

Forming simulation streamlines manufacturing process of large forgings

Authors: Volker Berghold (Schmiedag GmbH & Co. KG)
 Norbert Herrmann (Wildauer Schmiedewerke GmbH)
 Michael Wohlmuth (Simufact Engineering GmbH)



Large Diesel Engines Are Used in Container Ships

The challenge

Crankshafts for large diesel engines that are used in container ships are usually forged in middle and small series. Because every crankshaft has specific features, their manufacturing and design is a challenge. This is where the forming simulation comes into play.

Wildauer Schmiedewerke GmbH is one of the few companies in Europe that is able to manufacture such “calibers”. Wildauer’s flagship press, a 630 kJ hammer, allows the forging of die forging parts of up to 3500 kg. The customers of Wildauer Schmiedewerke include almost all manufacturers of large diesel engines, whose engines are used in shipbuilding, diesel locomotives and power generation.

To use the synergies for the tool concepts and the layout of the manufacturing processes, Wildauer Schmiedewerke cooperates with Schmiedag GmbH & Co. KG, Hagen. Both companies are independent plants in the Georgsmarienhütte Holding GmbH Group. Because different assemblies are used, Schmiedag and Wildauer Schmiedewerke offer a wide range of components. To optimize processes and get the desired results, the use of forming simulation is increased in both companies.

The crankshaft – heart of the motor

A crankshaft for large diesel engines is especially important. Crankshafts have to meet extreme requirements and have to be designed and manufactured to endure the enormous load of the engine during the entire life cycle, because a failure is almost always connected with immense costs and life-threatening situations (e.g. a drive malfunction at sea).

Smaller crankshafts, e.g. for cars, can be manufactured in forging presses. The required energy and the press force are still sufficient for the forming process. For larger crankshafts – for example for large diesel engines – the final and requested shape has to be created with various heats and blows, since the required energy for the entire forming process can not be applied at once. This requires an experienced master smith who has control over the forging process and his team. In addition, it is essential to have an appropriate layout of the dies and forging processes beforehand to simplify the entire manufacturing process and to create a perfect component.

Challenge:

Individual Layout of a Forming Process for the Manufacturing of a Large Crankshaft

Solution:

Process Simulation

Products used:

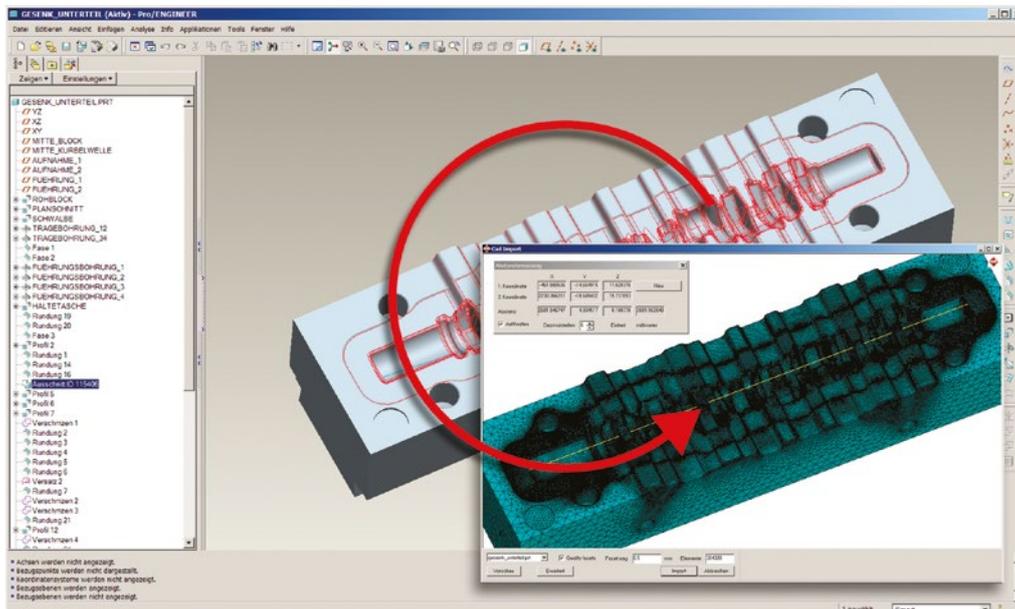
Simufact.forming

Customer:

