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Possibilities for Classification of Physical Factors in Water Jet Technology

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Abstract: The article deals with water jet technology as advanced technology. The dividing this process and facilities used for the classification of physical factors as acoustic, temperature and vibration that occur when water jet cutting. In the experimental part of the article deals with analysis of the acoustic emission, vibration signal, and thermal emission to waterjet cutting.

Keywords: *water jet, visualization, measuring.*

1. Introduction

Nowadays addresses the very topical issue of pollution and devastation. This damage is usually caused by satisfying the needs of man and society. Many manufacturing technology was replaced because of negative effects on the environment. Have been introduced, low waste and non-waste production technologies, the introduction of environmental standards and strict rules that oblige protect all components of the environment. In addition, environmental protection and greater emphasis on work environment utilize and generate new progressive technologies, which partly replaced by human activity, thereby reducing the incidence of occupational diseases in industry and shabbiness of the human body in manufacturing. Water jet technology is one of the progressive technologies with little interference with the environment and its pollution. In water jet technology, with regard to the environment, is occurring physical factors such as noise, vibration and a small amount of heat. For visualizing physical agents currently used various manners from analogy to digital instruments and methods.

2. Waterjet as a Progressive Technology

For centuries water changes the river basins and coasts. The water is the bearer of kinetic energy. The ability to change the water environment is confirmed by observation and experience. In the 19th century, the water began to use the technical objectives. This method of using water was known in the treatment of the outside water flow, especially in the mining and extractive industries.
In this days, one of the unconventional technology of production environmentally friendly technology is cutting water jet.

Demands on the cutting process in recent years are harder due to living and working environment and therefore water jet cutting technology represents a unique opportunity of introducing automation in high-pressure high-performance cutting different types of materials.

Using the kinetic energy of water and a very thin stream of water to achieve a power of the water jet, this is capable of imparting a variety of materials, structures and thickness.

From textiles through plastic, stone to steel and cast iron. This technology is one

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of the technologies segregation of cold.

The components of systems for water jet cutting are subjected to such a level of stress, in which are sensitive to the impact of the constituents in water and may result in local damage, for example corrosion. This can result in cracks and finally fully damaged metal pressure components.

Water in this technology enhances the quality of work, quality of products, equipment life, reduce repair, to reduce wear of nozzles, control valves. Water used in water jet technology division must be free of iron and calcium. The total hardness of the treated water should not exceed 10 mg/ l. [10]

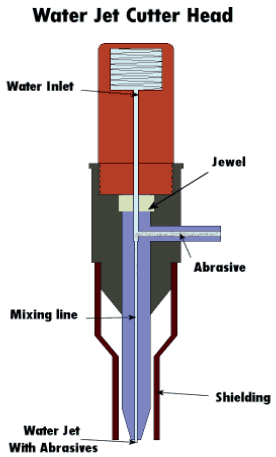

Fig. 1: *Scheme in the head section.*

Soluble solids are based on the solution and act as an abrasive material. The most affected are the components of the nozzle and high pressure seals.

When creating a high-speed stream of abrasive, the wear occurs in devices which mainly focusing tubes, it means the shocks due to the solid phase to the inner wall of the tube.

Fig. 2: *Device for cutting water jet.*

3. Visualisation and Measuring Device

3.1 Visualization and visualization techniques

The scientific visualization is an area of research for data collection and presentation. Its boom occurred in the field of information visualization and has become a big part of computer graphics.
In general visualization divided into:

- ***static parts (images, photos),***
- ***dynamic parts (outputs in the form of films and animations).***

Information accumulated generates data from which only some selected as input into the research. It is good to narrow the field of data entry for clarity studies.

At the beginning it is useful to understand what is visualized and to what end. Ways to work with the data are different. The data is displayed continuously or is handled only with data that is stable set. Visualization is mainly selects the appropriate techniques for the representation of data.

3.2 Measuring device

An acoustic camera is a device for identifying the acoustic emission using a special microphone system. The device allows frequency analysis of noise sources at a distance of several tens to hundreds of meters. The acoustic camera consists of the microphone matrix camera microphone array, hardware and software for recording and processing of data.

The acoustic camera system is composed of a number of microphone units, which are arranged according to the needs of the measurement up to the so-called triangle, star called a circle, ring and the sphere.
The construction of a microphone is extremely light membrane that yields to the outside vibration, densification and dilution, which varies the distance between the membrane and the capacity of the (one of the electrodes) and the fixed electrode.

Infrared non-contact measurement system captures the energy and changes it with the detector into electronic signals. The output is the creation of thermal images, as they are modified by the thermo-gram, and illustrating the temperature curve of the component surface. This method helps to observe of locate temperature anomalies invisible to the human eye, due to the inability to observe in the infrared part of the spectrum.

4. Experimental Measurement and Evaluation

4.1 Analysis of acoustic emission

Recently created many studies dealing with the acoustic emission when cutting material abrasive water jet. Many of these studies have been developed depending on the observation of surface roughness created and produced acoustic emission. This measure is aimed at creating a record of acoustic emission during cutting material abrasive water jet. The experiment was performed on a workpiece of steel AISI 309 with the material properties.

The scheme of the measurement is shown in Fig. 3, and consists of abrasive water cutter, accelerometer, multipliers, converter, software equipment LabView and Matlab. Using LabView the measured data stored in a suitable format for Matlab and then use the plot command shown the resulting signal (Fig. 4).

