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PRELIMINARY STUDY ON THE REDUCTION OF PM10, CO_2 THROUGH MIST SPRAYING OUTDOOR UNIT OF AIR CONDITIONER

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ABSTRACT

In this research, we conducted experiments to confirm the effects of particulate matterand CO2 reduction through mist injection by existing technologies of research on low-cost mist spray type high efficiency outdoor machines, with a reduction in air conditioner heat island, improved outdoor unit efficiency by 30% It was. We installed a sensor in the outdoor unit supply / exhaust section and confirmed particulate matter / CO2 amount in accordance with the summer air conditioner operation schedule. When applying the mist spraying device of the air conditioner outdoor unit, it is measured to be lower than the particulate matter / CO2 amount general outdoor unit, so we would like to confirm the effect of reducing the particulate matterdust and CO2 amount through the mist ejection outdoor unit on a building unit basis.

KEYWORDS: Mist spraying, particulate matter(PM10), CO2, Outdoor unit of Air conditioner.

INTRODUCTION

Every spring season, patients with respiratory and allergic disease have increased in Korea due to fine dust generated from China, domestic roads, buildings, etc. In addition, there is a phenomenon that the risk of black-out at the national level has been elevated as the electric power reserve rate is decreasing due to the increase of electricity peak in summer, and the phenomenon is shown in figure 1 as follows.

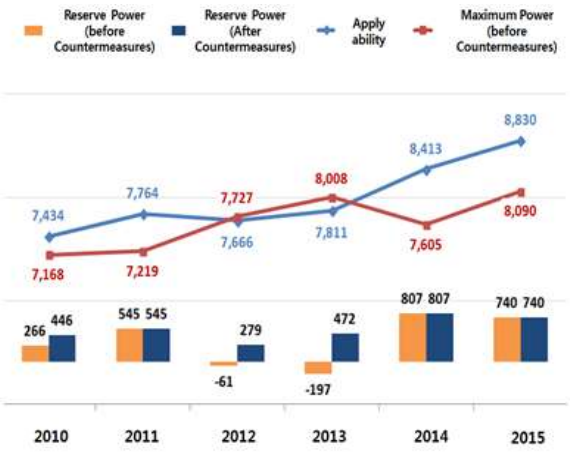

Figure 1: Summer demand peak demand and supply capacity trend (Unit:Ten Thousand kW)
(source: Ministry of Trade, Industry and Energy)

Creating pleasant environment in the urban area is becoming more difficult as Heat Island Effect in urban areas is aggravated due to climate change in summer. According to the advanced research, unpleasant wind, heat, etc. generated from the outdoor unit of air conditioners in summer are giving the environment and people displeasure, and through mist spraying outdoor unit not only can we lower the surrounding temperature of the outdoor unit but we are able to confirm the amount of energy reduction used in air conditioners. The purpose of this study is to confirm the reduction effect of fine dust•CO2 generated from the exhaust part of the outdoor unit of air conditioners and the temperature exhausted from the outdoor unit by applying the mist spraying outdoor unit on the outdoor unit of the air conditioner.

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Overview of the mist spraying technology

In this method, the first vaporing effect through evaporation is induced by spraying high pressure water in the form of mist to the outdoor unit of the air conditioner, and as a result, the surrounding air temperature of the outdoor unit is cooled by about 3~5℃.

The effect by cooled air increases the energy efficiency of the outdoor unit, reduces the exhaust temperature, the coefficient of performance (COP) increases according to the temperature drop of the outdoor temperature as shown in figure 2, and the outdoor temperature is decreased by the mist as shown in figure 3.

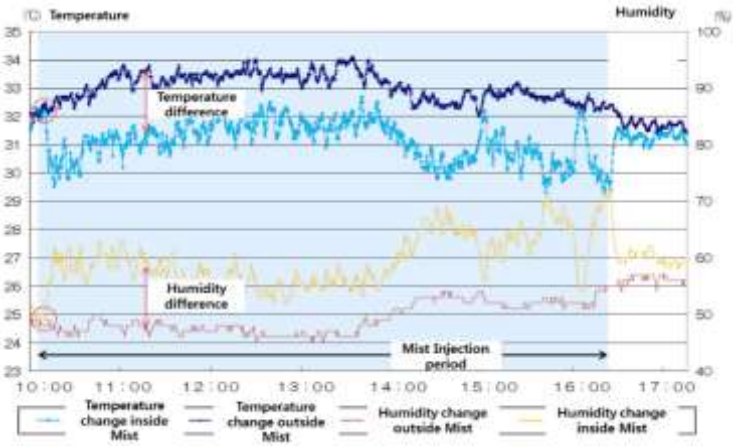


Figure 2 : Cooling Effect of Ambient Air by Mist Injection

Figure 3 shows the visualized operation method of the mist applied to the outdoor unit, and if the mist is applied based on the outdoor temperature of 32℃, the air with the temperature of 27℃ is drawn in to the outdoor unit increasing the air conditioning efficiency, and the discharged exhaust temperature is about 5℃ lower compared to the existing temperature.

