Press hardened bearing components (PRELAG)

Project within Sustainable Production Technology

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2012-04-26

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FFI in short

FFI is a partnership between the Swedish government and automotive industry for joint funding of research, innovation and development concentrating on Climate & Environment and Safety. FFI has R&D activities worth approx. €100 million per year, of which half is governmental funding. The background to the investment is that development within road transportation and Swedish automotive industry has big impact for growth. FFI will contribute to the following main goals: Reducing the environmental impact of transport, reducing the number killed and injured in traffic and Strengthening international competitiveness. Currently there are five collaboration programs: **Vehicle Development, Transport Efficiency, Vehicle and Traffic Safety, Energy & Environment and Sustainable Production Technology.**

For more information: www.vinnova.se/ffi

1. Executive summary

Gestamp HardTech invented the press hardening technology in the 1970's. The press hardening process is based on the forming of hot blanks, in the austenitic state, to improve the formability as well as obtaining a final martensitic structure by subsequent rapid cooling in the forming tools.

One used technology at SKF is cold stamping. The sheet steel could be used both for a bearing house or raceway for different bearing applications. Today the manufacturing of stamped bearing applications could be based on cold forming followed by heat treatment. In some cases this is followed by processes like grinding and polishing. The output from this manufacturing process can sometimes be sensitive to distortion.

The aim of the project was to evaluate if the press hardening technique could be used for bearing applications. The use of press hardening was believed to improve form stability and thereby enhance productivity. Also it was judged to reduce process steps since pressing and hardening was made simultaneously. This could give economical, logistical and environmental advantages. The material used was chromium alloyed sheet metal. The addition of chrome can be beneficial when to quenching the material in the cold tools. By using the press hardening technology a less alloyed material could be used. This was seen as an environmental advantage.

The project involved choosing two different bearing applications and modifying their geometry to better suit the press hardening process. The first bearing application (included in Work Packages 1-4) was performed as an internal project at Gestamp HardTech except Work Package 4, which contained the cost analysis and process definition of the serial production.

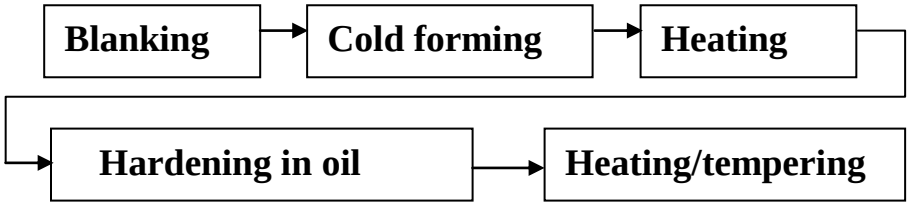
For the second application a material was chosen and thoroughly investigated in terms of mechanical properties and behavior during and after forming/hardening.
Prototypes were manufactured and measured. The tools were adjusted and new prototypes were made. One problem with the prototypes was draw marks on surfaces with high requirements on the surface finish. Different coatings on some of the tool surfaces were tested to see if the draw marks could be reduced.
The prototypes did not meet all of the requirements. They showed good potential regarding the form tolerances but did not meet the other requirements. On some of the areas where high hardness is required there are some local softer spots. These are believed to derive from a poor process tool contact. To reach the requirements on the prototype it was thought that a material with higher alloy content would be better suited for the chosen geometry.

Process layouts were made for the possible processes of the two bearing applications. New ways to shorten the cycle time for the products and decrease the amount of work in process by using new technologies for heating and cooling was investigated.

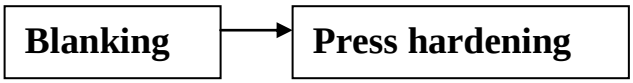
2. Background

The press hardening technology (hot stamping) of sheet metal is used in for example the automotive industry, and the use of technology is expected to increase in the future. This since that for a certain volume the cost will be lower if the manufacturing is done by stamping the parts instead of processing the steel with turning and milling. The stamping technology is preferably used for high volume production, simple application or components for lower loads. Sheet steel could be used both for bearing house and raceway for different bearing applications. The manufacturing process of stamped bearing components is based on cold forming followed by heat treatment. In some cases this is followed by processes like grinding and polishing on some of the bearing surfaces. The cassation level may vary for this kind of manufacturing process, mainly caused by distortion during the manufacturing process.

Traditional process:



New process:



The material used today could be chromium alloyed. The addition of chrome enhances the hardenability of the material during the cooling process.

The requirements on the application are generally very high, but can vary depending on the bearing application. The main requirements concerns sufficient hardness, microstructure, form stability and surface topography.

