THU-T9-S14-R1

7th World Tribology Congress, WTC 2022
July 10-15, 2022, Lyon, France

Ultrasonic measurement of oil & gas sealing interfaces

Andrew Hunter[1)*], Laurie Costello[2)], Georgios Tyreas[1)], Rob Dwyer Joyce[3)] and Henry Brunskill[1)]

[1)]Peak to Peak Measurement Solutions Ltd, Sheffield, UK
[2)] Creid 7 Ltd, Edinburgh, UK
[3)]Leonardo Centre of Tribology, University of Sheffield, UK
*Corresponding author: andy@pkto.pk

The wellhead in the upstream oil and gas fields is the keystone of any well architecture. It suspends the casing and tubing strings, as well as isolates the annular space between successive strings by way of seal bushes. The challenge drilling engineers face is the lack of visibility of conditions within the wellhead when installing equipment, due to operations being conducted within pipe and conduit to contain pressure and fluid. This work demonstrates the ability of ultrasound to measure aspects of the sealing interface and load shoulder, including seal integrity, seal position, inclusions and load.

Keywords: ultrasound, sealing interfaces, dry contacts, contact area

1. Introduction

Wellheads used in upstream oil and gas fields are load bearing, pressure containing systems which provide a conduit to which all the casing and tubing is run through and suspended from, an example is shown in Figure 1.

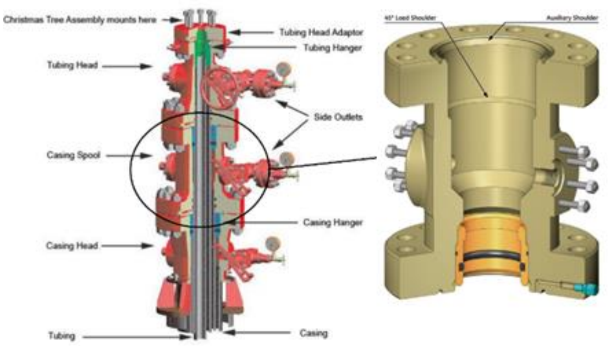

Figure 1: Example wellhead configuration [1]

The installation of wellhead equipment is currently based on inferred measurement, which has inherent uncertainty. The lack of visibility can lead to problems and delays with an associated risk.

2. Method

This work proposes a direct measurement solution based on ultrasonic reflectometry. Previous work has validated the approach of using ultrasonic reflectometry to characterise the pressure contact between dry metal surfaces [2].

An ultrasonic transducer is used to generate soundwaves in a primary medium (i.e. wellhead). When a second material (i.e. the packoff seal) comes into contact with the primary medium, a proportion of the signal will be transmitted into the secondary material. This proportion is dependent on the mating material properties such as acoustic impedance, surface finish and contact pressure. The greater the contact pressure the greater the signal transmission. Measuring the amplitude of the reflected signal provides a valid method of determining the contact pressure. Other methods to manipulate the signal response looking at signal phase and speed of sound in material can be used to enhance the measurement and make the solution more robust and reliable.

3. Results

Various geometries were tested including flat plate, small load shoulder rig and real world assets with varying wall thickness. Seal elastomer materials were investigated thoroughly; an example is shown in Figure 2.

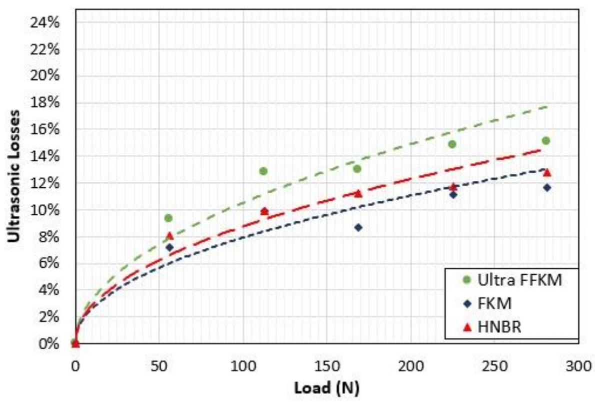

Figure 2: Comparison of Ultrasonic losses due to loading, for various seal materials

An increase in contact width as well as the conformity seemed was measured for softer seals. A load shoulder was tested to understand metal to metal contact. 2D imaging of the seal contact interface was also achieved.

4. Discussion

The proposed measurement approach was demonstrated as viable on a combination of industrial components and test fixtures, and was capable of detecting the parameters of interest in the outlined application under a variety of potential field conditions.

5. References

[1] IRP 5: Minimum Wellhead Requirements; An industry recommended practice (IRP) for the Canadian Oil and Gas industry, 3rd Ed., 2018.

[2] Brunskill, H.P., "The Real-Time Characterisation of Dry Machine Element Contacts Using Ultrasonic Reflectometry", PhD Thesis, Sheffield, 2013.