Analysis of electrochemical machining tool by using ANSYS CFX 15.0

V. Sathiyamoorthy[1*], K. Arumugam[1], R.Anbazhagan[1], N. Nandagopal[2], and S.Aravindh[1]
[1]Faculty of Mechanical Engineering, Vel Tech High Tech Dr.Rangarajan Dr.Sakunthala Engineering College, Chennai, Tamil Nadu – 600062, India.
[4]Research Scholar, Mechanical Department, Anna University, Regional Centre, Coimbatore, India
***Corresponding author: E-Mail: drvsathiyamoorthy@gmail.com**

ABSTRACT

Electrochemical machining (ECM) proves to be one of the most effective non-traditional machining processes used to machine materials predominant with high hardness. It was developed originally to machine the hard alloys, although any metal can so be machined. Studies of tool design is an utmost importance in ECM, since it is one of the most determining factors for achieving the objectives like Material Removal Rate (MRR) and Surface Roughness (SR). This research work focused on develops the geometrical model and analysis of the electrolyte jets pattern of ECM tool with different jet angles. The best optimum electrolyte jet outward angle of 34^0 is obtained by ANSYS CFX post processor results. These results of the ANSYS post processor simulations is used to understand the effects of electrolyte flow inside the electrolyte jets pattern to obtain the selected objectives of ECM.

KEY WORDS: ECM, ANSYS CFX, Tool configuration, Modeling, Analysis.

1. INTRODUCTION

ECM is one of the most widely used un-conventional machining processes. It is based on the principle of metal removal by electro-chemical dissolution of the anode dissolution process. With this process, tool material need not have high strength and hardness; hence, a complicated and different shapes can be machined. ECM is a complex machining process and it is difficult to predict the changes that occur in the inter electrode gap (IEG). The electrolyte properties vary due to the emission of an amount of heat and gas bubbles.

In addition, hydrodynamic parameters, such as pressure vary along the electrolyte flow path direction and make the design and analysis of ECM tool geometry quite complicated. In the past, trial and error methods based on practical experience were employed to design the electrolyte jets pattern. This research paper deals that to develop the model and analysis of the electrolyte jets pattern of ECM tool with a different angle of 32^0, 33^0, 34^0, 35^0 and 36^0 by using ANSYS CFX software. The results of the ANSYS CFX simulations are used to understand the effects of electrolyte jets pattern on the objectives of ECM.

ANSYS CFX: ANSYS CFX 15.0 is a general purpose CFD software suite that combines an advanced solver with powerful pre processing and post processing capabilities. CFX means Cold Fusion Extensions. ANSYS CFX is capable of modeling and analysis in Non-Newtonian flows, Multiphase flows, Flows in multiple frames of reference. ANSYS CFX includes the following features, advanced coupled solver that is both reliable and dynamic, analysis, full integration of problem and results presentation. Perceptive and interactive setup process, using menus and advanced graphics icon.

2. MODELLING AND MESHING OF ECM TOOL

Modeling: Proceeding from the intensive literature survey, it is proposed to model the ECM tool with the conditions as follows: Inclined outward electrolyte jets in circular configuration, Inclination angle of 34^o. The modeled ECM tool is shown in Figure 1. The above tool is modeled by using ANSYS 15.0 software.

Meshing: A new meshing application in ANSYS CFX provides to access many of the ANSYS meshing tools in a same location. A different "Meshing Method" can be applied to every part in the geometry. All geometry meshes are written to a common database that can be opened in CFX Pre processor. The available meshing methods are: ICEM, Automatic, All Tet, Hex dominant, Sweep, and CFX Mesh. The volume mesh can be generated in CFX Mesh and committed back to the meshing application. These types of meshing capabilities are available in the standard simulation tab (correct licenses required). A meshing options panel that appears when the meshing application is opened and the ANSYS CFX preferences area enable to set a preferred meshing method. Figure 2 shows the meshing of the selected configuration by using ICEM software.

