High-Speed Ultrasonic Testing of ERW Pipes

W.A.K. DEUTSCH [1], M. JOSWIG [1], R. KATTWINKEL[1], H. HARMUTH[1]
[1] KARL DEUTSCH Prüf- und Messgerätebau GmbH + Co KG, Wuppertal, Germany

Contact e-mail: info@karldeutsch.de

Abstract. Two ultrasonic testing systems for ERW pipes are put into operation in 2015 at the Polish pipe mill Huta Labedy. They are part of an entirely new production line which is realized by the SMS Group from Mönchengladbach, Germany. The following pipe dimensions were the basis of the project: diameters between 114 mm and 324 mm, wall thicknesses between 3 mm and 16 mm and pipe lengths between 6 m and 18 m.

The first ultrasonic inspection is carried out after forming steel strips into a round shape and after producing the longitudinal pipe weld. In this stage, the pipes are "endless". A test carriage is mounted to a stationary machine stand. The test carriage is placed onto the pipe in the 12 o'clock position and is smoothly guided by means of support rollers. The carriage can be moved into the service position in order to calibrate the testing system with a short test pipe carrying artificial defects. The test pipe is fixed to a motorized calibration unit for a dynamic check of the sensitivity. Five probes are used in this weld testing system: Four angle beam probes for longitudinal defects and one oscillating straight beam probe to check the descarfing process.

A final ultrasonic inspection is one of the last steps of the pipe production sequence. A testing bridge is used because of the high throughput requirements of up to 140 pipes per hour. The large testing bridge with a length of approx. 30 m is equipped with testing carriages on both sides. After bringing the pipe weld into the 12 o'clock position, the pipe weld is tested with up to 2 m/s with eight ultrasonic probes using the water jet coupling technique (squirter): Four angle beam probes for longitudinal defects and four straight beam probes for the detection of laminations in the heat-affected zone near the weld.

The pipe are then transversely moved beneath the testing bridge and put into rotation. The pipe body is tested in helical tracks with a total track width of 250 mm and a circumferential speed of up to 1.5 m/s. The lamination probes are coupled with the water gap technique. The probe holder mechanics were designed for smooth surface following also for pipe with stronger ovalities and for fast change-over by avoiding the change of mechanical parts/skids.

1. Introduction

Two ultrasonic testing systems for ERW-welded pipes were installed at the Polish pipe mill Huta Labedy in 2015. They are part of a completely new pipe mill, realized by the SMS Group from Moenchengladbach. The SMS Group was also the contractual partner of KARL

DEUTSCH. Basis of the contract were pipes with following dimensions: Diameters from 114 mm to 324 mm, wall thicknesses from 3 mm to 16 mm and lengths from 6 m to 18 m.

Two testing systems were provided: One for the pre-testing of the initially endless pipes and one for the final testing of the tubes.

2. Online System for Pre-Testing of the Pipe Weld

After forming the steel strips and welding, a first ultrasonic testing of the longitudinal weld is performed on the initially endless pipe. Figure 1 presents a model of the testing system:

