Article from Magazine "Werkstatt+Betrieb"(Germany), No.5/2014

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Tap holder with transmission gear replaces tapping attachments

New Convolutions of the Brain

Emuge´s Speedsynchro makes it possible to run machine spindles in a non-critical energy-saving rpm range during thread production. ZF in Passau expects shorter cycle times and extended maintenance intervals from this system.

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By Michael Hobohm

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→ The production section for the machining of aluminium components within the Performance Centre (PC) for Castings of ZF Friedrichshafen AG in Passau deals with electrohydraulic control units which like a technical brain control the forces of gear units in construction machines and agricultural machinery. These steering boxes control different clutch packs which are actuated by oil pressure and movable pistons. In combination with gear pairs of the gear units which are permanently engaged, the respective gear packs addressed determine which pairing will actually handle the power transmission. The gear is engaged.

Only parts actually required are produced.

The control units produced by the Performance Centre Castings on a Hüller-Hille NBH 95 in complete production consist of channel plate and valve body which are assembled later. In order to connect the plates to each other, tap holes are drilled into the sealing surfaces and afterwards the threads are cut. Based on 8 different product families of control units manufactured by the PC Castings , the quantity and size of the threads depend on the specific product. For example, one type of channel plate requires 32 threads M5. Only 5 months ago these threads were machined using tapping attachments, now the Speedsynchro of Emuge is used instead.

In their majority the components machined in the PC Castings are made of cast iron. Only a minor part of them are aluminium castings. „We machine up to 350 tons of material every day which we receive as raw casting" says Gregor Hausmann, Senior Manager Projects/Planning in the Performance Center. „After their machining, most parts are passed on to the Performance Center Assembly, a smaller part of them is sent to production facilities in Brasil, USA, China or India." The PC Castings contributes in particular drive technology for construction- and agricultural machines among the products received by the PC Assembly. Consequentially, there is a gear production for agricultural machines and another one for gear- and axle production for construction machinery in the Performance Center. A third product category are commercial vehicles and buses, for which for instance front- and rear axles are produced.

„A couple of years ago we set up a production system strongly based on the Toyota system for the production of these components at ZF in Passau. The essential principle of this system is: only parts actually required are produced“, says Hausmann. „ In order to install this principle, we focused on production islands as manufacturing structure, which are run as small- and medium-size series production units.“ There are islands which are directly controlled by a Kanban system . In this system, only those parts are delivered which are directly required on the 23 assembly lines of the Performance Center Assembly. These parts are entered into the production by means of order cards and afterwards are delivered to their final location. But not all of these islands work according to the Kanban principle. A couple of them work in an order-controlled way based on the SAP system which enters the respective orders from the Performance Center Assembly. After they have been processed in SAP and transformed in planned orders and production orders, the material procurement and the production of specific products is triggered which are finally stored in a direct delivery area next to the gates of the Assembly Unit. „An exclusive application of the Kanban system throughout would of course be the best solution“ says Hausmann. „But the number of product variants in our company requires the restriction of this principle. After all we currently have 1200 item positions which have to be produced. It is just not possible to map this production with Kanban items. For this reason we have to rely also on an order-controlled processing.“

The classical introduction to the topic are cycle time and maintenance

A topic in this production system in which the Performance Center is very active, are the tools. „ This is true both for the use of new systems and also for the optimization and rationalisation of existing ones.“ explains Christian Schmid, process planer within the PC Castings. „ Recently we successfully implemented several projects in which the Speedsynchro attracted our attention as a production alternative. Last December we started to test this tap holder. We used it for machining aluminium due to the smaller sized threads in this section. On the other hand the aluminum components with an annual production of 20.000 pieces represent one of the largest production series within the Performance Center Castings.

The tapping attachments used in series production so far, work with wear-prone gears which resulted in additional costs and maintenance. „ We try to reduce the maintenance required with the use of the Speedsynchro.“ explains Hausmann pointing out one of the main reason for the switch. „At the same time we would like to reduce cycle time and by this means increase efficiency„.

Reduction of cycle time and a decrease in maintenance requirement are in fact the classical motifs for users to give Emuge technology a try. Background to this: modern tool machines are often limited in their control response by spindle feed and rotational speed of the spindle when it comes to thread production.

