Continuous manufacturing of multifilament wound pipes

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Abstract

Composite pipes present a promising lightweight alternative to conventional metallic and polymer pipes, due to their high strength-to-weight ratio, corrosion resistance, and tailored material properties (1). However, the broader industrial adoption of composites remains limited by the lack of cost-efficient, high-volume manufacturing routes, especially in large-volume and cost-sensitive applications.
This work presents a continuous process concept for the manufacturing of filament-wound composite pipes. The established manufacturing line at ITA aims to significantly reduce production time and increase process efficiency. Moreover, by integrating process monitoring along the whole production line, material wastage is reduced and consistent quality can be ensured. The process integrates the extrusion of a thermoplastic winding core, which simultaneously acts as a permeation barrier, subsequent cooling and calibration of the core, multifilament pull winding with pre-impregnated fibres, and consolidation of the composite structure. By applying a continuous pull-winding approach, typically batch-wise manufactured FRP-pipes can be replaced. The multifilament winding process further enhances productivity by enabling the simultaneous deposition of up to 20 rovings per layer (2). With four composite layers applied per revolution in the current machine setup, the concept represents an advancement of conventional filament winding towards continuous, high-output pipe production.

The continuous manufacturing approach enables the production of pipes with theoretically unlimited length, thereby reducing the number of joints between individual pipe sections. Welded joints in pipeline applications pose a risk of leakage and failure, while their installation, testing, and maintenance are time- and resource-consuming processes (3). The developed composite pipes are designed for hydrogen transport and showed no detectable signs of hydrogen permeation at elevated pressure levels. Due to the use of a corrosion-resistant material system and the adaptable process design, the concept can be transferred to application-specific requirements and different pipe diameters. This offers a versatile alternative to conventional pipe materials for demanding fluid and gas transport applications.

References

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