Anti-Icing System

Purpose and Scope

This document provides a general description of anti-icing system along w/some basic design features of standard and optional equipment.

Function & Design of System-Principle of Operation

iTECS anti-icing system for the LM6000, LM2500 Base/+, MS6001, MS9001 gas turbines has been designed to duct warm air into the combustion intake airflow at certain temperature (T) and relative humidity (j) values to prevent the turbine from suffering damage as a result of icing. The conditions that produce icing are given by the following algorithms,

$-12°C < T < 3.6°C$ and $j > 84\%$

heat until $j\ [\%] = 0.61T + 67.32$

$T < -12°C$ and $j > 60\%$

heat until $j\ [\%] > 60\%$

$T > 3.6°C$

no heating required.

Measurements of temperature (T) and relative humidity (j) are taken from sensors located on the filter house wall (ambient or unconditioned air) and in the filter house plenum (conditioned air), upstream of the combustion silencer. As icing conditions are approached, the anti-icing system automatically operates to ensure that icing will not occur within the inlet.

For the successful operation of the anti-icing system, the following criteria must be observed:

1) The gas turbine should be operating at full load.
2) The heat in the turbine enclosure has reached a point of stability.
3) The heat in the turbine enclosure has reached a point of stability.
4) The enclosure ventilation exhaust system is operating at the full capacity.

Mechanical Design

Exhaust air from the gas turbine enclosure ventilation system is ducted, via non-return dampers, into a plenum box. The plenum box has two 'side' outlets, for use when anti-icing air is required, and a single top or rear outlet venting to atmosphere when anti-icing air is not required. Motorized dampers control each of these outlets.

The anti icing duct work is symmetrical about the turbine centerline, feeding equal amounts of anti-icing air to both sides of the intake filter house. When the system is in anti-icing mode, the ventilation exhaust damper modulates towards the closed position and the two anti-icing flow dampers modulate towards the open position. The system will modulate and position between fully closed and fully open, operate with these dampers at any relative position between fully closed and fully open, depending upon the amount of warm air required to prevent icing conditions in the gas turbine inlet plenum.

Once the anti-icing air has passed through the flow dampers, usually it is ducted around the 90° cascade bends.

The warm air is then mixed with the incoming combustion intake air, via the distribution rakes, before it passes through the filter bank and into the inlet volute.

The distribution ductwork is lagged to prevent heat loss and noise breakout.

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Instrumentation

The standard anti-icing system is fitted with a number of instruments essential to its correct operation. These instruments are listed, with their function, below:

Description	Function
Temperature/Humidity Sensor	Plenum T/j
Temperature/Humidity Sensor	Ambient T/j
Limit Switch	Damper-A Closed
Limit Switch	Damper-B Closed
Limit Switch	Vent Damper-A Closed
Limit Switch	Vent Damper-B Closed

All damper actuators and limit switches are factory installed and wired back to local junction boxes.

Operating Conditions

Ta - Measured ambient temperature in °C

ja - Measured ambient relative humidity as a percentage

jmp - Measured plenum relative humidity as a percentage

jsp - Calculated relative humidity set-point for control purposes

Damper Control

On the regular automatic control system consists of the set-point for the PID loop is determined from the following 3 equations:

IF Ta > 7°C THEN jsp = 100%

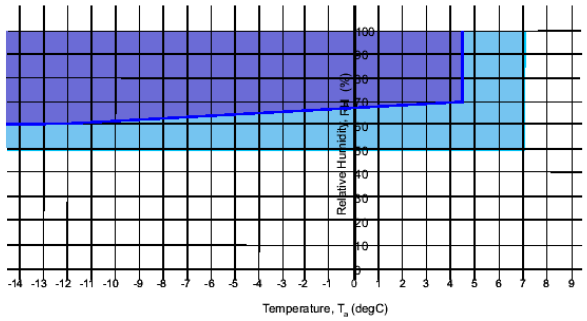
IF -12°C < Ta < 7°C THEN jsp = (0.61Ta+67.32)%

IF Ta < -12jC THEN jsp = 60%

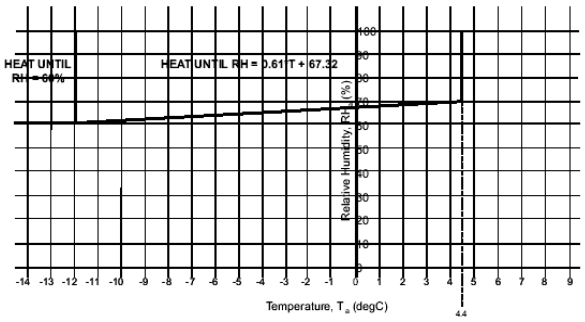
The dampers are then controlled to maintain

jmp = jsp, as measured.

The operational boundaries and conditions of the system are shown in the graphs given in figures below.



Anti-Icing System Operational Boundaries



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Anti-Icing System Operational Conditions

Once the ambient air conditions have moved out of icing conditions (i.e. if the ambient temperature rises above 7°C and the 15 minute overrun is completed) the system will shut down. At this point all dampers have returned to their rest positions (closed for the anti-icing dampers and open for the vent dampers) usually controlled by using the motorized actuator positioner.

The operational parameters and their associated performance values for the combustion and ventilation intakes are as follows:

Operational Parameters

Combustion	127.0	m3/s
Turbine Enclosure Ventilation	28.3	m3/s
Generator Enclosure Ventilation	18.4	m3/s
Total	173.7	m3/s

Calculations are made for LM6000 GTG package

Overall Clean Pressure Losses (across filter system)

Combustion	76mmH_2O	3"H_2O
Ventilation	51mmH_2O	2"H_2O

Overall Clean Pressure Loss (across combustion intake silencer)

Combustion Silencer	38mmH_2O	1.5"H_2O

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