Electrochemical Machining with Nonsymmetric Suction of Electrolyte Flow

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Introduction:

Electrochemical machining(ECM), which is a kind of machining method, removes metal by the electrochemical process[1]. It can be used for working extremely hard materials, even for the metal which cannot be easily machined by traditional methods. During ECM process, slug due to dissolved workpiece disturbs the continuation of ECM. Therefore, it is very important to control electrolyte flow field to remove contamination such as slug, or gas. In this paper, electrochemical machining tool with suction devices for electrolyte is investigated numerically. The numerical solutions have been obtained and visualized by using commertial finite-element analysis software: COMSOL Multiphysics® of Ver.5.3.

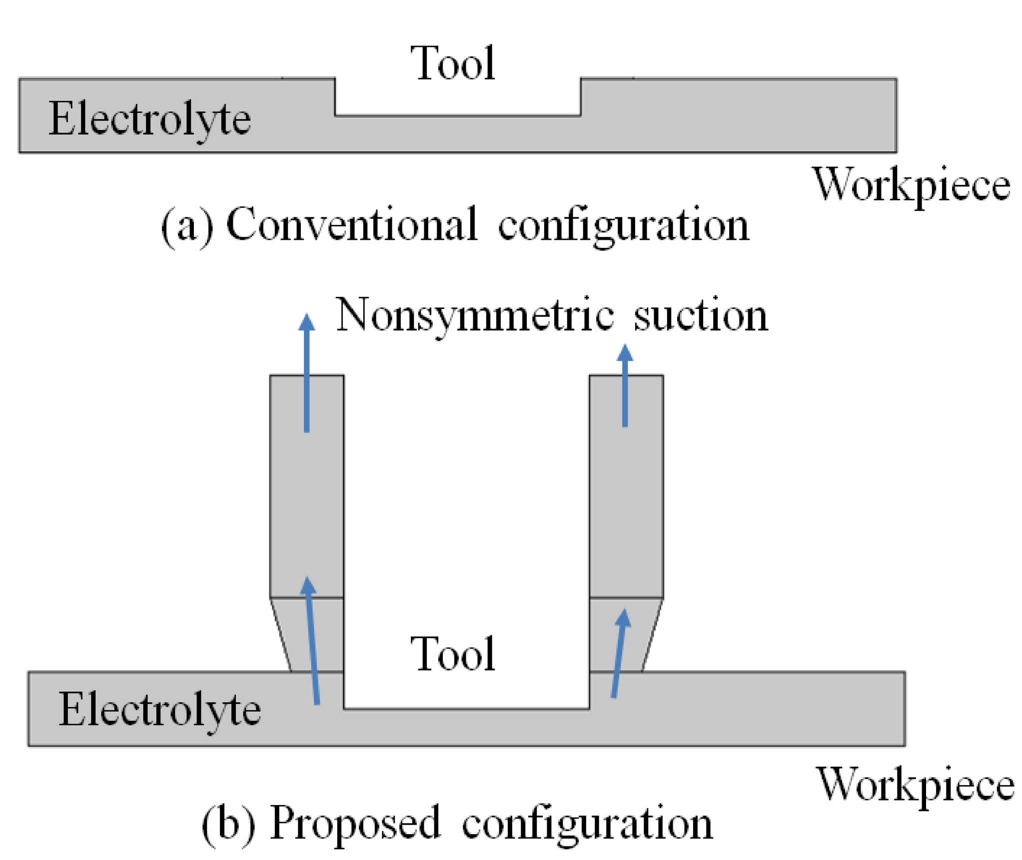

Figure 1. Proposed configuration for ECM.

Computational Methods:

Tool forms cathodic electrode. Workpiece forms anodic electrode and is dissolved according to Faraday's law.

It is assumed that electrolyte is fully mixed and its electroneutrality holds whithin electrolyte. Moving mesh is used to simulate the deformation of workpiece.

Results:

Firstly, we verified the present computation of electric current density together with moving mesh by tailoring a simple model of parallel plates configuration shown in Fig.2. Comupted results coincides with excat solution.

