

WATER QUALITY IN PROCESSING BY ABRASIVE WATERJET

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ABSTRACT:

The quality of the water used in processing by abrasive jet plays a very important role in the life of certain components such as: nozzle, seals, check valves and plungers. To perform high quality cutting, the orifices needs to create a high quality jet that is directed through the center of the mixing tube. Contaminates in the water can create a multitude of problems for the orifice.

KEYWORDS: water-jet, nozzle, seals, abrasive, hardness

1. INTRODUCTION

A concentrated energy for processing is made by use of the abrasive jet with metallic or non-metallic particles. Beginning from the glass processing, where the single problem were scratching from the surface, processed by water jet, by adsorption or injection of very fine abrasive particles, it was achieved the working of metallic or non-metallic materials. As an abrasive material the most frequent is stone, sand or carburet granules. The properties of the abrasive material depend on the work-piece's quality, the precision and the quality of surface or cutting working.

The abrasive particles are pulled into this high-speed stream or are injected in the high-speed stream, and mixed with water in a mixing chamber and then the velocity of the particle augment in a long ceramic mixing tube. The abrasive jet is directed toward the material that will be processed with a speed of 305 m/s. An important effect on the processing with abrasive water jet has, also, water that have to fulfill some conditions. It could have contaminates substances that can be classified in two groups: dissolved solids and suspended solids. Particles suspended in water impacts the edge and chips it, resulting a poor quality of jet, poor cutting's capability and lowered mixing tube's life. Dissolved solids can precipitate out of solution around the orifice's entrance.

In some cases a portion of this ring breaks and damages the orifice or disrupts jet's quality. If water is too pure can appear problems with the high pressure components.

Since water is so pure it exists a high possibility for water to dissolve the materials with which it comes in contact. An excessive water treatment can be detrimental to the components in the high-pressure water system. It is necessary to achieve a balance between pure water and untreated supply. The cost of water treatment must be compared to the costs resulting from shortened component life and cutting equipment downtime. The local water supply should always be tested prior to the installation of any water jet cutting system. This permits an appropriate water treatment system to be selected and installed.

2. PARAMETERS THAT INFLUENCE WATER'S QUALITY IN PROCESSING BY WATER JET WITH ABRASIVE

2.1. Ions from water

Water is the most frequent solvent in nature dissolving many substances. It dissolves electrolytes (acids, bases, salts) some organic or inorganic substances. Many reactions takes place in aqueous solution, resulting compounds and ions that have a negative influence on the processing with water jet.

a) *Water hardness* is given by the magnesium and calcium salts dissolved in water. These salts precipitate out of solution on the entrance of the orifice, reducing it's diameter and in the same time proving a rapid usage of critical components.

In the following table (table 1) are presented the values of water total hardness, expressed in German degree, as well as the corresponding hardness degree:

Table 1 Water hardness

D_T °G	Hardness degree of water
<5	Very soft
5....10	Soft
10,1.....20	Average
20,1....30	Hard
> 30	Very Hard

At the processing with water jet with abrasive, the necessity of some ions in water requires water with soft hardness.

b) *Anions and cations dissolved in water;*
Tape water have anions and cations from the

substances that were used for it's treatment or from the pipes through it flows. These ions, generally have , a negative influence on the processing with abrasive jet.

In table 2 are presented the substances that have been identified at the tape's water analysis, analyzed by the most competent professional agent in this domain LAREX coordinated by the National Authority of Consumer Protection.

Water molecules, in the presence of some ions as (Ca^{+2} , Na^+) should have a positive effect on the processing with water jet, because they form stabile structures (with hexagonal shape) that could be easily orientated in electromagnetic field and influencing the processing. Other ions (Mg^{+2} , K^+) have a destructive effect on these hexagonal structures as well as on the directing the water jet.

Table 2 Ions identified in tape's water

Nr crt	Characteristic U/M	Established value		
		Sample 1	Sample 2	Sample 3
1	Chlorure, mg/l	94,3	5,6	88,6
2	Iron, mg/l	71	Under detection limit10	
3	Total hardness german degree	20,35	0,55	18,72
4	Free residual chlorine,mg/l	0,04	0	0,01
5	Nitrites, mg/l	Under detection limit 0,007		
6	Fluor, mg/l	0,21	0,016	0,137
7	Cooper, mg/l	0,002	0,0003	0,0006
8	Cadmium mg/l	0,225	0,06	0,2
9	Lead	3,35	1,3	1,6
10	pH	7,42	6,43	7,98

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A possibility to remove these undesired ions is by reverse osmosis system. In table 3 are given the ions that have a favorable influence on the formation of water hexagonal rings and that's which remove these structures.

