail: matus.cuma@tuke.sk*

[2] *Department of Manufacturing Technologies, Faculty of Manufacturing Technologies , Technical University in Kosice, Bayerova 1, 080 01 Prešov, +421 55 602 6463, e-mail: jozef.zajac@tuke.sk*

[3] *Department of Production Engineering, Faculty of Management and Computer Modelling, Kielce University of Technology, Al. Tysiąclecia Państwa Polskiego, 25-314 Kielce, +48 41 34-24-378, e-mail: luscinski@tu.kielce.pl*

Abstract: *Cutting fluids play a significant role in machining operations and impact shop productivity, tool life and quality of work. They are also a key factor in machine shop productivity and production of quality machined parts. Today's cutting fluids are special blends of chemical additives, lubricants and water formulated to meet the performance demands of the metalworking industry*

Key words: *fluid contamination, metalworking cutting*

1 INTRODUCTION

Monitoring and maintaining fluid quality are crucial elements of a successful fluid management program. A fluid must be monitored to anticipate problems. Important aspects of fluid monitoring include system inspections and periodic measurements of fluid parameters such as concentration, biological growth, and pH. Changes from optimal fluid quality must be corrected with appropriate adjustments (such as fluid concentration adjustments, biocide addition, tramp oil and metal cuttings removal, and pH adjustment). It is important to know what changes may take place in your system and why they occur. This allows fluid management personnel to take the appropriate steps needed to bring fluid quality back on-line and prevent fluid quality problems from recurring.

The new metalworking cutting fluids generation brings also higher requirements for the system of fluid performance monitoring and control.

2 SAMPLES AND ANALYSIS

Exposure to aerosols of cutting fluids on workers was measured from samples of multi-hole filters after collecting gravimetric analysis to determine the total number of total inhalable particles (TIP). Filters were further analyzed the content of mineral oil mist for reconsideration in cyclohexane solvent and sample the mix of water cutting fluid were analyzed by elementary methods. This method involves measuring the elemental element (usually boron or potassium) by spectrometric analysis. If data are available concentrate on cutting fluid in the tank for liquid (% m / V), is then possible to calculate the concentrate in the air. The bulk of the cutting fluid samples were taken at the site of the workpiece or cutting tool. In some cases, where the central tank is used, one sample was collected. Temperature and pH of the aqueous mix of cutting fluid was measured on the spot.

Water mixes cutting fluids were analyzed to detect the bacteria content. A substantial portion of the water mixes of cutting fluids used for calibration of aerosol samples for analysis. Bacterial contamination of fluids was determined by dip-slide analysis. This analysis lies in the fact that the agar-coated plastic rod immersed in a liquid sample cut and placed into a sterile container and then placed in an incubator. By stable temperature after 48 hours the amount of bacteria on the bar is determined by comparing. Dip-slide analysis provides a simple, inexpensive and reliable method of determining bacterial growth.

3 THE RESULTS OF MEASUREMENTS

Exposure to aerosols of cutting fluids can happen in contact with the skin (such as through contaminated areas), or inhalation of spray droplets in the air. The aerosol is created when the cutting fluid is exposed to high shear strength or excess heat during the application process. Aerosol properties depend on itself, cutting fluid and the type of operation, but the fog may be relatively stable and usually do not last long. Summary statistical results for the analyzed air samples are listed in Tab.1, analytical results from the tank in Tab.2 and percentiles in Tab.3.

Tab. 1 *Summary statistics of the valued mean of air samples over 8 hours*

Analyzed sample	Samples amount	Min	Max	Median	Mean	Geometric mean	Mean deviation
Mineral oil (TIP) mg/m^3	30	0,06	4,38	0,55	1,11	0,61	3,26
Mineral oil mg/m^3	30	0,03	3,74	0,78	1,23	0,67	3,76
Water mix (TIP) mg/m^3	30	<0,04	23,06	0,32	0,67	0,33	3,05
Water mix concentrate	30	<0,01	13,2	0,12	0,35	0,13	3,9

Tab. 2 *Summary statistics analysis of tanks*

Analyzed sample	Matrix	Samples amount	Min	Max	Median	Mean	Deviation	Geometric mean
pH in tank	Water	30	5,4	10,5	8,8	8,7	0,7	8,7
Temperature in tank °C	Water	30	10,7	44,1	21,6	21,9	3,8	21,6
Fine particles mg/l	Water	30	<4	2200	18	56	165	20
Fine particles mg/l	Mineral Oil	30	80	1230	395	464	291	385
Amount of bacteria 10^6	Mineral Oil	30	<10	195	0,109	11,992	30,926	0,01774

