COOP-CT-2006-032438

CLAREFOSS

Clean and Reliable Forming of Stainless Steel

Co-operative Research

Horizontal Research Activities involving SMEs

D7.2 Final Report

Due date of deliverable: M30
Actual submission date: 3 April 2009
Dissemination Level: Confidential

Start date of project: 19-06-2006 Duration: 30 Months

Organisation name of lead contractor for this deliverable: TNO Science and Technology

Revision: 18 March 2009

Introduction

This report gives a concise overview of the aims, work and results of the Clarefoss project. The acronym Clarefoss stands for clean and reliable forming of stainless steel. This expresses the objectives of the research. For one thing, the search is for clean forming, that is, to use lubicants which are biodegradable and non-toxic. This in contrast to many currently used lubricants, which are toxic (due to chlorine and heavy metal content), and non biodegradable (since they are based on mineral oils). The lubricants to be developed in the Clarefoss project are ECO-friendly, that is, both biodegradable and non-toxic.

The second objective is to improve on the reliable forming of stainless steel. Current production methods experience a lot of scrap formation at start-up, limited tool life times, and multiple drawing steps where often only one drawing step is needed. The idea is to improve on this subject. By applying temperature control in the die, the formation of scrap at start-up can be prevented. This temperature control also allows the drawing process to be optimised, so that the number of drawing steps can be kept at an absolute minimum. Finally, by using better lubricants in a controlled fashion (minimum quantity lubrication), the lubricant cost can be reduced while lubrication properties are actually improved. The second objective can also be achieved by using different tool materials and /or coatings on top of existing tool materials. These modified tools can decrease wear, thus ensuring an increased life time and durability of the tool.

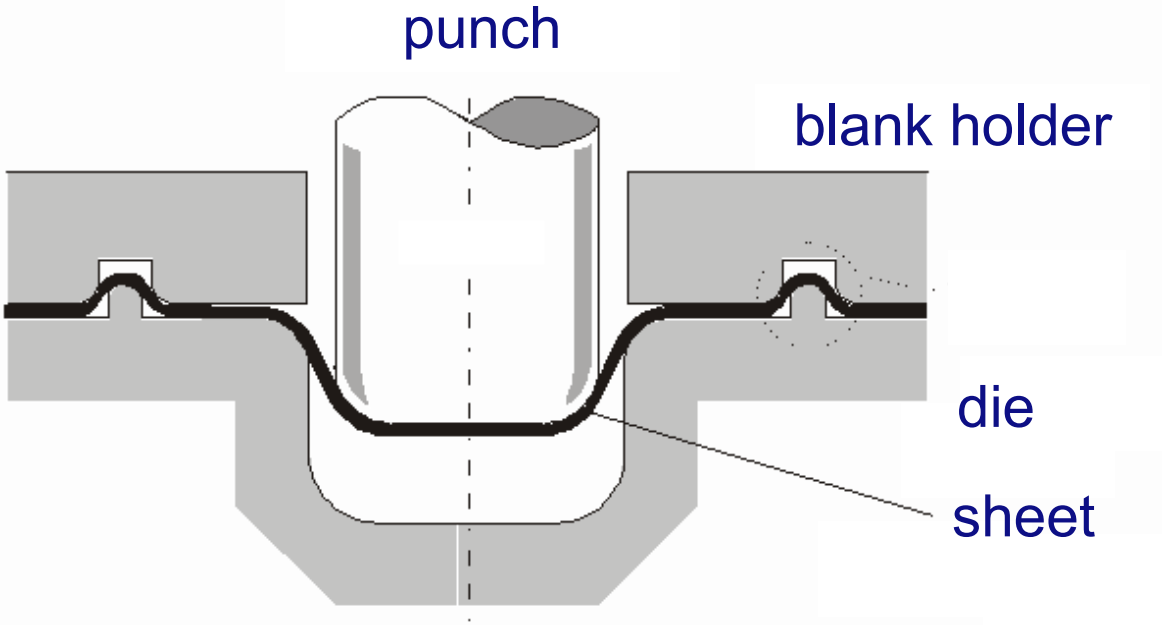

Figure 1: Schematic depiction of the deep drawing process.

