

Accepted Manuscript

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PII: S0959-6526(15)00719-2

DOI: [10.1016/j.jclepro.2015.06.007](https://doi.org/10.1016/j.jclepro.2015.06.007)

Reference: JCLP 5654

To appear in: *Journal of Cleaner Production*

Received Date: 15 April 2014

Revised Date: 8 May 2015

Accepted Date: 2 June 2015

Please cite this article as: Jiang Z, Zhou F, Zhang H, Wang Y, Sutherland JW, Optimization of Machining Parameters Considering Minimum Cutting Fluid Consumption, *Journal of Cleaner Production* (2015), doi: 10.1016/j.jclepro.2015.06.007.

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Optimization of Machining Parameters Considering Minimum Cutting Fluid Consumption

Zhigang Jiang¹, Fan Zhou¹, Hua Zhang¹, Yan Wang², John W. Sutherland³

¹College of Machinery and Automation, Wuhan University of Science & Technology, Wuhan, China, 430081

²Department of Computing, Engineering and Mathematics, University of Brighton, Brighton, United Kingdom, BN2 4GJ

³Division of Environmental and Ecological Engineering, Purdue University, West Lafayette, IN, USA 47907

Abstract

Dry or near dry machining is often regarded as an effective strategy for reducing ecological impacts of the cutting processes. However, due to the application limitations of dry or near dry machining, reduction of cutting fluid supply through machining parameter optimization offers a cost effective alternative. To this end, an optimization model of machining parameters considering minimum cutting fluid consumption and cost is proposed. Process cost and cutting fluid consumption are treated as the two objectives in the optimization model, which are affected by four variables, namely cutting depth, feed rate, cutting speed, and cutting fluid flow. In the model, process cost includes production operation cost and cutting tool cost, whilst cutting fluid consumption by a machining process, which consists of reusable cutting fluid and non-reusable cutting fluid, i.e., the remaining cutting fluid deposited on the workpiece and chips as well as that diffused into the environment. The multi-objective optimization problem is solved by a hybrid genetic algorithm programmed in Matlab7. An illustrative case study was implemented to verify the effectiveness of the multi-objective optimization model, and the simulation results showed 17% reduction of fluid consumption compared to that without optimization. This indicates that the proposed optimization is effective and has great potential to be adopted by industry.

Keywords: Machining parameters; Cutting fluids; Multi-objective optimization; Genetic algorithm (GA)

Nomenclature

a_p	Cutting depth (mm)
b	Width of the chip being cut (mm)
C_m	Machining cost rate (dollars/min)

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