Tab. 3 *Percentiles of cutting fluid samples*

Analyzed sample	90th percentile	95th percentile
Aerosols		
Mineral oil (TIP) mg/m^3	2,8	3,3
Mineral oil fog mg/m^3	2,8	3,4
Water mix (TIP) mg/m^3	1,4	1,9
Water mix fog mg/m^3	0,8	1,6
Tank		
Mineral oil fine particles mg/l	900	970
Water mix fine particles mg/l	90	270
Amount of bacteria 10^7/ml	4,3	8,3

During the period of 8 hours neither mineral oil aerosols did not exceed 5mg/m3 on average. Results completely inhalable particles (TIP) and fog are well correlated. Regression line equation is given by: oil mist = 0.0889 + 0.892 UIC and the correlation coefficient r = 0.957, suggesting that the TIP may provide a good estimate of the impact on the environment of oil mist for these samples. (Fig.1)

$$\mathbf{x=0,0889+0,892\ TIP} \quad (1)$$

x – Equation of the regression line
TIP – Total Inhalable particles

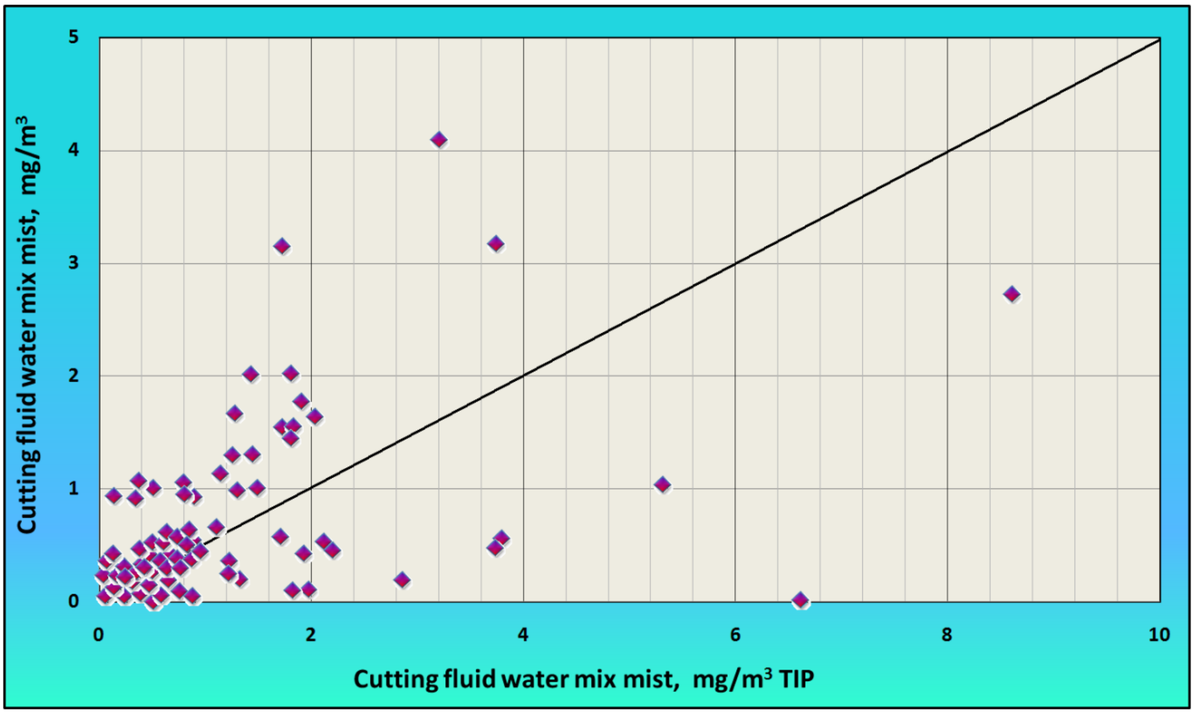

Fig. 1 *Mineral oil mist and mist of total inhalable particles*

A result of measurements of water mix suggests that most emissions are below the limit of 2 mg/m3. Chart mist cutting fluid concentrate total and inhalable particles (Fig.2) shows a high degree of dispersion, which shows, with the exception mentioned scattered values, the correlation coefficient is r = 0.598.