Partners involved
The consortium consists of a lubricant manufacturer (Brugarolas), a company with expertise in minimum quantity lubrication (Novatea), four deep drawing companies (Lacor, and only in the first project year also Stala, PaulKuppel and AWAB), two heat treatment and coating companies (TTT and Genta), a partner to supply the sheet materials (Ugine), a partner interested in hardmetal inserts (Wolframcarb) and two research partners, Tekniker and TNO. TNO is also coordinating the project.

Work performed and end results
Eco-lubricants means for application in deep drawing processes have been developed by Brugarolas. These lubricants have been characterised for lubricant properties and eco-friendliness by Tekniker, and compared with conventional reference lubricants. Further tribological characterisation by TNO and Tekniker showed that these lubricants were at least as good as conventional lubricants. Based on these findings, industrial tests at Lacor have been performed using these eco-lubricants to see whether they can replace conventional lubricants. The outcome of these tests is that Lacor is now industrially using eco-lubricants instead of conventional lubricants, commercially supplied by Brugarolas. From the cost aspect, the purchase price of the eco-lubricants is comparable the one for the conventional lubricants, but the disposal cost is much lower. This means that there is both an environmental and an ecomical advantage, while maintaining a strong technical reliability.

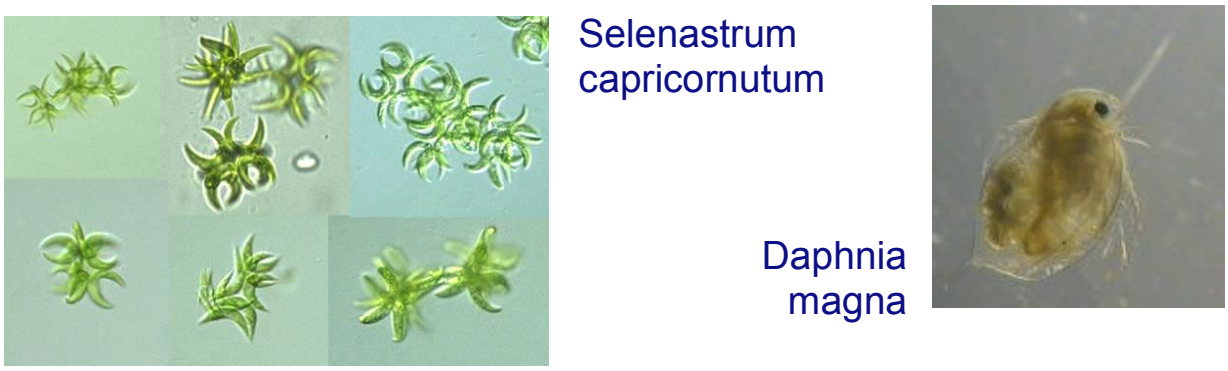

Figure 2: Algae (left) and Daphia Magna (right) used in the environmental characterisation of the eco- and reference lubricants.

Apart from the eco-lubricants, also tests were performed using coated tool materials. These coatings were first evaluated by TNO and Tekniker under laboratory conditions. Based on these preliminary tests, the most likely candidate coatings were selected for application at the end user. For this purpose, a separate test tool was made, which was coated by TTT, and used in production by Lacor. The application of this nitriding coating by TTT in deep drawing processes was an innovation for TTT. The applicability of hardmetal inserts by Wolframcarb was also tested in the laboratory tests, as was the applicability to use ferritic materials instead of austenitic materials. Finally, the use of minimum quantity lubrication was assessed for application in deep drawing processes, with the above mentioned lubricants.

