DEHUMIDIFICATION BECOMES IMPORTANT FOR A BUILDING HAVING THICK THERMAL INSULATION

Kouichi SHINAGAWA ,Noboru ARATANI , Sadeghian Mohammad TAGHI

Department Of Architecture, Hokkaido University, Japan
Kita 13, Nishi 18, Kita-ku, Sapporo, Hokkaido, Japan 060
Tel: +81-11-706-6251 .Fax: +81-11-706-7828

ABSTRACT As the sensible heat gain or cooling load are decreased by using thick thermal insulation in a building, the need for dehumidification increases. Especially in Kushiro, it is rather cool and humid in summer because of its foggy weather. In this study, two types of dehumidification systems were developed and their performances were examined. The first is a heat-recovery type, which uses a cooling coil and a sensible heat exchanger. The second is a moisture-absorbent type, which uses heating and cooling coils and an absorbent. Remarkable improvements in dehumidification were obtained using the first type of dehumidification system. Using the second type of system, although the temperature of the outlet air rose slightly, both the absolute and relative humidity decreased remarkably. These features are desirable for a city such as Kushiro, in which the climate in summer does not necessitate much cooling of inlet air as is the function of an ordinary air conditioner. The moisture-absorbent type makes the most effective use of the cooling power for dehumidification of the three types. The result also showed that dehumidification is indispensable for thick thermal insulation, indicating that thick thermal insulation should be a key factor in passive and low energy architecture.

1. INTRODUCTION

Table 1 shows monthly average temperature and relative humidity in Kushiro, Sapporo and Tokyo. Kushiro is a cool and foggy city in summer, and therefore, dehumidification is more important than cooling to maintain a comfortable room condition. In case where only thin thermal insulation has been used in the building construction, heating is used even in summer as a primitive means of dehumidification. However, considering the relatively low temperature in summer and recent progress in the thickness of thermal insulation in house and building constructions in Kushiro, heating is not the most suitable means of dehumidification .Ordinary air conditioning systems ,which need reheat, are also not so appropriate for Kushiro.

PLEA 1997 KUSHIRO Materials & Components

In this study, the performance of an improved model of an ordinary dehumidifier using a sensible heat exchanger and a newly developed model using heating and cooling coils and absorbent were examined. The results of experiments using two models as well as a comparison to an ordinary type of dehumidifier are presented in this paper.

<Table 1> Monthly temperature and humidity in Kushiro , Sapporo and Tokyo

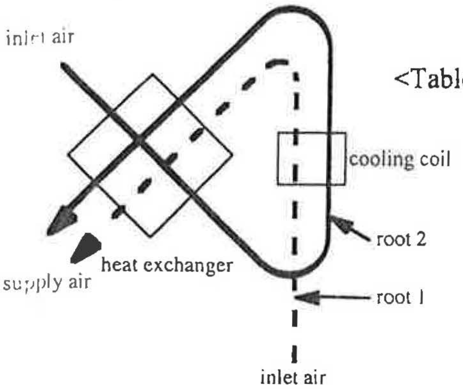
	July		August	
	temperature	relative humidity	temperature	relative humidity
Kushiro	15.5°C	89%	17.6°C	88%
Sapporo	20.2°C	79%	21.3°C	79%
Tokyo	25.2°C	77%	26.7°C	75%

[1]

2. Method

2.1 Heat-recovery type

Two types of dehumidification systems, ordinary type and heat-recovery type, were compared by changing the air flow route as shown figure 1. Specifications of the dehumidifier and cross-flow type heat exchanger are shown in table 2. In the case of the ordinary type, inlet air passing through route 1 is dehumidified by the cooling coil. In the case of the heat-recovery type, inlet air passing through route 2 exchanges sensible heat with the air passing through the cooling coil, so that the relative humidity of inlet air becomes higher and the air is effectively dehumidified by the cooling coil. In the case of the heat-recovery type, hot inlet air is precooled by the heat exchanger and the supplied air passing through the cooling coil is reheated. Thus most of the cooling power is used for dehumidification and its efficiency is improved.