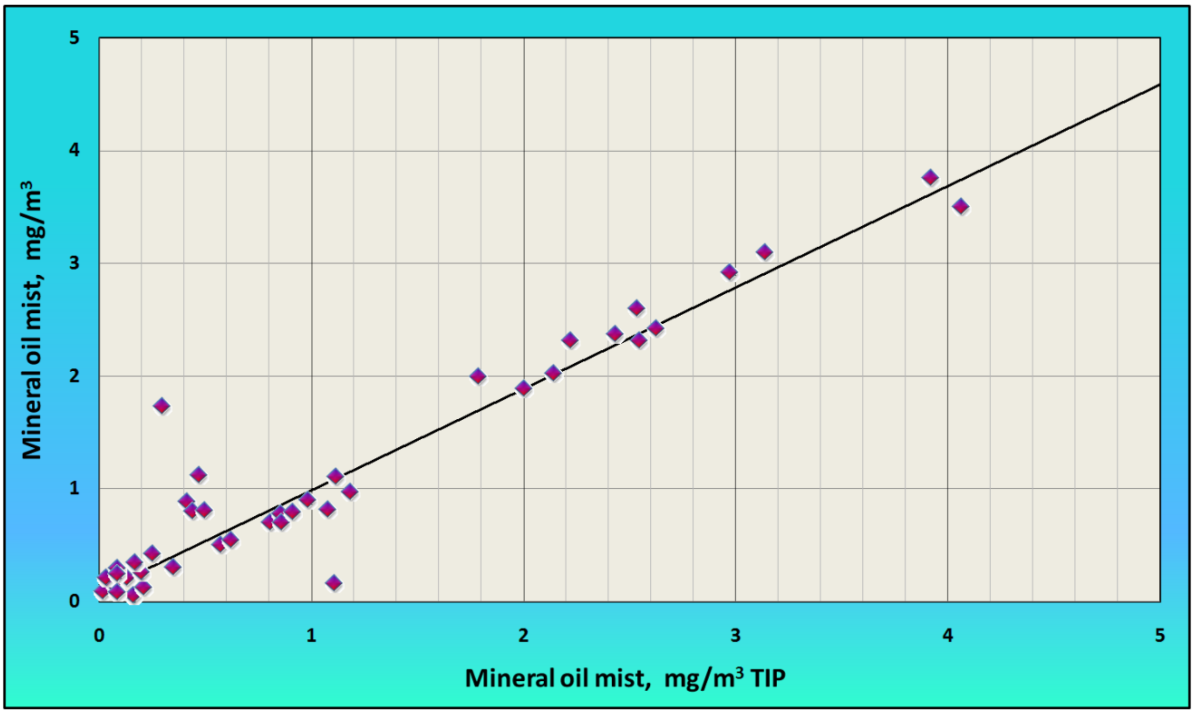

Fig. 2 *Mist of cutting fluid water mix and mist of water mix with total inhalable particles*

Differences in effect during machining are characterized as turning, milling, drilling, cutting and grinding (or combination of these operations in some cases). According to the values in Tab.4 can be concluded that results of measurements at various operations in the application of water mist cutting fluid mix (mg/m3) geometric grinding, drilling operations and the combination leads to higher impact of fog water mix as in turning or milling.

***Tab. 4** Results of measurements at various operations in the application of water mist cutting fluid mix (mg/m3)*

Process	Samples amount	Min	Max	Median	Mean	Geometric mean	Geometric deviation
turning	30	<0,01	1,82	0,06	0,15	0,07	3,32
milling	30	<0,01	0,92	0,07	0,13	0,08	2,84
drilling	30	<0,4	0,9	0,14	0,22	0,16	2,29
grinding	30	<0,02	13,22	0,35	0,73	0,29	3,87
sawing	30	<0,05	0,61	0,23	0,27	0,18	3,23
Combined operations	30	<0,01	3,22	0,2	0,71	0,28	4,81

Further analysis of these data shows that the growth of bacteria in a water tank with a mix of cutting fluids depends on pH and temperature of fluid (Fig.3, Fig.4), but also on other factors.

From previous analysis it can be stated that it is necessary to control the consumption of cutting fluids in machining processes wherever they are used. Mist and aerosols creation causes leakage of small particles of liquid into the operator working area or production line equipment.

