INTRODUCTION TO STEAM TURBINES

Turbine is a rotary engine that converts the energy of a moving stream of water, steam, or gas into mechanical energy. The basic element in a turbine is a wheel or rotor with addles, propellers, blades, or buckets arranged on its circumference in such a fashion that the moving fluid exerts a tangential force that turns the wheel and imparts energy to it.

This mechanical energy is then transferred through a drive shaft to operate a machine,

compressor, electric generator, or propeller.

Turbines are classified as hydraulic, or water, turbines, steam turbines, or gas turbines. Today turbine-powered generators produce most of the world's electrical energy. Windmills that generate electricity are known as wind turbines

Advantages

§ Ability to utilize high pressure and high temperature steam.

§ High efficiency.

§ High rotational speed.

§ High capacity/weight ratio.

§ Smooth, nearly vibration-free operation.

§ No internal lubrication.

§ Oil free exhaust steam.

§ Can be built in small or very large units (up to 1200 MW).

Operation Principles

The steam turbine unlike the reciprocating steam engine (which operates due to the pressure energy of system) operates due to dynamic action of the steam.

The acceleration, which may be a change in either magnitude or direction of a stream of fluid, produces a turning moment on a rotating shaft. In a steam turbine, the velocity of steam is increased at the expense of pressure by passing the steam through a set of nozzles and this high velocity steam when allowed to impinge on a series of moving blades fixed to a common shaft, produces the shaft work.

The velocity of steam may be partly increased in the passage between the moving blades themselves.

There are two principles through which turbine operate.

They are

§ Impulse principle

§ Reaction principle.

Impulse principle

For a turbine to be purely impulse there should be no pressure drop in moving blade ring. In principle the impulse steam turbine consists of a casing containing stationary steam nozzles and a rotor with moving or rotating buckets.

The steam passes through the stationary nozzles and is directed at high velocity againstthe rotor buckets causing the rotor to rotate at high speed. If steam at high pressure is allowed to expand through a stationary nozzle, the result will be a drop in the steam pressure and an increase in steam velocity.

In fact, the steam will issue from the nozzle in the form of a high-speed jet. If this high velocity steam is applied to a properly shaped turbine blade, the steam will change in direction due to the shape of the blade.

The effect of this change in direction of the steam flow will be to produce an impulse force on the blade causing it to move. If the blade is attached to the rotor of a turbine, then the rotor will revolve.

The force applied to the blade is developed by causing the steam to change direction of flow (Newton's 2nd Law - change of momentum). The change of momentum produces the impulse force.

In an actual impulse turbine there are a number of stationary nozzles and the moving blades are arranged completely around the rotor periphery. Note that the pressure drops and the velocity increases as the steam passes through the nozzles.

Then as the steam passes through the moving blades the velocity drops but the pressure remains the same. The fact that the pressure does not drop across the moving blades is the Distinguishing feature of the impulse turbine. The pressure at the inlet to the moving blades is the same as the pressure at the outlet from the moving blades.

Reaction principle:

If the moving blades of a turbine are shaped in such a way that the steam expands and drops in pressure as it passes through them, then a reaction will be produced which gives a force to the blades.

If there is no escape opening or nozzle for the steam, then the pressure will be the same on all walls of the container and the container will remain at rest. If, however, the container has an escape opening or nozzle, then steam will expand through the opening and drop in pressure.

Therefore there will be an unbalanced pressure on the wall opposite to the opening and a reaction force will be produced causing the container to move due

to reaction effect. A reaction turbine has rows of fixed blades alternating with rows of moving blades.

The steam expands first in the stationary or fixed blades where it gains some velocity as it drops in pressure. It then enters the moving blades where its direction of flow is changed thus producing an impulse force on the moving blades.

In addition, however, the steam upon passing through the moving blades, again expands and further drops in pressure giving a reaction force to the blades. This sequence is repeated as the steam passes through additional rows of fixed and moving blades.

Note that the steam pressure drops across both the fixed and the moving blades while the absolute velocity rises in the fixed blades and drops in the moving blades.

The distinguishing feature of the reaction turbine is the fact that the pressure does drop across the moving blades. In other words there is a pressure difference between the inlet to the moving blades and the outlet from the moving blades.

Special Aspects of Reaction Turbines

There is a difference in pressure across the moving blades. The steam will therefore tend to leak around the periphery of the blades instead of passing through them. Blade clearances therefore must be kept to a minimum.

Also, due to pressure drop across the moving blades, an unbalanced thrust will be developed upon the rotor and some arrangement must be made to balance this.

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