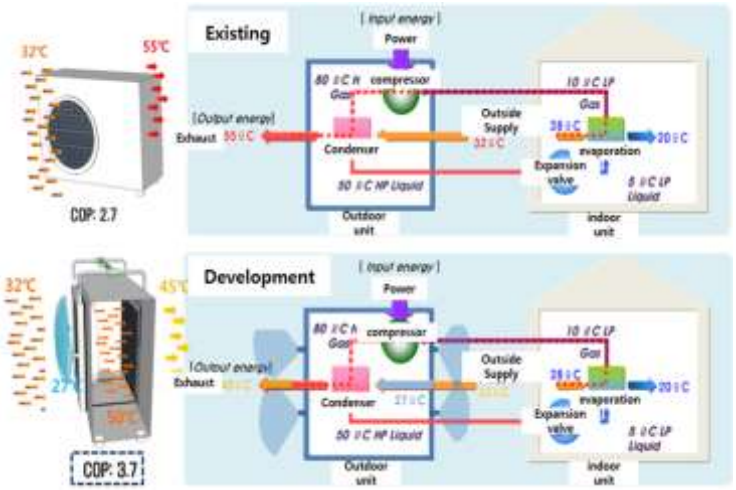


Figure 3 : Cooling Mist Injection System Concept Map

Actual measurement to understand the mist effect

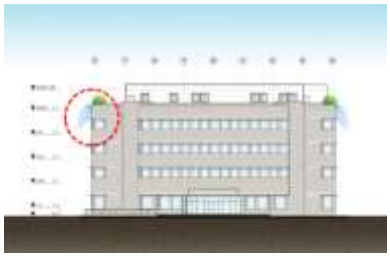
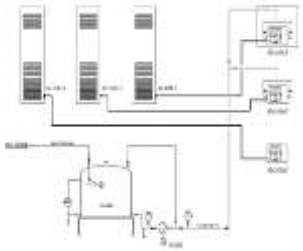
Overview of the Actual Measurement

In order to verify the effect of the mist, actual measurement was conducted targeting individual air conditioning and heater at some of the space on the 5th floor of the Korea Institute of Construction Technology. The overview of the actual measurement is shown in Table 1 as follows.

A total of 2 air conditioners were installed in the 5th floor of the construction innovation center, watt-hour meter was installed on each air conditioner, and they were measured at one-minute interval where one was set for normal operation and the other one for the mist.

The operation condition of the mist outdoor unit of the air conditioner is that when the compressor is operated at the outdoor temperature above 26℃, the mist is sprayed in connection to this and the water consumption for each nozzle is 93ml per minute. However, the mist equipment used in the actual measurement is a prototype and it is not optimized.

Table 1. Place of Installation of General and Mist Outdoor Air Conditioner

Place of installation of general and mist outdoor air conditioner	
	
	

Overview of test condition

(A) Air Conditioner Specifications

The air conditioner specifications used in the normal and mist outdoor unit of the air conditioners is shown in Table 2 as follows.

Table 2. Air Conditioner Specification

Air conditioner specification	
Operating specification	specification
Energy consumption efficiency : Level 5 Cooling efficiency : 3.06 W/w Rated cooling capacity : 6,000W	Stand type, 220V, 60Hz
	Size of indoor unit: 820x295x190mm
	Size of outdoor unit:660x475x242mm

(B) Overview of Air Conditioner Operation

The internal area connected to the two outdoor units is 72.4㎡ with the height of 2.4m, and the indoor temperature was set identically for both air conditioners regardless of normal operation and mist operation. The outdoor temperature was measured from the roof top of the construction innovation center, the interval of the actual measurement was set to 1 hour, and the test was conducted at the test condition so that the mist was sprayed above 26℃. However, the humidity condition of the outdoor unit was not set. The data measurement period of normal and mist operation is shown in Table 3 as follows. In addition, the operation time of the outdoor unit of normal and mist operation was set for 24 hours and tested, and it is shown in Table 4 as follows.

Table 3. Mist Operation Test Condition Temperature and Humidity Setting

	Experimental conditions	
	Outside temperature condition	Outside humidity conditions
Set condition of Whether	26℃	Do not set

Table 4. Normal and Mist Operation Data Measurement

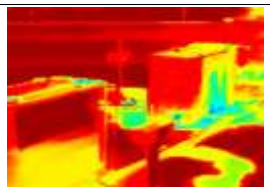
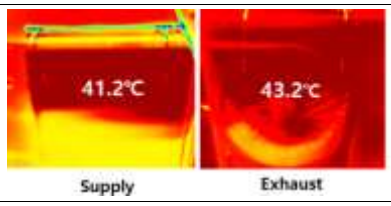
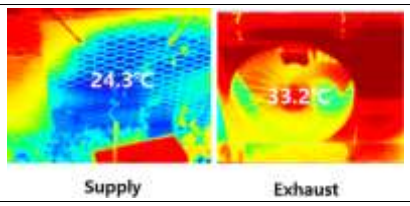
Measurement date		Indoor set temperature	Outside temperature	
			Max	Mim
2017	5/Aug	25℃	34.8℃	27.5℃
	6/Aug	25℃	34.0℃	28.2℃

Temperature measurement of normal and mist outdoor units

(A) Measurement of Surface Temperature

The surface temperature of normal and mist was measured using infrared thermal camera to confirm the mist effect. The surface temperatures of the inlet and the exhaust part of the normal and mist outdoor units were measured. Measurement result is shown in Table 5 as follows.

