

Ultrasonic Testing Goes Smart: How Industry 4.0 Revolutionized Gas Cylinder Inspection in Food Industry

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Non-Destructive Testing (NDT) is generally necessary for components where defects emerge over time due to wear and tear and where the use of such components on the markets is stipulated by their ability to pass periodic examination required by law. CO₂ seamless aluminum gas cylinders used in the food industry fall under this category. Historically, compressed gas cylinders have been tested using hydraulic testing, often resulting in undesired gas release, contaminated water that required treatment and further cleaning processes to bring the cylinder back to its operational condition. Accurate studies have shown how ultrasonic testing is able to find safety-relevant flaws in the seamless gas cylinders, flaws that would remain undetected using the conventional approach. A completely new machine concept has been created to test CO₂ gas cylinders for food industry using all the key components of the Industry 4.0. The deployment of those components and related technologies has led to a further optimization of the overall inspection process increasing productivity levels, multiplying inspection speed, and more generally opening new horizons in large scale manufacturing and quality control operations. This results in a distinct competitive advantage for businesses that are able and willing to technologically innovate. The machine designed and presented in this article is composed of several autonomous smart stations processing each cylinder in respect to their individual data: a robotic island for component's loading and unloading, weighing station, ultrasonic testing station and marking station, combined with several vision stations for data acquisition, control and verification. Cylinders travel on belt conveyors using pallets tagged by Radio Frequency Identification (RFID). This advanced tracking methodology, facilitates a true walk-away operation and continuous processing of consecutive test batches. The results is a minimal operator attendance and highest throughput. A multiple 3D Laser Vision system powered by a neural network based optical character recognition (OCR) is used for acquisition of cylinder data. An original equipment manufacturer (OEM) based ultrasonic acquisition unit has been used to drive the ultrasonic testing station, and user-friendly inspection software has been developed and refined to allow a fast and reliable interpretation of the results. The result is a complex machine that interacts in an optimal way with all involved entities, i.e. Production environment, information technology and human operators, thus providing the maximum value to the owner. Internet of things (IoT) has made all the machine's station "smart". Multiple local networks with dedicated purpose connect each station and a global network connects the system to the internet, allowing remote access for troubleshooting, effortlessly rolling out software updates and background neural network training, all while maintaining system resilience against cyber-attacks through use of a VPN module. Finally, the concept described in this article can be applied to different product lines and can it be used as a demonstrator of the power of the Industry 4.0 related technology when they are applied to NDT.