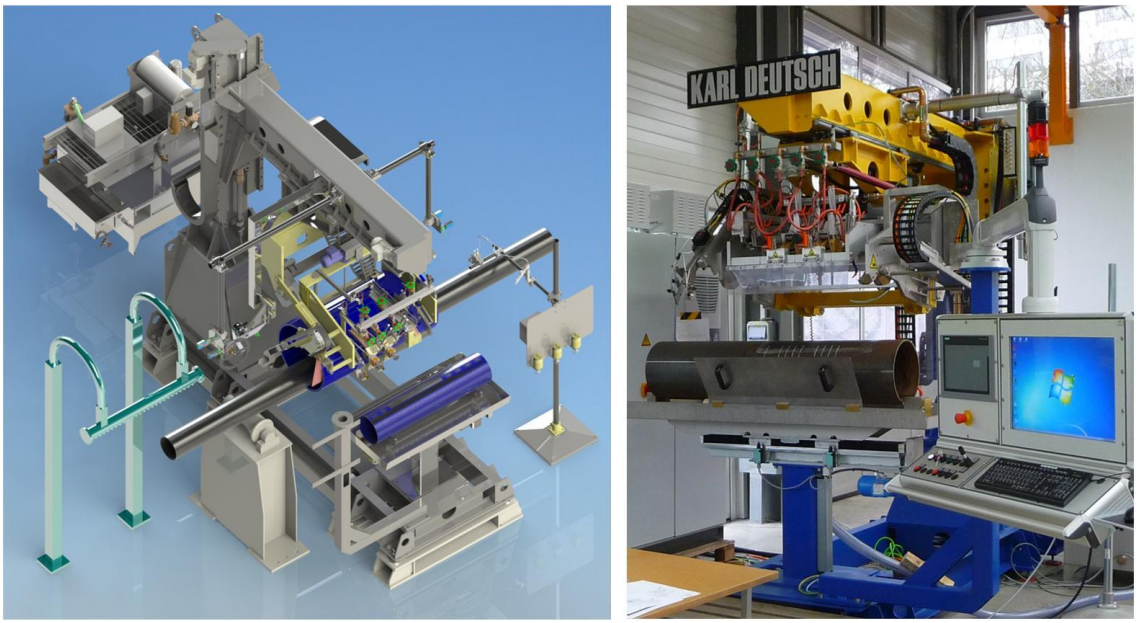

Fig. 1: Online weld testing system with calibration unit

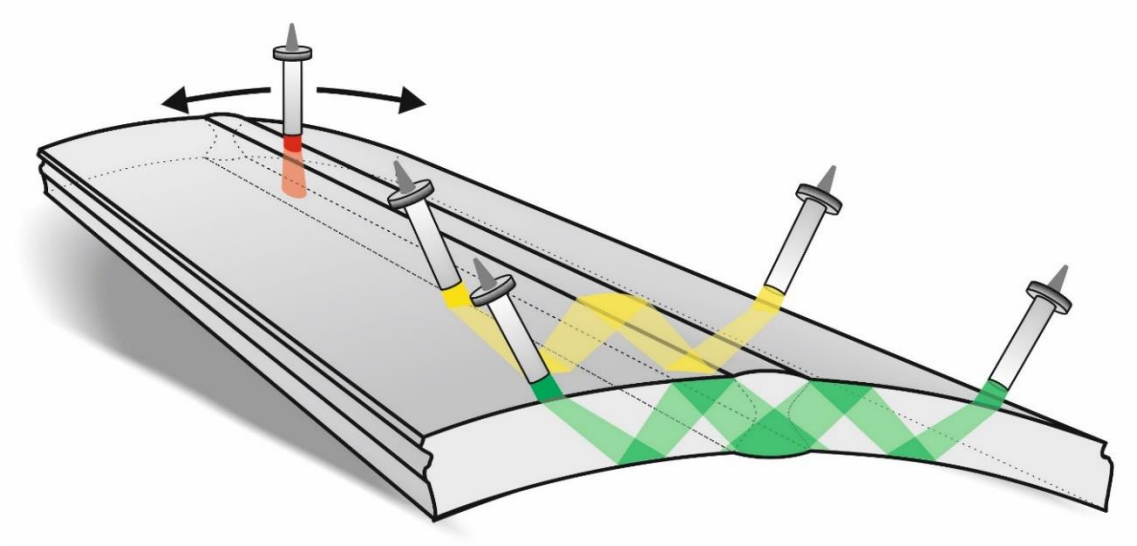

Fig. 2: Arrangement of the probes for the weld inspection on the endless pipe

The carriage contains five probes, all working with a water delay line for ultrasound coupling. Four probes are used for longitudinal flaw detection, two of them for inner flaws and two for

outer flaws respectively. The fifth probe is an oscillating straight beam probe, measuring the wall thickness in the area of the weld seam and controlling the quality of the scarfing:

The ultrasonic probes are mounted on a carriage which again is mounted to a machine stand. The carriage is placed on the top of the pipe and follows the pipe with rollers in an optimal way.

