White Paper

Radiant ceilings and the dew point – cool heads even in high humidity

Tailor-made solutions for indoor climate

BARCOL-AIR by Swegon

White Paper

Radiant ceilings and the dew point – cool heads even in high humidity

Radiant ceilings are standard in modern office buildings. Thanks to their large surface area and energy absorption by means of thermal radiation, they ensure an extremely high level of thermal comfort even at relatively high water flow temperatures.

As with all surfaces that are colder in relation to their surroundings, radiant ceilings raise the question of dew point control. Condensation – which can cause damage both to the ceiling and office furniture – is practically excluded through various technical measures and only rarely occurs.

Dehumidification of the air supply into the building is generally no longer carried out for energy reasons. Dew point monitors are installed to monitor moisture in the building zones.

Unfortunately, however, dew point monitors are often set to switch off the radiant ceiling in the event of doubt, which means that they do not provide cooling precisely when required – on hot and humid summer days.

This White Paper puts forward alternatives.

The White Paper addresses the following questions:

- Humidity – a brief overview
- Dew point monitors in conjunction with radiant ceilings
- How a ceiling could continue to provide cooling even at higher humidity

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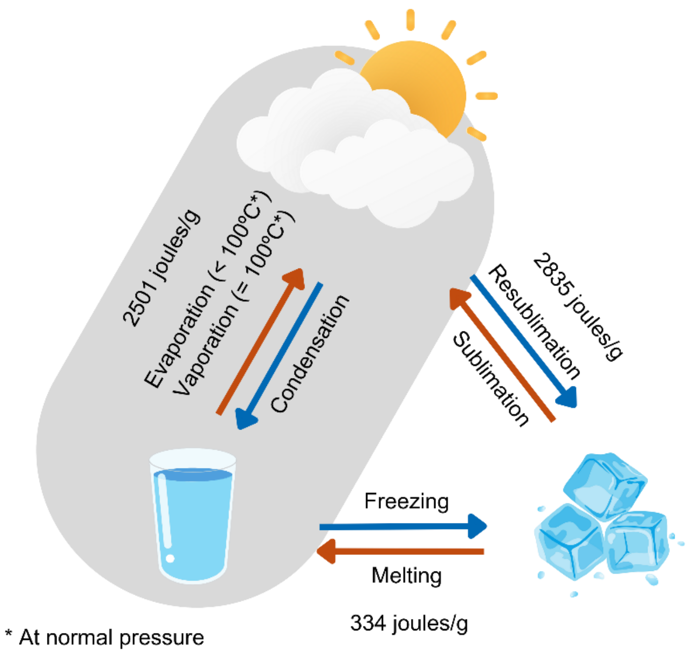
Humidity – a brief overview

Water evaporates in a variety of processes: from the transpiration of plants to the breathing of animals, and, of course, water surfaces also constantly absorb and release water – even at temperatures well below boiling point.

What all of these processes have in common is that during evaporation, energy must be transferred from the environment to the water molecule. This is the only way it has enough energy to escape the looser "web" of the liquid water. At the same time, the opposite process, condensation, requires the same amount of energy to be released.

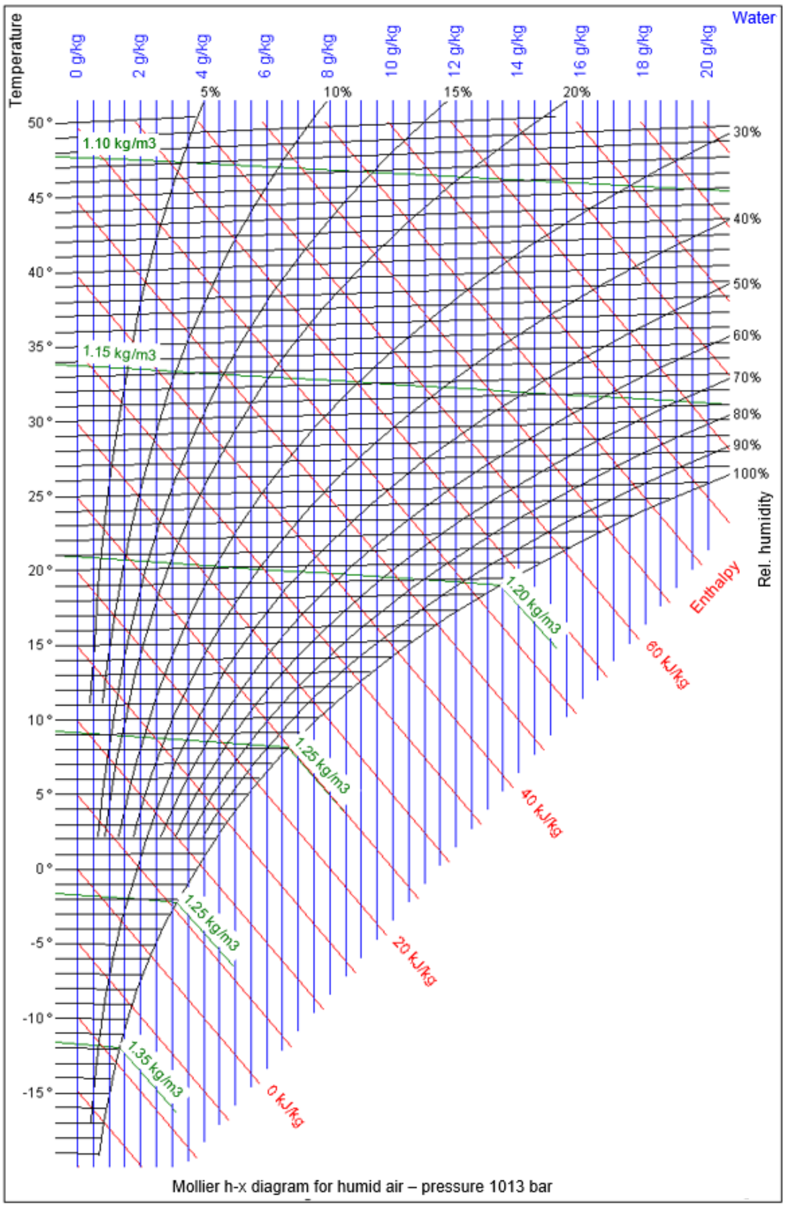
These amounts of energy are huge: whereas heating one kilogram of water by 1 K takes just 4'187 J, evaporating one kilogram takes 2'500'000 J – 500 times the amount! Precisely BECAUSE the connection between the water molecules is so strong.