<Table 2> Specification of the heat-recovery type

heat exchanger

total heating surface area	$1.21m^2$
pitch	2.5 mm
thickness of aluminum plate	2mm
number of aluminum plate	90

air flow rate of this system

air flow rate of traditional type	$200m^3$
air flow rate of heat recovery typ	$170m^3$

<Figure 1> Principle of heat-recovery type

2.2 Moisture-absorbent type

The principle of this newly developed dehumidifier ,which is different to that of an

ordinary type, is shown i
containing a calcium chlori
and wetted alternately by rot
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the moisture is absorbed by
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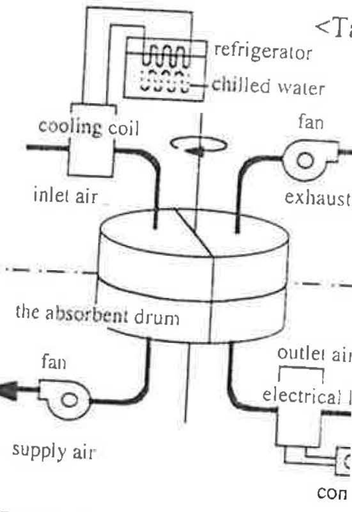


<Figure 2> Principle of the moi

3. TEST RESULTS

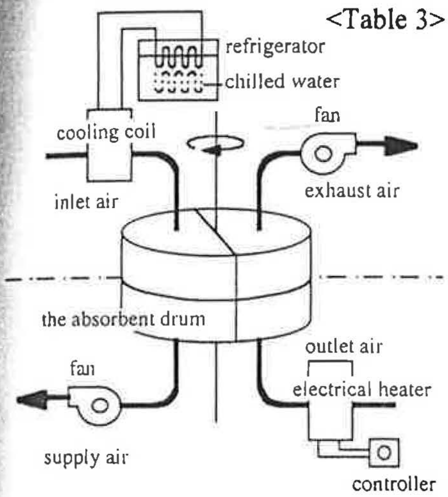
3.1 Heat-recovery type

The relationships between the ra
shown in Figure 3 by psychome
recovery-type. Figure 4 shows th
30 °C. As the temperature and
condensation rate increases. Th
130% to 200% larger than that
heat-recovery-type is less than
supplied air in the heat-recovery
The lower the relative humidity
recovery type become. When t
condensation forms at the heat ex
higher.

ordinary type, is shown in Figure 2. Cardboard rolled in a drum-sh[illegible]e and containing a calcium chloride was used for the absorbent. The absorbent [illegible]s dried and wetted alternately by rotating the drum. A rotation in a ten minutes wa[illegible] [illegible]sed in the experiments. The relative humidity of inlet air is raised by the cooling [illegible]oil and the moisture is absorbed by the drum. Then, the temperature of the sup[illegible]ied air increases by getting latent heat of condensation. On the other hand, the [illegible]rum is dried by the heated outlet air. An electrical heater was used to change the [illegible]antity of heat by four steps. The cooling power was changed in five steps. Table [illegible] shows specifications of the absorbent drum and the air flow rate of the [illegible]isture-absorbent type.

<Table 3> Specifications of the moisture-absor[illegible]nt type

moisure absorbent type	
sectional area of absorbent drum	[illegible] m²
thickness of absorbent drum	[illegible]
weight of calcium chloride in the absorbent drum	[illegible] kg
air flow rate	
heated air flow rate for recovery	[illegible] m³/h
dehumidified air flow rate	[illegible] m³/h

