ANNALS of the ORADEA UNIVERSITY.

Fascicle of Management and Technological Engineering

STUDY ABOUT PROCESS MONITORING ACHIEVED BY ELECTRICAL EROSION

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Abstract:
Electrical Discharge Machining, EDM is a non-conventional technology with many possibilities for application. EDM is defined as the process of stripping off material using a successive series of electrical discharges at short intervals. These discharges jump between two poles (electrode - or working tool - and piece to be machined). Electric pulse generators create these discharges. Integrate automation component control technology, reduce the preliminary operation time, elevate the actual machining utilization rate of machine, and avoid human error caused to positioning accuracy.

1. INTRODUCTION

Electrical Discharge Machining (EDM) is performed, therefore, by means of electric sparks who jump between two electrodes subjected to a given voltage which are submerged in an insulating liquid (dielectric fluid).

Sinker (die sinking) EDM-s is generally used for complex geometries where the EDM machine uses a machined graphite or copper electrode to erode the desired shape into the part or assembly. EDM comes in two basic types: probe (die sinker) wire.

Automation component control technology reduces the preliminary operation time, elevate the actual machining utilization rate of machine, and avoid human error caused to positioning accuracy.

In general, the automation is an important operation that can to create technical system integration. In that case, the process of electrical erosion depends from a good monitoring system by automation.

The paper will contain a succinct presentation of the electrical erosion principle and a presentation of Electrical Discharge Machining - one of the most accurate manufacturing processes available for creating complex or simple shapes and geometries within parts and assemblies.

2. ABOUT ELECTRICAL EROSION PRINCIPLE

One of the most accurate manufacturing processes available for creating complex or simple shapes and geometries within parts and assemblies is Electrical Discharge Machining, EDM. That is defined as the process of stripping off material using a successive series of electrical discharges at short intervals. These discharges jump between two poles (electrode - or working tool - and piece to be machined). Electric pulse generators create these discharges. EDM machining is performed, therefore, by means of electric sparks who jump between two electrodes subjected to a given voltage which are submerged in an insulating liquid (dielectric fluid).

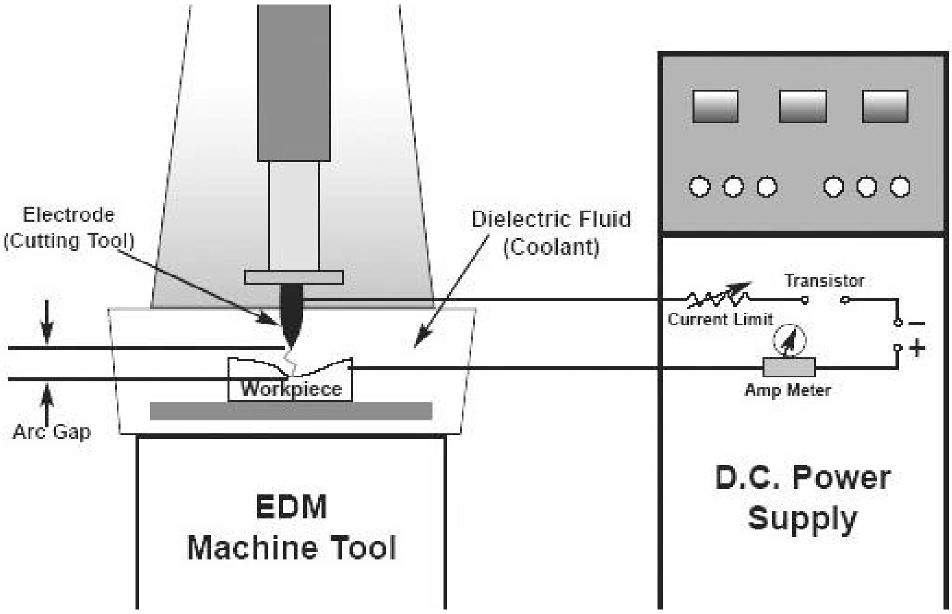

***Figure 1**. - Functional scheme of an Electrical Discharge Machining.*

There are two electrodes in a dielectric or insulating medium, the voltage applied to them must be sufficient to create an electric field, which is greater than the dielectric rigidity of the fluid. As a result of the action of this electrical field, free positive ions and electrons are accelerated, creating a discharge channel, which becomes a conductor, and it is precisely at this point where the spark jumps. This causes collisions between the ions (+) and the electrons (-). A channel of plasma is thus formed. These collisions create high temperatures in both poles and a ball of gas is formed around the plasma channel, which begins to grow. At the same time, the high temperatures in the two poles melt and vaporize part of the material of the part, while the electrode itself suffers only very slight wear.

In this situation (large ball of gas and molten material at both poles) the electric current is turned off. The plasma channel collapses and the spark disappear. The dielectric fluid then breaks the ball of gas making it implodes (explode inwards).

This creates forces, which force the molten material out forming two craters on the surfaces. The molten material solidifies and is carried away in the form of balls by the dielectric fluid to form what we might call the "EDM splinter". The basic components of a Sinker EDM system are illustrated in the fig.1. The work piece is mounted on the table of the machine tool and the electrode is attached to the ram of the machine. A DC servo unit or hydraulic cylinder moves the ram (and electrode) in a vertical motion and maintains proper position of the electrode in relation to the work piece. The positioning is controlled automatically and with extreme accuracy by the servo system and power supply. During normal operation the electrode never touches the work piece, but is separated by a small spark gap. During operation, the ram moves the electrode toward the work piece until the space between them is such that the voltage in the gap can ionize the dielectric fluid and allows an electrical discharge (spark) to pass from the electrode to the work piece. These spark discharges are pulsed on and off at a high frequency cycle and can repeat 250,000 times per second. The spark discharge (arc) always travels the shortest distance across the narrowest gap to the nearest or highest point on the work piece. The amount of material removed from the work piece with each pulse is directly proportional to the energy it contains. Each discharge melts or vaporizes a small area of the work piece surface. This molten metal is then cooled in the dielectric fluid and solidifies into a small spherical particle, which is flushed away by pressure/motion of the dielectric. The impact of each pulse is confined to a much-localized area, the location of which is determined by the form and position of the electrode.

