2D Axisymmetric Simulation of the Electrochemical Finishing of Micro Bores By Inverse Jet Electrochemical Machining

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Abstract

Introduction
Within this publication a wide scope of technology users, system developers and research institutes have worked together in a cooperation project funded by the European Union through the European Regional Development Fund (ERDF) and from state funds of the Free State of Saxony.

Focus of the project was the creation of conditions for a quality-oriented mass production of micro bores with defined hydraulic flow. These micro bores are used for several high-precision applications, especially in hydraulic systems. In this case the shape of the micro hole, particularly the edge rounding, has a significant influence e. g. on atomization of fluids [1]. After wide-ranging experimental studies for the desired function, the application of shaped electrodes could be detected to be unsuitable and therefore an inversion of the Jet Electrochemical Machining process has been developed [2].

In this case the erosion area is localized by a continuous electrolytic free jet. Forming a free jet leads to a high localization of the current density resulting in a highly localized machining area [3].

Use of COMSOL Multiphysics®
In this study, the inverse Jet-ECM process of micro bore is investigated by help of multiphysics simulations. Figure 1 gives an overview about the process. The nozzle is connected to a positive electrical potential. Zero potential is connected to the tool which is the cathode. For simulating inverse Jet-ECM a fully coupled model has been developed. Therefore the Electric Currents and the Deformed Geometry interfaces were used.

Figure 2 shows as example a 2D sectional view of the eroded geometry after 0.1s of machining. It can be seen, that the maximal removal took place at the edge of the bore hole and only a slight removal at the internal bore wall. This reflects the high localization of the erosion area.

Reference

[1] Mollenhauer, K.; Tschöke, H.: Handbuch Dieselmotoren. Springer – Verlag, 2007 (3., neubearbeitete Auflage). ISBN 978-3-540-72164-2
[2] Hommel, B; Jähn, F.; Scharrnbeck, M.; Garn, R.; Lenk, A.; Hackert-Oschätzchen, M.; Schubert; A.: Edge Rounding of Micro Bores by Inverse Jet Electrochemical Machining, Proceedings of the 9th International Symposium on Electrochemical Machining Technology, accepted for publication
[3] Hackert-Oschätzchen, M.; Meichsner, G.; Zinecker, M.; Martin, A.; Schubert, A.: Micro Machining with Continuous Electrolytic Free Jet, Precision Engineering, DOI: 10.1016/j.precisioneng.2012.05.003, 2012

Figures used in the abstract

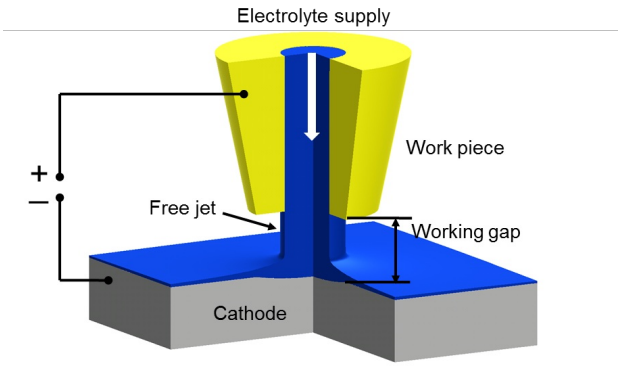

Figure 1: Scheme of inverse Jet-ECM

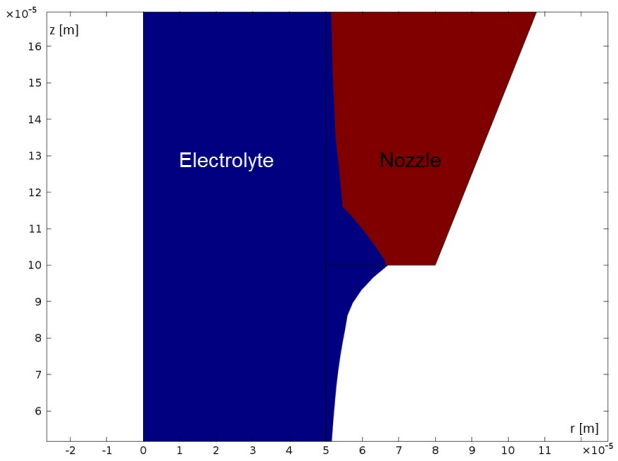

Figure 2: 2D sectional view of the eroded geometry at time step t1 = 0.1 s