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Considerations for Active Chilled Beam Designs

What About Control Strategies?

This design bulletin deals with considerations of Active Chilled Beam **Control Strategies**

What are the most important control considerations?

1) **Primary Air Strategy:** Determine the primary air absolute humidity condition needed to ensure the design latent capacity is delivered through primary air absolute humidity differential (Δw) to the room design condition and control the primary air handler to maintain that absolute humidity condition in the primary air as a minimum requirement.

   Refer to explanations on page 2 of this design bulletin regarding absolute humidity differential for a given primary air quantity. If the primary air handler control strategy can be made to maintain the design absolute humidity differential (Δw), or the design primary air absolute humidity value, the design latent cooling for a given primary air quantity will be consistently delivered.

2) **Dew Point Strategy:** All chilled beam designs are well advised to incorporate a dew point strategy in the event latent loads are exceeded from time to time or primary air latent capacity is marginal for whatever reason.

   A dew point strategy would see dew point conditions measured at a typical return/relief air point for comparison of the dew point temperature against secondary water temperature. Where dew point conflict is sensed or calculated, one of two control strategies can be adopted.

   a) Increase secondary water temperature by one degree to avoid condensation while reducing primary air temperature to the coldest design condition to maximise latent performance delivered. This minimises the impact on secondary cooling performance while maximising latent delivery to the space.

   b) Terminate secondary water flow while reducing primary air temperature to the coldest design condition to maximise latent performance delivered until the dew point conflict is resolved. This strategy significantly reduces sensible cooling delivered to the space and should only be seen as an emergency strategy.

Choose dew point sensor locations carefully to ensure a common return air path does not dilute the air being sensed due to all zones not being in maximum occupancy conditions at all times. Favour return air dew point sensors installed per independent zone space as close to the return air or relief air opening as possible, or the use of combination humidity/temperature room sensors where the humidity sensor component can communicate as a dew point sensor.

What degree of primary air temperature control needs to be considered?

Generally, primary air can be constant volume and constant temperature for cooling applications.

Where needed or preferred, primary air temperature can be allowed to 'glide' to warmer temperatures where sensible loads are reduced but care must be taken to ensure that latent capacity is always being delivered. Warmer primary air temperatures often do not provide for adequate latent performance in the primary air stream.

If sensible loads are likely to increase during part-load conditions, primary air temperature should be reduced to the lower design temperature (maximum latent cooling) first before allowing the secondary water flow to resume.

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For more design considerations, see other issues of the Design Bulletin

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Does the primary air system need VAV control?

No. The primary air system can easily be constant volume (CAV) as the amount of air in question is quite small compared to a conventional VAV system design.

In some designs for larger buildings even greater fan power savings can be realised by incorporating VAV strategies into the primary air but it is not considered essential to a successful design.

In multi-purpose use buildings requiring different primary air temperatures or quantities per floor or zone, a VAV strategy can be useful in overcoming problems related to over-cooling or over-heating through primary air.

How to ensure the required latent cooling capacity is being delivered?

Latent capacity is extremely important in ensuring unwanted condensation does not occur.

Consider latent loads carefully and include accurate loads in your original load assessment.

Once the primary air quantity is reasonably known, air handler requirements for ensuring latent capacity is delivered can be checked.

Assume the primary air latent capacity requirement for a given zone is 2955W for a primary air quantity of 670 L/s; 12ºC & 90%rh primary air is the design condition and the room design condition is 24ºC & 50%rh.

24ºC & 50%rh room air has an absolute humidity value of 9.34 g/Kg

12ºC & 90%rh primary air has an absolute humidity value of 7.88 g/Kg

The absolute humidity differential (Δw) is therefore 1.46 g/Kg

The (Δw) of 1.46 g/Kg is required to ensure design latent capacity is delivered for 670 L/s

If primary air design condition is 12ºC & 90%rh the air handler control logic must simply be scheduled to deliver a primary air absolute humidity value of 7.88 g/Kg, or controlled to ensure the correct absolute humidity differential (Δw) of 1.46 g/Kg compared to room air absolute humidity is satisfied.

Compromising on primary air latent capacity will likely lead to dew point conflicts and unwanted reductions in sensible cooling through secondary water flow limitations in avoiding condensation as discussed earlier in this Design Bulletin.

How can you avoid condensation at system start up?

After prolonged periods of HVAC system shut-down such as commissioning, weekend closure or night purge where humid ambient air infiltrates the building, it is important to first gain control over the room humidity or dew point before allowing secondary water to circulate through the Active Chilled Beams.

Start the primary air handler and operate a moisture staircase strategy to gradually reduce indoor humidity to a pre-determined level. Dew point sensors in the space can be used to measure room space absolute humidity and to confirm if dew point conflicts with secondary water temperatures are likely.

If design room condition is 24ºC & 50%rh and primary air design condition is 12ºC & 90%rh, the air handler control logic and dew point strategy must simply be scheduled to achieve a room air absolute humidity value of 9.34 g/Kg or lower to prevent condensation occurring during start-up where no additional latent load exists in the space.

Operate the air handler, without enabling secondary water circulation, until a room absolute humidity value equal to or lower than 9.34 g/Kg is achieved regardless of room dry bulb temperature before enabling secondary water flow to the active chilled beams. Secondary water flow can then be enabled to increase sensible cooling to the space for pull-down performance.

Failing to establish the necessary absolute humidity value of the room air condition increases the risk of condensation occurring when secondary chilled water is enabled through the secondary heat exchanger of the ACB units.

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This series of design bulletins is provided by Dadanco in the interest of sharing design experience with those interested in learning more about Active Chilled Beam design fundamentals

ACTIVE CHILLED BEAM

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For design assistance or further information, contact:

Dadanco Pty Ltd
89 South Road
Hindmarsh, S.A. 5007
Australia
P: +618 8346 3588
F: +618 8346 7822
info@dadanco.com.au
www.dadanco.com.au