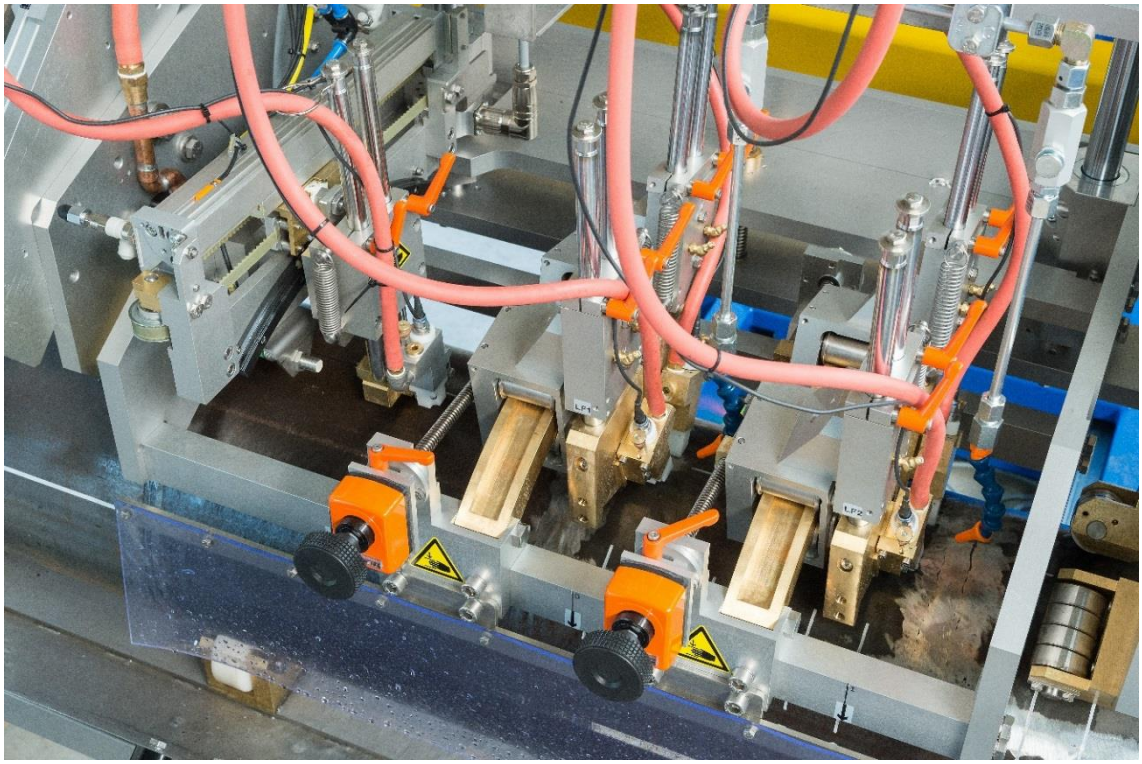

Fig. 3: Probe holder mechanics

The carriage can be moved into a service position (offline) to check the calibration on a short reference pipe. The reference pipe can be moved motor-driven, allowing a dynamic verification of the calibration.

3. Offline Testing Bridge for the Final Pipe Weld and Full-Body Testing

At the end of the production line, the pipes undergo final testing, executed by means of a testing bridge since this concept provides maximum throughput: In the extreme case 140 pipes per hour have to be inspected!

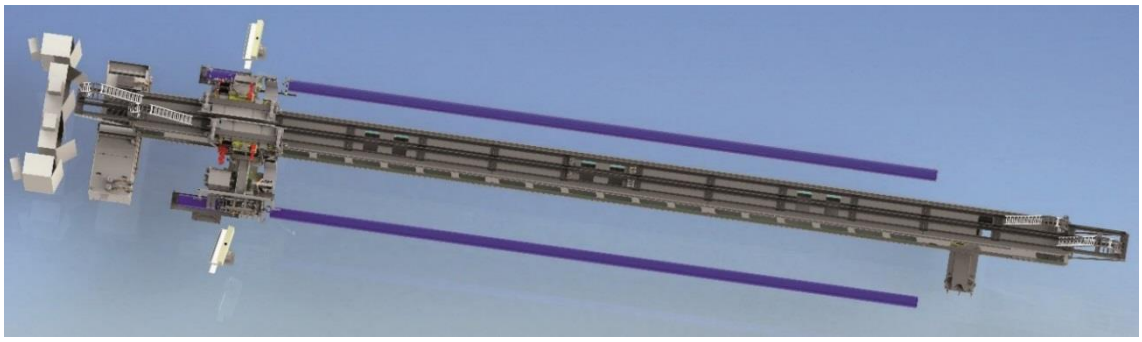

Fig. 4: Top view model of the self-supporting bridge with two testing positions: Weld inspection at the bottom and a rotating inspection of the full pipe body at the top

