STEAM TURBINES LOSSES

By Scott MacFarlane

Steam turbines are far from 100% efficient in converting steam into mechanical power. Most industrial turbines have a flange to flange efficiency of about 55% to 75%. When we calculate turbine efficiency we look at the amount of available energy in the steam that has been converted to useful work. The margin between a maximum attainable efficiency of approximately 80% and a 55% to 75% efficient steam turbine is found mostly in the losses along the steam's flow path. These losses can be categorized into four main types of losses; leakage, friction, moisture, and particle.

Leakage is any flow that escapes travel through the blading. For example, steam seeping through clearances and gaps between the rotating and stationary components. An example of leakage is found when steam passes through the seals on wheels and diaphragms. The loss through each stage is directly proportional to the mass flow of the steam. This leakage from the steam not passing through the vanes is a direct loss of efficiency in the machine. Frictional losses occur when the steam comes into contact with any surface between the inlet and exhaust. The density of the steam is significantly higher at the inlet compared to the exhaust, which causes more frictional losses. Since the rotor is completely surrounded by the steam, the surface roughness of any component in the turbine casing directly impacts the steams energy. Substantial friction between the steam and any of these surfaces may result in windage or turbulence which will affect the steam's flow direction.

Moisture occurs in condensing turbines when the temperature of the steam drops below the saturation line. Moisture loss occurs when the condensed moisture passes through the vanes and affects the moving blades as the temperature of the steam drops. Since the moisture is moving at a much slower rate than the blades, contact with the moisture droplets impedes the motion of the rotor.

Particle loss is a function of steam purity. Steam purity can be categorized as either inert or reactive. Inert describes a contaminant that causes deposit to form whereas reactive describes a corrosion causing contaminant. All solid contaminants produce steam path deposits which roughen steam passage walls and reduce flow areas. An example of damage that can occur from these contaminants is stress corrosion cracking. When any damage or build up occurs on the rotor's surface, each of the previously mentioned losses will increase.

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