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Particle hydrodynamics of the electrical discharge machining (EDM) process - Part 2: Die sinking process

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Abstract

The objective of this work is to investigate the dynamics of the dielectric fluid in the die sinking electrical discharge machining (EDM) process. Different methods were developed to investigate the fluid dynamics of the dielectric and particles. Both computational fluid dynamics (CFD) and experimental tests were performed.

The most important achievement of this project is the improvement of the evacuation of the waste particles within the gap workpiece-electrode. An exhaustive understanding of the processes was crucial to obtain a uniform particles distribution which leads to a more efficient discharging and particle evacuation. A CFD analysis was used to figure out the characteristics for the electrode, such as its shape and dimensions and its kinematic properties. In particular, different combinations of axis Jerk, acceleration, speed and movement of the electrode were studied in detail. Different dielectric liquids were also considered.

The experimental tests on full scale and increased scale models were performed at the AgieCharmilles laboratory and at the CMEFE laboratory in Geneva, in order to validate the CFD results. A test rig was built to perform study at a scale of 50:1 has been built, and a particle image velocimetry (PIV) was developed in order to study the effect of the fluid flow. The analysis of the trajectories of the waste particles inside the dielectric was performed for several configurations. The effect of the gas bubbles generated during the process is also under investigation.

*Keywords:*EDM; hydrodynamics; particles; die sinking

Nomenclature and symbols

u	Reference speed, m/s
D	Reference length, m
μ	Dynamic viscosity, kg/(m·s)
ρ	Density, kg/m^3
v	Kinematic viscosity, (m^2/s)
σ	Surface tension, N/m
Re	Reynolds Number
Fr	Froude Number
y_{max}	Amplitude of the electrode movement, mm
v_{max}	Maximal speed of the electrode movement, m/s
a_{max}	Maximal acceleration of the electrode, m/s^2
J_{min}	Minimal derivate of the acceleration, or Jerk, m/s^3
J_{max}	Maximal derivate of the acceleration, or Jerk, m/s^3
$\phi_{B\text{-}exp}$	Bubbles diameter in experimental tests, m
$\phi_{B\text{-}real}$	Bubbles diameter produced during the EDM process, m
$V_{B\text{-}exp}$	Volume of the bubbles generated with the test ring, m^3
g	acceleration due to gravity, m/s^2
Π	Non-dimensional number

1. Introduction

During the die sinking electrical discharge machining (EDM) process, waste particles produced within the gap tend to remain in the dielectric fluid. Local concentration of the produced particles leads to a poor surface quality,