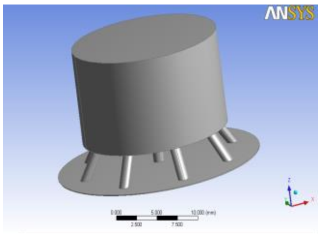

Figure.1. Modeling of ECM tool

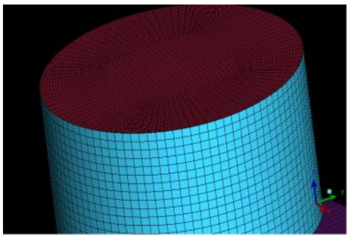

Figure.2. Meshing of ECM tool by using ICEM

3. ANALYSIS AND DISCUSSION

The modeled ECM tool is analyzed by using the ANSYS CFX and the various stages of the analysis are discussed.

ANSYS CFX Pre: The next generation physics pre processor, ANSYS CFX Pre processor, allows the multiple meshes to be imported, allowing section of complex geometries to use the most appropriate mesh. Boundary conditions, flow physics, initial values and solver parameters are specified in ANSYS CFX Pre processor. A full range of boundary conditions, including inlets, outlets and openings, together with boundary conditions for fluid models are all available in ANSYS CFX through ANSYS CFX Preprocessor. The ANSYS CFX Pre setup is shown in Figure 3.

ANSYS CFX Solver: ANSYS Solver solves the solution variables for the simulation for the problem specification created in ANSYS CFX Pre processor.

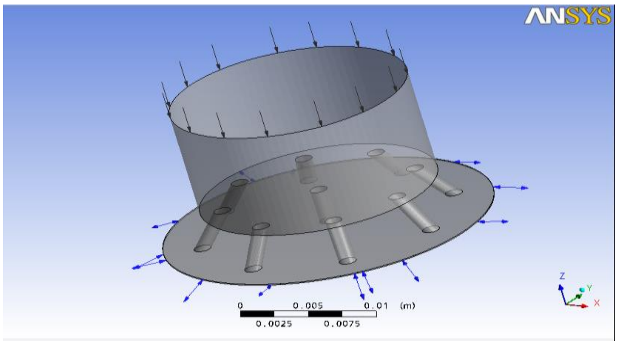

Figure.3. ANSYS CFX Pre Setup

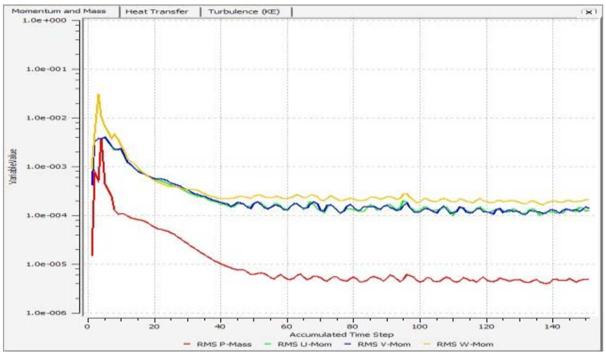

Fig.4. Mass and Momentum results

One of the important features of ANSYS CFX 15.0 is, its use of a coupled solver, in which all the hydrodynamic equations are solved as a single process. The coupled solver is faster than the traditional solver and less iteration are required to obtain a converged flow simulation results. The following graph is obtained after iterations, which is shown in Figure 4. The graph focuses the behavior of mass and momentum of the electrolyte in three axes.

ANSYS CFX Post: ANSYS CFX Post provides the interactive post processing graphics tools to analyze and present the ANSYS CFX post simulation results.

Important features include: Quantitative post processing, Command line, Report generation, session file or state file input, User-defined variables, Generation of a variety of graphical objects where Transparency, Visibility, Line/Face and Color rendering and controlled, 'Power Syntax' to allow fully programmable files. Move from ANSYS CFX Solver to ANSYS CFX Post. Once ANSYS CFX Solver has finished, ANSYS CFX Post processor can be used to review the results. The figures 5-6 show the variation of pressure and velocity in the selected plane respectively.