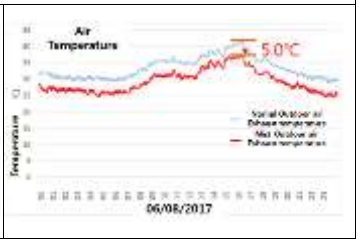
Table 5. Measurement of Surface Temperature of General and Mist Outdoor Unit

Measurement of surface temperature of general and mist outdoor unit	
	
Normal outdoor air supply / exhaust surface temperature	Mist Outdoor Air Supply / Exhaust Surface Temperature
	

As a result of measuring the surface temperature of normal and mist outdoor units, the temperature of the inlet part was 41.2℃, whereas the exhaust part was 43.2℃ for the normal outdoor unit, and the temperature of the inlet part was 24.3℃, while the exhaust part was 33.2℃ for the mist outdoor unit. There was a 16.9K difference in the inlet part and a 10K difference at the exhaust part due to the mist effect. We were able to confirm that as a result of comparing the surface temperatures, there was a great mist effect.

(B) Measurement of Air Temperature

Table 6. Normal and Mist Outdoor Air Temperature Measurement

Normal and Mist outdoor air temperature measurement		
		

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Air temperatures of normal and mist inlet/exhaust parts were measured using a thermometer to confirm the mist effect the result of the air temperature measurement is shown in Table 6 as follows.

The inlet part of the normal and mist outdoor units showed the temperature difference of 8.2℃ and the exhaust part showed 5.0K difference. The maximum air temperature of the inlet part of the normal outdoor unit was measured as 39.5℃, and the exhaust part was 42.3℃ while the maximum air temperature of the inlet part of the normal outdoor unit was measured as 31.3℃ and the exhaust part was 37.3℃. We were able to confirm that there was also a great mist effect on the inlet and exhaust parts similar to the comparison result of the surface temperature.

Particulate matter (pm10) and co2 measurement of normal and mist outdoor units

The result of fine dust (PM10) and CO2 measurement of normal and mist outdoor units is shown in Table 7, 8 as follows.

As a result of measuring fine dust (PM10) at the exhaust part of the normal and mist outdoor units, weconfirmed that fine dust (PM10) was reduced at the mist outdoor unit and discharged compared to the normal outdoor unit all on August 5, 2017 and August 6, 2017.

Table 7. Normal and Mist Outdoor Exhaust Air

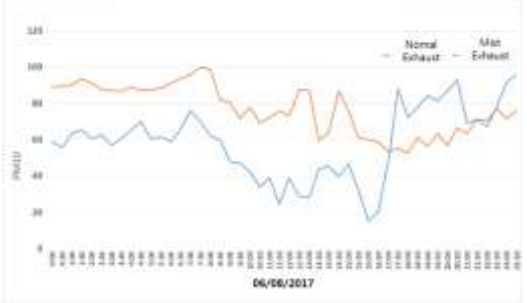
Actual measurement of fine dust (PM10) (August 5, 2017)	Actual measurement of fine dust (PM10) (August 6, 2017)
	

Table 8. CO2 Measurement of General and Mist Outdoor Unit

CO2 measurement (August 5, 2017)	CO2 measurement (August 6, 2017)
	

As a result of measuring CO2 at the exhaust part of the normal and mist outdoor units, we confirmed that CO2 was reduced at the mist outdoor unit and discharged all on August 5, 2017 and August 6, 2017.

When the mist is applied, fine dust (PM10) and CO2 generated from the exhaust part of the outdoor unit of the air conditioner were all measured lower than the normal ones. It is judged that this can reduce the amount of fine dust (PM10) and CO2 generated from the outdoor unit in summer season.

CONCLUSION

In order to verify the effect of the mist spraying system, outdoor units of the air conditioners used in the building were installed surface temperatures and air temperatures of the inlet and exhaust part of the outdoor units were

measured, and tests to verify the effects were conducted by measuring fine dust (PM10) and CO2 generated from the outdoor units. Therefore, the conclusion regarding this study is as follows.

(A) As a result of actual measurements of inlet/exhaust temperature difference of normal and mist outdoor units, test result shows apparent reduction in the air temperature and the difference in the surface temperature at the outdoor units where the mist spraying system is applied rather than the normal ones, and from this, it is judged that this may influence the energy reduction and heat island effect in the future.

(B) When the mist was applied, fine dust (PM10) and CO2 generated from the exhaust part of the outdoor unit of the air conditioner were all measured lower than the normal ones. It is judged that this can reduce the amount of fine dust (PM10) and CO2 generated from the outdoor unit in summer season, and it is considered that research regarding the processing method of liquified fine dust and CO2 is required in the future.

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