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Energy saving by manufacturing technology

A. Erman Tekkaya*

Institute of Forming Technology and Lightweight Components, TU Dortmund University, Baroper Straße 303, 44227 Dortmund, Germany

Abstract

There are different ways of saving energy in production engineering and thereby reducing the environmental stress. Here, different possibilities of saving energy by manufacturing technology are presented.

On the one hand, this is possible through lightweight components. The production of components for the automotive industry with low weight while maintaining the same mechanical properties helps to reduce the fuel consumption of the vehicles. This can be achieved by means of load-adjusted components. Furthermore, suitable materials can be selected for the respective function of the part. This is in interaction with the selected manufacturing process of the component. Press hardening can be mentioned as an example. Here, the production of complex components with high strength gets only possible by the forming process.

On the other hand, energy can be saved directly during the production of the components. This is possible through energy efficient production and begins with the selection of the production process. A huge part of the energy used for the production of a component results from the manufacturing of the raw materials. Consequently, a production process should be selected which produces as little as possible excess material. For example, the production of a screw by forming results in a high utilization of the material. If this part would be produced by machining, there would be relatively much waste of material in form of chips. This in turn would have a negative impact on the environmental stress. However, the production of the forming tools must also be considered. Therefore, this example is mainly valid for large-scale production. This consideration is also important for the sector of additive manufacturing where the entire material has to be melted and therefore a large amount of energy is required. Nevertheless, if advantages with regard to lightweight components are obtained, this increased energy expenditure can be justified.

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* Corresponding author. Tel.: +49 231 755 2681; fax: +49 231 755 2489.

E-mail address: Erman.Tekkaya@iul.tu-dortmund.de

1. Introduction

Carbon dioxide emission is one of the main causes of current climate change. The CO₂ emissions emitted by humans can be subdivided into the respective responsible sectors (Figure 1).

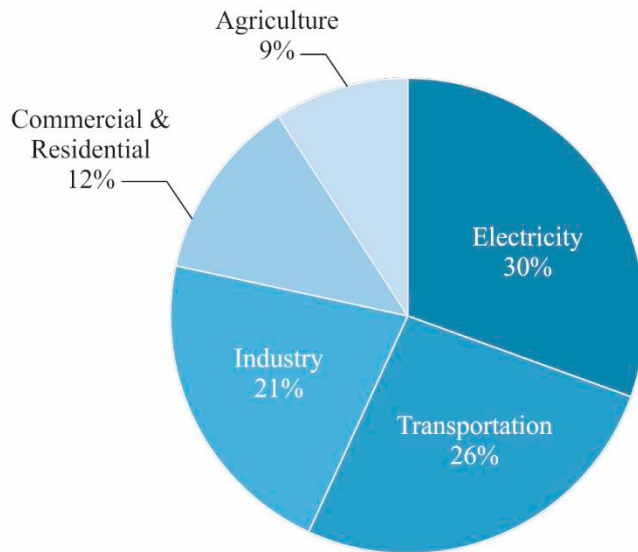


Figure 1 Total U.S. greenhouse gas emission in 2014 = 6,870 million tons of CO₂ equivalent [1]

The industry and the transportation sector are responsible for almost the half of the emission. In these sectors lay the chances of the production technology to influence the emission of pollutants. The transportation sector is mainly given by the fuel consumption from vehicles. If this gets reduced, the pollutant emission will also be reduced. This is possible, among other things, through the consequent implementation of lightweight construction concepts. The second area, the industry, includes the emission which is generated by the production of components. This can be influenced positively by energy-efficient production. Within this article, possibilities and examples will be presented, to make the two previously mentioned points possible.

2. Lightweight components

According to [2], fuel savings of up to 0.35 l / 100km are possible with a weight reduction of 100 kg of a vehicle. This shows the high potentials of lightweight components for saving energy. Within the scope of manufacturing technology, there are various possibilities to realize lightweight structures. Thus, constructive, materials engineering as well as production engineering concepts can be pursued in order to concentrate the material where the stresses are highest.

One example is a press hardening process. This allows the reduction of component weight by higher strength materials. The high strength is thereby realized in the forming process itself by a hardening process. Figure 2 shows the weight reduction by the use of different materials for a car body demonstrator where steel serves as reference [3]. By the use of high strength steel, the component weight could already be considerably reduced. A further weight reduction was possible by the use of aluminum as well as by fiber-reinforced plastic.

However, it is pointed out that the energy for the production of such components is many times higher than the energy needed to produce the steel component. This increased environmental pollution would have to be justified by the lightweight reduction achieved.

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