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Power generation and blade turbine erosion

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ABSTRACT – The generation of electricity in power plants, makes use of different types of prime movers depending on the available primary energy.

In thermal power plants, Steam turbines are employed to drive the main generators, whereas Pelton or Francis turbines are used in hydraulic power plants, depending on the water flow and fall height.

Gas turbines are widely used to drive the main generators in the internal regions of the country, due to water lack.

The efficiency of all of the above turbines can be seriously reduced due to the erosion phenomena, caused by the sand particles for gas turbines, solid particles in water for hydraulic turbines and water droplets for steam turbines.

In Algeria, the steam turbines are mainly used in the coast regions, whereas the gas turbines are used in the internal regions because of the lack of water needed for cooling purposes.

The hydraulic power generation stands for less than 01% of the national total generation capacity.

For steam turbines, sea water is desalinated and chemically treated to avoid the corrosion effects on the boiler, steam installations, turbine stages and condensers.

The erosion caused by wet steam flow reduces the efficiency of the last stage rotor blades of condensing steam turbines, and makes their service life shorter [3]. The problem of steam turbine blade erosion is not new and many studies have already highlighted different aspects of this issue. It is dependent on a variety of parameters, the most important being droplet size and velocity as well as peripheral speed of the rotor at the location of droplet impact [1].

Water droplet impact erosion of last stage steam turbine blades has been a well-known and at times aggravating phenomenon in the steam turbine and power utility community for a century. The steam is expanded to a low pressure and temperature in order to improve the thermal efficiency of the plant and this causes the steam to expand below the saturation line leading to the formation of droplets in the flow. It is commonly agreed that this kind of droplet erosion is unavoidable when a steam turbine is operated under wet steam conditions [2].

For gas turbines, the situation is not different, because the consequences of erosion are serious on life and performance of the turbines [4], the erosion is caused by the sand particles intake with air, due to imperfect filtration, especially in the Sahara deserts, where we have not only sand but the sand storms.

It is easy to understand that the extent of the erosion is a direct function of the quantity and mass of the impinging particles. As the mass of a particle is proportional to its volume (i.e., to the third power of its diameter), erosion is mainly due to the ingestion of particles having a diameter $\Phi > 5\mu m$, which represents a major portion of the mass of a typical atmospheric aerosol and transfers the greatest amount of kinetic energy [5].

To limit the effects of the erosion phenomena on the turbine blades, new blade coatings and materials are being developed to meet the challenging requirements of modern gas and steam turbines [4].

For gas turbines, and in order to adapt machines to a variety of environments while realizing their full potential in terms of performance and reliability, it is necessary to treat the air that they consume [5].

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