The aim of the project was to evaluate if the press hardening technology can be used for selected bearing components. The use of press hardening was believed to improve form stability and thereby enhance productivity. There could also be fewer process steps since pressing and hardening are made simultaneously. This could give economical, logistical and environmental advantages.

The traditional bearing consists of bearing raceways in cold formed sheet steel or machined part. In the innovative solution with press hardened bearing raceways and bearing applications more functions can be integrated in the application. This could enable a more weight and cost effective component.

Preferable in the project less alloyed material was to be used. With press hardening technology where the steel quenches faster, due to tool contact, less alloyed and more environmental friendly lower alloyed steels could be used.

There was seen a potential in the project, that a successful result could improve the competiveness and increase the production of press hardened components within Sweden.

Gestamp HardTech invented the press hardening technique and was the first in the world to produce press hardened reinforcement products for the automotive industry. They are a partner in the project that is inspired by new challenges. The company is a part of Gestamp Automoción and produces components for most of the car manufacturer worldwide. Characteristic products for the company are bumpers, side impact beams, doors and most of the components in the safety cage like the A- and B-pillar, floor- and roof reinforcement. The components are relatively large, about 0.5m to 2m.

3. Objective

The project aim was to evaluate the use of the press hardening technique on components for bearing applications.

The first phase of the project evaluated different materials where hardness and form tolerance were critical factors. Tooling technique for small components was another important part. In the first phase an application was chosen that should set up the requirements for the rest of the project.

The second phase of the project reviewed and characterized a chosen material and geometry application. The results should give guidance to a press hardening process for a serial production of components for bearing applications.

The project should demonstrate potential, and also act as a decision basis for investment for press hardened components.

4. Project realization

The project was split into several work packages as given and briefly explained below. The Work Packages (short WP) are here given as performed, with some changes from the initial plan in the project application.

WP 1 Theoretical process analysis
Performed as an internal project between Gestamp HardTech and SKF.

WP 2 Initial material study
Performed as an internal project between Gestamp HardTech and SKF.

WP 3 Study of press hardened "Bearing application no.1"
Performed as an internal project between Gestamp HardTech and SKF.

WP4 Cost analysis serial production press hardened "Bearing application no.1"
An efficient press hardening process for serial production was defined, and a process layout was made. A cost analysis for the product was made.

WP5 Material study and tooling development
A material, new for press hardening, was characterized in terms of mechanical properties during forming/hardening and in the hardened condition. This WP also contained the tooling technique to fulfill the requirements of surface finish for press hardened bearing components.

WP6 More thorough study of a press hardened "Bearing application no.2" production of prototypes
Prototype tools were developed and produced and prototypes were manufactured. Evaluation of the prototypes showed that the tool had to be adjusted. Thermo mechanical forming analyses were done according to the tooling geometry and the production process during the first run of prototypes to have as a reference. With the help of the forming analysis the tool was adjusted and new prototypes were manufactured. New ways to heat and cool more rapidly were tested.

WP7 Press hardened "Bearing application no.2" process definition serial production
An efficient press hardening process for serial production was defined, and a process layout was made. A cost analysis for the product was made.

WP 8 Project management
One management group was responsible for overall management, economy and reporting to VINNOVA.

5. Results and deliverables

- Geometry changes of both of the applications adapted to the press hardening technology.
- Prototype tools have been produced.
- Prototypes have been produced.
- Process layouts have been developed of a possible serial production for both of the bearing applications.
- New knowledge of how to manufacture products with a good surface finish.
- New knowledge of heating.
- New knowledge of cooling/quenching.
- A material, new for press hardening, ha s been characterized in terms of mechanical properties during forming/hardening and in the hardened condition.
- A more cost effective product compared traditional technology.

5.1 Delivery to FFI-goals

The project contributes to the program for Sustainable Production Technology. The product concepts could lead to a more cost-effective production. The products could be more environmental friendly since less energy is used to produce them and lower alloyed steel can be used. The project will strengthen both SKF and Gestamp HardTech in their respective fields of work, and hopefully increase the amount of press hardened products in Sweden. The bearing applications in the project are innovative and allow an integration of functions on account of the unique possibility to form complex geometries set by the press hardening technology.

6. Dissemination and publications

6.1 Knowledge and results dissemination

Gestamp HardTech is interested of investigating new types of heating and cooling in the process and will study this further. The new type of process that has been developed for the serial production in this project is also of interest to study further.

6.2 Publications

No external publications have been released at the writing moment, but participation with project posters at FFI-conferences.

7. Conclusions and future research

The project has shown very promising results regarding the possibility to use the press hardening process for components for bearing applications. It might be of interest to investigate other materials to find an alloy that is better suited for the components in the project.

Gestamp HardTech and SKF will continue the co-operation and investigate if the press hardening process can be applied to bearing components.

8. Participating parties and contact person

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