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Review: Analysis of Thermal and Fluid Flow of Lubricant in Grinding Operations

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Abstract: This fundamental research presents a review of analysis of thermal and cooling effect of lubricant in grinding operations. This study is based on incompressible second order fluid flow in an approximate combined boundary layer, predicting heat transfer by developing functional models, factors affecting for the flow rate in lubricant while observing using thermal analysis and other predefined equations and algorithms. This paper consists a review of different optimizing numerical methods for analyzing of thermal fluid flow in different grinding operations. Many research papers are being reviewed but a systematic review of thermal and fluid flow analysis of lubricant in grinding operations was missing in current research areas. However, the outcome of the study is to determining the critical conditions for the loss of stability of the basic flow and in the study of the transition to turbulence of continuity, and also to investigate the conditions which will be happening with high intensity of lubricant flow affecting in abrasive chips in grinding operations.

Keywords: Continuity, Fluid flow, Grinding operations, Thermal.

Introduction

B.S Dadapat discusses in his paper that, the flow of an incompressible second-order fluid due to the stretching of a plane elastic surface in the approximate of boundary layer theory. Authors have indulged numerical calculation to predict the self-similar flow by non- linear equation. The author says that the temperature at a point in a given second-order fluid decreases with an increase in Prandtl number. This is consistent with the fact that the thermal boundary layer thickness with increasing Prandtl number (A. S Gupta et al.). C. Guo represents in his study, to develop functional models for heat transfer and fluid flow in grinding which would provide a basis for predicting thermal constraints and optimal grinding conditions. The author also says that, experimental measurement of the amount of fluid that passes through the grinding zone during straight plunge grinding using conventional plunge application. The percentage of fluid utilization was found to significantly increase with more porous wheels and a closer positioning of the nozzle to the grinding zone (C. Guo et al.). C. Guo proposed in his study that, fluid flow through the grinding wheel is analytically predicted in terms of flow through porous media. Mass continuity and momentum equation is derived and solved numerically for the fluid tangential velocity, radial velocity, and depth of fluid penetration. The author's results indicate that the nozzle velocity, effective wheel porosity, and the nozzle position are the main factors that influence the useful flow rate (S. Malkin e. al.). C.W Ng says in his approach that, it takes into account many well-established facts concerning turbulent shear flows. In non-planar mean flows isotropy of turbulent momentum transport is assumed. After the mathematical assumption, the author says that linearization is achieved by assuming the flow is approximately a Couette flow (C. H. T Pan et al.). E. Brinksmeier presents his research that, the consideration of chip thickness and its influence on the grinding process, due to the grinding parameters, such as cutting speed, depth of cut,

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and work speed. Grinding investigations shows that the total power required in high performance grinding increases with increasing cutting speed. Finally, after the experiment author says that no-load power demand and the specific normal force component depend on the coolant amount as well as on the wheel speed (E. Minke et al.). E.M.A Elbashbeshy says in his study that, the boundary layer equations are transformed into ordinary differential equations containing a Prandtl number, permeability parameter, injection parameter, and heat source/sink parameter. After analyzing the experiment author says that the skin friction increases with heat source parameter and decreases with permeability and the thermal boundary layer thickness increases with high injection and decreases with suction (M. M. A Bazid et al.). G.G Hirs tells in his research that, the bulk flow relative to a surface or well and the corresponding shear stress at that surface or wall under a given set of conditions of turbulent flow are considered and correlated. Finally, after the experiment, the author says that, the turbulent flow in bearing films interposed between smooth surfaces (G. G Hirs). H.I Anderson demonstrates that the similarity solution derived by the author is not only a solution of the boundary layer equation but also represents an exact solution of the complete Navier- Stokes equation. Finally, the author says that the magnetohydrodynamic flow past a stretching sheet was based on conventional boundary layer theory, in which a fundamental assumption is that the fluid viscosity is small, i.e; the Reynolds number is significantly higher than unity (H. I Andersson). L.R Silva proposed in his research that, he evaluate the performance of MQL technology applied to minute flow rates as an environmentally correct alternative for the cutting fluid used in plunge cylindrical grinding. The small amount of lubricant is pulverized in a compressed air stream, reducing the undesirable effects by supplying lubricant and cooling. The author says that the quantity of lubricant and cooling are factors that influence the grinding process (L. R Silva et al.). M.K Ho says that velocity profiles for turbulent lubricant films are calculated using an energy model for turbulent flow. This agreement lends credibility to both analyses and indicates that either theory can predict with reasonable accuracy the relationship between flow and pressure gradient in turbulent bearing films in which mean flow convective effects are not significant. The author again says that turbulent lubrication theory offers a potential advantage over theories based on established eddy diffusivity expressions or mixing length expressions in that the energy model for turbulent transport can be applied to flows in which mean flow convective effective effects are significant (J. H Vohr et al.). M.R Schumack restricts their analysis to bulk fluid behavior and does not model the local lubrication phenomenon at the grinding wheel grains. The author applies the basic lubrication equation with appropriate modification to analyze the fluid flow and pressure distribution under conditions similar to surface grinding. The author says that only a model based on a full two or three dimensional Navier Stokes equation incorporating the complex end boundary conditions can adequately model grinding type flows (W. W Schultz et al.). P. Hrynieuricz investigated and discusses fluid flow in grinding with non-porous wheels with an emphasis on the hydrodynamic pressure developed in the grinding zone. The author says that a smooth wheel is employed instead of a rough grinding wheel to simplify the analysis. After the experimental analysis, the author says that Reynolds number (Re) the turbulent model of the author over predicts the developed pressures especially at lower values of Re (A. Z Sxer et al.). R. Cortell presents a numerical study of the flow of an electrically conducting power-law fluid in the pressure of a uniform transverse magnetic fluid. The author implemented the Runge-Kutta method to study the experiment.