2.2. Water superficial tension

Molecules from the liquid-gas interface are under the influence of some attraction forces different from that's from the inside of the liquid. *Superficial tension* is the sum of all the attraction forces that acts tangential on the liquid surface, with the tendency to reduce this surface.

The superficial tension of water in an electromagnetic field will be reduced because of the alignment of water dipoles in an electrostatic field. Te temperature rising also determine the decreasing of the superficial tension of water because increases the distances between molecules.

Table 3 Ions influence on hexagonal structure

Structure making ions			Structure breaking ions		
Element	Ions	ΔE_{vw}	Element	Ions	ΔE_{vw}
Calcium	Ca⁺²	32,2	Magnesium	Mg ⁺²	-8,8
Lithium	Li ⁺	27,2	Potassiu	K ⁺	-3,8
Sodium	Na⁺	3,3	Rubidium	Rb ⁺	-6,3
Zinc	Zn ⁺²	50,6	Aluminium	Al ⁺³	-313,4
Iron	Fe ⁺³	51,9	Chloride	Cl ⁻	-7,5
Cooper	Cu⁺²	49,8	Bhromide	Br ⁻	-7,5

2.3. Water conductivity

It depends on the ions concentration and type, on temperature and solution's viscosity. Pure water has at 25°C, a conductivity $k_{25}=5,483 \mu\text{S/m}$. The tape's water have dissolved different substances. The water conductivity is strongly influenced by the content of dissolved substances, indicating the mineralization degree of water.

The mineralization degree can be calculated depending on the water conductivity, with the relationship:

Mineralization

$$\text{degree [mg/l]} = C \times \text{Conductiv [} \mu\text{S/cm]} \quad (1)$$

Where coefficient C has the values given in table 4:

Table 4 Water conductivity

Position	k [$\mu\text{S/ cm}$]	C[mg/l /]
1	<50	1,365
2	50 – 166	0,048
3	166- 333	0,769
4	333- 833	0,716
5	833 -1000	0,758
6	> 10 ³	0,850

From this table it can be concluded that the increasing of water conductivity is directly proportional with the increasing of mineralization degree, respectively of ions concentration from water. A great conductivity is proportional with a high mineralization degree but in the same time too much ions in water will negative influence the processing with water jet with abrasive.

The average value that has been found for samples taken from tape's water is 963 $\mu\text{S/cm}$ indicating a high mineralization degree. From this point of view water is improper for processing, being necessary a demineralization.

After demineralization to improve the water's properties necessary for processing by jet, there have been added some amount of Ca⁺² and Na⁺ ions in salts form. As it was presented before there is required a small ion's concentration for a better processing, theirs concentration is controlled by measuring the water's hardness (in German degree). In table 5 are presented the concentration of CaCl₂ (which provides Ca⁺²) and the resulted hardness:

Table 5 water hardness for different CaCl₂ concentration

C [%]	0,01	0,024	0,03	0,045	0,05
D _T	4,15	8,15	12,84	14,32	20,92

3. WATER COOLING

Because during processing with water jet with abrasive is used a high pressure, water will be warming, as it's energy is converted to heat. If water is recirculated it can quickly get too warm. The warmer the water, the more wear occur on the pump. The optimal temperature should be 21°C.

Taking into account the negative effect of the high temperature on the equipment's components is absolutely necessary to use a cooling system for water.

4. CONCLUSIONS

The quality of water used at the processing with abrasive water jet is very important because it can influence the life of components from the equipment. It is necessary to achieve a balance between pure water and untreated supply water to control the content in ions. From this point of

view water have to be soft, with some ions as Ca, Na with a positive influence on the formation of hexagonal rings between water molecules. These structures can be easily oriented in an electromagnetic field in which the process takes place and increases the processing efficiency.

The superficial tension will decrease not only because of the alignment of water molecules but also because of temperature increasing. The average value for water conductivity proper for processing is 963 $\mu\text{S}/\text{cm}$ depending on the existent ions .

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