Description

Image

Image caption

(1) An example of a 5-Axis waterjet cutting head used to cut complex 3-Dimensional parts on a CNC waterjet cutting machine. © WARDJet at Wikimedia Commons (CC BY 3.0) (2) Retro Systems Waterjet © Steve Brown Photography at Wikimedia Commons (CC BY 3.0) (3) An abrasive water-jet cutter puts the final cuts on a special tool © GeeJo at Wikimedia Commons [Public domain]

The process

In WATER JET CUTTING and MACHINING (WJM or HDM) water is pumped at high pressure (up to 400 MPa) through a sapphire nozzle with a diameter of 0.1 - 0.3 mm, from which it emerges with a velocity of up to 850 m/s -- roughly 3 times the speed of sound. This gives it enough kinetic energy to slice through relatively soft materials such as plastics, thin composites, paper, leather and food stuffs. The range of materials is extended by a modification of the process in which an abrasive grit such as garnet is entrained then the water jet. The maximum thickness that can be cut depends on the hardness of the material.

Process schematic

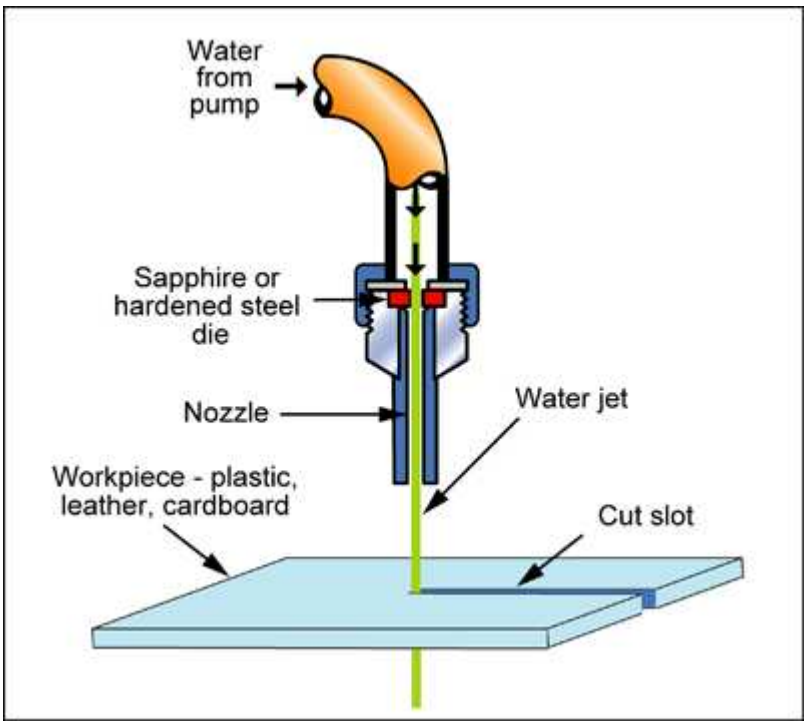

Figure caption

Water jet cutting. In a modified process (AWJM) abrasive is added to the water jet.

Tradenames

WJM and AWJM; Hydrodynamic machining, HDM.

Material compatibility

Ceramics	✓
Composites	✓
Glasses	✓
Metals - ferrous	✓
Metals - non-ferrous	✓
Natural materials	✓
Polymers - thermoplastics	✓
Polymers - thermosets	✓

Shape

Flat sheet	✓
Dished sheet	✓

Economic compatibility

Relative tooling cost	low
Relative equipment cost	medium
Labor intensity	low

Physical and quality attributes

Range of section thickness	19.7	-	984	mil
Tolerance	3.94	-	19.7	mil
Roughness	0.0315	-	0.248	mil
Surface roughness (A=v. smooth)	B			
Cutting speed	0.118	-	1.18	in/s
Minimum cut width	2.95	-	15.7	mil

Process characteristics

Primary shaping processes	✗
Machining processes	✓
Cutting processes	✓
Discrete	✓
Continuous	✓
Prototyping	✓

Supporting information

Design guidelines

Water-jet machining (WJM) is particularly good at cutting soft, pliable materials. The process exerts only very small forces on the workpiece, minimizing the need for clamping and distortion or damage, and it leaves a high quality edge. Almost no heat is generated so there is no heat-affected zone adjacent to the cut. WJM is best used on materials with yield strengths below 80 MPa. For stronger materials, abrasive water-jet machining (AWJM) should be used.

Technical notes

The cutting fluid is filtered water (to remove suspended particles that cause wear of the sapphire nozzle) with additions such as glycerine to control flow. The fluid is pumped with a conventional pump of power up to 30 kW. The flow-rates are relatively low (up to 7 liters/minute) despite the high jet velocities (300 to 850m/s). Cutting speed depends on material thickness and hardness.

Typical uses

The principal uses of WJM are those of cutting paper, cardboard and other packaging. In the electronics industry WJM is used to cut circuit boards. On a smaller scale it is used to cut non-reinforced polymers, rubber, leather, woven and random-mesh fabrics, polymer foams and foods. Abrasive water jet cutting (AWJM) can be used to cut almost anything. It is particularly suited for cutting non-homogeneous materials such as composites, and for cutting metals when properties are sensitive to high temperature or to the work hardening and surface damage caused by other cutting techniques.

The economics

WJM is a competitive process -- fast, clean and with relatively low equipment and tooling

The environment

In most ways WJM is eco-benign. It produces no dust, there is no fire hazard, and it does not involve unpleasant chemicals. It does, however, create noise at levels that exceed the guidelines of the Occupational Safety and Health Administration, requiring that ear protection be worn.

Links

MaterialUniverse

Reference