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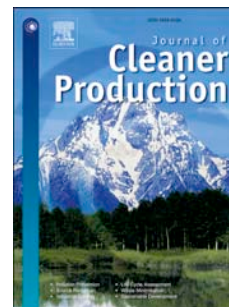
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Energy saving opportunities in direct drive machine tool spindles

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Abstract

The aim of the work is to carry out a comprehensive assessment of the energy saving opportunities linked to the introduction of direct drives solutions in machine tool spindle systems. Although there is a clear industrial trend towards the replacement of the traditional motor-transmission based spindle solutions, there is a lack of scientific studies focused on the associated energy-related aspects. For this purpose, two spindle units characterized by similar performances were analyzed from the energy consumption, losses and efficiency perspective. Empirical spindle system energy models were developed exploiting experimental tests performed on a motor test bench used for reproducing different machining conditions. The identified models were used to estimate the energy savings that can be achieved substituting the traditional gearbox-based solution with the novel direct-drive spindle. The analysis was carried out considering a realistic production scenario for the machine equipped with the analyzed spindle. It was demonstrated that about 7% of the energy absorbed by the overall machine can be saved and that this improvement accounts for the 147% of the requested cutting energy. For sake of generality, the analysis was repeated considering different production scenarios and ways of using the machine. It can be concluded that the achievable energy savings are even robust to the change of the executed machining operations.

Keywords: energy savings, energy modeling, spindle systems, direct drives

1. Introduction

Since manufacturing is one of the most energy demanding industrial sectors, institutions, universities, industrial organizations and companies, each one at different levels and with different roles, started tackling the challenging issues of using energy in a more efficient way. The European Commission, in order to fulfil the Worldwide greenhouse gas emission reduction target, delivered a directive for the eco-design of energy-related products ErP (EU (2009)) that establishes a common framework for the promotion of energy efficiency policies.

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