Materials and Methods

A model based on a full two or three dimensional Navier Stokes equation incorporating the complex end boundary conditions can adequately model grinding type flows (W. W Schultz et al.). P. Hrynieuricz investigated and discusses fluid flow in grinding with non-porous wheels with an emphasis on the hydrodynamic pressure developed in the grinding zone. A smooth wheel is employed instead of a rough grinding wheel to simplify the analysis. After the experimental analysis, the author says that Reynolds number (Re) the turbulent model of the author over predicts the developed pressures especially at lower values of Re (A. Z Sxer et al.).

In this paper, the author employed to give numerical solutions to the magnetohydrodynamic viscous flows of non-Newtonian fluid over a stretching sheet. After doing the numerical analysis, the author tells that the proposed order for higher-order initial value problem (IVP) offers an effective tool for solving these nonlinear problems in fluid mechanics (R. Cortell). R. Cortell presents a numerical study of the flow of an incompressible fluid of grade; this parts an infinite porous flat plate, subject to suction at the plate.

Results and Discussion

Graphical expression and Runge-Kutta 4th order solve the technique (R. Cortell). R. Cortell presents his study of the flow and heat transfer of an incompressible second-order fluid past a stretching sheet. The equation for the heat transfer analysis was solved by the Runge-Kutta method of fourth-order. R.X Dai demonstrates that both the Navier-Stokes and the bipolar lubrication solutions converge monotonically to results from classical lubrication theory. After the experimental analysis, the author says that convective inertia is also important in determining the critical conditions for the loss of stability of the basic flow and in the study of the transition to turbulence and also when steps or other effects locally neglect the condition**.**

Conclusions

This work presents a review of several numerical optimization approaches for assessing thermal fluid flow in various grinding processes. Many research articles are being examined, however there was a gap in current research fields for a comprehensive assessment of thermal and fluid flow analysis of lubricant in grinding operations. The research's goal is to determine the crucial circumstances for the loss of fundamental flow stability and the study of the transition to continuous turbulence, as well as to explore the conditions that will occur when high-intensity lubricant flow affects abrasive chips in grinding operations.

Conflict of Interest: The authors declare that there are no conflicts of interest concerning the publication of this article.

References

Andersson, H.I., 1995. An exact solution of the Navier–Stokes equation for magnetohydrodynamic flow. Acta Mechanica 113, 241–24.

Brinksmeier, E., and Minke, E., 1993, ''High-Performance Surface Grinding — The Influence of Coolant on the Abrasive Process,'' Annals of the CIRP, 42, pp. 367–370.

Cortell, R., 2005. A note on magnetohydrodynamic flow of a power-law fluid over a stretching sheet. Appl. Math. Comp. in press.

Cortell, R., 1993a. Numerical solutions for the flow of a fluid of grade three past an infinite porous plate. Int. J. Non-Linear Mech. 28, 623–626.

Cortell, R., 1994. Similarity solutions for flow and heat transfer of a viscoelastic fluid over a stretchingsheet. Int. J. Non-Linear Mech. 29, 155–161.

Dai, R. X., Dong, Q. M., and Szeri, A. Z., 1992, ''Approximations in Hydrodynamic Lubrication,'' ASME J. Tribol., 114, pp. 14–25.

Dandapat, B.S., Gupta, A.S., 1989. Flow and heat transfer in a viscoelastic fluid over a stretchingsheet. Int. J. Non-Linear Mech. 24, 215–219.

Engineer, F., Guo, C., and Malkin, S., 1992, ''Experimental Measurement of Fluid Flow Through the Grinding Zone,'' ASME J. Eng. Ind., 114, pp. 61–66.

Elbashbeshy, E.M.A., Bazid, M.A.A., 2004. Heat transfer in a porous medium over a stretchingsurface with internal heat generation and suction or injection. Appl. Math. Comp. 158, 799–807.

Guo, C., and Malkin, S., 1992, ''Analysis of Fluid Flow through the Grinding Zone,'' ASME J. Eng. Ind., 114, pp. 427–434. @6# Chang, C. C., Wang, S. H., and Szeri, A. Z., 1996, ''On the Mechanism of Fluid Transport across the Grinding Zone,'' ASME J. Manuf. Sci. Eng., 118, pp. 332–338.

Hirs, G. G., 1972, ''A Bulk-Flow Theory for Turbulent Lubricant Films,'' in ASME ASLE Conference, ASME, New York.

Ho, M. K., and Vohr, J. H., 1974, ''Application of Energy Model of Turbulence to Calculation of Lubricant Flows,'' ASME J. Lubr. Technol., 96, pp. 95–102.

Hryniewicz, P., Szeri, A. Z., and Jahanmir, S., 2001, ''Application of Lubrication Theory to Fluid Flow in Grinding: Part II—Influence of Wheel and Workpiece Roughness,'' ASME J. Tribol., 123, pp. 101–107.

L.R. Silva, E.C. Bianchi, R.E. Catai, R.Y. Fusse, T.V. Franc-a, P.R. Aguiar, Study on the behavior of the minimum quantity lubricant-MQL technique under different lubrication and cooling conditions when grinding ABNT 4340 steel, Journal of the Brazilian Society of Mechanical Sciences and Engineering XXVII (2005) 192–199.

Ng, C. W., and Pan, C. H. T., 1965, ''A Linearized Turbulent Lubrication Theory,'' ASME J. Basic Eng., 87, pp. 675–688.

Schumack, M. R., Chung, J. B., Schultz, W. W., and Kannatey-Asibu, E., 1991, ''Analysis of Fluid Flow Under a Grinding Wheel,'' ASME J. Eng. Ind., 113, pp. 190–197.