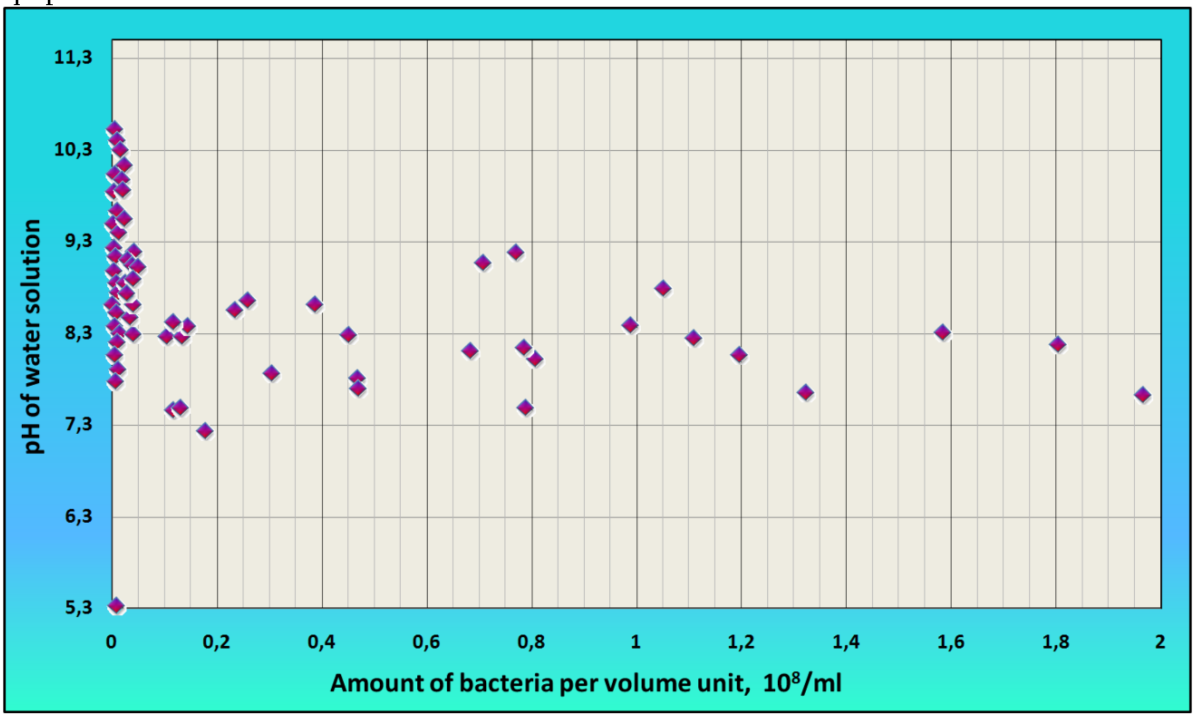

***Fig. 3** Growth of bacteria per volume unit, depending on the pH of the water mix of cutting fluid, X axis =10^8*

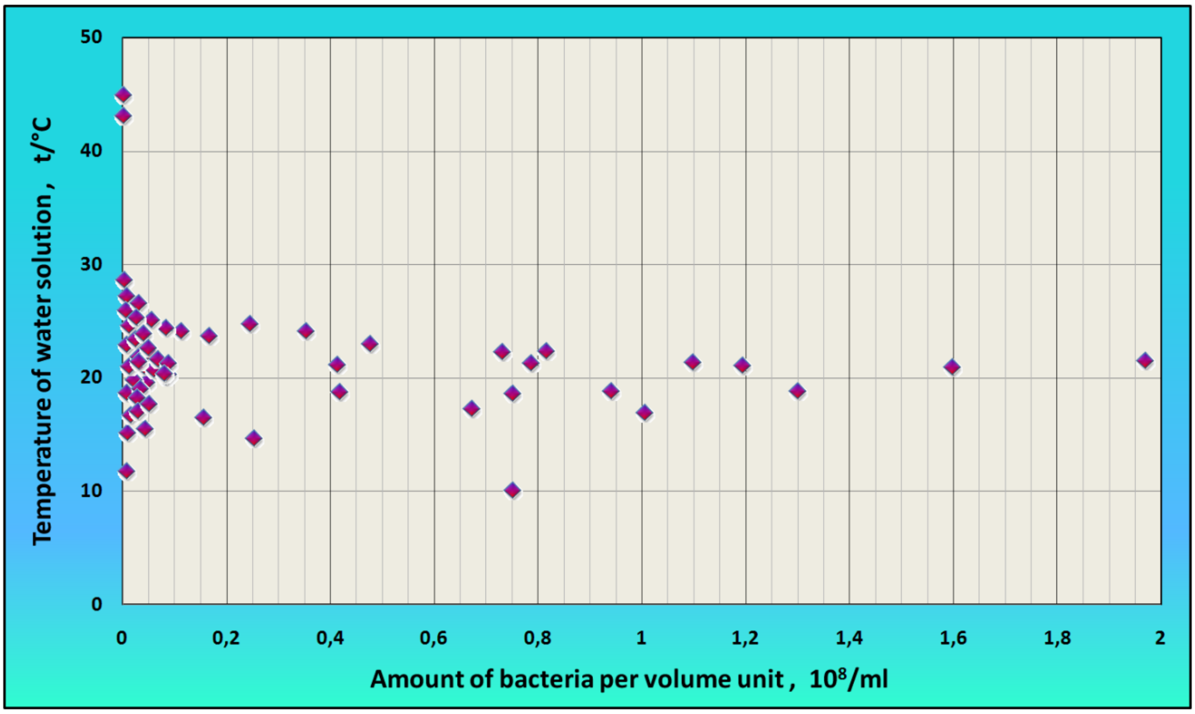

Fig. 4 *Growth of bacteria per volume unit at different temperatures of water mix cutting fluid, X axis = 10^5, Y axis = ° C*

This has implications not only for the health of working personnel, but also coating devices that come with those particles in contact. Reducing the impact can be assured not only by controlling consumption, but also constantly monitoring the quality of the media process and thus prevent their degradation and subsequent dispersal of pollutants into the workspace.

6 CONCLUSIONS

Fluid monitoring and maintenance are the key element of an each successful fluid maintenance program. Fluids must be monitored to prevent problems. An important aspect of fluid monitoring is a system of controls and periodical measurements of the fluids properties, such as concentration, pH and biological growth. Changes to the optimal fluids properties must be compensated by adequate additives (such as fluids concentration increasers, biocides additives, tramp oils, metal parts removers and fluid pH increasers). It is important to know what changes may cause in the system and what causes them. This allows personnel in fluid management to take necessary steps to bring the fluid properties and its quality back to optimal values and avoid possible problems recurring.

References

[1] Adamczak, S.- Makieła, W.- Stepień, K.: Correspondence Address Investigating Advantages and Disadvantages of the Analysis of a Geometrical Surface Structure withthe Use of Fourier and Wavelet Transform .In: Metrology and Measurement Systems . Volume 17, Issue 2, 2010, Issn: 08608229.

