Tubes for demanding applications

There is strong interest within the power industry in improving the efficiency of gas powered stations.

The rolling process for the production of seamless tubes was invented by the Mannesmann brothers in 1885 in Remscheid, Germany. Today the Mannesmann Stainless Tubes team is proud of its long heritage and is committed to the continuous development products to support the most demanding of customer needs and applications.

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Power generation

In the context of the power generation sector, the accelerating migration towards renewable energy forms such as solar power is driving ahead innovation. However, recognising the balance and contribution of gas-fired power stations is essential. As such, there is an increasing emphasis on improving the efficiency of gas power generation. In particularly, enhancement can be achieved by combining a gas turbine with a heat recovery steam generator (HRSG). These generators utilise exhaust heat from the gas turbine to produce steam that drives the steam turbine, creating a significant amount of additional power. When combined with the primary energy produced by the gas turbine, it enables the efficiencies of the plant to exceed 60%. In a typical modern combined cycle gas turbine (CCGT), about 40% of the power is typically generated by the steam cycle.

Similarly to coal-fired power plants, a gas turbine becomes more efficient as the combustion temperature increases. The latest generation of gas turbines operates with waste gas temperatures around 1500°C (2700°F), enabling superheated steam to be produced within the heat recovery steam generator (HRSG). A significant consequence of these high exhaust and steam temperatures relies on both the development of material selection and tube length.

Conventional steels, when exposed to HRSG environments, suffer oxidation on the inside (steam side) of the tube. This, in turn, leads to the migration towards austenitic stainless steels for the hottest zones and now, as HRSG improves still further, the use of special alloys such as DMV 304HCu.

Tube length also becomes an increasingly important factor as temperatures rise. As HRSG's increase in size to reflect improved cost and energy efficiencies, so the shell-and-tube heat exchangers are becoming more and more compact. As the drive towards improved operational efficiencies continues, many end-users can no longer accept the consequences of welded joints in any of the straight tube sections and instead require exceptionally long tubes.

Hot extrusion

While the cold processing part of seamless tube manufacturing is a key process for manufacturing 'long' lengths, the hot extrusion process is equally

important. MST utilises two extrusion presses within its facilities; at Remscheid, Germany, from 44.5 to 122mm outside diameter (OD) and in Montbard, France, from 33.4 to 280mm OD.

Hot extrusion is a critical process for determining the structure, quality, mechanical properties and ultimately length of a seamless stainless steel or nickel alloy tube or pipe.

Supporting the need for longer tube lengths, in both hot and cold finished products, the extrusion press located in Montbard, France has recently been upgraded. This press upgrade enabled both an increase in ultimate extrusion force to 4300 tonnes and an increase in the maximum admissible billet diameter and length. This was achieved by changing pistons and cylinders to increase the force and by increasing the press stroke, maintaining the existing functionalities and capabilities of the extrusion press. This major evolution in the Montbard press has enabled significant increases in length capability.

The driving factor for the improvements came from being able to use bigger and longer extrusion billets with higher ratios resulting from the increased, ultimate force.

The production process by extrusion of short, heavy tubes and pipes has its own, well-known constraints, but the production of long tubes and pipes creates other types of constraints and challenges. Due to the higher extrusion ratios, the glass powder lubrication system has to be adapted to guarantee the soundness of the products. The increased billet length necessitates that the time needed for processing be controlled to obtain the metallurgical properties of the material, allowing optimised corrosion behaviour with regard to the selected chemistry. The final properties and the dimensional characteristics such as straightness, roundness and eccentricity limits must be maintained along the complete length. All these facts need to be considered and validated. With the MST upgraded extrusion press, the combination of both larger and longer billet helps to deliver up to +30% longer tubes and pipes.

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From the starting point of hot extrusion, the product can either go through the finishing process as a hot finished product or be used as a mother tube or "hollow" – which forms the starting point for the cold manufacturing process.

Cold manufacturing process

Cold processing within MST enables the production of tubes up to 43m (141ft) long. The two technologies employed are cold pilgering, up to 60.3mm OD at Costa Volpino, Italy and Houston, US; and cold drawing, from 0.3mm OD at Issoudun, France.

The production of long tubes at Costa Volpino is focused on heat exchanger tubing (straight or U-bent), instrumentation, HRSG and umbilical tubing; and HRSG boiler tubes up to 30m (98ft) long.

Several process improvements have been implemented In recognition of the need for longer tube lengths and the benefit of increased extrusion capabilities. These include upgraded pilger mills to handle increased input hollow sizes; and for degreasing, increased capacity to handle longer tube lengths and ensure complete cleanliness prior to heat-treatment. Bright annealing capabilities ensure the required metallographic structure is obtained in an inert environment, removing the need for acid pickling; while fully automated, in-line, non-destructive testing (ultrasonic and eddy current) is carried out for both dimensional and compliance to specification testing. Finally, internal handling equipment and processes respect the often high specification requirements for straightness and surface condition.

Production of long tubes at the Issoudun, France facility is focused on cold drawing technology with tube diameters as small as 0.3mm and lengths up to 43m (141ft). The cold drawing process takes long hollows from the extrusion of cold pilgering process and reduces these to the required dimensional size in a number of draw passes. Processes were developed for handling long tubes, and for the manufacturing steps of drawing, degreasing, annealing, testing and final inspection.

A significant part of the production from the Issoudun facility is focused on the high specification applications serving the aerospace, nuclear, oil & gas and medical markets with applications including instrumentation, hydraulic systems, actuation to high-pressure controls. With a product range from 0.3mm OD to 280mm OD combined with tubes ranging from cut pieces to tubes 43m (141ft) long, the team at MST is well placed to meet the challenge of today and innovations of tomorrow.