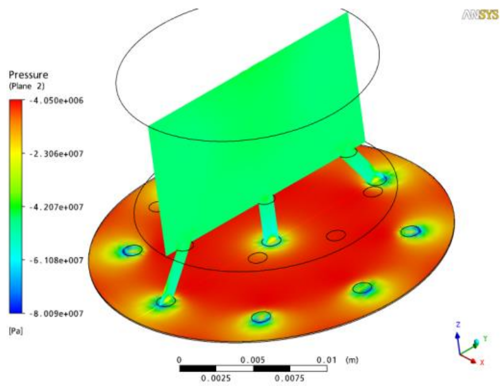

Figure.5.Pressure variation in selected plane (2)

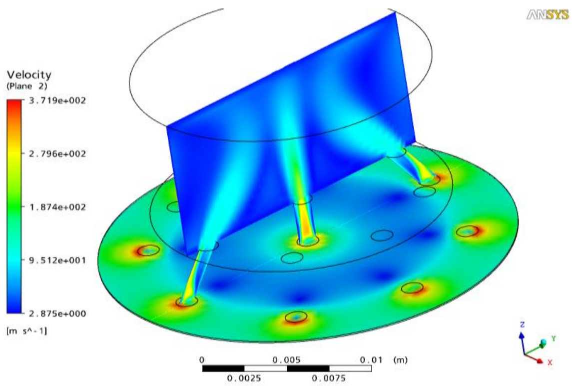

Figure.6.Velocity variation in selected plane (2)

The velocity would be maximum at the outer boundary of electrolyte when compared with the inner region. Hence, the back pressure is minimized in the region which enables to improve the performance of ECM while machining.

4. CONCLUSION

The following observations are done from this research work can be summarized as follows:

a) The electrolyte jets of ECM tool with an angle of 34^0 configuration has been modeled by using ANSYS 14.0 and Analyzed by using ANSYS CFX 15.0.

b) Referring to the ANSYS CFX 15.0 results, the obtained mass, momentum, velocity and pressure helps to identify the suitable parametric combinations which improve the performance of ECM.

c) The ANSYS CFX post processor simulation results indicated that a 34^o angle of electrolyte jet pattern satisfy the all the boundary conditions and yield optimum result to produce a physical model of a tool.

REFERENCES

Mukherjee SK, Kumar S, Srivastava PK, & Arbind Kumar, Effect of valance on material removal rate in electrochemical machining of aluminium, Journal of Materials Processing Technology, 202 (1-3), 2008, 398-401.

Sathiyamoorthy V, & Sekar T, Experimental studies on improving the performance of electrochemical machining of high carbon high chromium die steel using jet patterns, Carbon - Science and Technology, 6 (1), 2014, 321-329.

Sathiyamoorthy V, & Sekar T, Optimization of processing parameters in ECM of AISI 202 using multi objective genetic algorithm, Int. J. Enterprise Network Management, 7 (2), 2016, 133-141.

Sathiyamoorthy V, & Sekar T, Optimization of processing parameters in ECM of Die Tool Steel using Nano fluid by Multi Objective Genetic Algorithm, The Scientific World Journal, 2015, 1-6.

Sekar T, Arularasu M & Sathiyamoorthy V, Investigations on the effects of Nano-fluid in ECM of die steel, Measurement, Elsevier, 83, 2016, 38-43.

Westley JA, Atkinson A, & Duffield A, Generic aspects of tool design for electrochemical machining, Journal of Materials Processing Technology, 149 (1-3), 2004, 384-392.

Wilson J.F, Practice and Theory of Electrochemical Machining, Wiley Interscience, New York, 1971.

Yong Liu, Di Zhu, Yongbin Zeng & Hongbing Yu, Development of microelectrodes for electrochemical micromachining, International Journal of Advanced Manufacturing Technology, 55 (1-4), 2011, 195-203.

Zhiyong LI & Hua JI, Machining Accuracy Prediction of Aero engine Blade in Electrochemical Machining Based on BP Neural Network, International Workshop on Information Security and Application, 2009, 244-247.