[2] Fedorko, G.- Husáková, N- Dudáš, G. Correspondence Address Design of Allocation of New Technological Equipment within the Frame of Production Process in Company Getrag Ford Transmissions Slovakia, S.R.O. In: Acta Montanistica Slovaca. Volume 15, Issue 1, 2010, Pages 14-22

[3] Hatala, M. – Orlovský, I.: Sprinkle Drying Kiln Ceramic Granulate Drying Characteristic and Experimental Measurements of the Drying Process Parameters. In: Technički vjesnik. Vol. 16, No. 2 (2009), P. 27-30, Issn 1330-3651

[4] Leiseder, L. M. - Metalworking Fluids, Verlag Moderne Industrie Ag&Co, Berlín 1991

[5] Roháčová, I.- Malindžák, D.: System Design for Evaluation of Company Production Strategy. In: Acta Montanistica Slovaca Volume 15, Issue 1, 2010, Pages 44-52

[6] Weiss, E.- Fedorko, G-Futáš, P.B- Pribulová, A.- Vasková, I.: Dependence of Quality Properties for Grey Iron on Used Raw Materials. In: Metalurgija Volume 48, Issue 1, January 2009, Pages 43-45

[7] Zajac,J. - Príspevok k riešeniu synergie brúsenia a kvapalín v procesoch brúsenia. In: Výrobné Inžinierstvo. 2003, Č. 2-3, S. 14-16, Issn 1335-7972-01, FVT TU Košice so sílom v Prešove

[8] Gros I., Grosová S., Dyntar J.: Importance of the System Identification in Supply Systems Modelling Theory and Praxis. In: Transport and Logistic, No. 6, 2009, Issn 1454 -107 X

[9] Smetanka Ľ.:, Zajac J, Monka P., Hrin Ľ.: Construction Solutions and their Economic Efficiency Using Various Transport Containers for Rubber Granules Manipulation and Storage ,In: Transport and Logistic, No. 10, 2010, Issn 1454 -107 X

[10] Sidor I., Zajac J., Smetanka Ľ.: Modern Analysis and Synthesis of the Semioperational Transport of the Composite Material Based Recovered Waste. In: Transport and Logistic, No. 10, 2010, Issn 1454 -107 X