Components made of titanium as close to the final shape as possible are in high demand in many industries. The tendency for more complex and larger components which are robust and at the same time light is growing in the area of technical developments. Consequently, the relevance of titanium for machine and plant engineering as well as the automobile and aviation industries is rising. For all process steps in the forming of titanium Siempelkamp provides press systems which are specifically tailored to this material.

By Samiron Mondal

Turbine blades have to be robust and light at the same time
The main source material for the manufacture of titanium is a mineral by the name of ilmenite. The second main source of titanium dioxide is a mineral called rutile.

Even though the chemical element titanium was already discovered in 1791, the commercial manufacture of the metal did not succeed until the 1940s. Titanium dioxide is first converted into titanic chloride which is afterwards reduced with magnesium and sodium. This process results in titanium sponge which is either re-melted with various alloy-additions to create a titanium alloy or processed to pure titanium.

Due to its broad experience with the material and the individual process steps, Siempelkamp could develop new concepts for forming presses which make it possible to optimally exhaust the potentials of titanium. In this way, our customers obtain not only reliably reproducible material properties but also components that are close to their final size and, consequently, require only minimal post-machining.

First forming step: Titanium sponge becomes a strong metal alloy

While steel and aluminum are both directly smelted from ores, during the production of titanium first an intermediate product is formed – that is, the extremely porous titanium sponge. For the production of titanium another process step, the compacting of the titanium sponge, is required. Siempelkamp has been building presses for the compacting of titanium sponge for a long time and has gained a lot of experience in this area.

The Kazakh titanium and magnesium manufacturer UKTMP will press titanium sponge to so called ‘compacts’ with a new Siempelkamp-made press which is currently being assembled. In a subsequent process, the compacts are then re-melted using an electric arc furnace. When designing this press the engineers not only had to deal with controlling the large forces involved but, because of the high oxygen affinity of titanium, their design required that the compacting would take place under vacuum.

The distinct feature of the new press is that it works from both sides. Because it has a press capacity of 2 x 80 MN, it generates an extremely high specific forming pressure which so far is new for the compacting of titanium sponge in presses of this dimension. The resulting compacts have a high density and, consequently, are easier to process.
Siempelkamp supplies the new open-die forging press including hydraulics, die change system and two manipulators which position workpieces precisely for forging. They can move forgings with a weight of up to 15 t (16.5 US tons).

Third forming step:
die forging of the semi-finished titanium products with unmatched precision

Since 2007 ADH has been operating one of the world’s largest and strongest closed-die forging presses at its factory in Pamiers, France. Among other parts, this press reduces the temperature drop of the workpiece during forging. The results are almost tension-free semi-finished products with very homogenous properties.

Our design engineers have since continued their work: In 2011 we will install a new high-performing forging line for products made of titanium alloys. This new press is characterized by its unmatched number of planishing strokes per minute. For standard forging, using all cylinders, 48 strokes per minute are normal, for the planishing up to 100 strokes per minute are possible. And all that with movable dies weighing approx. 200 t (220 US tons)!

This saves time and energy during the following forming in open-die or closed-die forging presses.

Second forming step:
open-die forging at an ideal forging temperature

Utilizing a new Siempelkamp forging press with a press capacity of up to 45 MN, our Chinese customer Goldsky Titanium Industry Technology will forge rods, square bars, flat bars as well as tool blocks, flanges, washers and pins. These parts are primarily made of titanium but also contain tool and stainless steels. The investment in the new press was triggered by an increasing demand for high-strength and, at the same time, light-weight components for the aircraft industry.

Because of the tight temperature range, which has to be maintained when forging titanium, the Siempelkamp design engineers had to design a press with a short forging process. Siempelkamp’s solution to this technological challenge was an optimized press design and an optimized control concept for the hydraulics and electrical engineering which would increase the forging frequency per minute. This high forging frequency not only results in shorter processing times but it also applies thermal energy to the workpiece. This, in turn,
produces structural parts and turbine disks for the aeronautical and aerospace industries, such as for the Airbus A380.

The request from Aubert & Duval was to provide a large and flexible space that would allow fitting the dies and the use of dies with a height of 4,500 mm (14.7 ft). Furthermore, the press should guarantee high working accuracy and low press deformation even under extreme concentrations of pressing forces, high eccentric loads, and crosswise forces. In this connection ADH specified that the crosswise movement of the upper bolster under a horizontal force of 1,500 t (1,653 US tons) can amount to no more than 3.2 mm.

Since three dies are installed next to each other, the press is under high eccentric loads whenever either one of the outside dies is in use. Despite the high eccentric loads, unparalleled shape precision was requested. With the new concept Siempelkamp combined all requirements into one solution. This solution is a 4-column underfloor press with outside-installed main cylinders and hydraulic parallelism control which can compensate the different vertical strains during high eccentric loads. The press has a press force of up to 40,000 t (44,092 US tons). ADH seems to be satisfied with this press because only a few months after the start-up, the company ordered from Siempelkamp the above mentioned high-frequency forging press.

The design process of presses for titanium is especially unique. For a relatively small market, every press is one of a kind. Oftentimes the press represents the centerpiece of a factory. If it is not working, production comes to a standstill.

This means that from the day the press is put into operation the prototype has to work reliably, efficiently, and precisely day in and day out for many decades. That is why the designing of new presses at Siempelkamp is a repetitive process in which engineers of different fields take part. This is the guarantor for efficient operation on one hand and high quality of the forgings on the other hand.
The closed-die forging press at Aubert & Duval in France is one of the world’s largest and strongest.