PLANT ENGINEERING

ENERGY MANAGEMENT

# Best practices for steam turbine maintenance and operation

## Steam turbine operation and performance require the correct steam pressure at the turbine inlet and high steam quality (steam without condensate entrapment) to ensure high turbine reliability.

BY KELLY PAFFEL, SWAGELOK COMPANY MAY 12, 2011

Steam turbine operation and performance require the correct steam pressure at the turbine inlet and high steam quality (steam without condensate entrapment) to ensure high turbine reliability. The following addresses best practices for optimal steam system turbine maintenance and operation.

### Steam Quality

Steam must be of the highest quality. Condensate entrapment in the steam supply increases turbine steam rates, reduces the steam turbine efficiency, and causes erosion of steam turbine components (governor valves, blading, and nozzles). Insulating the steam supply lines and components (valves, casing, etc.) helps prevent steam from releasing latent energy, which causes condensation to occur in the steam system.



All steam supply lines must be properly designed with appropriate condensate removal components, including correctly sized steam line drip pockets and steam trap stations. The steam trap stations must have the proper blow down valves that allow operating personnel to properly blow down the trap at startup and shut down. The steam valves need to be highly reliable, and should adhere to a minimum Class VI shut off.

If steam supply quality is questionable, a mechanical coalescing separator should be installed before the turbine inlet to prevent low-quality steam, entrapped with condensate, from entering the turbine.

Steam piping should be reviewed, analyzed, designed, and properly installed to ensure there will be no excessive forces transmitted to the turbine flanges. Steam piping may exert forces from four sources:

1. Pipe dead weight
2. Thermal expansion
3. Thrust
4. Spring rate caused by different types of expansion joints

Thermal expansion also causes movement of the turbine's flanged connections, which must be considered during the piping design.

The steam piping must be designed to allow for expansion and contraction of the steam piping. The steam lines must have the correct number of appropriately sized hanger supports. Guides should ensure there are no forces or moments on the turbine that exceed the values provided by the turbine manufacturer. If the piping is unable to flex while accommodating the expansion and contraction, then consider the installation of an expansion device such as a pipe loop or expansion joint.

Low-pressure and vacuum lines are usually large and relatively stiff. It is common practice to use an expansion joint in these lines to provide the needed flexibility. If an expansion joint is improperly installed, it may cause a pipe reaction greater than the one which it is intended to eliminate. An expansion joint can cause an axial thrust equal to the area of the largest corrugation times the internal pressure.

The force necessary to compress or elongate an expansion joint can be extraordinarily large. Either of these forces may be greater than the limits for the exhaust flange. In order to have the lowest reaction, it is best to avoid absorbing pipe line expansion by axial compression or elongation. If it is found that the expansion joints are required, it is essential that they be properly located and their foundations determined.

## Supply and Exhaust Line Sizing

Steam piping must be designed to provide full-line steam pressure at the turbine inlet at full-load capacity. The supply line size needs to be calculated not only for the load, but also to include the pressure drops due to length of pipe and system components, including valves and fittings. Any pressure loss in the supply line will affect turbine performance.

The discharge piping exhaust pressure will dictate the required discharge line size. As with the inlet piping, all pressure drops must be taken into consideration. Excessive pressure must be eliminated so turbine performance is not affected.

Typically the inlet and outlet steam piping size will be equal to or greater than the actual turbine connections provided for by the manufacturer.

## Improper Installations

An improper installation can cause the following problems:

- Premature bearing failure

## Steam Piping Supports

All steam piping requires support for the dead weight of the pipe. The two types of support commonly used in practice are rigid and spring designs. Both types are designed to support the piping, but not to aid in guiding the pipe for expansion reasons. However, a rigid support can be used to restrict the movement of piping in conjunction with an expansion joint. Typical installations employ anchors, supports, and guides. Each of these components assists in supporting the steam piping, but performs different functions. A detailed analysis should always be conducted to ensure proper weights are supported.

## Best Practices

1. Ensure proper steam quality is delivered to the turbine
2. Proper expansion compensation
3. Supply and exhaust line are sized properly
4. Steam piping needs to be properly supported

For more information, visit www.swagelokenergy.com.

*The above material is part of Swagelok Energy Advisors' series of Best Practice papers, authored by Kelly Paffel. Kelly is a recognized authority in steam and condensate systems. He is a frequent lecturer and instructor on the technical aspects of steam systems. In addition, Kelly has published many papers on the topics of steam system design and operation. Over the past 30 years, he has conducted thousands of steam system audits and training sessions in the United States and overseas, which has made Kelly an expert in trouble-shooting actual and potential problems in the utilities of steam. Kelly is a member of the U.S. Department of Energy's (DOE) Steam Best Practices and Steam Training Committees.*

## Related Articles

- *Best practices for steam trap installation*
- *Steam Quality – Plant Operations Require High Steam Quality*
- *Best Practices for Condensate System Piping*
- *Concentrate on condensate*

### Yale Materials Handling Corporation

MP30UX electric walkie pallet truck

### GAL Manufacturing

CleanCab by GAL

### TDK-Lambda Americas

120W - 240W DIN Rail Mount Three Phase Power Supplies

### Cementex Products, Inc.

Cementex Announces Belt Pouch Combinations

## RELATED CONTENT

Factors for retrofitting an existing space for cold storage

ROBERT BRODSKY

Energy price surge shows the need to accelerate clean energy transitions

OECD AND IEA

Researchers building a greener future with clean hydrogen

WEST VIRGINIA UNIVERSITY

A new era of thermowell-free temperature measurement

GURUPRASAD SOSALE

Hydrogen production capacity to rise 20-fold by 2030

GLOBALDATA

## Propane council launches national brand

PROPANE EDUCATION & RESEARCH COUNCIL

## RELATED CONTENT

Factors for retrofitting an existing space for cold storage
ROBERT BRODSKY

Energy price surge shows the need to accelerate clean energy transitions
OECD AND IEA

Researchers building a greener future with clean hydrogen
WEST VIRGINIA UNIVERSITY

A new era of thermowell-free temperature measurement
GURUPRASAD SOSALE

Hydrogen production capacity to rise 20-fold by 2030
GLOBALDATA

3010 Highland Parkway Suite 325
Downers Grove, IL 60515
(630) 571-4070