Fig. 5: Testing bridge with two probe carriages, left for the offline weld testing and right for the full-body testing

The self-supporting bridge, with an overall length of 30 m, is equipped with probe carriages on both sides. In twelve o'clock position the longitudinal weld seams are inspected first. Afterwards the pipes are transported transversally underneath the bridge into the second testing position:

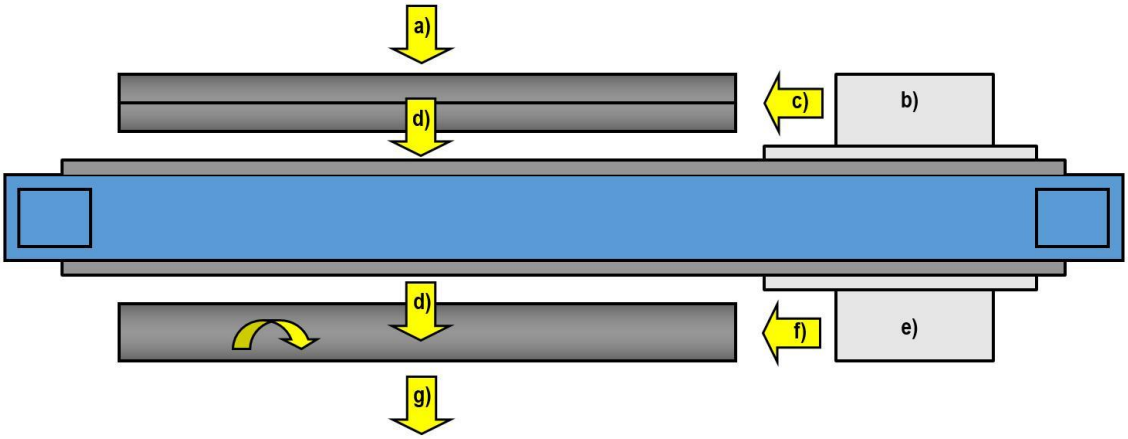

Fig. 6: Testing principle with bridge mechanics, a) feeding of pipe, b) probe carriage for offline weld testing, c) probe travelling direction with seam in 12 o'clock position, d) transverse feeding towards full-body testing, e) probe carriage for full-body testing, f) probe travelling direction for rotational full-body testing, g) discharging of tested pipe

For a full-body inspection the pipes are rotated and the probes linearly move producing a helical test track. Both testing positions are equipped with calibration units, which allow a reproducible calibration of the testing sensitivity with the aid of short tube sections.

Weld testing is performed by a total of eight probes mounted on a single carriage, working at a testing speed of 1.5 m/s. As in the first testing system four probes are used for longitudinal flaw detection. The remaining four probes are used to inspect the heat-affected zone next to the weld for delaminations.