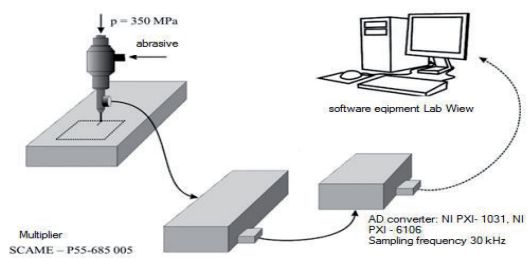

Fig. 3: *Scheme of measuring.*

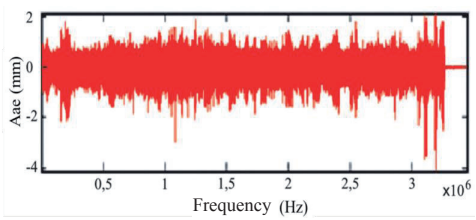

Fig. 4: *Input signal.*

4.2 The cutting process And infrared camera thermo vision

The aim of the authors of this measurement display output temperature during abrasive water jet cutting. This is carried out under normal working/operating conditions at a room temperature of T = 293,15 K. There was used to infrared camera ThermaCAM S65 by manufacturer FLIR Systems. The work piece was made of aluminum 6061-T6 with a width of 46 mm and with the thickness 25.4 mm. Infrared thermal images were recorded with frequency of 25 frames per second.

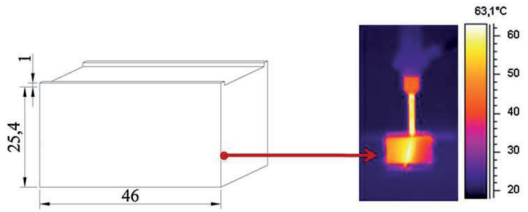

Fig. 5: *Selected images thermo gram of measurement.*

On-line measurement with a thermal imager, it was found that the maximum temperature during cutting was at 336,15 K. The heat is already the compression stream of water in a high pressure pump for water pressure of 300 MPa and movement through the transport system of the technology. The speed of cutting head movement is set at 3.23 $mm.s^{-1}$.

4.3 Emission of vibration at AWJ technology

In this section describes the results of measurements of vibrations that arise in abrasive water jet cutting steel plate. Figure 6 shown scheme of measuring of emission of vibration.

The following plot of vibration parameters, shown in Fig. 7 and Fig. 8 it can be seen how the changing values of vibration when changing material thickness of one species. This shows that the type of abrasives, material thickness and topography of the product has a direct impact on the AWJ technology and its quality and vibration.

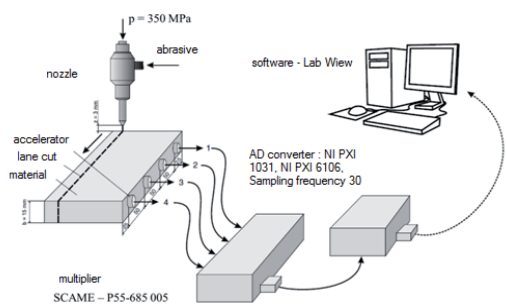

Fig. 6: *Measuring scheme.*

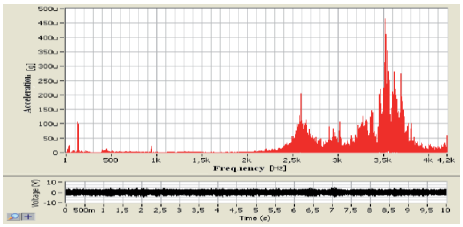

Fig. 7: *Orbital parameters - addiction (Barton) abrasive grain size, mesh size (50), material thickness 6 mm.*

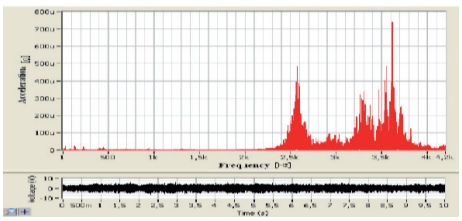

Fig. 8: *Orbital parameters - addiction (Barton) abrasive grain size, mesh size (50), material thickness 15 mm.*

5. Conclusion

The evaluation of measured and recorded acoustic emissions during material separation as previously negative phenomenon, can contribute to improving the quality of the working environment and the subsequent correction measures and the management process, setting the appropriate technological parameters. From experiments and defining the manufacturing process mathematical equations, the authors establish a general equation form, which can be used on any material and cutting conditions.

The most significant impact on worker has the technology producing noise arising from the electric motor, high-pressure water pump, water flow through the nozzle, a transport system for abrasive and finally cutting the material. In addition to the water jet technology also create the ambient noise produced by vibration and also the heat during the production process. Adverse effect on the environment can occur in renal water jet cutting system and leakage of oil from the high pressure pump, evasion and avoidance abrasive fluid mixed with abrasive and debris.

Technology cutting water jet largely contributed to environmental protection. Cutting process is clean, does not in fact have any dust, which does not occur by the chemical pollution of the air. Debris, resulting in the cutting process with abrasive is gathered and extracted sludge system. Maximum utilization of material, the use of zero as an emulsion in classical machining, is nowadays regarded as strength of the production technology

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