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IDENTIFICATION OF SAFETY AND ENVIRONMENTAL CONDITIONS FOR WATER JET TECHNOLOGY

The contribution deals with the safety and environmental requirements at water jet dividing. In the frame of experiments were verified safety properties of water jet with using of various types of cutting parameters. The tests were realised on two working tables on each with one cutting head. After evaluating of test results, we can make a conclusion that by dividing of high-pressure water into two cutting heads and with determining of suitable parameters, it is possible to increase the rate of working process, to make it more effective one and it is the possibility how to save financial resources for the firms in the frame of safety requirements..

Key words: Water-jet cutting, model, safety requirements, environment

1. INTRODUCTION

Water-jet cutting technology represents unique environmental friendly manner of material processing and also for the future orientated possibility of technology with high automation and with the introduction into high-speed cutting really for all material types.

In 30-thy year's American and Russian engineers first time tried to use water stream in mining, demarcating by high speed and that for coal, stone and rock mining. In the end of 60-thy year's one American airplane producer has decided that he will use water jet cutting for processing of fleeced bonded textiles, plastic materials and materials folded from more layers. High-pressure cutting with water stream, which is named also Water jet-Cutting, was afterwards continuously developed. Important impulse for water jet using in production technique like tool has come from aircraft designing and cosmonautics. At the present days water jet and abrasive jet cutting represent the technology with the minimal harmful influence on environment.

2. WATER JET TECHNOLOGY - SAFETY AND ENVIRONMENTAL CONDITIONS

Water jet technology introduces high-pressure cutting and shape dividing of all material types. The biggest plus of this technology in comparison with other cutting methods in machining is cold dividing process. It is used in the places, where chip-less, chip and thermal production techniques do not give good results from mechanical or physical reasons, or where we cannot give any convenient results. The division of water jets are shown in the Fig. 1.

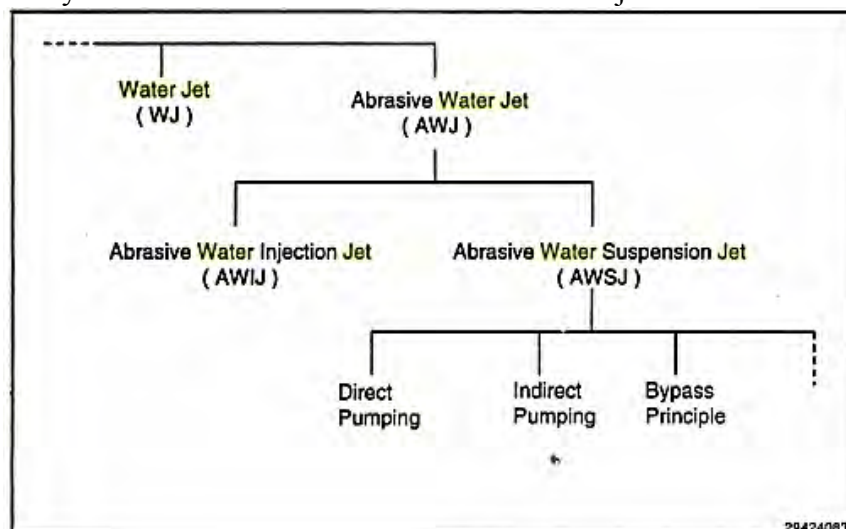


Fig. 1 The division of water jets

In the Fig. 3 is shown the hydro erosion jets, where the photos compare hydroerosion jet as a suspension of water and abrasive jet outflows from abrasive nozzle, which is surrounded by water mist. That phenomenon of the structure of the hydroerosion jet confirms that not only the mist, but the stroke of water nozzle above the material influence on the safety and on the surrounding, where occurs the spraying of water, but occurs the upper erosion of cut material and influence on the quality of work.

The safeness and environmental conditions of workplace were controlled and proposed in the workplace of the firm WATING Prešov, s.r.o., Fig. 2. The experiments theoretically and practically verified the environmental and safety properties of water jet workplace.

The water-jet cutting principle is visible on following Fig. 2.