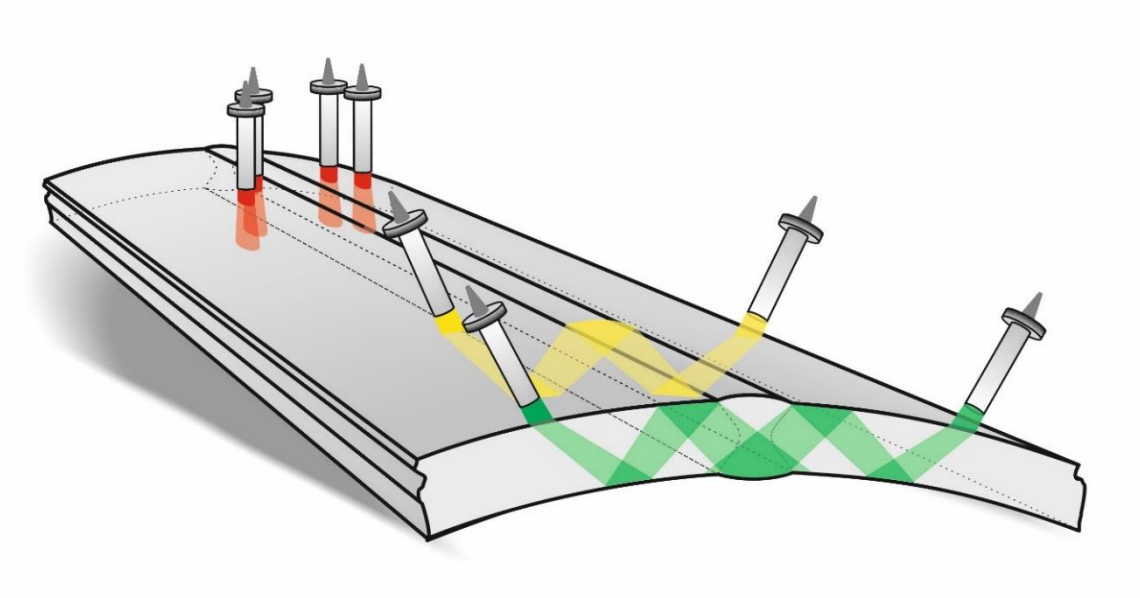

Fig. 7: Arrangement of the probes for the second weld inspection

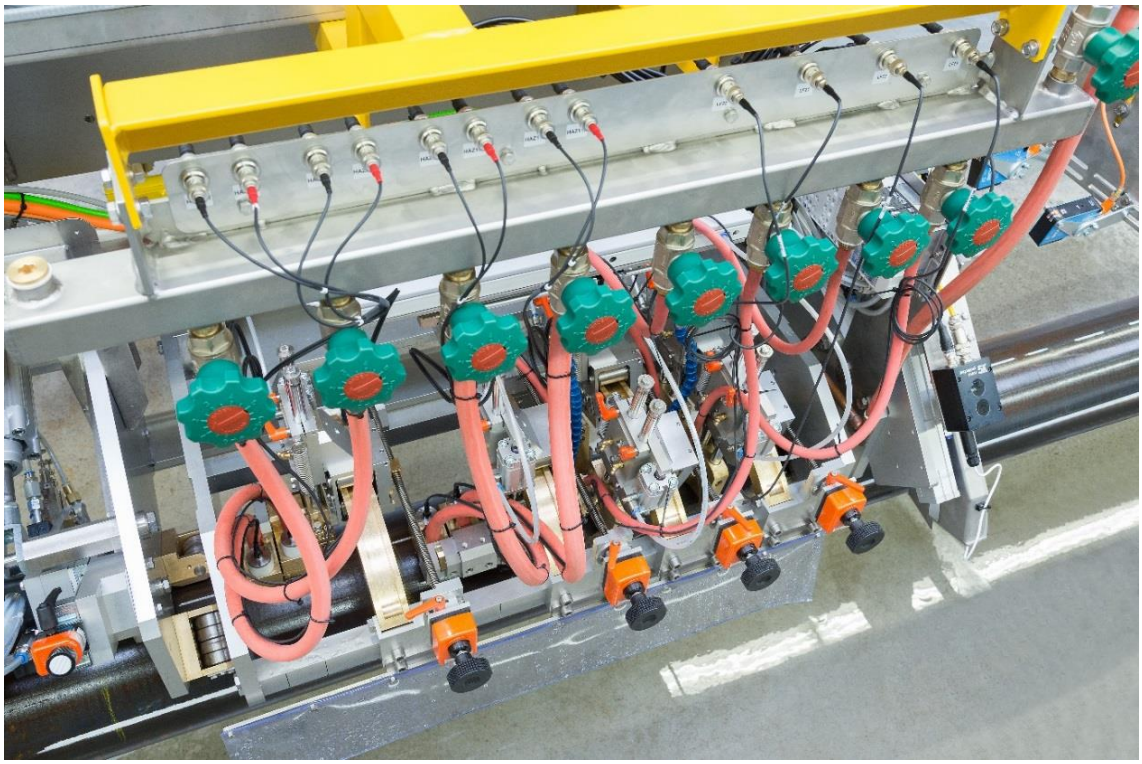

Fig. 8: Probe holder mechanics for the second weld inspection

Fig. 9: Front side of the self-supporting bridge with a probe carriage and calibration unit (left side) for linear weld inspection