There is always a certain amount of water present in the air around us. The “solubility” of water in the air, however, depends among other things on how warm it is (similar to how table salt dissolves better in hot water).

Whether or not water condenses in a specific case is therefore based not on the absolute water volume (in g of water per kg of air), but rather on the relative humidity of the dissolved water in % of the maximum solubility at a certain temperature (or two; that of the air and that of the surface).

The exact data of these correlations can be found in the h-x diagram developed by Richard Mollier in 1923. However, the following is more of a qualitative approach.



Dew point monitors in conjunction with radiant ceilings

It is clear that, for a radiant ceiling to function properly, it must be colder than the room to be cooled. As described above, the air in the room contains a certain amount of water.

If, for example, the air temperature is 25 °C, then 20 g of water per kg of air can be dissolved. If the temperature of the coldest ceiling panel is 16 °C, only 12 g/kg can be dissolved in the cold air directly on the panel – the rest condenses on the pipes, which are cold in relation to the room.

For various reasons, this does not always occur in rooms with radiant ceilings:

- Naturally, the relative humidity is usually not 100 % but rather around 40-60 %. This means that only around 8-12 g/kg of water is dissolved in “normally humid” ambient air – i.e. less than the dew point of the pipes at 16 °C, for example. In particular, the supply air into the building could be dehumidified in a monobloc. However, for energy reasons (dehumidification requires a considerable amount of energy; see above), such solutions are approved less and less often.
- For energy reasons alone, attempts are made to design the flow temperature of ceilings to be as high as possible. Considerable successes have been achieved in this regard in recent years. The higher the waterflow temperature, the lower the frequency of excessive relative humidity. You can find out more about this in our White Paper “Increasing the cold water flow temperature – energy efficient cooling”.
- A dew point monitor is installed in the room, which switches off the radiant ceiling (via the local actuator) as soon as the relative humidity in the ambient air approaches the dew point of the radiant ceiling.