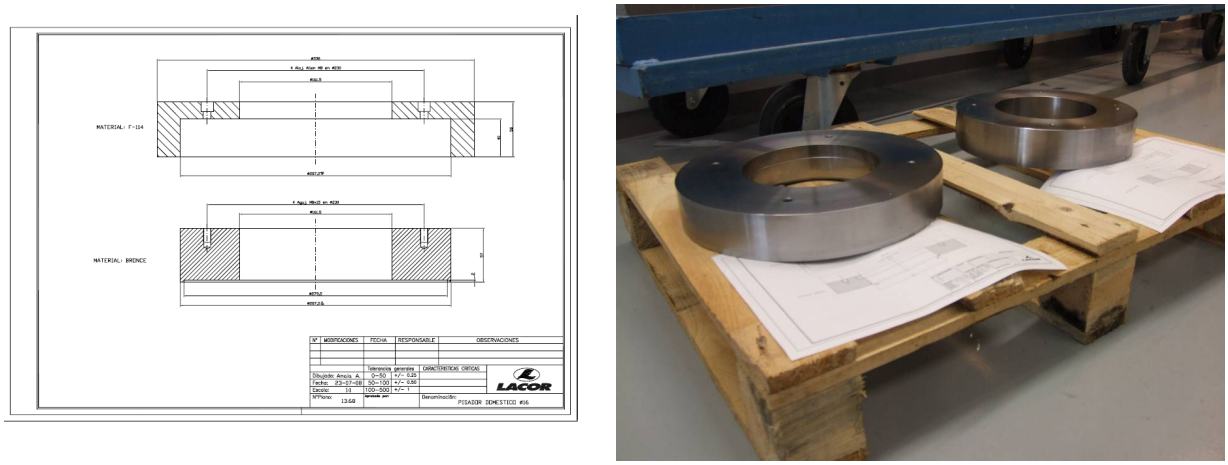

Figure 3: Test die produced within the scope of the Clarefoss project for evaluating the effect of the different coatings, used in the industrial validation tests.

The goal of introducing tool heating to improve reliability has not been reached. Tool heating is only economical for large production runs anddifficult products. Based on the industrial interest, it became clear that there is at the moment no demand for such technology. TNO and Tekniker have therefore thoroughly described the advantages and means to apply tool heating, so that in a later stage the industrial partners can easily adopt tool heating if they want to. However, no tests with tool heating were done in the programme.

Figure 4: Deep drawing press and pots drawn during the industrial validation tests at Lacor, using the eco-lubricants developed within the Clarefoss project.

Based on all of these tests, several options have become clear to improve the cleanliness and the reliability of the deep drawing process. These have been described in the associated deliverables, and make a great achievement of the Clarefoss project.

Web site
More information about this project can be found on the project web site:
http://clarefoss.tekniker.es.

Methodologies
The industrial partners were invited to supply possibly relevant sheet materials, tool materials, samples of coatings and eco-lubricants. Lubricants were characterised using standardised lubricant tests. In addition to these tests, specific eco-friendliness tests were used, including the "Daphnia Magna"and "algae growth inhibition" test. Simulated deep drawing tests were performed to investigate the relative behaviour of each lubricant, sheet material and tool material and coating combination. Based on these tribological tests, the industrial tests were planned. In this way the most promising laboratory results were validated in industrial practice.

Relation to the state of the art
The application of eco-lubricants instead of conventional lubricants has not been shown before for the field of deep drawing. The commercial success of these eco-lubricants is truly new. Improving the deep drawing tools by means of coatings and hardmetal inserts was also a new market for the companies Genta, TTT and Wolframcarb, so also there is a new development.

Dissemination and use
The Clarefoss project was presented in lectures at several conferences, and two work shops were held with presentations of the different partners in the Clarefoss project. General information on the project is available on the project web site.

At this moment, with all deliverables ready, part of the results can also be published to a larger audience. Scientific and/or popular publications are foreseen. These will probably be submitted later this year.

The main publishable results are:
-Development and characterisation of eco-lubricants for use in deep drawing processes
-Successful industrial application of eco-lubricants in deep drawing processes
-Application of coatings to enhance tool life time in simulated deep drawing processes
-Application of hard metal insets to enhance tool life time in simulated deep drawing processes
-Advantages of tool heating in deep drawing processes
-Guidelines for introduction of tool heating in existing deep drawing processes.
-Advantages of minimum quantity lubrication (MQL) in the field of deep drawing processes