

A comparative experiment on energy consumption in cleanrooms with indoor water spray humidification and steam humidification systems

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For a large-scale high-tech industry plant, cleanrooms need to introduce conditioned air from the outdoor ambient environment. At this time, huge amounts of energy are consumed in an outdoor air conditioning (OAC) system to heat, humidify, cool, dehumidify outdoor air. Meanwhile, an indoor water spray humidification is helpful to replace the high energy consumption nature of steam humidification in the OAC system. Therefore, a comparative experiment on the energy consumption is needed to assess and prove energy reduction in cleanrooms with different humidification systems. In the present study, we conducted the comparative experiment on consumed electricity in cleanrooms with two types of humidification systems. The present twin cleanroom is located in Ansan-si, Kyunggi-do, South Korea and has 2,200 m³/h ~2,300 m³/h outdoor air intake.

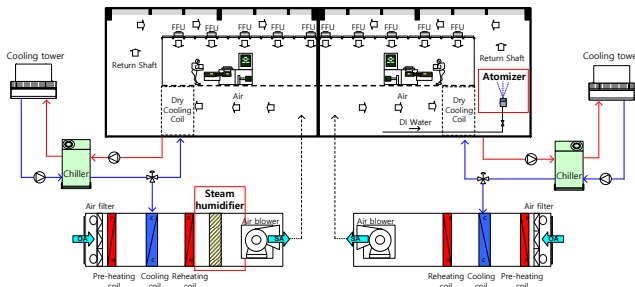


Figure 1. Schematic diagram of the present twin cleanroom for a comparative humidification experiment.

Table 1. Condition of twin cleanroom experiment

Climatic condition	Ansan, 2015-2016
Outdoor air flow	2,200 or 2,300 m ³ /h
Outdoor air temperature and relative humidity	Winter : 5.3 °C, 65.2% RH Intermediate : 25.9 °C, 25.6% RH Summer : 28.6 °C, 76.1%
Air state in cleanroom	23 °C, 45% RH
Cleanroom area, height	14.11 m ² , 2 m
Return shaft area, height	2.52 m ² , 4.2 m
Nozzle pressure, number	0.2 MPa, 10 ea

Table 2. Experimental results of cleanroom energy consumption.

Season	Item	Steam (kW)	Indoor water spray (kW)			
Summer	Consumption	15.849	17.173			
	Reduction	0	-1.32			
Break-Down	FFU		2.469	2.473		
	Cooling System	Cooling Tower	11.63	0.3	12.67	
		Chiller		6.93		7.87
		Pump		4.4		4.5
	Air Conditioning System	Heater	1.75	0	2.13	
		Humidifier		0		0
		Fan		1.75		2.13
	Intermediate	Consumption	25.816	27.208		
		Reduction	0	-1.392		
	Break-Down	FFU		2.472	2.47	
Cooling System		Cooling Tower	21.044	0.5	22.338	
		Chiller		16.044		17.628
		Pump		4.5		4.41
Air Conditioning System		Heater	2.3	0.15	2.4	
		Humidifier		0.41		0.1
		Fan		1.74		2.16
Winter		Consumption	24.784	17.472		
		Reduced	0	7.312		
Break-Down		FFU		2.471	2.472	
	Cooling System	Cooling Tower	9.52	0.35	9.83	
		Chiller		4.9		5.19
		Pump		4.27		4.32
	Air Conditioning System	Heater	12.793	2.253	5.17	
		Humidifier		8.72		0.94
		Fan		1.82		2.05

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