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Energy-Efficient Production with High-Power Disk- and Diode-Lasers

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Abstract

This paper presents and discusses two main aspects of energy-efficient production using laser technology: First, the laser as a tool and the evolution of important laser characteristics; second, potential improvements in design and novel approaches in production due to the use of lasers are discussed.

Keywords: Energy efficiency; wall plug efficiency; high power disk lasers; high power direct diode lasers

1. The laser efficiency

Since the introduction of the first industrial lasers the power conversion efficiency has been vastly improved starting from a few percents using lamp pumped solid state lasers to above 40 % using latest direct diode lasers. With increased power conversion efficiency (or wall plug efficiency), the electrical power consumption can be cut by a factor of up to 10, as can be seen in Fig. 1 comparing the efficiency of lamp-pumped lasers with the efficiency of disk lasers or direct diode lasers. Such improvements in efficiency lead to massively reduced requirements on peripheral equipment that is necessary for using lasers, i.e., medium voltage transformers, chillers, etc. For example, a medium voltage transformer that was previously designed for providing electric energy for five lamp pumped rod lasers can now be used for up to 50 novel direct diode lasers. Besides these improvements in efficiency, latest state-of-the-art disk- and diode lasers come up with intelligent energy saving modes, wake up and sleep timer functions that allow energy savings also within idle times.

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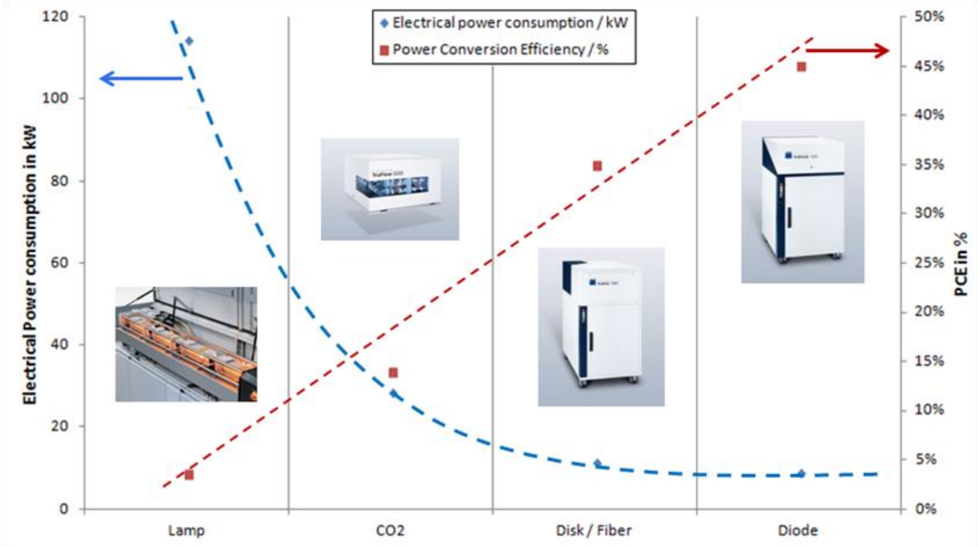

Fig. 1. Comparison of energy consumption and energy conversion efficiency of different high-power lasers, Killi, 2013

2. Lasers enabling energy-efficient production

The laser as a tool allows for novel joining approaches compared to state-of-the-art resistance spot welding, as elaborated in Stephan, 2007. A laser-adapted redesign of components, e.g., a reduction of flanges or a change from overlap to butt-joints (flange-free joint), can reduce energy consumption up to 50 %. Besides energy savings at the tool side, less material is used resulting, e.g., in fuel savings at end customers due to light weight designs. New process technologies, such as welding at low pressure, enable a further reduction of energy consumption: welding at low pressure further reduces laser power necessary for the joint (additional energy saving) while improving process results and eliminating subsequent brush processes at the same time. Besides advantages in conventional welding applications, lasers allow for energy savings due to enabling novel laser-based processes such as laser metal deposition, laser metal fusion and processing of carbon fiber reinforced plastics (CFRP).

Novel disk- and diode lasers as energy-efficient production tools play an ever increasing role in industrial processes and pave the way for modern energy-efficient production.

References

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