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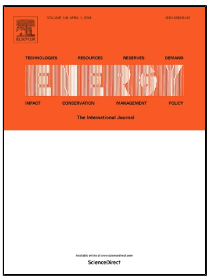

A life cycle energy analysis integrated process planning approach to foster the sustainability of discrete part manufacturing

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A life cycle energy analysis integrated process planning approach to foster the sustainability of discrete part manufacturing

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Abstract

Recently, a paradigm shift towards environmentally benign manufacturing (EBM) has been evoked in view of the substantially deteriorated environment. To realize more sustainable manufacturing, mitigating the production energy has been recognized as one of the viable strategies. In discrete part manufacturing, different process plans would result in significantly varied production energy. Thus in this investigation, a life cycle energy analysis integrated process planning (LCEA-PP) method is developed to achieve energy-efficient process planning for a certain product design. The life cycle primary energy (LCPE) analysis, considering the energy footprint of a product during virgin material production, product manufacturing and material recycling, is incorporated into the process planning. The case study on an industrial component, produced in two different materials - steel and aluminium, is carried out to demonstrate the effectiveness of the developed approach. The investigation shows that applying the near-net shape (NNS) strategy results in an energy mitigation of over 40% compared to the conventional shape (CS) strategy. However, further analysis demonstrates that the CS strategy can be more energy-efficient under certain manufacturing settings. Therefore, the developed approach is necessitated to support industrial manufacturers to adopt energy-efficient process plans and will effectively help them to achieve more sustainable manufacturing.

Keywords: Sustainable manufacturing; Process planning; Life cycle energy analysis (LCEA); Primary energy; Primary shaping process; Machining

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