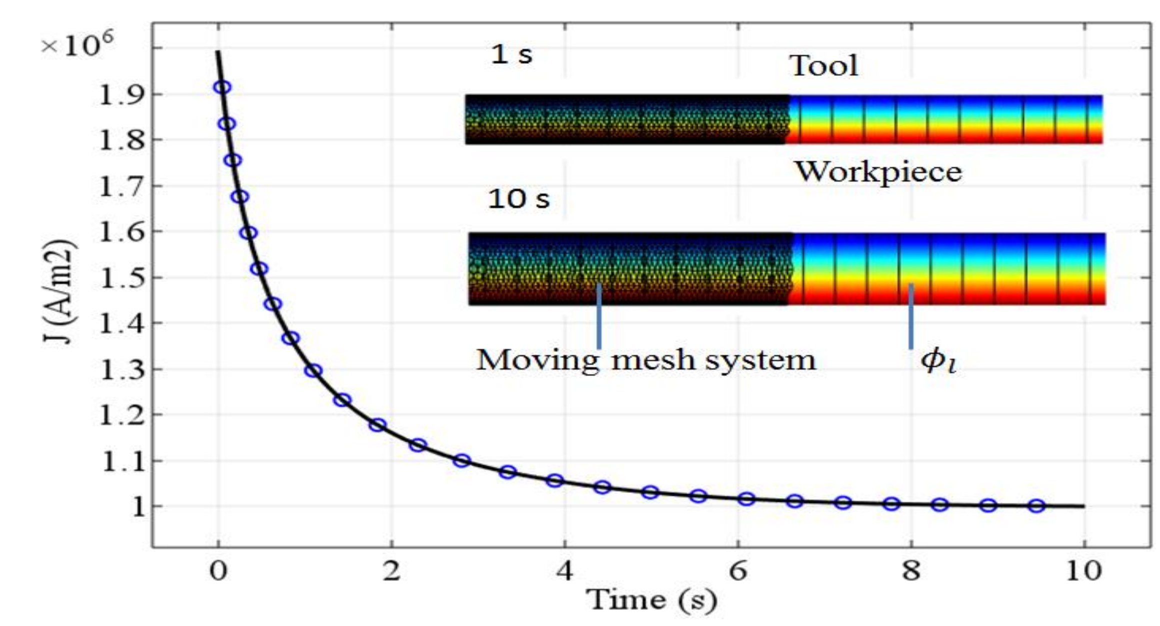

Figure 6. Time evolution of the x-component of flow velocity along the vertical line through the center of the tool.

Secondly, we simulated ECM system proposed here (Fig.1(b)) ,where the left suction speed is 5m/s and the right suction speed is 2m/s. It was found the proposed system generates no reversal flow (Figs.3,4) and could remove contamination efficiently during ECM process.