The rotational inspection of the pipe body is carried out at a circumferential speed of approx. 1.5 m/s with five special TR-probes with three channels each. Each probe has one transmitter and three receiver channels, yielding a scan width of 50 mm. The total scan width of 250 mm from all five probes enables a high throughput. Ultrasonic coupling is performed by a water gap and all probes are mounted into holders, which perfectly follow the surface even in case of pipes which are not perfectly round and straight. Additionally, the probe holders are designed to cover the entire pipe diameter range without need of mechanical changes.

Fig. 10: Five highly-flexible probe holders for full-body testing
containing special multi-channel dual-element probes for the detection of delaminations

The testing systems are currently under commissioning in Poland. All roller conveyors and rotating devices were within the scope of supply of the SMS Group, Germany.

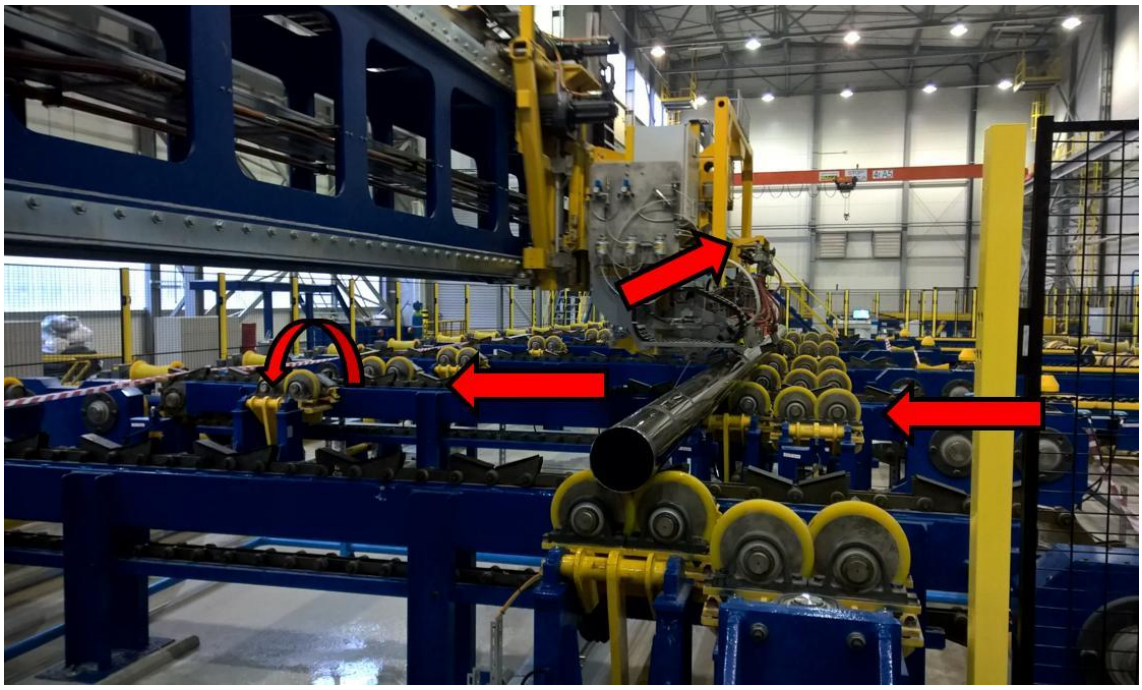

Fig. 11: Onsite view at Huta Labedy, Poland, showing test bridge and pipe conveyors.

4. Summary

Two systems for the inspection of ERW welded tubes are presented. The online system for the first inspection on the initially endless pipe contains four angle beam probes for the detection of longitudinal flaws in the weld and an oscillating straight beam probe which measures the wall thickness in the weld zone and controls the quality of the scarfing.

The offline system for the final test of the tubes also contains four angle beam probes for the detection of longitudinal flaws in the weld. Four further probes inspect the heat-affected zone next to the weld for delaminations. The system also performs the full-body testing with five multi-channel probes. The bridge design of the testing system provides the highest possible throughput.