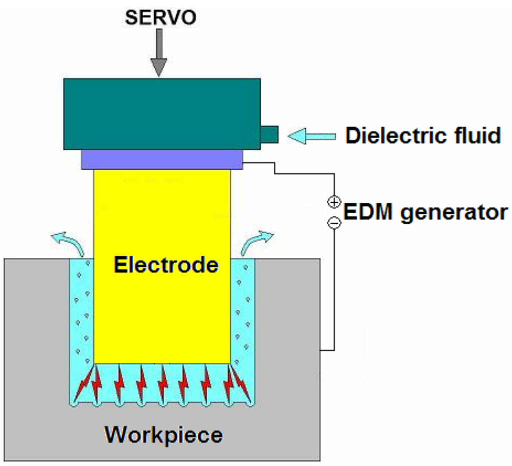
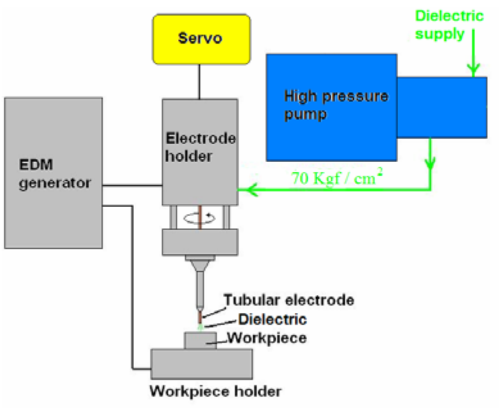
Optimisation of EDM Fast Hole Drilling through an Evaluation of Electrode Geometry

Electrical discharge machining (EDM) is a process in which material removal is achieved by sparks between electrode and workpiece, with associated melting and vaporisation caused by high temperatures. The workpiece and the electrode are covered in a dielectric fluid and are connected to a generator delivering periodic pulses of energy. There is no physical contact between the workpiece and the electrode and the small gap separating them is maintained under servo control.





There are different variations of EDM processes including die sink EDM, wire EDM and EDM fast hole drilling. The main difference between fast hole drilling and other processes lies in the use of a high pressure (70 – 100 bar) dielectric pump. The combination of the high pressure dielectric fluid, the rotation of the tubular electrode and the high electrode feed rate (controlled by a fast response servo) make it possible to produce holes at a very *fast* rate**.**

Drilling rates up to 1mm/second can be achieved and hole sizes are generally between 0.3 and 3mm, with a length-to-diameter ratio of over 150:1. The process can be applied in the production of a variety of parts including fuel injectors, cutting tools, medical equipment and aerospace components.

EDM fast hole drilling plays a significant role in the aerospace industry. It is one of the few manufacturing processes that can be applied to the drilling of precision small holes in a number of parts, including turbine blades.

One of the most important factors affecting the speed of EDM fast hole drilling is the high pressure dielectric fluid which is usually supplied to the gap through the bore of tubular electrodes. Thus, it can be expected that the bore size and geometry have a great impact on the process performance.

EDM performance also depends on a number of other factors including the generator (electrical parameters) and on a very complex relationship among these parameters, electrode geometry and dielectric flushing. Under such circumstances, optimal results are easier to be obtained with the application of statistical methods such as response surface design. This work shows that drilling time and electrode wear can be decreased by 165 % and 25% respectively, depending on the type of electrode geometry used, which has specific requirements for generator parameters. The software, Design-Expert v7 (by Stat-Ease, Inc.), was used to design the experiments. One of the main advantages of this software is its ability to combine categorical and numerical factors in a single experimental matrix (obtained by the response surface design) with a minimum number of runs.

This work will be published in the format of a scientific paper in the Journal of Materials Processing Technology. It explores in detail the interaction between the factors and tries to give a physical meaning for them. The experiments were carried out in the University Nottingham (UK), where Rolls-Royce has a University Technology Centre (UTC) in Manufacturing Engineering.

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