UPCOMING CHALLENGES FROM RISING THREATS AND EMERGING TRENDS IN THE OIL AND GAS INDUSTRY AND HOW TO TACKLE THEM

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ABSTRACT

The impact of climate change on the ecosystem has been rising at an unprecedented rate over the past decades. One major aspect of climate change is the increase in evaporation rates due to the rising temperatures, which leads to more frequent extreme weather conditions such as rainfalls and storms. This in turn, compromises the stability of natural soil slopes, which can ultimately threaten the integrity of pipelines on elevated terrain.

This paper focuses on the impact of ground movement incidents on the integrity of pipelines, with an emphasis on how these can be effectively managed, and the additional factors that will need to be considered due to upcoming trends in the Oil and Gas industry. The results call for a plausible change of angle when conducting integrity assessments in cases where a new fuel has been introduced in the pipeline.

Keywords: Climate change; ground movement; integrity; Oil and Gas, pipeline

1. INTRODUCTION

Throughout history there have been various periods of climate change, however, over the last decades, the world has experienced a level of climate change that has the potential impact on a planetary scale which has never been seen before. The rise in temperature has had a proportional effect on the frequency of extreme weather phenomena such as heavy storms and rainfalls. These have affected industries and cultures that heavily depend on natural soil and its stability.

As far as pipeline integrity is concerned, the threat from geohazards is often managed by routing pipelines in such a way to minimize their exposure. However, inevitably, pipelines must still cross steep slopes and elevated terrain where the likelihood of ground movement increases significantly, in particular when combined with increases in extreme weather events. This is evident from the growing number of pipeline failures due to ground movement seen over the recent years [1]. Driven by this, more effort has been put into creating technologies utilizing an Inertial Measurement Unit (IMU) within an in-line inspection tool that could more accurately detect potential pipeline threats due to the deterioration of natural soil terrain, namely bending strain and pipeline movement. This focuses on the use of dedicated IMU technology to detect shifts in the profile of the pipeline before it has reached a critical point. Specifically, bending strain and pipeline movement services use ILI data from the most recent as well as previous inspection runs of a line in order to detect any changes in its vertical or horizontal profile. This not only makes apparent any movement in either direction, but also detects any change in the geometry of the pipeline, which allows for the calculation of bending strain that it may be subject to. In turn, the reported levels of strain can be compared against specified limits in the pipeline's tensile and compressive strain capacities, and appropriate actions can be taken as a result.

2. THE IMPORTANCE OF STRAIN CAPACITY

Various essential parameters and thresholds need to be calculated and strictly compared against ILI data to ensure the pipeline's integrity is thoroughly assessed.

Two such parameters that play a pivotal role in ensuring the bending strain experienced by the pipeline is within the acceptable range, are the tensile (TSC) and compressive (CSC) strain capacities. These refer to the maximum capacity of a pipeline to accommodate for longitudinal tensile and compressive deformation respectively. The two parameters are calculated by taking into consideration a plethora of limiting factors, such as the effect of anomalies, steel grade, operational conditions, and pipeline geometry. If the total bending strain at any point in the pipeline is greater than the tensile or compressive strain capacity, the acceptable strain limits are considered surpassed and immediate action is strongly recommended.

3. RESULTS AND DISCUSSION

This section describes in more detail the exact factors that affect the outcome of tensile and compressive strain capacity calculations, as well as how emerging trends in the oil and gas industry can have an effect on those factors.

3.1 Compressive Strain Capacity

When calculating the compressive strain capacity of a pipeline, a large number of factors needs to be accounted for. These can be divided into 3 main categories:

1. Operational factors
2. Geometrical factors
3. Material-related factors

The main operational parameters which are considered are external as well as internal pressures and temperatures. Geometrical factors usually include pipeline geometries such as its diameter and wall thickness, which can be affected due to metal loss related anomalies. Material-related factors include Young's Modulus, Ultimate Tensile Strength (UTS) and Specified Minimum Yield Strength (SMYS). Once all these factors are accounted for, a series of calculations is made in order to deduce a conservative value for the pipeline's compressive strain limit, below which any reported bending strain is considered acceptable.

3.2 Tensile Strain Capacity

When determining the appropriate tensile strain capacity for a pipeline, a different approach to the one outlined above is used. A conservative value according to the European Pipeline Research Group Tier 2 guidelines is initially assumed. To verify that this value is appropriate, material and Charpy impact testing results are used, whenever available.

3.3 Future Challenges in Managing the Threat from Geohazards

In order to tackle the increasing threat of incidents caused by ground movement and other geohazards, a combination of changes needs to be implemented to ensure that the current and upcoming challenges are tackled in the most effective manner.

It is clear that due to the increasing pattern in geohazard-related incidents, the frequency of in-line inspections also needs to rise. A simple and efficient way to achieve this is by utilizing a new technology such as PipeDrift in a dedicated IMU platform. This solution makes it much easier for operators to successfully run the tool and collect the ILI data than to use more complex technologies [2].

As far as upcoming trends and fuels are concerned, although the effect that Hydrogen has on the mechanical properties and overall integrity of oil and gas pipelines is not yet fully understood, research has indicated that a major change due to the use of hydrogen as a fuel is a decrease in the fracture toughness of the pipeline. A lower fracture toughness means that the pipeline is more susceptible to the propagation of cracks which then can lead to failure. In general, cracks tend to be a greater threat when combined with tensile loads, as these cause further cracking in areas with existing defects. This calls for a potential shift in focus when assessing the two types of strain capacities mentioned above. As with the calculation for the CSC which accounts for various factors that can affect the pipeline's integrity, it is recommended that research is put into developing a similar approach when calculating the TSC of a pipeline, especially when an upcoming fuel like hydrogen is introduced in already existing steel pipelines.

4. CONCLUSION

The rise in ground movement related incidents has made apparent that integrity services such as bending strain and pipeline movement analyses are becoming of increasing importance in the oil and gas industry. This calls for a rise in frequency of In-line inspections which can be achieved by utilizing new technologies in already existing IMU platforms. The emergence of new technologies and fuels like hydrogen, and their effect on mechanical properties like fracture toughness, could have a great impact in deciding where the main focus should be put when conducting integrity assessments.

REFERENCES

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