

# In process laser tube diameter measurement

VALLOUREC Mannesmann is a leading company in the production of seamless steel tubes for the oil and gas, power generation and other industrial applications, with an annual production of 2.5mn tons. The oil and gas industry accounts for almost 50% of Vallourec total sales, predominately casing and tubing used in off-shore exploration and production by the oil majors and smaller independent operators.

Casing is pipe generally up to 20" diameter and is used to line the walls of the drilled well, to protect the well from geological pressures. Tubing is pipe generally up to 7" diameter, situated inside the casing, through which the produced oil or gas flows to the surface or through which fluids are injected into the oil/gas reservoir.

Casing/tubing is exposed to internal and external pressures, compressive and tensile loading, high temperatures and highly corrosive fluids. Consequently these products are produced to the most demanding of standards. One downhole failure can result in several days of lost production to a huge offshore drilling platform and is extremely costly to the operators.

To supply the needs of the UK oil and gas industry in the technically demanding North Sea market Vallourec has a facility near Glasgow, Scotland, which produces approximately 50kt of casing and tubing annually. In this plant pipe supplied from the company's pipe mills is heat treated (quenched and tempered) followed by precision machining of a thread and seal on each end of each pipe.

A threaded short connecting piece is then wrenched onto one pipe end. The individual 'joints' are then consecutively screwed together in the vertical position offshore and run into the well.

The quench and temper process causes pipe distortion due to metallurgical transformation stresses. This distortion has to be corrected to allow the pipe to meet strict dimensional tolerances and is achieved by passing the pipe, immediately after tempering while the pipe is hot, through a pipe diameter calibration mill. The mill rounds the pipe outside diameter to the required diameter tolerance.

While every pipe is measured when

cooled to ensure the diameter is within the specification requirements, the method of setting the calibration mill was crude, involving manual measurement of the hot pipe immediately after calibration by an employee wearing protective clothing. Measurement was on usually only the first pipe of the production run, which could be a run of up to 500 pipes, and only at one location on the pipe.

The mill setting could not be continually optimised, and relied on operator expertise. Most importantly, any errors or non-optimum setting practice could not be identified until the pipes had cooled, by which time up to 50 pipes may have been processed through the calibration mill. The result of non-optimum mill setting resulted in pipes either too large (in which case a further, expensive, heat treatment was required) or, in the worst case, too small, meaning the pipe had to be scrapped.

Vallourec realised that it needed a method of accurately measuring the diameter and shape of each hot pipe at the calibration mill to optimise the process. After looking at various suppliers, Limab was chosen as the preferred company because of its experience in measurement of tubes, and the company's TubeProfiler suited the needs for accurate and

continuous in-process tube measurement. The system was installed in November 2009 at the exit of the calibration mill. The TubeProfiler uses eight lasers to measure the circumference of the tube, providing four axes of measurement at 0, 45, 90 & 135, 180, 225, 270 and 315 degrees. The system has a diameter range from 114 to 419mm (4½" to 16½") and measures to an accuracy of better than ±0.1mm.

The software displays the shape cross section in a 2D or 3D graphical view in real time. Trend graphs show the dimensions of the tube in the two mill adjustment axes over the length of the tube. This not only tells the operator how much adjustment is needed to get the tube on target size, but also which mill stand needs to be adjusted to achieve good tube ovality.

A pyrometer is used to measure the tube temperature at the point of measurement and this is used in the hot to cold compensation calculation in the TubeProfiler. The displayed dimensions are cold corrected making it easier for the operator to hit the correct final size, avoiding the need for further calculations.

The system logs the measurement of each tube against a unique tube identifying number in a database which is available for further analysis at a later date, providing full traceability and quality assurance information.

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Limab's TubeProfiler has been installed at Vallourec Mannesmann