Wheel Set Axle Inspection Using Advanced Phased Array Approach

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To gain the performance of ultrasonic wheel set axle inspection the soundfield of the phased array probe, the coupling and the signal processing has to be optimized. Therefore a set up has been developed based on a phased array sensor using immersion technique in combination with an acoustical lens. An automated adaptive time gain compensation has been implemented to improve signal to noise ratio.

**Experimental setup with specimen**

- Phased array probe using immersion technique, distance to specimen 2 mm

**Signal processing using adaptive algorithms**

- Probe: 3.5 MHz, 16 elements
- \( \alpha_1 = 60^\circ, \alpha = 10^\circ - 70^\circ, \text{step} = 1^\circ \)

**Multiple active scan areas, e.g. \( \alpha_1 = 59^\circ, \alpha_2 = 40^\circ \)**

- Probe, 3 MHz, 16 elements, \( \alpha = 10^\circ - 70^\circ \)
- A-Scan
- TD-Scan
- TD-Scan at 59\(^\circ\) transversal wave
- TD-Scan at 40\(^\circ\) transversal wave

**Influence of axle geometry on the soundfield**

- Soundfield on plain geometry
- Soundfield deformation by curved geometry
- Compensation of the soundfield deformation by acoustical water lens
- Sensitivity benefit by compensation of the surface shape by using an acoustical water lens
  - Example: Sickle shaped test reflector with 2 mm depth, couplant water

**Experimental results**

- Axial position
  - Result with no signal processing applied
  - Result using soundpath based adaptive TGC algorithms