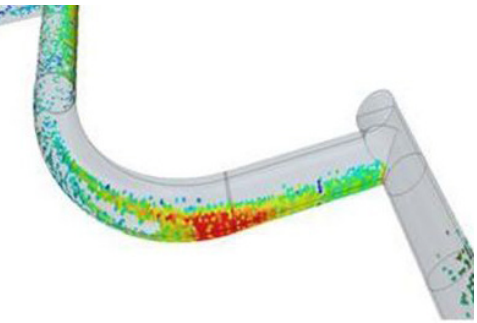
INTECSEA
WorleyParsons Group

TECHNOLOGY BULLETIN

High Fidelity Erosion Assessment of Subsea Structures



Customer Benefits

- Reliable prediction of erosion rates on subsea structures
- Flexible selection of alternative empirical erosion rate correlations
- Rapid evaluation of alternative design options (geometry; pipe size; flow capacity; sand content)
- Minimise risk of premature wall loss and compromised integrity

Introduction

Assurance of integrity of subsea structures during the life of a field is of prime importance for production optimization. Sand in the produced hydrocarbon can lead to erosion as it is transported from the well to host facility through various subsea structures. Therefore, knowledge of the specific details around its travel can be a good indication of the amount of erosion that might occur over the life of a field. Prior understanding of erosion in a field can help assure system integrity by prompting mitigations such as cladding the subsea structures where required or putting in place predictive devices, such as real-time erosion monitors.

Erosion prediction has always been difficult in the oil and gas industry, mainly due to the challenge of understanding the spatial distribution of solid particles in the flow. The complexity of erosion prediction significantly increases for multiphase flow, when gas, liquid and solids are present. In contrast to single-phase, multiphase flow has different flow regimes, which depend upon gas, liquid and solid flow rates, pipe size, inclination angles, fluid properties, etc., and affect the solid particle impact velocity.

INTECSEA has developed a mechanistic, CFD-based numerical tool that provides a reliable estimate of erosion rates on a subsea structure and also highlights the locations of maximum erosion (termed “hot spots”) under complex flow behavior circumstances (e.g. annular flow). The developed tool is fully parametric; hence, it can be easily adjusted to certain design modifications with minimal effort. In addition, this method uses the most recent empirical erosion correlation developed by Tulsa University.

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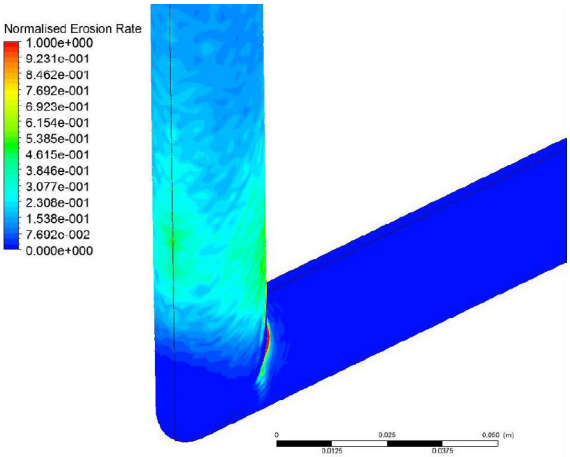
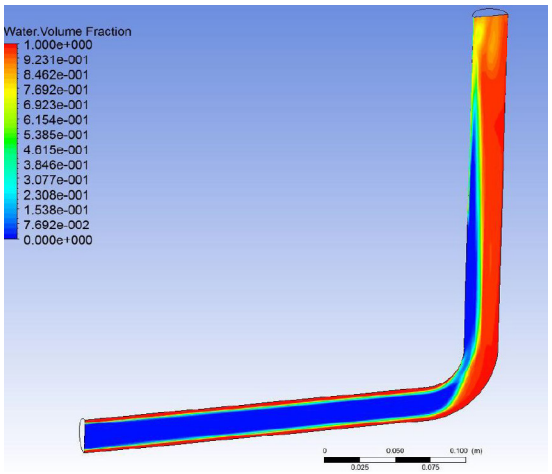
INTECSEA experts have a thorough understanding of erosion-related risks in subsea developments, and have developed a validated, high fidelity, CFD-based tool which can address these risks and help assure integrity for enhanced production.



Details of the Model

The CFD-based tool has been developed in ANSYS Workbench 14.0 with CFX as a CFD solver. The model uses the Lagrangian method for particle tracking and the Eulerian approach for continuous phase. A FORTRAN user function has also been implemented, which offers flexibility in using the erosion empirical correlations for estimation of erosion rates. The model uses restitution coefficients as a function of impact angle for enhanced accuracy of complex geometries and practical scenarios where flow direction changes very rapidly. In addition, this model has been developed fully parametrically in order to adapt to desired design modifications with minimal manual intervention.

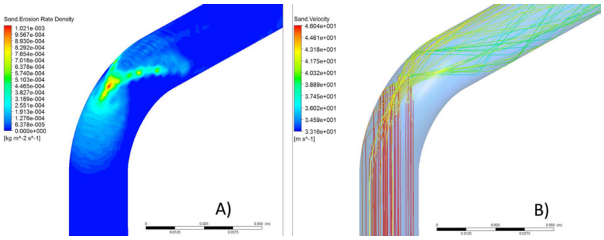


Case Studies / Experience

Some of the most commonly experienced practical scenarios, such as gas with sand, liquid with sand and multiphase flow with sand on a range of subsea structures, have been simulated with INTECSEA's CFD tool.

In multiphase gas-liquid annular flow, sand is transported in the liquid phase, which partly flows in the form of a liquid film attached to the wall, while the rest remains dispersed as droplets in the gas core. The liquid film attached to the wall significantly reduces sand impingement force, leading to reduced erosion. This effect has been successfully modeled in the multiphase flow case study with annular flow regime.

Comprehensive validation exercises with single and multiphase annular flow show good agreement with the empirical methods developed by Tulsa University's Erosion Corrosion Research Center. Images show the sand erosion rate plots for typical subsea structures such as Blind Tee, Mitre Bend, and also for a bend with single phase and multiphase annular flow regime.



Publications

OTC 2013-24114-MS: Advances in Multiphase Flow CFD Erosion Analysis
Deng-Jr Peng, Afshin Pak, Luca, Chinello, Terry Wood, Andrew Low

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