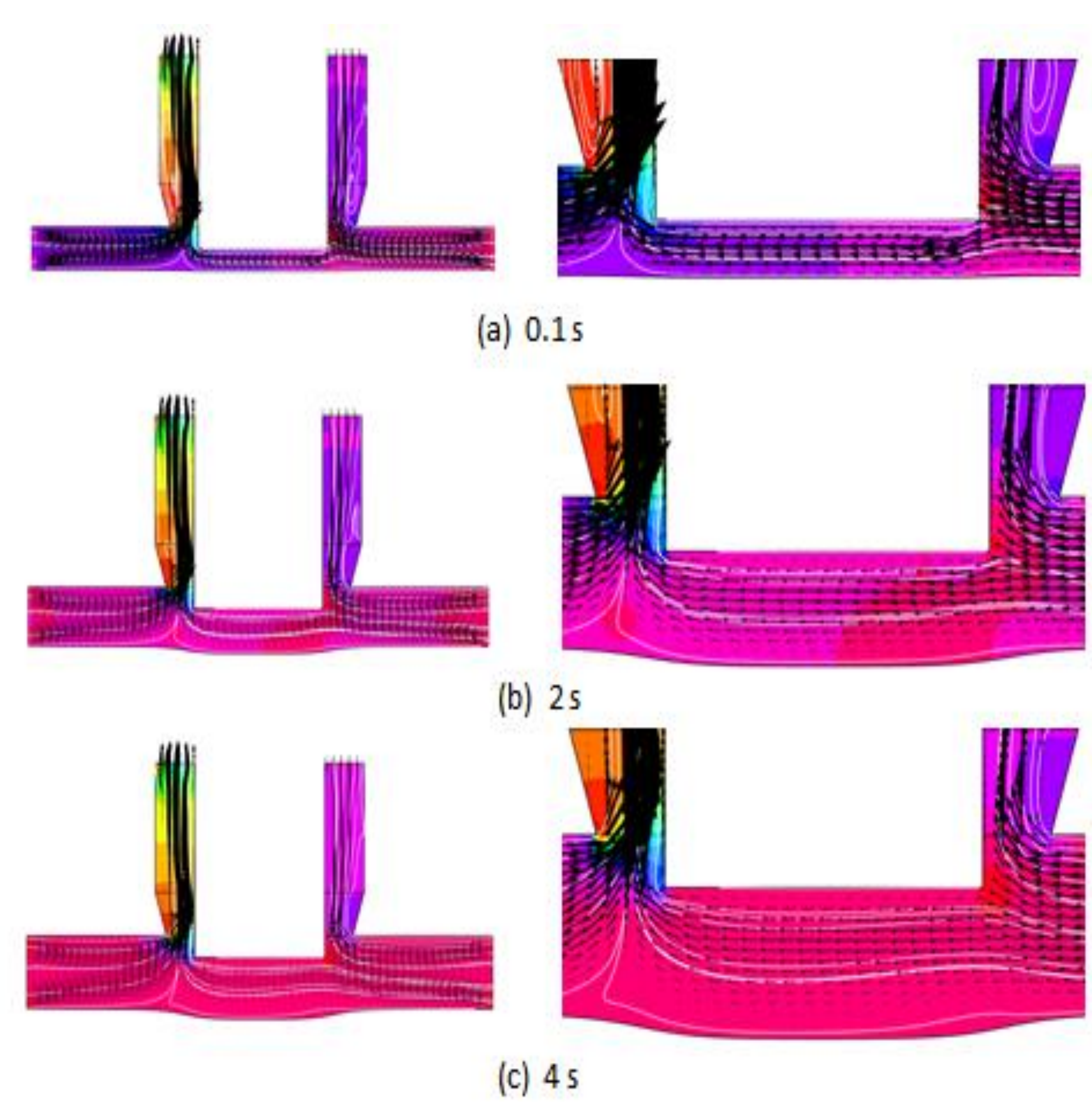

Figure 3. Time evolution of the flow field (left colums: whole field, right colums: the enlargement); color shading: pressure field, white lines: instanteneous stream lines, vectors: instantaneous flow vectors.

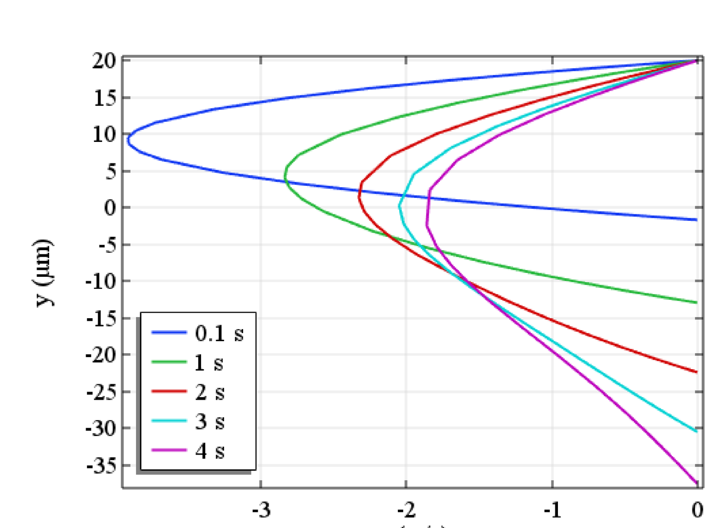

Figure 4. Time evolution of the x-component flow velocity along the vertical line through the center of the tool.

References:

1. Mohan Sen, H.S. Shan, A review of electrochemical macro- to micro-hole drilling processes, Int. J. of Machine Tools & Manufacture 45, 137-152 (2005).

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