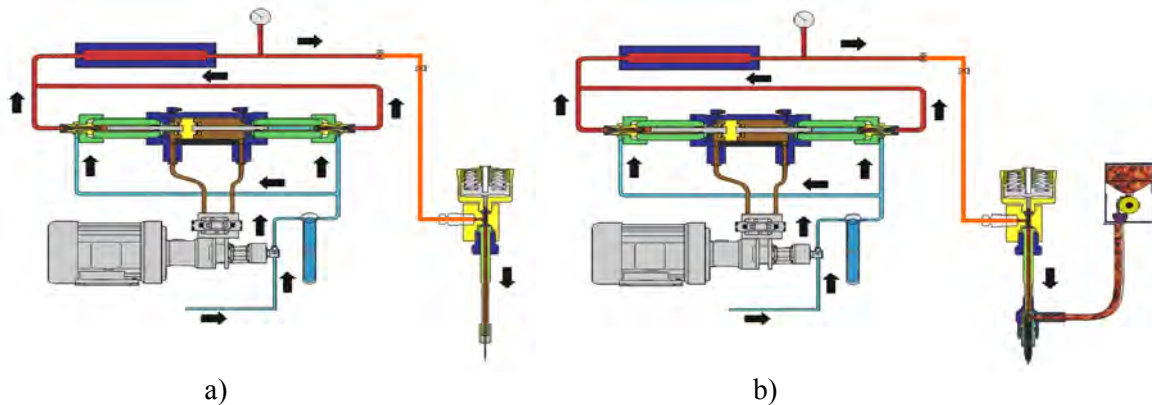
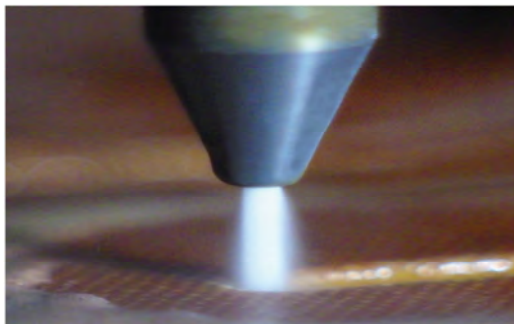
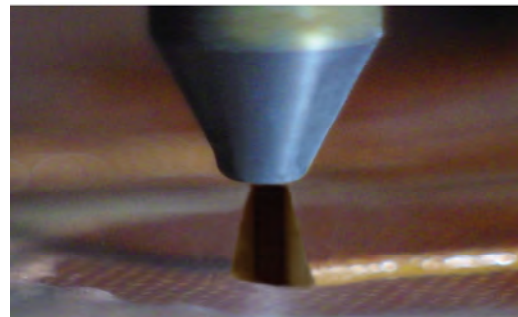


Fig.2 The principle of water-jet cutting – a) hydro method, b) hydro-abrasive method



a) AWJM - surrounded by water mist



b) AWJM - dispersion of abrasive into water mist

Fig. 3 Hydroerosion jet surrounded by water mist



Fig. 4 The workplace of water jet technology

Safety processes and safety practices of water jet technology must be monitored during introducing to the operation, during lonely operation and maintenance of high pressure pumps. In this area has created tables and symbolic descriptions used in real practice, which is needed to follow at operation of workplaces for water jet material separation.

For successful utilization of WJ or AWJ process, it is necessary to analyse the following process criteria, process parameters influencing of the AWJ Cutting Process is shown in the Fig. 3.

1. Material removal rate (MRR),
2. Shape and finish of the work piece,
3. Wear rate of the nozzle.

All the involved parameters can be classified into two categories:

- the input parameters or independent parameters
- and output parameters or dependent parameters.

These parameters are further summarized into different types in each category as follows:

- Input parameters: Hydraulic parameters: water pressure and water jet diameter.
- Cutting parameters: Nozzles traverse speed, number of passes, standoff distance and impact angle;
- Mixing and acceleration parameters: nozzle diameter and nozzle length.

