

**Czech Technical University in Prague, Faculty of Mechanical Engineering**

**Doc. Ing. Libor Hlaváč, Ph.D.**

## **MACROSCOPIC PHYSICAL DESCRIPTION OF HIGH-ENERGY LIQUID JET INTERACTION WITH MATERIAL**

### **Summary**

High-energy, alternatively high-velocity, liquid jets and abrasive liquid jets, constrictively water and abrasive water jets, have become a very important tools for material cutting and disintegration within last thirty years. It is expected that this trend will continue as the liquid jets, similarly to other flexible tools (plasma, laser, electron jet), bring an enormous advantage – they cannot be damaged in standard applications and the moving machine remains also intact when parameters are insufficient for effective material removing. Liquid jet has a very important advantage opposite to the rest three mentioned tools. Its cut is cold, because only a microscopic volume is influenced thermally in the interaction of jet with material, directly corresponding to the contact of an abrasive particle with cut or machined material. Another advantages of liquid jets are huge thickness of a cut-through material with a high quality surface and easy regulation as well as control that enables applications in automated systems and on robots.

To control the interaction process between liquid jet and material effectively, not only for cutting purposes but also for lathing, drilling, sharpening, polishing and even shaping, it is necessary to have at one's disposal a set of relationships describing changes of quantities important for determination of process effectiveness, e.g. depth of penetration, removed volume, created surface and all these relationships expressed in macroscopic parameters determining jet quality or quality and quantity of the interaction process between liquid jet and machined material. The lecture is aimed at determination of the physical relationships describing two aspects of liquid jet existence separated in time and space, the second of them being strongly influenced and determined by the first one.

The first aspect to be mentioned is generation of liquid jet and its propagation in free space. The attention is focused at formulation of simple macroscopic model enabling rapid results highly correlating with experimental results. Such a model is necessary for very rapid calculations of parameter changes during on-line control of quality and quantity of interaction process between liquid jet and machined material, especially during shaping. Model is based at the idea that liquid jet is composed of a compact converging core and a diverging less compact cover. The results of the model are in a good correspondence both with performed

experiments and with a flow structure calculated from a set of differential equations that describe the phenomena in a more detailed and complex form.

The second analyzed aspect is interaction of liquid jet with material. The attention is aimed both at interaction of pure liquid flow with abrasive particles during mixing process and at interaction of generated abrasive liquid jet with machined material. The process is described by macroscopic parameters through simplified equations enabling acceleration of calculations and shortening of feedback delay during on-line control of quality and quantity of machining process.