KNIGHTHAWK TECH NOTES

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Erosion Corrosion Control

Just the other day I was out at my boat dock. I had some guide poles for my Jet Ski Lift and the section that was always in the water corroded quickly in just over two years. It amazed me how bad it was and how bad it looked. The end pieces looked as if I dipped them in acid and it just ate away. As it turned out, for this application at my boat house, I simply had the wrong stainless steel pipe. But this costly exercise got me thinking about all the industrial applications I have worked on and I "blew" the design at my own home.

What I am primarily concerned about in this article is erosion corrosion control. Now what is erosion corrosion? Well no matter how you might look at it, it involves the degradation of the material by some mechanical action in conjunction with a chemical interaction between the material and the media it is in contact with. There are many forms to express erosion. One way can be as follows and there are many other ways. Some chaps have been spending a lifetime coming up with the equation, but the point that I am trying to make will be clear as we go along.

$$L = \frac{C\, v^n \dot{m}_p t}{\rho\, A}$$

L – Linear loss of material

v – Impact velocity

$\dot{m}_p$ – Mass flow rate of particles hitting sample

ρ – Density of rubber or steel

A – Rubber packer or steel components impacting area.

C – Pre-exponential erosion / corrosion constant

n – Power-law erosion constant

t – Time of exposure to erosion

The first principal in using third party data is that your ultimate work probably has errors in the solution or maybe significant errors depending on the application. For example in the equation above the constants C and n greatly affect the results. These constants are dependent on specific experimental conditions and can vary greatly. Notice how significant velocity can be to the problem, if it builds up to a high level. The rest of the parameters in the equation are relatively "hard numbers" that one can have some level of confidence in. Remember it is the number of particles that is hitting the sample and not the number of particles in the flow field.

The best test is one that considers the exact application and where samples can be put in an actual operating environment. However, in the real world when failure occurs that is not always possible. Sometimes the actual failure conditions cannot be duplicated or determined without great difficulty and cost.

One way to determine C, $\dot{m}_p$, or v^n, is to perform what is called a reverse analysis. In such a situation you have had a failure and there is a desire to determine what the corrosion erosion rate was. A CFD (computational fluid dynamics) model can be developed and sensitivity studies can be performed to extract reasonable values for the constants. There is typically enough data available in the problem such that one can set an "anchor" on one or more of the critical parameters that will enable one to extract through the simulation what the other values may be. Using this approach, is typical and remarkably more accurate than using third party data and information.

One of many successful case studies involved erosion in a mixer. Several things were known such as flow rate and particle composition that was contained within the carrier fluid. We found through the CFD studies that the failures were occurring at locations of high velocities. Since we knew that the component of erosion was a function of $v^{2.5}$, we knew what the target velocities had to be. We anticipated the impact would be the same, we just wanted to keep the velocity down. The project was successful and the erosion was no longer a problem because we reduced the velocity by stream lining the mixer.

As with many of these complex systems this analysis should be led by a professional engineer competent to do the work using a multidiscipline approach.

Cliff's Notes: KnightHawk Engineers have the expertise, tools, and equipment to get the job done. With a Lab, Field Services, and Specialty Engineering we are one of the few firms that perform world class work on both static and rotating equipment in multiple industries. Much of our work is not covered directly by governing Codes, because we work in areas that are on the leading edge of industry problems. Yet, we know how and where to introduce the intent of the Code and how it should be applied base on our experience.

We hope each of you had a wonderful spring break and don't get too Mad during March Madness.

Take care and God Bless,

Cliff Knight

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KnightHawk Project Update

- Clamping Connector Analysis – Petrochemical
- Critical Pipe Stress – Petrochemical
- Vertical Cast Transporter Failure – Nuclear Power
- Transient Fluid Dynamics – Petrochemical
- Transfer Line Exchanger – Petrochemical
- Brittle Fracture Analysis – Petrochemical
- Fit for Service Analysis – Petrochemical
- Pipeline Hydro Testing – Oil & Gas
- Well Bore Flow Analysis – Oil & Gas
- Tensile Testing – Manufacturing
- Pump Vibration Analysis – Petrochemical
- Riser Stack Analysis – Offshore
- Gas Pipeline Coupling Failure – Oil & Gas
- BOP Analysis – Subsea
- Reciprocating Compressor Re-Design – Petrochemical
- Compressor Skid Pipe Stress – Petrochemical
- Pump Vibration Analysis – Petrochemical
- Vessel Destructive Testing – Oil & Gas
- Corrosion Analysis – Gas Pipeline
- Centrifugal Pump Rotor Reverse Engineering – Petrochemical
- Reactor Failure Analysis – Petrochemical
- Balanced Torque Measurements – Power
- Creep Tensile Testing – Communications
- Gasifier Equipment Design – Power
- High Temperature Molten Salt Tank Design – Green Energy