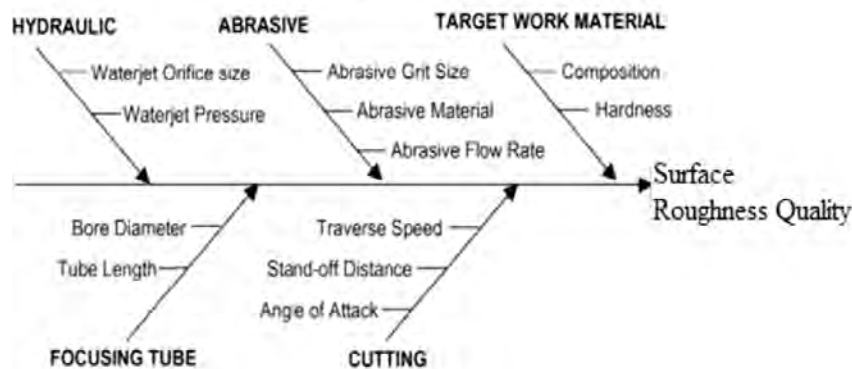








Fig. 5 Process Parameters Influencing the AWJ Cutting Process

The great injuries can be made also when the machine does not work, but the pump system was not switch off. After following starting of work on machine, the high pressure of water jet can injure the person as cutting injuries. The Tab. 1 shows the most important symbolic descriptions of water jet.

Tab. 1

Tables and abbreviations for safety at work with water-jet

	Show on dangerous, which can cause personal injuries or property damage, if care instructions are ignored.
	Show on dangerous, which can cause serious personal injuries, death or substantial property damage, if warning is ignored.
	High pressure of water stream can cause eyes injuries. Protect your eyes, when you work near the machine.
	Dangerous noise can cause hearing loss. Protect your ears, if you work near the machine.
	Dangerous electric tension can cause injury or death. Before opening the case unplug and disconnect main electric supply.
	Wrong function
	Hydraulic multipliers

	Pressure control
	High pressure
	Low pressure
	Start/Initialization
	Stop
	Running

Safety procedures must be following while it is worked with high pressure pump, with some its high pressure part. Such pump can operate only by qualified person. It is concerned at following safety procedures:

- High pressure of water from 3800 to 4150 bar at water-jet cutting systems. The user must have respect before that pressure and use current safety processes and safety working practices.
 - Everyone, who is connected with water-jet cutting system must realize, that power of water-jet cutting stream can penetrate into many hard and strong materials.
 - Not qualified personal must not move in water-jet cutting area.
 - In water-jet cutting area must be all time used safety glasses and earmuffs.
 - All emergency STOP buttons must be regularly checked. During normal operation are pulled out.
 - Check of buttons: Turn on electric supply and activate emergency STOP button so, that are pushed, you must see, if energy exploding. Every device should be checked according special table. All the time, when device is checked, must function or must be returned into the original status before the start of operation.
 - Use high clean lubricating wax for all threaded high-pressure connections. All piping, assembled and screwed connections should be tightened into the recommended moment values. If the circuit is under high pressure, do not try tight or install any high pressure parts, see safety of high pressure tubing.
 - All high pressure leakages must be immediately repaired.
 - Check all equipment according tables.
 - Before maintenance starting, turn off the main stop and ensure that high pressure is released.

The warnings of water jet operations are following:

- Never perform any work on device without that you have guarantee that electric panel is unplugged.
- Never work on any part with high pressure or released high pressure connections without that you firstly released the system and ensure that there is not high pressure.
- Ensure that safety devices are in the operation. At dangerous stop the pump and unplugged high pressure. Emergency STOP buttons must be pushed. Pressure valve system must be opened.
- Do not try to touch or be exposed to high pressure water. High pressure water penetrates into all parts of human body without exceptions.
- Dropping water or material produced by this extreme pressure can injury or kill.

3. GENERAL MAINTENANCE FROM POINT OF VIEW OF SAFETY WORK






Suitable maintenance is important for reliable and rigorous performance. Preventive maintenance reduces stoppage time for repairing, provides bigger operating life of parts and increases work safety.

High-pressure water will cut almost all what touches. Every infiltration must be immediately repaired to prevent damage or serious personal injury.

In the Tab. 2 is shown the important symbols and precautions from the point of view of maintenance and service.

Tab 2.