From experience, the actual problem is often the rotational speed. This is true in particular with regard to small tool diameters: the programmed cutting speed can not be achieved in many cases resulting in a deterioration of tool life and cycle time. „For this reason we

designed an ER16 collet holder with transmission gear, the Speedsynchro which is used between spindle and tool and combined this with the minimum length compensation function of the Softsynchro“, says Peter Liebald, product manager clamping technology at Emuge. „Based on a transmission ratio of 1:4,412 the gear makes it possible to work in a synchronous rpm range of less than 1.500 min^{-1} and at the same time it guarantees high cutting speeds of the tap. Cycle time can be reduced by up to 40% due to the consistently achieved rotational speed. At the same time the collect holder requires less maintenance. Additional potential effects are the high quality of the threads not subject to variations in depth as well as energy saving of up to 90% of spindle power consumption.

The Speedsynchro tap holder is designed for the thread range M1 to M8, a maximum spindle drive of 2000 rpm and an internal coolant supply up to 50 bar. Versions with one-or two-channel minimum quantity lubrication are available as an option.

Visible effects are verified

Since end of last year the Speedsynchro has been thoroughly tested in the Performance Center Castings. Important effects relevant for the production at ZF became already aparent. „ Up to now they have used three different tapping attachments in the machining of gear boxes in order to deal with projecting edges and taps of different lengths“, says Armin Kusch, responsible for sales and technical consulting at Emuge. „The larger the projecting edges were, the more we had to reduce the rotational speed. The Speedsynchro made it possible to use a short tool extension maintaining the rotational speed. This way we were able to reduce projecting edges, keep up speed and substitute expensive long-shank taps.“

Instead of using three tapping attachments, only the collet holder is now required. Furthermore, DIN taps can be used now which are shorter, cheaper and more readily available. As a result it is already clear at this stage that this project will save costs.

With regard to machining time, the Performance Center Castings had expected a larger effect than was actually realised. „Currently we save seven seconds per component with a total cycle time of 2 minutes 35 seconds for all threads“says Schmid. „The time saving effect is rather small which is due to the fact that they had already used tapping attachments before“, explains Liebald. „A change from a synchronous spindle to the Speedsynchro would show a significantly larger time saving. But a user of the Speedsynchro can increase rotational speed. In contrast to this, when using tapping attachments rotational speed is limited due to mass inertia and the resulting wear of switch elements.“.

With regard to quality and maintenance- and repair costs, only a preliminary result is available at the moment.Nevertheless it has already become clear that the quality of the threads increased. This is due on the one hand to the Softsynchro effect which compensates any synchronization errors of the machine and ensures an even load on the cutting edges of the taps. On the other hand, the Speedsynchro guarantees a consistent depth of threads. „Furthermore, while the threads done with the tapping attachments were true to gauge, they did have some play. „Screws have a tighter fit in threads machined with the Speedsynchro“, adds Schmid.

In order to verify the statements regarding increased quality and reduced maintenance- and repair costs, the current tests will continue to run for two or three more months. The

production of the channel plates continues – 270 threads are machined per cycle with 110 components per day; based on this the current tendencies will soon be transformed into reliable conclusions. If everything runs smoothly, this system will then be introduced also on a second, third, and fourth machine. Once a reliable operation is achieved, they plan to adopt the system also for cast iron or larger threads (M10, M12). „We are interested in producing larger threads with the Speedsynchro“, emphasizes Hausmann. Liebald lowers the expectations: „in threads larger than M10 the time saving is strongly dependant on the possible cutting speed of the tap and on the component material to be machined.“ But basically he can image „ to design gears with other transmission ratios analogous to tapping attachments which are available in small, medium-size and large versions with corresponding different rotational speeds.“ The further proceeding is not clear yet. It remains to be seen where the journey is headed.

Bildtexte:

1) Electrohydraulic control on a ZF Ergopower gear for construction machines.

2) Emuge´s Speeedsynchro: this ER16 collect holder with transmission gear and Softsynchro minimum lenght compensation is designed for reducing cycle time and maintenance costs.

3) Representative example: in an operation with a cold-forming tap M6 the Speedsynchro - in contrast to a fixed synchronous spindle - significantly reduces machining time, axial force and power consumption dependant on rotational speed.

(Diagrammbeschriftung:)

Reduction with Speedsynchro in percent (%)

Rotational speed of thread tool (min^{-1})

Energy saving with Speedsynchro

Reduction of axial force with Speedsynchro

Time saving with Speedsynchro.

4) Valve bodies of an electrohydraulic control unit mounted on a two-piece clamping tower are complete machined on a NBH 95.

5) Peter Liebald, Armin Kusch, Christian Schmid and Gregor Hausmann (from the left) introduced the Speedsynchro in a joint project at ZF in Passau. The effects of the system are currrently tested and quantified with regard to cycle time, quality and maintenance costs.