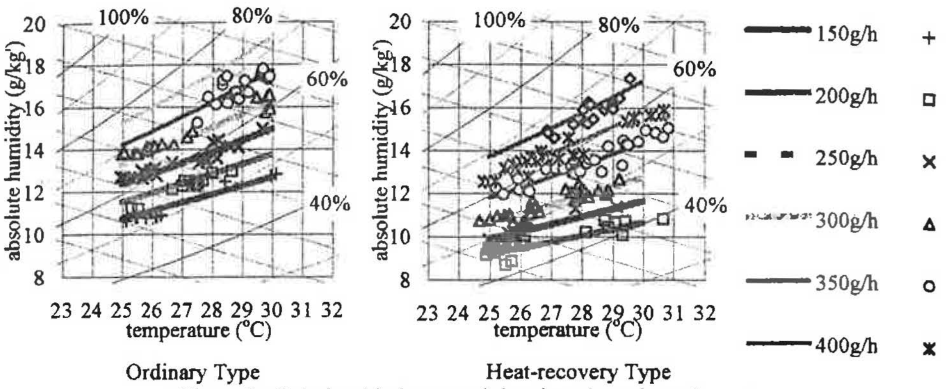


<Figure 2> Principle of the moisture-absorbent type

3. TEST RESULTS

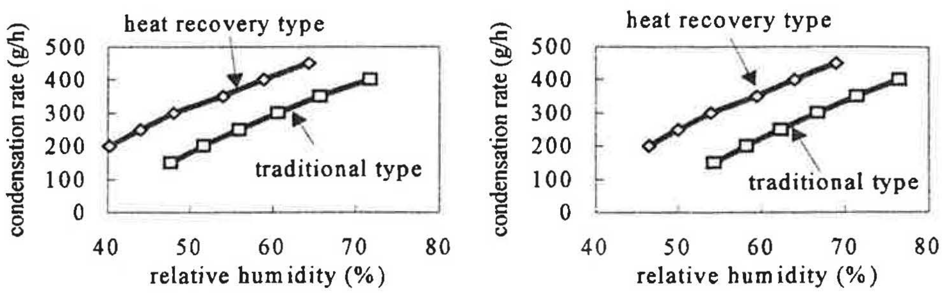
3.1 Heat-recovery type

The relationships between the rate of condensation and the condition of inl[illegible] air are shown in Figure 3 by psychometric charts for both the ordinary type and [illegible]e heat-recovery-type. Figure 4 shows the condensation rate of the inlet air at 25 [illegible] and at 30 °C. As the temperature and relative humidity of the inlet air incr[illegible]se, the condensation rate increases. The condensation rate of the heat-recovery type is 130% to 200% larger than that of the ordinary type. As the air flow ra[illegible] of the heat-recovery-type is less than that of the ordinary type, the humidit[illegible] of the supplied air in the heat-recovery type becomes lower than that of the ordin[illegible]y type. The lower the relative humidity of the inlet air is, the more effective [illegible]e heat-recovery type become. When the relative humidity of the inlet air [illegible]s high, condensation forms at the heat exchanger, making the temperature of the [illegible]utlet air higher.



Ordinary Type Heat-recovery Type

<Figure 3> Relationship between inlet air and condensation rate

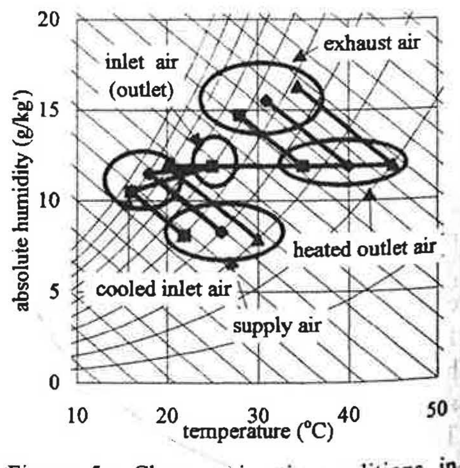


30 °C 25 °C

<Figure 4> Comparison of the condensation rates between two types when the inlet air is 25 °C and 30 °C

3.2 Moisture-absorbent type

Figure 5 shows changes in the air conditions of the moisture-absorbent type by a psychometric chart. The conditions of both inlet and outlet air are the same. The temperature of the cooled inlet air is determined by the water temperature of the cooling coil, and the moisture in the air is absorbed by the absorbent drums under conditions of similar enthalpy. The temperature of the heated outlet air is determined by the quantity of heat generated by the electrical heater. The moisture in the drum is evaporated by heated air under the conditions of similar enthalpy.