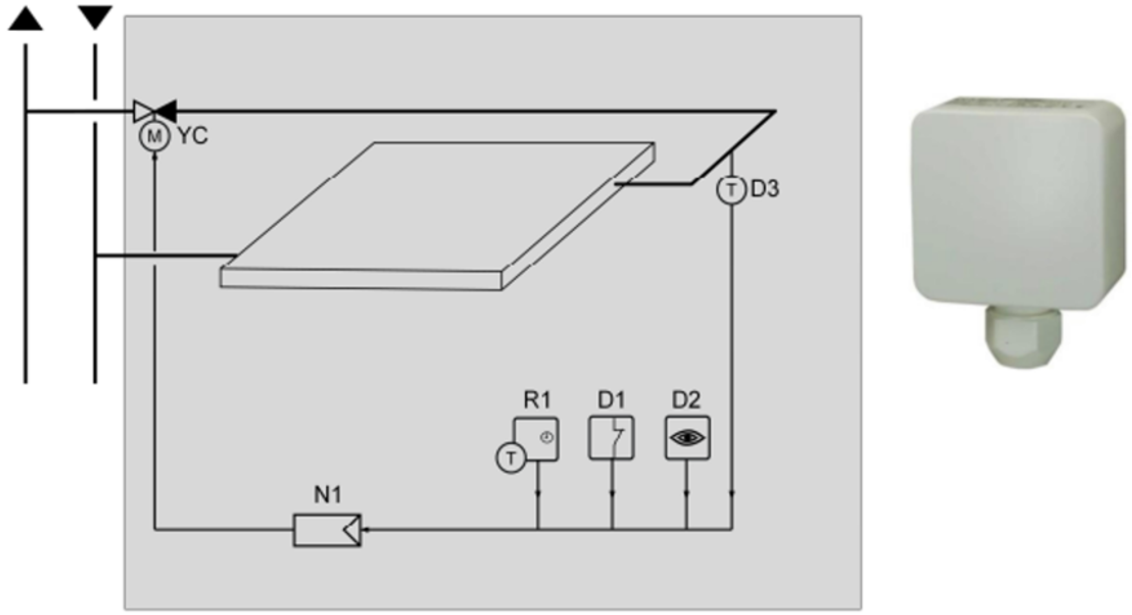


Fig. 7-11 Radiant ceiling with local dew point monitoring (source: Siemens)

D3	Dew point sensor	R1	Room unit with temperature sensor
YC	Cooling valve (continuous)	D1	External contact (e.g. window)
N1	Individual room controller	D2	Presence detector

Dew point monitors are designed in such a way that they “close without energy”, i.e. they always switch off the ceiling if there is no power.

How can a radiant ceiling be operated even at high humidity?

Dew point monitors switch off a radiant ceiling as soon as the humidity approaches the dew point of the flow temperature. As we practically never see condensate on radiant ceilings, this works very well.

It is a shame, however, that the radiant ceiling does not work precisely when we need it most – humid summer afternoons after 3pm.

There is a simple and popular trick to get round this: as soon as the moisture in the air approaches the dew point of the ceiling, the flow temperature is raised (usually centrally, for the entire building). This causes it to move further away from the dew point.

For example, the University Hospital Zurich writes in its “Cold distribution guideline 2023”:

- “To eliminate the risk of condensation, the flow temperature must be above the respective room dew point. The control valve must also close when the windows and radiator valves are open (e.g. interlocking through window contacts). The return temperature of the pumped cold water should be designed to be as high as possible.
- The **flow temperature must be adjusted subject to the room humidity and the resulting dew point**. This means that, despite a slight drop in performance, operation of the radiant ceiling can continue without interruption through a change in flow temperature.”

Local control of the cooling water flow temperature according to room conditions

Dew point monitoring is carried out individually in each room. The permissible cooling water flow temperature is calculated in each room from the temperature and room humidity, and – if necessary – is increased in this room. The cooling water connection is carried out via a variable-temperature hydraulic circuit (e.g. mixing or injection circuit).

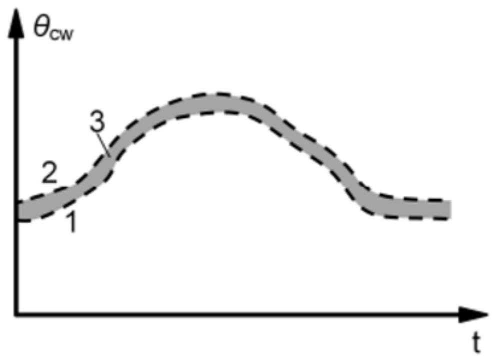


Fig. 7-14 Local control of the cooling water flow temperature according to room conditions
1 Dew point temperature of the room
2 Cooling water flow temperature
3 Safety zone

Source: Siemens

In this way, not only is the formation of condensate avoided, but the radiant ceiling also continues to function – albeit at reduced capacity.

My radiant ceiling switches off when humidity is high – what can I do?

Unfortunately, it is precisely the hot days in late summer, around 3pm, that are particularly humid. These can cause the radiant ceiling to switch off.

It is for such cases in particular that a flow temperature change should be planned by technical designers and implemented by I&C engineers during the construction phase.

If this was forgotten during the construction phase, I&C engineers can help. They know how to set up a flow temperature change.

Under no circumstances should you manually override the dew point monitor. Not only do you risk damage to the ceiling and furniture, this would also void the guarantee.

Manually reducing the flow temperature is also not practical – it would only cause the temperature to fall even further below the dew point.

Conclusion

Keeping a ceiling free of condensate is not difficult – in addition to dew point monitors, the constantly improving performance of radiant ceilings and therefore the higher water flow temperature helps.

The trick is, in the rare cases where the water volume in the air approaches the dew point of the flow, not to simply switch the ceiling off, but to increase the flow temperature.

This should be planned and implemented by technical designers and I&C engineers. So that we can keep a cool head even on sweltering summer days.

Any questions? Get in touch. Our specialists are happy to help.

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