Krautkramer Testing Machines

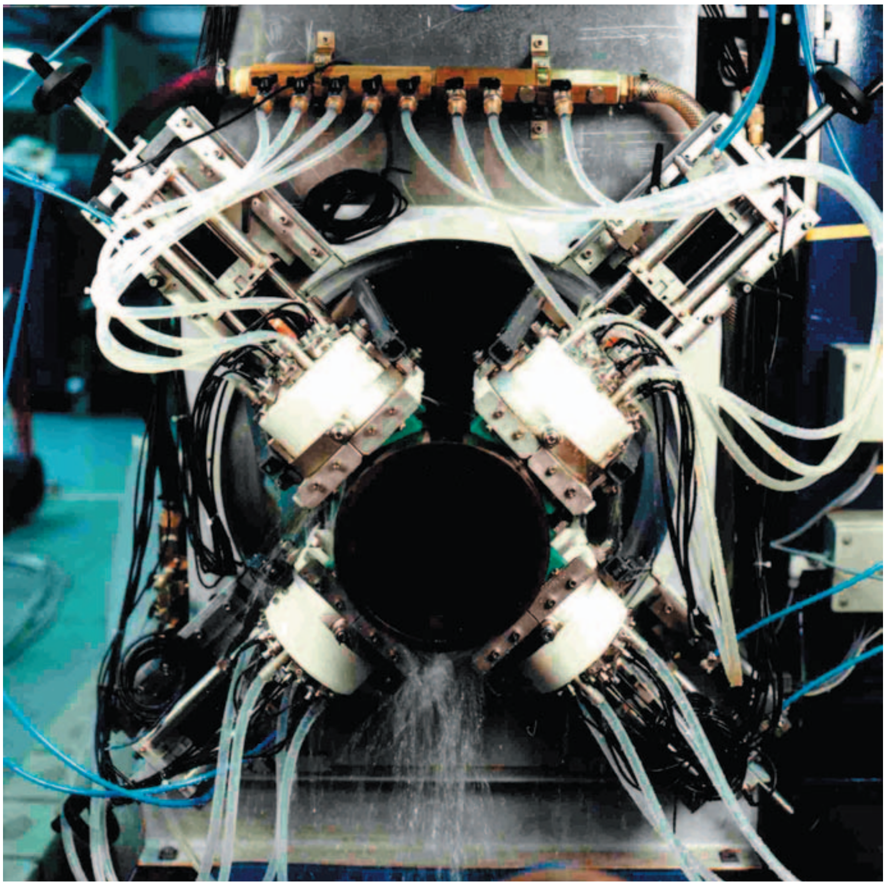
Fundamental principles - Ultrasonic testing of seamless tubes

Depending on the application and specification, seamless tubes have to be tested for several flaw types over the entire circumference and length. The specification to be applied usually describes in detail the flaw sizes, test densities (pulse intervals), track widths, test and evaluation methods.

Basically, three different types of tube testing are possible. In the case of rotating probes, the tube transport movement is linear. In the case of helically transported tubes, the probes are arranged stationarily. With stationarily rotating tubes, the probes are guided along the tube.

The resulting test tracks on the tube surface are always helical. The test density in the longitudinal tube direction (pitch of scan helices) depends on the speed of the tubesor probes and on the required/ preset tube advance. In the circumferential direction of the tube, the test density depends on the surface speed and the pulse repetition frequency.