3. WIRE-CUT ELECTRICAL DISCHARGE MACHINING (WCEDM)

The basic principles of wire-cut electrical discharge machining (WCEDM) are essentially the same as die-sinking EDM described above and is illustrated in fig. 2.

The major difference is that instead of using an electrode with a complex shape, in WCEDM the electrode is a simple wire, typically .006" to .012" diameter, which follows a horizontal path through the work-piece. Instead of using dielectric oil as in die-sinking EDM, WCEDM uses de-ionized water.

WCEDM started from scratch in the early-70's and has made steady progress, with the most rapid process improvements occurring from the mid-80's to the mid-90. Progress in six key measures of price/performance is outlined below.

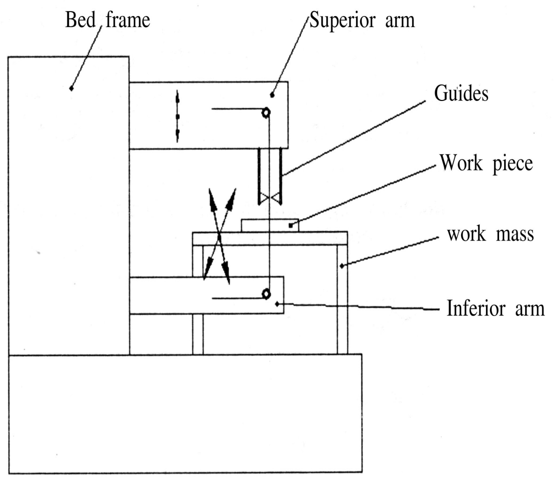

Figure 2. *Basic structure of WCEDM system.*

Speed – The biggest advantage for most applications has been the improvement in nominal (ideal conditions) cutting speed, which increased from about 1 sq. in. per hour in the early-70's to approximately 3 sq. in. per hour in the mid-70's and then surged about 800 percent to 28-30 sq. in. per hour in the mid-90's. The actual average cutting speeds achieved in real applications have always been less than the nominal speeds, but have also risen proportionately. The reasons for the speed increases are primarily: higher flushing pressure and faster solid-state generator circuitry that allows optimization of settings. Another reason is the improvement in wire quality and the variety of wire alloys available. As the speed increased, the number of jobs that could be cut per hour or per day increased proportionately. To take advantage of the speed and avoid having the faster machines sitting idle at night, the EDM manufacturers introduced increasingly e effective automatic threading systems, wire breakage prevention strategies and work-piece loading automation, the equivalent of tool changers, tool failure detectors and work-piece loading systems in machining centers. Work-piece size – WCEDM was initially almost exclusively used for stamping dies and punches. Thus the early applications had a maximum work-piece height of 2-4 inches. As makers of molds, plastic extrusion dies and various production parts sought the advantages of EDM, the wire machines maximum work-piece size capability increased in all dimensions, but especially in Z. The increase in size has come partially from new mechanical designs, including combining a stationary work-piece design with the efficient and accurate stacking of the axes. Taper – Since the earliest models were primarily designed for die making, a 1 degree die relief to 4 or 5 in. was typically the maximum possible taper. To meet the broader requirements of molds, plastic extrusion dies and production parts, the maximum available taper increased dramatically in the mid-80's and again in the early 90's so that now a taper of 30 degrees to about 16 in. is available on the most popular models. The increased taper has opened up significant new applications for EDM.

4. AUTOMATION WCEDM PROCESS

A further technique for rapid production of moulds and dies directly from CAD data or for finishing Rapid Tool inserts is high speed machining. The new machines can machine a work-piece in 5-axes (X, Y, Z and 2 rotational), providing greater flexibility and productivity, and, in many cases, better quality. Its swivel head and rotary CNC table achieves a positional accuracy of µm.

Integrate automation component control technology, reduce the preliminary operation time of mold or electrode mounting, elevate the actual machining utilization rate of machine, and avoid human error caused to positioning accuracy. The EDM machine must be CNC controlled and be available with some type of robotic interface. This can be accomplished by simple M functions or through the use of RS232 serial or parallel interface. Depending on the type of automation selected, automated electrode changing may be required. Some robots will load and unload both electrodes and work-pieces while others are designed exclusively for work piece changing only. Auto wire feeding is a must for automation of WEDM machines.

5. CONCLUSION

The aspect about dimensional process monitoring achieved by electrical erosion is chanced because this non-conventional technology is in a long optimization process, in time many things in this domain are developed. A further technique for rapid production of moulds and dies directly from CAD data or for finishing Rapid Tool inserts is high speed machining. The new machines can machine a work-piece in 5-axes (X, Y, Z and 2 rotational), providing greater flexibility and productivity, and, in many cases, better quality. Its swivel head and rotary CNC table achieves a positional accuracy of µm. Integrate automation component control technology, reduce the preliminary operation time of mold or electrode mounting, elevate the actual machining utilization rate of machine, and avoid human error caused to positioning accuracy. With high-performance machining there is five-axis capability, allowing for shorter tools and more efficient machining of difficult geometries.

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