Transactions of the Korean Nuclear Society Autumn Meeting
Gyeongju, Korea, October 26-27, 2023

Calculation of Cooling Load for Reducing Condensate in Radiation Management Area of DU Facility

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***Keywords : DU Facility, Condensate Water, Air Conditioning, Cooling Load**

1. Introduction

The Nuclear Cycle Experiment Research Center is one of the facility of Korea Atomic Energy Research Institute(KAERI).

This facility is a laboratory-scale version of pyro-processing technology. Mixture depleted Uranium(DU) and depleted Uranium(DU) feed material are used in this facility for pyro-research.

During summer, air conditioners which maintain temperature and humidity are always in operation to protect analysis equipments. 15 air conditioners are installed in this facility.

Condensate from 15 air conditioners is increasing every year. In addition, the process of treating it as liquid radioactive waste is complicated, costly and time-consuming, causing a lot of inconvenience.

Therefore, we tried to identify and calculate the underlying causes of condensate generation.

This Paper calculated the facility's sensible and latent heat. This calculation can be used for equipment selection which has a cooling function and reducing condensate.

2. Calculations

To briefly explain sensible and latent heat, sensible heat is the amount of heat required to change the temperature of an object without changing its state, and latent heat is the amount of heat required to change the state of an object without changing its temperature.

The calculation method is to calculate the conduction and radiation heat, internal sensible heat, internal latent heat, and external load, and finally add each value to get the total load. variables include the size and exhaust volume of the facility, the number of employees, and the equipment owned.

The facility has a volume of 3,648 mters, an exhaust volume of 6,000 CMH(Cubic Meter Hour) and 10 employees.

2.1. Conduction and Radiant heat

Table. 1. Table of shows the results of the conduction and radiation heat calculations

	Area (m^2)	K (Total heat tranfer coefficient)	outdoor temperature difference (℃)	Cooling load (kcal/h)
South	152.0	0.32	3.2	153.2
North	152.0	0.32	14.3	695.6
West	96.0	0.32	18.8	577.5
East	96.0	0.32	14.3	439.3
Roof	912.0	0.30	3.2	861.8
Floor	912.0	0.90	6.3	5171.0
		Total(kcal/h)		**7,898**

The cooling load was calculated using the total heat transfer rate and the significant out door air temperature difference, including east, west, south, north, and roof and floor based on the building, and the final result was 7,898 kcal / h . From the table, we can see that the larger the area and sun exposure, the lager the cooling load.

2.2. Internal sensible heat

Table. 2. Table of shows the internal sensible heat

	Human sensible heat (kcal/h)	Equipment power consumptio,n (kcal)	Lighting load (W)
Value	760	86,000	27,360
CLF (Cooling load factor)	-	0.5	0.1
	760	43,000	2,736
		Total(kcal/h)	**46,496**

The indoor generated heat load was calculated using the CLF coefficient, which is one of the methods that simplifies the TFM(Transfer Function Methods) so that it can be calculated numetically. After adding various conditions, it was calculated and finally confirmed 46,496 kcal / h. Equipment power consumption is calculated assuming that all laboratory equipment is operational, and is the largest of the internally generated sensible heat

2.3. Internal latent heat

Table. 3. Table of shows the internal latent heat

Imployees	Human latent heat (kcal/h)	**Total (kcal/h)**
10	124.0	**1,240**

The latent heat generated internally by human respiration and sweating was 1,240 kcal / h.

Humans indoors give off heat and moisture through their skin and breathing, so it is necessary to calculate the heat dissipation for both sensible and latent heat loads.

2.4. External load

Table. 4. Table of shows the external load

Displacement volume (CMH)	Human emissions (CMH)	Ventilation emissions (CMH)	Absolute humidity difference(kg/kg')
6000	350	365	0.0079
		Total(kcal/h)	**34,020**

It is the sum of the Human emissions and laboratory ventilation, multiplied by the displacement volume and the absolute humidity difference.

The result of 34,020 kcal/h was obtained by calculating the exterior exhaust, human exaust, ventilation exhaust, and absolute humidity difference during cooling. Also, the absolute humidity difference is calculated by subtracting the summer outside temperature from the summer indoor temperature.

3. Results

The resulting load for cooling is 89,654 kcal/h.

However, we add a safety factor of 5% to 10% to allow for a number of variables. so the total load is 98,620 kcal/h.

The reason for adding a safety factor is to allow for leeway in the selection of end devices, and to ensure that the device is loaded heavily in advance

4. Conclusions

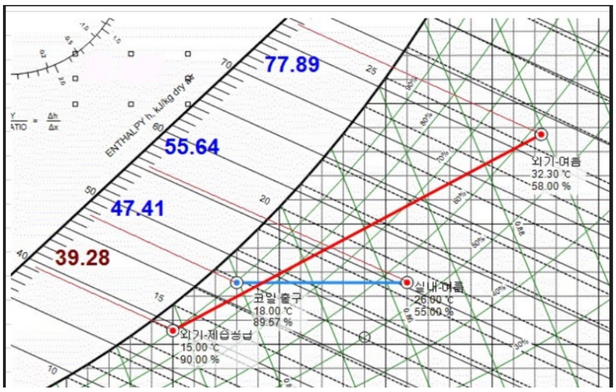

Fig. 1. psychrometric chart of equipment for condensate reduction

The final cooling load is 89,654 kcal/h. supplying air through an air conditioner with more cooling heat than the cooling load makes the workers feel comfortable. In the process, condensate is generated. To remove this condensate, an outside unit for dehumidification is installed to reduce the humidity and discharge the condensate to the outside. This way, there is no condensation inside.

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