Success Story
COMET

Competence Center for Tribology
Program: COMET – Competence Centers for Excellent Technologies
Program line: K2-Centers
COMET-project 3.11, 2015-2020; tribological evaluation of manufacturing processes, multi-firm project

Innovative manufacturing of worm wheels for spindle jacks

In order to strengthen Austria as a production site the local industry needs to reach and maintain technological leadership in in their respective fields. In addition to high product quality, economical production facilities are necessary for a competitive product. This can only be achieved by innovations which make use of alternative materials and novel manufacturing processes, in order to save resources and reduce costs during production.

The spindle jack – a highly complex device

Spindle jacks (Fig. 1) are universally applicable drives for many products of mechanical engineering, and are being produced in Austria in high quality. One of the most critical zones of the spindle jack is the friction contact between the spindle thread and the worm wheel. In addition to its geometric complexity, material properties play a major part. While the spindle is made of steel, a variety of copper based alloys, e.g. bronzes, are employed for the worm wheel.

Lost Foam casting – innovative, resource-saving manufacturing

Worm wheels made of bronze are usually wastefully machined out of continuously cast semi-finished products. This manufacturing process requires a huge number of steps and expended resources. Therefore, the researchers at AC^{2}T teamed up with industrial partners to apply a more economic production process: Lost Foam Casting (LF) is a modern sand casting process which has been so far used for the production of steel or aluminium alloy parts, but is completely novel with respect to the use of copper based alloys. This process employs casting models made of polystyrene foam, which evaporates in contact with molten metal. Application of this type of models allows manufacturing of complex parts in a near-finished state, so that additional steps such as machining or joining of parts can be reduced, thereby achieving significant cost reductions of material and labour (Fig. 2).

Fig. 1: Spindle jack (Copyright Maschinenfabrik Albert)

Potential pitfalls resulting from process modification

Changing the manufacturing process of a mechanical part can cause differences in mechanical properties of the material, such as strength or

wear resistance, even when the same alloy is employed, and thereby significantly influence the durability of the part.

A tribological system like the spindle drive can very sensitively be affected by even slightest changes in the materials properties. Therefore, when a running system is modified for economical or ecological reasons, the resulting influences and interactions must be studied extensively, in order to gauge the effects on durability. Those material parameters, which can be adjusted in LF-casting, must be evaluated with regard to their effects on durability and wear rate.

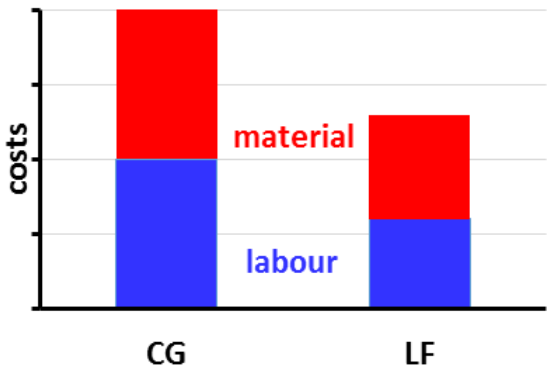

Fig. 2: Savings in labour and material costs due to changing technology from Lost Foam Casting (LF) to continuous casting (CG) – symbolic representation

Depending on the casting process, various differences in microstructure, such as grain size or segregations, can be observed. It is rather difficult to estimate the effects of these differences on the tribological properties. In order to evaluate these effects, tribometrological testing procedures ranging from abstract model tests on a laboratory scale to elaborate real component tests are employed.

In order to represent the complex real contact of the worm wheel, a multi-scale approach was chosen, in order to comprehensively describe the changes of the tribological behaviour. Experimental tests with two laboratory tribometers, which reflect effects on several scales, were compared with special component-based lifetime tests. In this manner, process parameters of LF casting could be correlated with wear behaviour, and thereby optimum manufacturing conditions were defined.

Constant quality, economic benefit

As a result of these efforts there now exists an economic and ecologic manufacturing process for a component which even outperforms the original process with regard to resulting wear resistance. Lost Foam casting with copper alloys makes a cost-effective manufacturing process available for components with high geometric complexity and with required tribological quality.

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