WATER DROPLET REMOVAL TECHNIQUES

By Scott MacFarlane

When steam flows through a steam turbine it expands while its temperature and pressure decrease along the same flowpath. At a specific point through the flowpath, the steam can expand across the saturation line and water can form. As stated in previous editions, the steam flow through the last few stages of a steam turbine can be wet, meaning it contains a mixture of steam and water. This wet condition can cause severe erosion to the rotor's blades.

For steam turbines that are subjected to these wet conditions in the flowpath, it may be desirable to remove as much of this water as possible. Mainly this is required to decrease the rate of erosion damage to the inner turbine components and furthermore to improve blading efficiency. There are two common water extraction methods that can be utilized in the steam turbine. The first method is designed to remove the water droplets directly away from the steam path. The second method is designed to separate the water droplets from the steam altogether.

Overshooting the last few stage blades or incorporating water traps are the primary designs for water droplet removal from the steam path. With a specially designed overshooting nozzle, the water, which is centrifuged outwards because of its higher density, will travel through the gap between the blade tips or shrouds and the turbine casing. Figure 1 shows the steam and water trajectories in a steam turbine stage. Water traps are pockets usually placed in the casing after the rotating blades. When the water droplets are centrifuged outwards they collect in these pockets instead of re-entering the steam path. The water traps will drain off to the turbine condenser in most cases. These modifications to the turbine can cause significant penalty to the turbines last stages performance, however. Increasing gap clearances and disrupting the continuity of the casing walls will cause unsteady flow patterns.

To separate the water droplets from the steam, slotted hollow diaphragm vanes or solid drilled vanes are used to separate the water film from the nozzle surface. The internal vane spaces are drained to the turbine condenser in most cases. The slots can be placed on the suction side and pressure side of the vane but should be placed where the steam pressure is equal to avoid a water pumping scenario. An example of a slotted hollow vane can be seen in Figure 2.

Based on the size range and the trajectories of water droplets as well as the operating conditions of the steam turbine, the above moisture removal methods can vary to suit your needs. If moisture is an issue, there are several other modifications, such as Stellite Shields, that can slow the rate of erosion on the last stages of blades that were discussed in a previous edition.

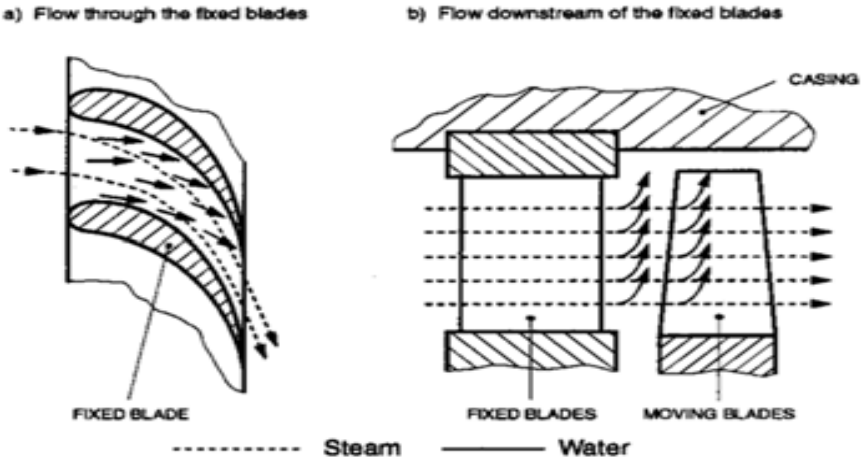

Figure 1

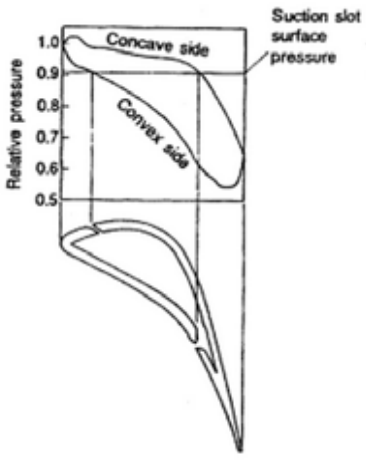

Figure 2

For more information:
Email: RMS@rotatingmachinery.com
Tel: 484-821-0702

Headquarters
2760 Baglyos Cir.
Bethlehem, PA 18020

Houston Office
16676 Northchase Dr., Ste 400
Houston, TX 77060

rotatingmachinery.com
Tel: 484-821-0702
Parts: rms@rotatingmachinery.com

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