<Figure 5> Changes in air conditions in moisture-absorbent type

Figure 6 shows th
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condensation rate increase
the humidity of the heate
Therefore, it is important
dehumidification. Howeve
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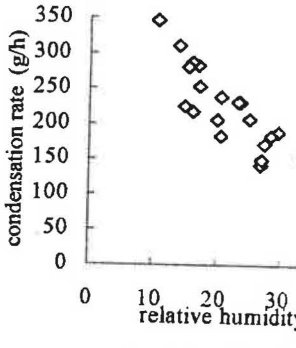

heated outlet air

<Figure 6> Condensation rate
according the relativ

4. DISCUSSION

Figure 7 shows differences
chart. In the case of the re
heat is exhausted from the c
of dehumidifier was develo
heat-recovery type, the tem
relative humidity is about 1
type. However, in the case o
the supplied air is much low

Figure 8 shows the
humidity of the inlet air and
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Kushiro with its cool summ
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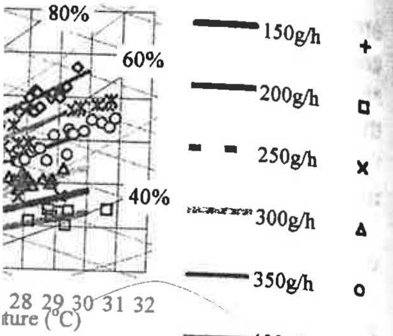

overy Type
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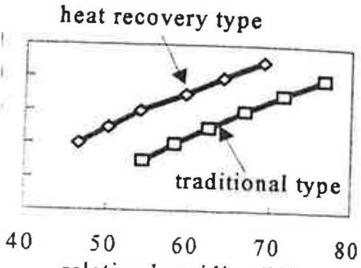
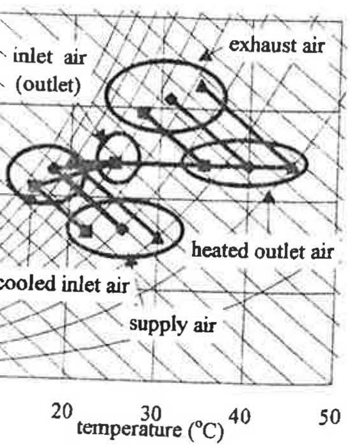
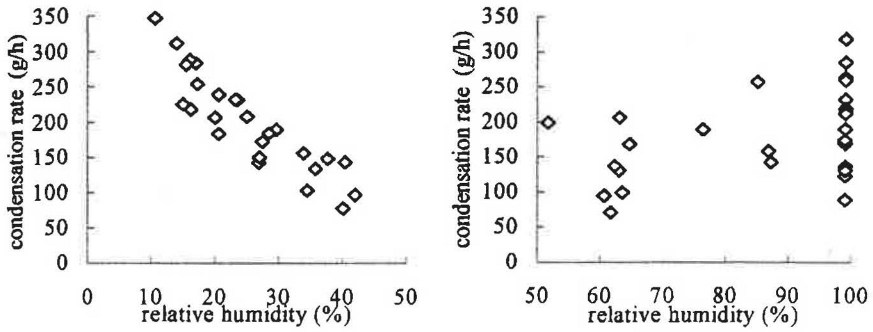


25 °C
tes between two types
30 °C



> Changes in air conditions in
ɔsorbent type

Figure 6 shows the relationship between the relative humidity of heated outlet air and condensation rate, and the relationship between the relative humidity of cooled inlet air and condensation rate. As the humidity of the outlet air decreases, the condensation rate increases. As the humidity of inlet air increases, the condensation rate increases. Compared with the humidity of the cooled inlet air, the humidity of the heated outlet air is directly related to the condensation rate. Therefore, it is important to lower the relative humidity by heating for effective dehumidification. However, excess heating increase heat loss. Thus, an appropriate balance between heating and cooling is important.



