GHENT UNIVERSITY

SOETE LABORATORY

Pressure vessel assessment: Lifetime/Fatigue and Burst

The evaluation of pressure vessels (such as pipeline, heat exchangers, accumulators, …) for their internal pressure capacity in terms of fatigue performance, burst pressure capabilities and leak detection are crucial for their qualification and/or (remaining) lifetime assessment. To this extend, Soete Laboratory designed a set of custom test rigs to perform these assessments with water as a pressure medium.

Figure 1: Simultaneous internal pressure fatigue testing of four 3.5m x 203mm (8") pipe sections between 31bar and 62bar

Quasi-static burst pressure testing or leak detection testing of pressure vessels can be performed in an enclosed environment for vessels up to Ø1m with internal pressure levels up to 700 bar.

The internal pressure fatigue and dynamic-burst test rig is built around a water piston, driven by an oil piston. The water piston is connected to the evaluated pressure vessel, while the oil piston is driven by a 110 kW (150 Hp) hydraulic pump through a servo-valve. The servo-hydraulic controller allows for custom programmable pressure waveforms (sinusoidal, triangular, square, …) with an accurate active control loop to allow for pressure levels typically within 1% accurate. When oil under pressure is admitted below the oil piston, the water jack pumps water into the test vessels, which are thereby pressurized. When oil is admitted on the upper side of the oil piston, the water flows back from the test vessels to the water jack.

Different combinations of oil- and water pistons available allow for dynamic water pressures up to 175 bar on pressure vessels up to 3 m³. Multiple (smaller) pressure vessels can be simultaneously tested to allow for a high throughput evaluation of pulsating internal pressure fatigue. The number of simultaneous tests are depending on vessel geometry and test conditions.

The test rig is equipped with data acquisition devices to measure various additional instruments such as internal pressure levels at various locations, temperatures, local displacements, local strains, … . For cylindrical pressure vessels, a dedicated fixture is available to actively compensate the internal pressure acting on the end caps. This to evaluate in influence of axial compressive loads or plane strain conditions (e.g. relevant for buried pipelines). Artificial features (cracks, gauges, …) or dents can be applied upon request.

TEST RIG CHARACTERISTICS

Property (max. internal pressure level)	30 bar	70 bar	175 bar	700 bar	Custom
Quasi-static (burst or leak detection)	Yes				The test rigs are designed in such a way to allow for project specific customization
Dynamic or fatigue testing	Yes			Upon request	
Max. loading rate	0.75 l/s	0.75 l/s	0.2 l/s	0.01 l/s	
Max. loading frequency	5 Hz	3 Hz	2 Hz	/	
Loading frequency for pressure vessel (without internal restrictors) of 1 m³	0.8 Hz*m³	0.6 Hz*m³	0.2 Hz*m³	/	
Max. vessel volume	3 m³	2 m³	1 m³	max Ø1 m	
Simultaneous testing	Max. 8	Max. 4	Max. 4	1	
Active compensation of End Cap Effect	Axial compressive load up to 4000 kN				
Environmental temperature conditioning	At ambient temperature (23 °C ± 5 °C) or submerged in conditioned water bath at +5°C → +80°C (± 5°C)				

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