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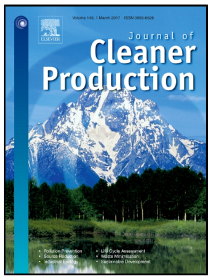

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Comparative Study on the Machinability of Lead-Free Brass

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Abstract

Lead is a heavy metal which is toxic even at low exposure levels. Although the amount of lead used in industry is steadily declining, it still constitutes a common alloying element for most conventional brass varieties. Today, conventional brasses contain roughly 3 wt. % lead. One of the main incentives for using lead as an alloying element is that it has a markedly positive effect on the machinability of the workpiece material. However, as an increasing amount of lead-free brasses are becoming commercially available and future legislative actions could be expected, even further limiting the use of lead as an alloying element, there is a renewed interest in evaluating the machinability of these new lead-free materials. The current article focuses on evaluating the machinability of the commonly used, lead-containing, CuZn39Pb3 brass as compared to the commercially available, lead-free alternative CuZn21Si3P. An improved understanding of the difference in machinability was obtained by comparing the properties and behavior of these two materials in machining. For instance, it was noted that the tool wear is significantly higher while machining CuZn21Si3P as compared to CuZn39Pb3 under similar conditions. This can, to a certain extent, be counteracted through the use of inexpensive tool coatings, making lead-free brass a viable option for commercial production.

Keywords: Machining; Brass; Lead; Machinability; Material properties; Tool wear.

1. Introduction

Even though brass is defined as a copper and zinc alloy, it generally also contains other alloying elements such as lead, silicon, aluminum, iron, tin, manganese, nickel or arsenic whose presence are part of the reason for the wide variety of properties inherent to these alloys (Vilarinho et al., 2005). So called free-machining brasses are commonly used for a wide range of applications including household products, door handles, nuts and screws, plumbing fittings, etc. (Pantazopoulos, 2003). These free-machining brasses generally contain roughly 3 wt. % lead in order to acquire the desired machinability and thus aid in the production of the desired parts. The addition of lead is considered as resulting in an enhanced machinability through improving the chip breaking, lowering the cutting forces, decreasing the tool wear, as well as permitting better surface roughness and tolerance (Gane, 1981; Pantazopoulos, 2002). However, due to the detrimental effects of lead on the environment, the use of lead as an alloying element is becoming increasingly questioned. Currently, copper alloys are permitted to contain up to 4 wt. % lead according to the directive on the restrictions of the use of certain hazardous substances, RoHS, and the directive on end-of-life vehicles, ELV, approved by the European parliament and council (Buzek and Győri, 2011; Juncker, 2016). However, as the importance of sustainable production is becoming increasingly recognized, further legislative actions could be expected in the future as emphasized by Nobel et al. (2014). It is also worth noticing that