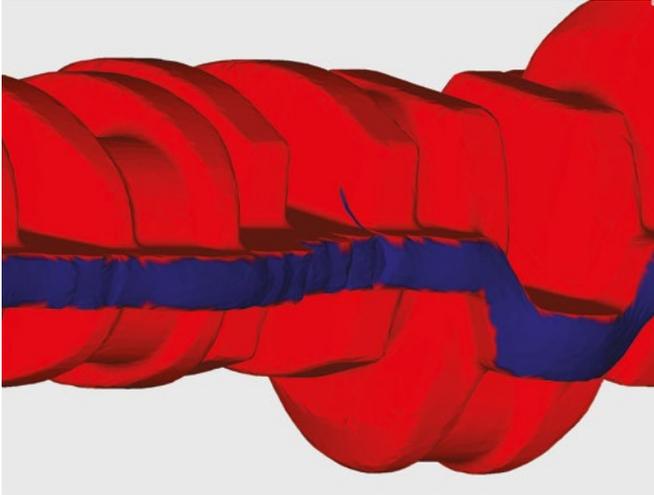
Schmiedag GmbH & Co. KG
Wildauer Schmiedewerke GmbH

The Forging process

Large crankshafts are usually forged in two stages. The first stage is for distributing the mass to have sufficient material in the area of the crank arms. Afterwards, the final forging process starts. Multiple blows then create the final shape. If the workpiece has cooled down too much in the meantime and is thus not forgeable, it is put back into the furnace and completed afterwards. It is a well-known fact that forgings of this size are hardly producible without surface defects.



Complete Assemblies Can Be Taken Over from the CAD Software



Surface Defects Can Be Detected in the Simulation and Fixed in the Die Layout

The virtual preliminary work

The actual production of the crankshafts is usually preceded by the development and layout of the required forging dies. In the process layout phase, the construction includes the entire manufacturing process and specifications for the single stages from forging to finishing – including the defect correction.

The customer's inquiry usually includes a drawing of the finished part, which is the basis for the blank layout. This means that when developing dies, standard machining

measurements of the finished part in connection to the size of the crankshaft are regarded.

Depending on the complexity of the blank component, a forging blank is than designed from which the tool is derived. To check whether the constructed component is realizable by forging, a simulation is run. This makes sure that the blank can be adjusted in time if necessary, before it is presented to the customer for clearance.

The goal of the layout is to have the fewest possible defects after forging, flanges and flange chamfers should not be reworked at all, if possible.

Success with simulation

The simulation software Simufact.forming is used for these processes and the design of a weight-optimized use of the raw material. It is very often aimed at using a reduced weight for the forging to reduce the flash. This is the goal for all simulation projects at Schmiedag.

A weight reduction of 10 - 30% compared to a first draft can be reached by a variation study with relatively small simulation effort.



The main reason for using forming simulation was that the entire forging process can be simulated at the computer and thus test forgings and tool changes can be avoided. The simulation lets us find possible errors early on and we are able to react before bigger costs result from that.”

Volker Berghold,
Head of Engineering, Schmiedag





This assembly has a total height of approx. 20 meters, 14 meters of that are underground. Dies of up to 4.5 meters length can be installed. These (upper and lower die) weigh around 20 tons each.

A typical application

The latest case of a preliminary layout of a crankshaft manufacturing showed that it was possible to reduce the surface defects on the component to minimize the time for the finishing. The only parameters that were available were the changes of the block measures and the modification of the primary pressure operation to reach a different mass distribution and the desired flash formation. For the described crankshaft, the desired improvements could be realized by changing the pre-form and slight modifications to the flash, the block measures could be kept the same compared to the initial manufacturing concept.

Conclusion

The forming simulation with Simufact.forming is used at Schmiedag for over six years. Since then, the material flow in the die, flash formation and variations of different die and workpiece shapes are analyzed and optimized virtually.

Previously, a tool was build and – based on the knowledge of some experienced workers – a test forging was made. This required three or four variations, now it only requires a maximum of two to get the desired results, thanks to the simulation.

Despite further improvements to the entire manufacturing process of large crankshafts in the future, it can be stated today that the use of forming simulation significantly simplified and accelerated the preliminary layout and the manufacturing process itself and made it more cost-efficient.



We save one or two iterations per project for 50-60 projects per year. Without stating concrete numbers, one can assume that five-figure expenses would emerge per variation. Right now we use the simulation to analyse the material flow or the die life quantity. In the future, we also want to take a closer look into the die itself to optimize these in terms of die loads and wear.”

Volker Berghold,
Head of Engineering, Schmiedag

simufact engineering gmbh
Tempowerkring 19
21079 Hamburg, Germany
Phone: +49 40 790 128-000
info@simufact.com



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