Title
LIFE CYCLE MANAGEMENT OF ABRASIVE TOOLS AND EFFECTS ON SUSTAINABLE GRINDING

Permalink
https://escholarship.org/uc/item/5th4d3q7

Author
Linke, Barbara

Publication Date
2011-06-17
LIFE CYCLE MANAGEMENT OF ABRASIVE TOOLS AND EFFECTS ON SUSTAINABLE GRINDING

Dr.-Ing. Barbara S. Linke
University of California, Berkeley
Laboratory for Manufacturing and Sustainability
barbaralinke@me.berkeley.edu

ABSTRACT:
The world-wide trend to environmental awareness is accompanied by a rising need for manufacturing technologies that spare energy and resources. The sustainability of products and processes becomes more and more a main competitive edge. However, the very essential aspect of abrasive tool design and its impact on process eco-efficiency have not been examined in a holistic view yet. Therefore this work evaluates the whole tool life from manufacturing to use phase and end-of-life.

Abrasives too have a huge variety in specifications, manufacturing steps and ingredients. Therefore a framework has to be set up to evaluate tool manufacturing with a thorough investigation of main and auxiliary ingredients, emissions, waste and energy. Tool design affects the abrasive machining process in terms of productivity, workpiece quality and tool life. Relevant mechanisms of impact are discussed, evaluated and included into a suitable holistic life cycle management of abrasive tools. Not only the improvement of the single abrasive process, but moreover the process chain and leveraging effects on product performance are considered. Different scenarios for the end-of-life of abrasive tools concludes the life cycle management. Abrasive tools are not only complex products, but moreover important enablers for green manufacturing.

ABRASIVE TOOL PRODUCTION

The system boundaries are important for the quality and relevance of life cycle considerations. The production of abrasives and vitrified bonds is characterized by mining and processes emitting greenhouse gas; resin and electropolished bonds include chemical production steps. Manufacturers are pressed to substitute pore builders based on naphthalene. New chemicals, however, change the manufacturing robustness.

The choice of abrasives, e.g. CBN vs. corundum, implies not only different production chains for the abrasive tool (e.g. abrasive layer on steel body vs. full-body), but also an appropriate process layout for the use phase. For example, a high-speed machine and oil are needed to gain the intrinsic advantages of superabrasives. This affects the process sustainability by energy use, maintenance, worker education and health, etc.

ABRASIVE TOOL END OF LIFE

Today, abrasive tools are often disposed via household waste or special waste leading to waste combustion or to the garbage dump. For different end of life scenarios, energy, emissions and toxicity are examined and evaluated. Nevertheless, in the case of grinding wheels with layers the bodies are often re-plated. The potential for recycling of superabrasives is discussed.

CONCLUSION AND FUTURE WORK

Abrasives are complex products that enable high performance and high quality processes. Their life cycle is regarded in terms of energy and resource efficiency including their production and end of life. Moreover, their capability to enhance green manufacturing itself is discussed and evaluated in this project.

Future work will focus on abrasive grits in terms of the energy that is consumed during their production related to the productivity of the abrasive tool. The design of the grinding tool body (material and shape) affects process capability and machine power. Sustainability of grinding processes will be evaluated by machine power measurements as well as by analysis of grinding debris, emissions to air, or cooling lubricant. Tool conditioning leverages tool performance and tool life, which will be considered. Discussions with tool manufacturers will reveal how much research should be done in future on supply chain and packaging aspects.

ACKNOWLEDGMENTS

The work is sponsored by the Deutsche Forschungsgemeinschaft DFG through the project Li1939/3-1. The author would like to thank sincerely Prof. Klöcke, RWTH Aachen and Prof. Dornfeld, UC Berkeley. Thanks to the Aachen Grinders and the LMAS colleagues for valuable discussions.

MSEC2011-50309