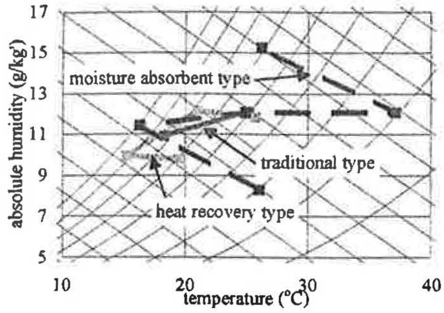
heated outlet air cooled inlet air

<Figure 6> Condensation rate
according the relative humidity of outlet air and cooled inlet air

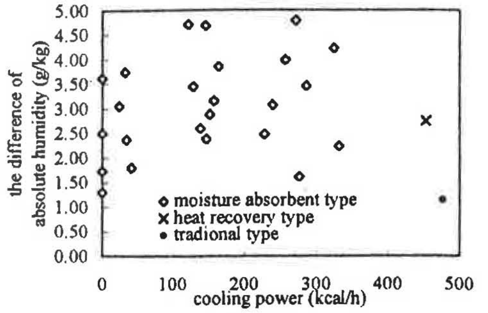
4. DISCUSSION

Figure 7 shows differences in the three dehumidifying systems by a psychometric chart. In the case of the refrigeration type only cooling power is used, and more heat is exhausted from the condenser without any use. The moisture-absorbent type of dehumidifier was developed to make use of this exhaust heat. In the case of the heat-recovery type, the temperature of the outlet air is about 2 °C higher and the relative humidity is about 10 % lower with less cooling power than the ordinary type. However, in the case of the moisture-absorbent type, the absolute humidity of the supplied air is much lower than that in the other types.

Figure 8 shows the cooling power and the differences between absolute humidity of the inlet air and that of supplied air at 26 °C and 60 % humidity. In the heat-recovery type, the deference is about twice that of the ordinary type. Although the moisture-absorbent type consumes less energy than the other type, the condensation rate of the moisture-absorbent type is almost the same rate as that of the heat-recovery type. In addition, it is possible to dehumidify without cooling. In Kushiro with its cool summer climate, if electrical heaters are replaced by boilers, it would be possible for the moisture-absorbent type of dehumidifier to supply sufficiently dehumidified air.



<Figure 7> Psychometric chart showing the differences in the three dehumidifying system



<Figure 8> Relationships between cooling power and the differences between the absolute humidity of the inlet air and that of the supply air at 26 °C and 60%

5. CONCLUSION

An improvement type of dehumidifier with a heat exchanger and a newly developed moisture-absorbent type were examined. The results of experiments using these new dehumidifiers showed that the condensation rate of the heat-recovery type was 130% to 200% larger than that of the ordinary type. In the case of the moisture-absorbent type, although the outlet air temperature rose slightly, the absolute humidity was much lower than the other types. This cooling system was considered to be most suitable for the climate of Kushiro .

Thermal insulation of buildings is becoming popular due to consideration of energy consumption and comfort. Although intermittent heating and cooling have been traditionally used in Japan, continuous heating is also becoming popular due to the increase in thick insulation. [2] In the case of cooling, continuous cooling is also very effective for minimizing load and making it possible to use floor cooling. [3] In such a case, the temperature of a room can be controlled by a water system and the role of air conditioning system must be concentrated to the humidity controll. The moisture-absorbent type of dehumidifier is suitable for an air conditioning system in a building using thick thermal insulation.

6. REFERENCE

[1] chronological table of science 1990, deter by a national astronomer, P16-10,1990

[2] Sadeghian. Mohammad. Taghi et al: "simplified calculation of cooling load for insulated building under the condition of small swing of room temperature." summaries of technical papers of meeting 1996 d-2, AIJ, P.35-36, 1996

[3] Sadeghian. Mohammad. Taghi et al: "The effect of heat exhaust by using Successive Integration Method." summaries of technical papers of meeting No. 69, Hokkaido branch OF AIJ, P313-316, 1996

Improv

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Yasuyuki FURUYAN

Eastern Hiroshim
2-39, 3-chome
Tel: +81-849

ABSTRACT It is difficult
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1. INTRODUCTION

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perforated specimen. The main
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