Warning Label Precautions

	The electrical enclosure and motor junction box can present an electrical shock hazard. Always disconnect and lockout the main power before opening the enclosure. You must always disconnect and lockout the main power and the circuit disconnect on the electrical enclosure door before performing any type of maintenance.
	The surface of high pressure water and hydraulic components becomes hot during normal operation. Failed or failing components, can become extremely hot during operation.
	Ensure that all protective guards, shields or covers are in place on the equipment at all times. Never operate the pump with the guards removed.
	High pressure water and/or hydraulic pressure can remain in the system even when the pump has been shut off. All pressure can be safely bled from the system by opening the high pressure cutting water valve for a few seconds after shutting off the pump. Depressurization of the high pressure system creates a loud hissing sound when the dump valve opens. The sound fades quickly as the pressure drops.
	All personnel involved in the installation, operation and/or service of the intensifier must carefully read, understand and follow the procedures in this manual to avoid creating unsafe conditions, risking damage to the equipment, or personal injury.

Maintenance directions are following:

- Regular equipment checking is recommended.
- Keep equipment and surroundings clear.
- Check pressures, temperatures and seal tightness.
- Immediately execute repairing.
- Maintenance record should be saved.

Working environment at water jet operations:

- Keep clear working environment for repair and maintenance waterjet pump.
- Use clear working table for repairs and clear working environment.
- Use not woollen materials for wiping.
- If parts with compressed air are released, use only clear, dry air. If parts are wash solvent, use only clear filtrated liquid.
- Always use original spare parts from producer for original version, reliability, safety and guarantee protection.

Safety and maintenance recommendations for working persons:

Carefully read the safety instructions.

Turn off all electric power.

Shut all incoming delivery valves and open all unwatering valves.

- Shut injection and transfer valves, if energy is closed, safety exiting valve will open and release water high pressure hidden in releasing tubing.
- Ensure suitable drawer, bowl, tanks, etc. For fixation and detention liquid to avoid of hazardous working environment.

- Abide double control for ensuring, that all pressure is removed from system before you continue in work.
 - Especially medical treatment is required always at treatment of wounding by waterjet according to card for emergency rescue. This card is part of technology delivery.
 - Avoid of leaking, sharpen abrasions or bend loads, if work with expensive technology parts.
- Ensure, that all parts are clean, without sharpen edges, particulates, dirt, etc.
Use high clean lubricant wax, if assemble some high pressure part or set.
- After repair any high-pressure part, check all high pressure connections for releasing of pressure.

4. STANDARDIZATION

As more and more production firms and corporations begin to market their hydroerosion equipment around the world, the need for standardisation of the high-pressure components becomes absolutely essential. Great organisations as ANSI (American National Standards Institute), ASTM

(American Society for Testing and Materials), CEN (European Community for Standardisation), IOS (International Organisation for Standardisation), ISEA (Industrial Safety Equipment Association), NFPA (National Fire Protection Association), OSHA (Occupational Safety and Health Administration) must join and establish international and national guidelines for world-wide standardisation of high pressure components for water jet technologies.

5. CONCLUSIONS

Work safety with water-jet in various production technologies must make provision not only for safety work with water-jet technology, but also safety work with all devices, which are on that workplace situated and also material manipulation. Water jet is a remarkable tool, which enables to cut various shapes from very soft to hard and brittle materials, as it is evident by the number of applications reported in many conferences.

However, bearing in mind the following points, will benefit everyone involved in this environmentally friendly technology:

- Exercise extreme care in the use of high pressure equipment,
- Always be alert on the job,
- Make sure that everyone involved in the operation of high pressure equipment is aware of all the safety guidelines and regulations formulated by national or international organisations and remember there is no substitute for “on the job training”,
- Do not ignore fluid jet injury no matter how small it may appear at first sight,
- Report immediately to the hospital and seek the attention of an experienced physician or surgeon, not the inexperienced staff who are usually in attendance at the emergency departments.

In case of other workplace devices, manipulation with material, interoperable transport, storage, control and overall work environment, i.e. production logistic, safety regulations valid for technology operation are applied and followed, in accordance with law, in terms of Inspectorate of work safety and State health authority.

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