Forging Rail Ends for Switches for High Speed Rail Traffic

The development of an all-new concept for forging of rails for high-speed railways involved a lot of cross-disciplinary thinking and re-thinking among Hydraulico’s engineers and technicians, spurring several all-new inventions and solutions.

The Hydraulico Rail Forging System is a fully automated, advanced production line with astonishing performance that forges rail ends almost to final shape.

The system reduces the need for milling and other post-forging operations significantly, saves power, time – and money.

High-speed railways are changing the concept of rail transport profoundly in these years. Dozens of countries are building fast rail networks to connect cities and regions. In December 2012, the world’s longest high-speed railway line opened in China, connecting Beijing to the southern boomtown of Guangzhou – a distance of 2,298 km (1,428 miles).

The current goal for the Chinese Ministry of Railways is a 12,000 km high-speed railway network, to be completed by the year 2020.

More lines are projected or under construction in Asia, Europe, the US and the CIS.

Obviously, with new travelling speeds up to 300 km/hour (186 mph), the demands on rails and rolling equipment are huge. Among the challenges are the interconnection of rails and rail switches. Reliable and robust rail forming is absolutely critical to ensure smooth and safe riding.

The shaping of rail ends for switches

Traditionally, the shaping of rail ends has involved lots of post-forging operations: Extensive milling, machining and extra heatings – all very costly and time-consuming.

As no technology existed that could provide a close-to-final shape in the forging process itself, the required shape could only be obtained through tedious post-forging processes.
The challenges of rail forging

To solve some of these problems, Hydraulico’s engineers have for years been investigating the specific problems concerning the forging of rails for high-speed railways. The process poses several challenges:

1. **Heating and cooling of steel may weaken the material structure**

   The heating and cooling of a rail poses the risk of weakening the steel – a structural process known as de-carburizing – and developing a weak zone (between cold and warm rail) known as the Hazard Zone (HAZ). An exceptionally precise control of the heating process is vital to success.

2. **Controlling the final shape of forged rails can be difficult, but essential to reduce machining cost significantly**

   The design of the dies is an important parameter to perfect the final shape of the forged rail. Here, Hydraulico Rail Forging System benefits from advanced computer simulations that have been especially developed to refine the die design for optimum shape and minimize milling cost.

3. **Reducing operation cycle time is crucial**

   Another important issue in rail forging is the overall speed of the entire production cycle. The temperature of the pre-heated rail, leaving the oven at app. 1,200° Celsius, drops quickly as the forging proceeds. The challenge for Hydraulico’s engineers was to build a production line that could complete all press operations to final shape with just one heating.

The solution – a fully automated production line with extremely precise forging

Hydraulico’s Rail Forging System involves four synchronized manipulators that move fast and precisely enough to grab, rotate and position each rail throughout the entire forging process.

As all lifting and handling of the rails is executed by the manipulators, the production cycle runs smoothly and effectively – without stops.

Moreover, the complete automation of the production line provides engineers and operators with a new level of control of the entire production.
From just one control panel, the operator can monitor and control all elements of the production process: Handling, heating, temperature and forging parameters.

Rails are placed onto input section by cranes, picked up by the manipulators and fed into the oven, moved to the press where they undergo three forging operations, and finally placed in an output section. The process involves no manual lifting or handling and provides a safe and efficient working environment.

This production concept can improve the efficiency of the entire process. Hydraulico has proven productivity gains of more than 100%.

Controlling the flow of metal

To ensure maximum control of the metal flow within the die, Hydraulico has worked closely with technology-leading universities who have developed advanced computer software for simulation of the way metal flows during the forming process.

Detailed analysis of process simulations has produced many important data that benefits die construction.
Fig. 3 Intense studies of the metal flow during the forging process have resulted in a near-perfect result. With Hydraulico Rail Forging System, the forged rail is so close to the optimum shape that only the head and the foot of the rail will need minor additional milling.

Fig. 4 In traditional rail forging, a considerable amount of material has to be removed after the forging (left). With Hydraulico Rail System, only minor adjustments on the rail’s head and foot are needed (right).

**Detailed process documentation**

The Rail Forging System from Hydraulico also stands out due to the detailed documentation of every aspect of the entire production. Every process parameter in the system has been detailed and documented.

For customers, this provides a complete overview of all events and processes in the production line, as all data from manipulators, heater, dies and press continuously are made accessible for analysis and modification, as well as documented quality control.

**System benefits at a glance:**

- High capacity: 4-8 rails/hour
- Saves 75% of manpower
- Saves 65% on milling
- Saves more than 50% energy
- Eliminates post heat treatment
- Hardness of rail head same or better than the input rail
- Machining only on rail head and under foot
- Reduced Hazard Zone (HAZ)
References

Hydraulico Rail Forging systems have been implemented in: Zhuzhou, China; Nottingham, UK; Bhilai, India; – more systems are being projected.

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