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OIL & GAS CONSULTING

UPSTREAM & MIDSTREAM PIPELINES AND FACILITIES

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Weight Management

Overview

This has nothing to do with watching your diet, but rather with managing the weight of equipment packages, modules, etc and achieving the following objectives:

1) Establish and maintain a weight budget
2) Keep the area/discipline reported weights at or below the individual control targets
3) Keep the total reported weight at or below the control target
4) Create an optimal platform/vessel through efficient design, material selection, and procurement activity

In order to properly manage weight, it is critical to task each Contractor(s) with responsibility for the management and control of their own control target. In that way, the disciplines within each Contractor organization are responsible for the management and control of their own individual control target.

Once that is set in place, the performance of Contractors/disciplines should be measured against their ability to control their own control target.

In order to achieve compliance, each Contractor/discipline should appoint personnel with specific responsibility for weight optimization and the control of weight.

This should start early in the project phase and assure that design, material selection and procurement activities are carried out in such a way as to minimize the weight implications on the project as a whole within the context of the overall project objectives

Owner Company and Contractor management should therefore define early the emphasis, and priorities it will give to weight management and development.

Philosophy

The reported weight is built up from weights derived from equipment, drawings, weight take-offs, etc., and weight allowances, which represent weights added for items not yet identified, bulks estimated from past projects, etc.

The proportion of weight take-off will increase as the design develops and more detailed information becomes available. An important aspect of the weight control philosophy is to evaluate the weight allowance and change this according to the level of accuracy of the weight take-off.

Weight calculations should be made based on good engineering practices and to a level of detail compatible with and based on the latest documents, drawings and CAD models available. All estimates should refer to a document, drawing or CAD model including the revision number. Avoid percentage additions to the weight estimates to allow for uncertainties.

Design Weight Margin is the difference between weight budget and reported weight. The design margin may have a positive or negative value.

Velocity Limits for Pipelines

When looking at pipeline velocities, simply using API-RP-14E C-factors calculations alone is not an acceptable process and will not give you an accurate threshold velocity. Modeling Erosion and Corrosion Control as well as calculating Wall Shear Stresses are more important than determining an API RP 14E C-factor velocity limit alone. These steps are what most people skip and thus go wrong.

The API RP 14E equation applied by itself is no better than a rule of thumb – API RP 14E itself states that it is not valid if solids are present as well as the fact the corrosion rates change the C-values that should be used. However, when you understand the erosion, corrosion, and shear stresses in a system, together with C-factor limits, a maximum velocity or threshold velocity limit can be set.

There are 5 basic steps to take in order to properly arrive at threshold velocity. These steps include proper corrosion control to negligible metal loss levels, modeling sand/solid erosion rates and limiting velocities according, calculating shear stresses to benchmark chemical inhibitor performance, and lastly doing API-RP-14E C-factor calculations using the table of C-values provided.

Step 1 – Calculate sand erosion penetration rates for carbon steel (200 BHN hardness) using a model (i.e. the Univ. of Tulsa's SPPS model).

Step 2 – Calculate carbon steel CO_2 corrosion rates using the appropriate model(s) or others per Owner.

Step 3 – Choose the proper C-Factor from API RP 14E. Corrosion should be nil to use the C-Factors for the case of CS w/o inhibition.

Step 4 – Calculate the threshold velocity from API RP 14 E – $V_e = C / \rho m$, where ρ m is gas / liquid mixture density at flowing pressure and temperature, lbs/ft3.

System	CS w/o inhib	CS w inhib	13 % Cr & Modif. 13 % Cr	Duplex SS	Super Duplex SS	Ni-Base CRAs
Seawater	250	not applicable	not applicable	not applica ble	370	450
Single Phase Production (all liquids)	250	250	300	370	370	450
Multiphase Production (oil wells or gas wells)	200 - tentative	200-tentative	250	370	370	450
Dry Gas Injection (no corrosion - no liquids)	450	not applicable	450	450	450	450
Methanol (no corrosion)	V liq <100 fps	V liq <100 fps	V liq <100 fps	V liq <100 fps	V liq <100 fps	V liq <100 fps

API RP 14E C-factors

Step 5 – Use the most conservative velocity (lowest) as determined by RP 14 E or by the SPPS erosion model.

Gas velocity (single phase flow) and mixture velocity (multiphase flow) should not exceed 100 fps. Calculated wall shear stress should not exceed 1,000 N/m2 (Pascal's). You will need to be sure and qualify chemical corrosion inhibitors to this shear stress or adjust downward accordingly.

A few other things to keep in mind are that C-factors used should prevent the removal of protective films on the metal surface and prevent metal removal due to liquid droplet impingement.

C-factors for 13 % Cr, Modified 13 % Cr, and Duplex SS may need adjustment based upon the chloride concentration and the water pH.

C-factors for seawater assume that oxygen is controlled to 20 ppb. Velocity-enhanced corrosion may limit C-factors to lower values than calculated for sand erosion. C-factors for production environments without inhibition assume nil corrosion. If not, default to C=100.
Sand break through at high velocities can cause wells to loose integrity in a single day. Therefore, sand monitoring is essential if C factors > 100 are used.

Leveraging & Project Finance Analysis

When a project has 100 percent equity financing, the economic analysis is done by discounting cash flows (without any interest/principle payments since there is no borrowing) at a reference rate, or with weighted average cost of capital (WACC) of the equity investors.

In a leveraged project, the project or the stakeholders put in equity (at certain level based on agreements) with its own capital, at the same time, the project-entity funds the project by borrowing a certain amount of money. Since lenders have first claim on a firm's assets and cash flow, equity investors bear more risk per dollar invested. Therefore, as financial leverage increases, equity investors require a higher expected return (i.e., the cost of equity increases).

In the *leveraged* case where a project is funded not only by equity but also by borrowing, *leveraged economics* are often prepared by including interest/principle payments (and subsequent tax impacts) in project cash flows, then discounting the cash flows with unadjusted WACC of the equity investors as in 100 percent equity case. These leveraged economics typically overestimate returns since they do not compensate for the increased financial risk borne by the equity investor. In fact, there is no economic benefit from including principal and interest payments in cash flows where the discount rate is being adjusted upward for increasing risk. Economic analysis based on leveraged cash flows without appropriately adjusting the discount rate is incorrect and should not be used as the primary basis for project evaluation. The correct discount rate needs to be determined from the stakeholders to use for these cases.

Economic analysis based on leveraged cash flows without appropriately adjusting the discount rate is incorrect and should not be used as the primary basis for project evaluation.

Leveraged economics should not be used regardless of the existence of recourse or non-recourse debt. Non-recourse or off-balance sheet financing, after consideration of the borrowing rate and debt covenant restrictions, is unlikely to have an economic value that is significantly higher than recourse financing. While non-recourse financing has legal implications in the event of project default, an ex post event, it does not have a lower expected level of financial risk, an ex ante event. Any actual economic benefit from non-recourse financing is not accurately captured through the use of *leveraged* economics.

If a project-financed investment could actually be evaluated as a stand-alone entity from an economic and legal perspective, it would still have a capital structure that requires an economic trade-off between debt and equity. Project finance does not provide a *magic* method of improving a project's returns.

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