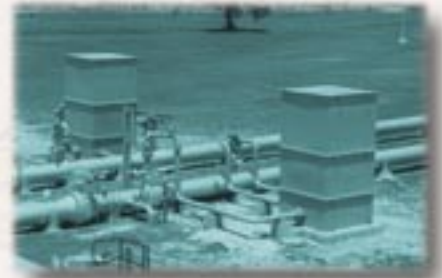




**COASTAL, MARINE
AND OFF SHORE
GAS TURBINE
INSTALLATIONS**



**Mueller
Environmental
Designs, Inc.**



**Air Filtration
Evaporative Cooling
Noise Control
Mist Elimination
Turnkey Projects**



SPECIAL CONSIDERATIONS FOR GAS TURBINE COASTAL, MARINE, AND OFF SHORE INSTALLATIONS

Coastal, marine, and off shore gas turbine installations present unique problems for inlet air filtration systems. Due to the large amounts of air required to operate a gas turbine, the cleanliness of the air is of primary importance for turbine performance and life expectancy. Contaminated intake air will cause erosion, fouling, corrosion, and cooling air passage plugging. In particular, due to their environs, coastal, marine, and off shore gas turbine applications are susceptible to hot gas path section corrosion by ingestion of airborne sea salt. Because of the dual nature of airborne sea salt, special considerations must be taken to insure gas turbine inlet air to be free of this contaminant.

Airborne sea salt varies in quantity due to wind and wave action. Sea salt density for a given time and place is a function of wave height, wind velocity and direction, temperature, humidity, and elevation. Salt content of air above or near the sea is from two sources; very fine droplets ejected from bursting bubbles (oxygenation) and coarse spray from whitecaps and breaking waves. Salt in a marine environment can exist in three forms: aerosol, spray, and crystal.

SEA SALT AEROSOL

The generation of sea salt aerosol is a complex process of bubble film shattering on the sea surface. Most of the aerosol droplets are in the 2 to 20 micron diameter. The larger droplets have a high settling rate and drop back to the sea surface. Smaller droplets collide and agglomerate into larger droplets and again fall back to the surface. The vast majority of aerosol droplets that escape into the atmosphere are less than 10 microns in diameter.

SEA SALT SPRAY

The creation of sea salt spray by wave interaction, moving ships at sea, or stationary platform structures in high seas, are responsible for generating large droplet sizes up to 200 microns in diameter. Because of their mass, the gravitational effect causes sea salt spray droplets to rapidly fall back to the surface. Additionally, wave spray acts as a wet collection system, washing the larger droplets back to the surface. Sea salt spray is locally generated in the immediate vicinity of wave action.

SALT CRYSTAL

Salt crystal is always cubiform and hygroscopic in nature. Critical humidity of pure salt is 80% relative humidity. At this humidity, the salt crystal will continue to absorb moisture until it reaches supersaturation, at which time it deliquesces. The resultant saline droplet is five times larger than the original crystal cubiform.

Therefore, at relative humidity below 70%, the salt is always dry and cubiform. At relative humidity between 70% and 78%, the salt crystal has not changed its shape, but is supersaturated. At 80%, the critical relative humidity, the salt crystal becomes a saline droplet 5 times its original size. The relative humidity between 75% and 80% is referred to as the dynamic range for salt.

The relative humidity at sea surface is 98.2%, the vertical distribution of the relative humidity above the sea surface track a logarithmic curve dependent on wind velocity. The average relative humidity 25 feet above sea surface is around 80%. At 125 feet above the sea surface, offshore operators with meteorological capabilities, have recorded frequently and regularly varying relative humidity, below the 70% to 75% relative humidity level where salt begins to change from dry crystalline to the dynamic supersaturated state.

Subsequently, the gas turbine inlet air filter design for coastal, marine and off shore installations must handle salt in its wet, dry and dynamic phases.

The wet and dry phases of airborne sea salt can be easily handled utilizing weather louvers, coalescers, pre-filter pads, and 90% ASHRAE efficient barrier filters. The dynamic phase of airborne sea salt represents the most difficult aspect of inlet air filtration due to the possibility in a change of state as the relative humidity rises and falls above or below the critical relative humidity.

To Illustrate This Problem Consider The Following Scenario:

A typical inlet air filter system consisting of 2½ pass weather louver, coalescer pad, pre-filter, and high efficiency barrier final filter have been operating for several weeks in a warm, pleasant, dry period when the relative humidity of the ambient air has been below 70%. However, air entering the system does contain large quantities of dry salt crystals of 1 to 2 microns. The high efficiency barrier filter is doing a great job retaining millions of salt crystals within interstices of the filter media.

The weather changes at the platform site. The relative humidity gradually increases above critical relative humidity of salt. There is no free moisture entering the filter system. However, potential catastrophic conditions exist. The collected dry salt crystals, being deliquescent, have absorbed moisture in the vapor phase from the incoming airstream. The salt crystals are now in their dynamic phase and can hold no more moisture. The relative humidity exceeds the critical phase causing the salt crystals to deliquesce, forming saline droplets.

If the high efficiency barrier filter media is not waterproof, the saline droplets will leach through the media and into the turbine inlet. When saline droplets reach the second stage of the axial compressor, the heat of compression is sufficient to evaporate the moisture. At this point dry crystals enter into the hot gas section of the turbine. The filtration system has failed.

To prevent system failure, waterproof media in the high efficient final filter would collect and retain both liquid and solid particulate, protecting the substantial capital investment of a gas turbine.

MUELLER ENVIRONMENTAL DESIGNS has the experience, applications, and design capabilities to provide high quality air filtration and noise control products.



GE LM 2500 off shore gas turbine compressor set inlet air filter manufactured from 316 SS

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