KNIGHTHAWK TECH NOTES

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"Heat Transfer - It is Involved in Most Every Industrial Situation"

Heat transfer - the awful subject many of us tried to avoid in college. What a subject! Heat transfer is the study of transport of thermal energy with a temperature difference present. Many researchers have devoted their career to the study of heat transfer in many specific applications. Much of this research has provided a basis for a real world solution to problems.

Many times we desire to calculate the thermal conditions in static and rotating equipment for process and mechanical concerns. One can rarely look up a real world problem in a heat transfer handbook and directly solve the problem. The process of performing heat transfer calculations most often involves the engineer calculating a heat transfer film coefficient. The heat transfer film coefficient is essentially the coefficient that characterizes transport of heat from a fluid medium to a solid media over time and a surface. A heat transfer handbook or reference will provide correlations for calculating specific situations that may or may not be close to the ones you need to evaluate. So what do you do to calculate film coefficients in the real world.

Some basis methodologies are as follows:

1. You are lucky. Either you or a friend has a heat transfer reference that fits your specific situation and you just "crank" out the numbers.
2. Absolute Analysis: This is what is sometimes called the university analysis and you have lots of time. You are able to conduct the research and derive the equations that fit your specific situation that you are calculating.
3. Bracketed Analysis. The bracketed analysis is like a ship firing a shell short and long for targeting purposes. After a few shots the gunner can close in on the location of the target. This thought process can apply to heat transfer as well. Most often in heat transfer we are looking for the worst case situation. This methodology involves calculations using hand derived or computer simulations to establish the lower and upper boundaries on process conditions and geometric responses, therefore, determining the operating range of a heat transfer film coefficient.
4. Relative Approach: This approach involves the establishment of the film coefficient based on known conditions and similar geometry. This might be at different operating or process conditions. It might also involve field data acquisition. Film coefficients are back-calculated based on known conditions. Non-dimensional parameters may be established and the condition of interest is evaluated. The trick for this methodology is to insure that all parameters are accounted for. Many times this requires advanced experience in heat transfer. This technique is probably the most advanced and accurate for real world industrial problems.
5. Computational Fluid Dynamics (CFD): Using this tool, one can model the fluid and solid sections of the areas of interest and extract the heat transfer conditions. This is accurate provided the engineer is experienced in CFD modeling. Many CFD users with over 15 years of experience and a proven track record will tell you "you can get 10 engineers modeling the same problem in CFD and get 10 different answers…." The CFD code providers would like you to believe that running a CFD model is like running a simple process simulation program. This is not the case. However, it is a good tool when used by a person with the right experience.
6. Field Data Acquisition. This involves measuring field parameters such as flows, pressures, and temperatures in order to extract the hard data required to calculate the local film coefficient. Unfortunately, it is often difficult to take the measurement and if it is a new design, what do you do, there is nothing to measure.

Watch out for the gremlins in heat transfer. A few tips are:

- Real world gaps between parts that are calculated to be homogenous.
- Material properties varying with temperature.
- Calibration of field data acquisition equipment. Not just the analyzer, but also the accuracy of the probes in the process or mechanical component.
- Units – Heat transfer involves many different units so make sure your units are consistent.
- Seek out and find a heat transfer engineer with lots of gray hair to review your results; it will pay off.

Heat transfer analysis is valuable in failure analysis and design of rotating and static equipment. Many times, for projects that involve heat transfer driven stress analysis the correlations may vary the results as much as 50%; thus leading to false or incorrect conclusions. While the failure may require a structural analysis, the real crux of the problem is the heat transfer problem and not necessarily the stress analysis problem.

As always when performing or using heat transfer analysis have a professional engineer competent in heat and mass transfer to review and approve the results and conclusions of the analysis.

Cliff's Notes:

I believe we have one of the best crews in the world for performing heat transfer analysis. KnightHawk Engineering has spear headed many advanced techniques in solving these problems. Our integrated systems approach to problems is *one* of the best, if not *the* best. We developed a strong "bracketed" and "relative" approach that can handle many problems. For other problems, we perform computational fluid dynamics. Our key staff started performing CFD analysis in the early 80's and have many problems under our belt. That's important when you want the right solution.

I hope everyone had a wonderful spring break. I experienced the personal loss on March 7th of my mother and last year of my father. I was blessed that they lived to 86 and 87 and it gives me peace that they are with my Lord. I hope each and everyone one of you have your priorities in life as to what is really important. For many years I did not, even though my parents always did. I was blessed to have them and they certainly blessed KnightHawk with all their encouragement and support. They have even read every newsletter since 1991. Although I know their new address, I don't believe the postman is delivering there. But somehow, I'm sure that they will keep up with what's going on at KnightHawk.

Cliff Knight

KnightHawk Project Update

- Reverse Engineering Pump – Off Shore
- Fan Vibration - Nuclear
- Open Faced Compressor Impeller – Gas Plant
- Metallurgical Analysis of Failed Valve Parts - Petrochemical
- Turboexpander Failure Analysis – Gas Plant
- Bearing Design – Heavy Manufacturing
- Mechanical equipment design – Off Shore
- Vaporizer Design - Petrochemical
- Gear drive failure – Petrochemical
- Valve Failure – Petrochemical
- Vessel Nozzle FFS – Power
- Structural Dynamics – Petrochemical
- Ring Header Failure Analysis & Redesign - Petrochemical
- Gasifier Process Analysis – Petrochemical
- Reactor Fit for Service – Petrochemical
- Furnace Failures – Petrochemical
- Waste Heat Boiler Failure – Petrochemical
- High Temp Casting Failure – Petrochemical
- Compressor Reverse Engineering & Analysis – Offshore
- Rotordynamics Analysis – Offshore
- Surge Drum Vibration Analysis – Petrochemical
- Clinker Grinder Design Assessment – Petrochemical
- Ignition System Redesign – Petrochemical
- Compress wreck – Offshore
- Syngas Heat Exchanger Design Assessment – Petrochemical
- Specialized Pump Skid Design – Offshore
- Pump Impeller Reverse Engineering – Manufacturing
- Fire Tube Boiler FFS – FFS -1/ API 579
- Titanium Tower FFS – 1 / API 579 Analysis – Petrochemical
- Pump Impeller Metallurgical Failure Analysis – Manufacturing
- Flange Leak Analysis – Off Shore
- Waste Heat Boiler FFS – Petrochemical
- Thermosyphon Analysis – Petrochemical
- Pump Metallurgical Assessment – Off shore - Africa
- Vessel Fluid Dynamics – Petrochemical
- Integrally Geared Compressor Redesign – Petrochemical