RMS Rotating Machinery Services, Inc.

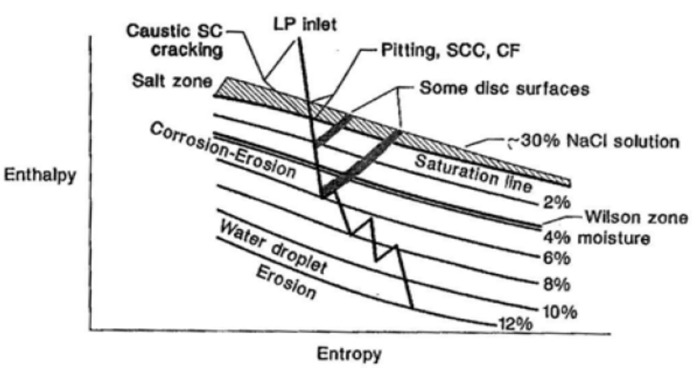
STEAM TURBINE WATER DROPLET EROSION

By Sydney Gross

When there is no need in the plant for the steam after it passes through a turbine, a condensing turbine is often preferred over a back pressure turbine. Condensing turbines operate with an exhaust vacuum or pressure below atmospheric. A surface condenser is typically used to maintain exhaust vacuum and can achieve pressures as low as 1 ½ inches of Mercury absolute (3/4 psia). This results in significantly more power per pound of steam than if the turbine exhausted to atmosphere. However, it comes at a price with larger, more expensive turbines and the increased maintenance concerns associated with the formation of water droplets in the last turbine stages.

In large generation units where the effects of moisture on efficiency can be very costly, a great deal of research and development has been devoted to removing moisture and delaying the onset of condensation. But in the process environment where reliability and maintenance concerns supersede relatively small gains in efficiency, the bigger issue is water droplet erosion and component life.

Water droplet erosion occurs when condensate droplets repeatedly strike the rotating blades at relatively high velocity causing spalling of the surface metal. Erosion is most severe at the leading edge tip because the relatively massive droplets are centrifugated outward and their inertia won't allow them to turn around the leading edge obstacle with the vapor. I have been asked on several occasions the recommended maximum moisture content at which to design or operate a turbine with respect to droplet erosion. The Mollier diagram shows that at around 10% moisture, water droplet erosion becomes evident.



(Turbine Steam, Chemistry, and Corrosion, Palo Alto, CA, Electric Power Research Institute, August 1994, TR-103738)

This is usually in the last stage of rotor blades but may also occur in the next to last or L-1 stage. Erosion becomes severe when moisture levels increase beyond the 12% region.

The most common solution to this problem in industrial turbines is to attach a Stellite shield to the leading edge of the blade by brazing. The desirable wear properties of Stellite delay the erosion process and extend the run time of the blades. In more severe cases a solid Stellite bar nose can be welded to the blade leading edge to further extend blade life. The photos above show last stage blades that have experienced moderate erosion. They were fitted with Stellite shields that have been eroded near the tips.

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