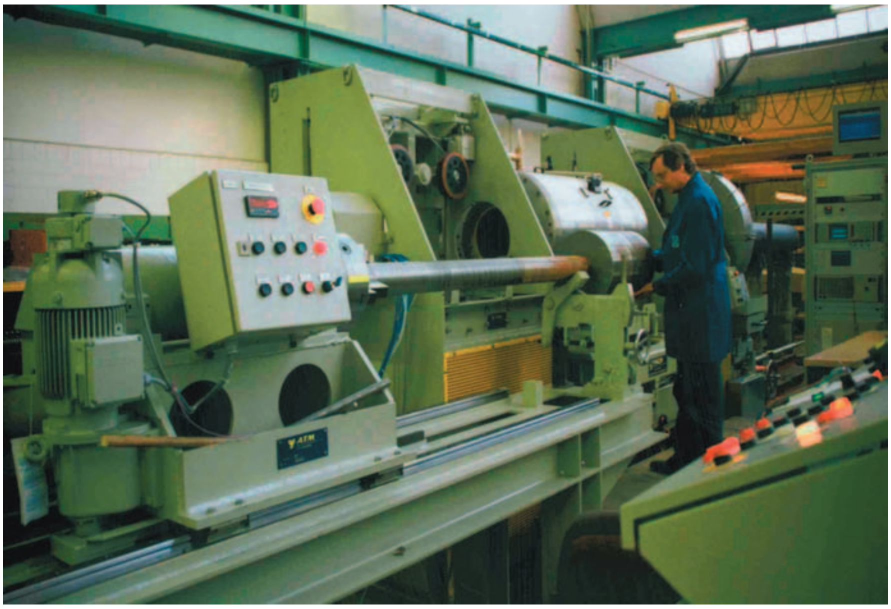
As a rule, scanning is always carried out in either direction when testing seamles tubes, i.e. clockwise and counter-clockwise in longitudinal flaw testing – and in transport direction as well as in the opposite direction in transverse flaw testing.



Ultrasonic tube testing with stationary porobe systems

The most important flaw detection type when testing seamless tubes is longitudinal flaw testing. Due to the manufacturing processes, this flaw type is the one most often encountered.

Depending on the testing machine type and the test requirements, the test is carried out using a single probe or a probe array. The main advantage of the probe array is the higher test speed.



Ultrasonic tube testing with rotating probe systems

With rotation testing machines, it's the size and the number of single probe transducers in an array in combination with the rotor speed that determine the maximum possible test speed of the tubes to be tested and the minimum flaw length – i.e. the flaw length that can be reliably detected. With stationary or helically driven tubes, the decisive criteria for the test speed are the rotational speed, surface speed and tube diameter.

Transverse flaw testing, which is not required that often, is a more critical method than longitudinal flaw testing from the point of view of ultrasonics. As the tube or probe advance per rotation is smaller than the circumference with most tubes (usually already from a diameter of 10 to 15 mm), the result are more or less steep scan helices. Due to that fact that – to put it simply – at least one test track must definitely encounter the flaw, the minimum flaw length chosen should always be a bit larger than the scan helix. This can easily be determined on the basis of the advance per rotation in longitudinal flaw testing, and therefore the test speed normally refers to longitudinal flaw testing. In transverse flaw testing, the minimum flaw length depends on the tube diameter (steepness of scan helices) and on the number of the single probes arranged around the circumference. It's normally not possible to use probe arrays in this application case.

If tubes are to be tested for almost the same flaw lengths both in longitudinal and in transverse testing, the transverse flaw testing method limits a possibly faster testing process for longitudinal flaws.

Moreover, it's possible to carry out tests for laminar flaws (material separations) and wall thickness measurements; theses tests and measurements are carried out using the same straight-beam probes. In addition, rotation testing machines allow calculations of the geometry data, such as outside and inside diameters, ovality and eccentricity to be made since the probes are arranged opposite to one another in these machines and they are not guided directly along the tube. These geometric calculations also include the measurement of the distance between probe and tube surface in water. These measurements can be strongly affected by temperature variations (changes in the sound velocity) of the coupling water. Various measures are taken to compensate for this effect. Random amplitude variations, interferences and measurement failures cannot be totally avoided in dynamic operation. Because of this, the measured time-of-flight values have to be averaged and subjected to interference suppression and plausibility checks before they may be output as thickness readings and further analyzed.

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