

Methods for Integrating Energy Consumption and Environmental Impact Considerations into the Production Operation of Machining Processes

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Abstract: Energy consumption and environmental impact considerations of machining processes are viewed as the important issues for the global trends towards sustainable manufacturing. The existing research of reducing energy consumption and environmental impacts of machining processes greatly focuses on design and process planning activities, while the issue is seldom considered in production operation activities, especially for machining processes. This paper explores the systematic methodology for incorporating energy consumption and environmental impact considerations into the production operation of machining processes. Firstly, the framework of the methodology is proposed to establish the generic procedures for integrating the above considerations in production operation activities. As the two key issues of the framework, the profile index value matrix is determined by valuing the individual quantity of energy consumption and environmental impacts of machining each job on each machine, and the multi-criteria models are constructed by the operational methods. Furthermore, with the guideline of the framework, the specific formulations of the method are modeled by two sub-models for the parallel machine scheduling problem, in which makespan and energy consumption are the optimizing objectives as well as the constraints of environmental impact considerations. The specific formulations provide a practical method to integrate energy consumption and environmental impact considerations into the scheduling activity, and also can serve as a reference to other activities in the production operation. The case study for a batch of jobs including seven kinds of gear in the machining shop floor is presented to demonstrate the application of the specific formulations of the methodology. The proposed methodology provides potential opportunities for reducing energy consumption and environmental impacts in machining processes, and helps production managers in decision-making on the issues of energy consumption and environmental impacts in the production operation.

Key words: green manufacturing, energy, environmental impact, production operation, machining

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