KNIGHTHAWK TECH NOTES

January, 2012

PHONE: (281) 282-9200 • FAX: (281) 282-9333
WEBSITE: www.knighthawk.com

Issue 12.01

Challenges of Steam Conditions

Once again a failure has occurred on the steam turbine that drives a large compressor train. Broken parts are everywhere and as the maintenance manager; you have been called in to determine what the root cause of the problem is. The steam supply system in the plant has been problematic and immediately you suspect the supply has been disrupted or affected by the various systems that generate the steam. In the worst case your plant has to import steam from outside the fence line to meet the demand. The unit tripped out on high vibration but it was too late to avoid the damage in the steam turbine. At the time of the failure the entire unit was unstable, likely due to a thunderstorm in the area.

In your particular plant, steam comes from waste heat in the process, boilers, heat recovery steam generators (HRSG), and/or is imported. The utilities department handles the balance of plant. In other words they are the ones that take care of the quality of steam, demand, and conditions required. During a normal day the steam supply is usually known. However, when equipment fails or malfunctions occur in the system, often unplanned shifts will occur in the steam supply. To keep the plant efficient many production facilities such as yours rely on using as much waste heat as possible from the process system to generate steam.

These conditions and challenges are common in many facilities. An approach to diagnosing and solving the problem may be as follows.

In this case the root cause is looked at from several points of consideration. First since the steam turbine failed, the steam conditions must be determined. But like many plants the instrumentation is not available. To determine what the steam conditions were at the time of the incident, other data such as compressor data can be used. In this case the compressor data was known and available. A compressor performance study was conducted based on the actual process condition to determine the horsepower consumed. Through a heat transfer analysis based on the flow conditions, an estimated steam turbine inlet temperature could be calculated. In this particular case there were many users on the system so each user had to be evaluated to determine the total flow conditions. Iterations based on the heat transfer are performed to converge on a heat and material balance that would equate to horsepower developed versus consumed. In this case it was determined that wet steam probably slugged the turbine or initiated high vibration due to the development of water in the internals in a region or regions not designed for liquid fall out. There was also a question of the aerodynamic flow field due to the increased demand of steam caused by lower superheat.

In summary one approach to solving a problem such as this is.

1. Material & Metallurgical analysis to evaluate the failed components. In this case we would be looking for evidence of high erosion due to water and sudden failure due to liquid slugs.
2. The process and mechanical data should be collected and reduced.
3. A mechanical evaluation of the train should be conducted.
4. Perform a Heat & Material balance of the steam system.
5. The consumed horsepower should be calculated from the process side.
6. The steam side and process side of the system should be reconciled so that an accurate flow rate of steam could be determined.
7. A root cause failure analysis should be developed from the above.

It is important in these systems to look at transients that may have occurred such as in this case many users of the steam. Some could have tripped in and out causing transient/momentum leading to unwanted pulsation in the system. As with many of these complex systems the design and root cause analysis should be led by a professional engineer competent to do the work using a multidiscipline approach.

Cliff's Notes: KnightHawk is has been involved with many steam conditions in production facilities that include but are not limited to pressure let down devices, steam turbine failures, waste heat boiler failures, steam pipeline failures, valve control issues, stop valve failures, turbine rerates, and steam turbine blade design. KnightHawk has been involved with a whole host of multidiscipline projects involving steam systems over the last 21 years of KnightHawk's projects.

We look forward to 2012 and the upcoming challenges for our company to work on. We had many them in 2011 and it was rewarding to be a part it. We appreciate the business from all our clients.

I trust each of you had a Merry Christmas & Happy New Year.

Cliff Knight

cknight@knighthawk.com

KnightHawk Project Update

- Compressor Skid Pipe Stress – Petrochemical
- Transfer Line Exchanger – Petrochemical
- Clamping Connector Analysis – Petrochemical
- Critical Pipe Stress – Petrochemical
- Titanium Tower FFS – Petrochemical
- Brittle Fracture Analysis – Petrochemical
- Screw Mixer Failure – Petrochemical
- Compressor Vibration Analysis – Offshore
- Well Bore Flow Analysis – Oil & Gas
- Motor Bearing Failure – Water Treatment
- Pump Vibration Analysis – Petrochemical
- Riser Stack Analysis – Offshore
- Gas Pipeline Coupling Failure – Oil & Gas
- BOP Analysis – Subsea
- Reciprocating Compressor Re-Design – Petrochemical
- Pump Vibration Analysis – Petrochemical
- Vessel Destructive Testing – Oil & Gas
- Critical Pipe Stress – Petrochemical
- 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
- Transient Fluid Dynamics – Petrochemical