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Hitachi WAC System as Gas Turbine Power Booster

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1. Introduction

A land based gas turbine tends to decrease its power in hot summer days when electricity demand will mount to peak. It is because high temperature causes air density to be thin and reduces mass flow of compressor intake air which in turn lowers fuel flow. So, needs are on the rise for recovering the output of gas turbines in summer, especially in cheaper way. In order to meet this requirement, Hitachi WAC system is developed that injects finely-atomized water droplets at inlet to compressor. WAC is an abbreviation of Water Atomization Cooling System.

2. WAC System Concept and Power Up Mechanism

Fig.1 illustrates a conceptual flow diagram of the WAC system. Water spray device is allocated in the intake air duct which is connected to feed water piping as well as pressurized air piping for atomization.

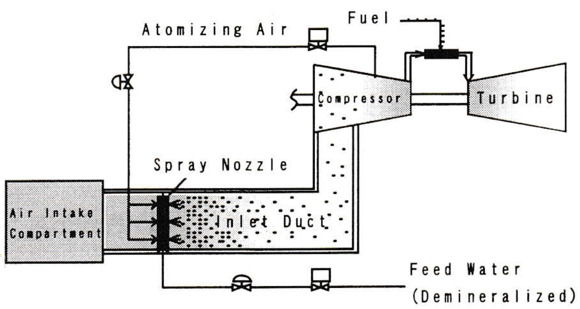


Fig. 1 WAC system flow diagram

Special spray nozzle to generate water droplets with sauter mean diameter of 10μm is developed. Finely-atomized water droplets make the incoming air saturate by partial evaporation before reaching compressor, the rest of which enter the compressor and complete evaporation inside the compressor.

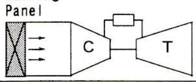
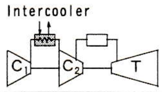
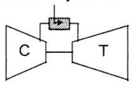
Evaporation in the duct cools the air along equi-wet bulb temperature line, makes the air denser and eventually increases the mass flow of compressor intake air. Evaporation within the compressor lowers compressor discharge temperature. Thus, cooling of working fluid by use of high value of evaporative latent heat of water effectively recuperates power output.

As shown in Table 1, it can be said that the mechanism of the WAC system is composed of three conventional power up techniques.

Table 1 Machanism of WAC system

$\Delta Q = p \cdot \Delta W + W \cdot \Delta p$

Q : GT Power Output W : Intake Air Flow, p : Specific Power Output

Mechanism of MAT Cycle	ΔQ	Existing System	Concept
(1) Inlet Air Cooling ↓ Increased Intake Air Mass Flow	$p \cdot \Delta W$	Evaporative Cooler	Cooling Panel 
(2) Compressor Internal Cooling ↓ Required Work Reduction	$W \cdot \Delta p$	Intercooler (No Heat Loss)	Intercooler 
(3) Turbine Mass Flow Increase (4) Increased Isobaric Specific Heat ↓ Turbine Power Increase		Steam Injection	Steam Injection 

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