

Mechanical systems and building envelope working together for better buildings

ABEC, November 27, 2019

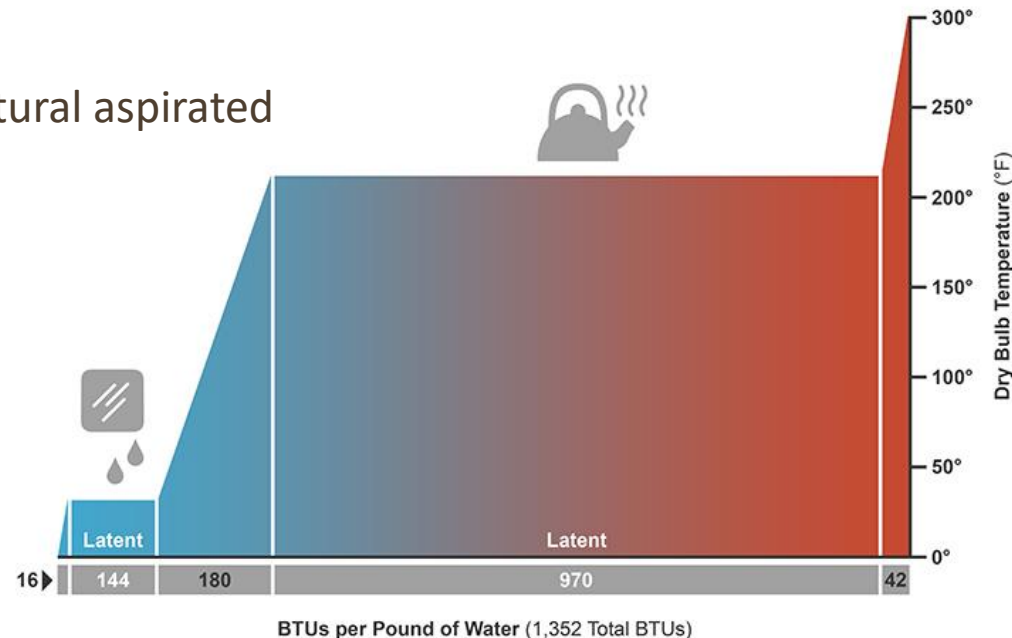
Agenda

- Introduction
- Understanding Mechanical Systems
- Mechanical Systems, Building Envelope & Energy Efficiency
- How the different Mechanical Systems affect Indoor Air Conditions
- Possible Problems due to Mechanical Systems that may affect the Building Envelope



Understanding Mechanical Systems

- Latent heat vs sensible heat
 - Sensible no change in phase
 - Latent change in phase – gas to liquid or vice versa
 - A/C
 - Evaporative humidification
- Forced air
 - Closed combustion chamber versus natural aspirated
 - Make-up air
 - Combustion air
 - A/C
- Hydronic heating
 - Infloor
 - A/C - mini split system



Understanding Mechanical Systems, cont'd

- Hybrid system
 - FCU and infloor
- Roof top units (commercial)
 - Supply only fan with mix box
 - Positive pressure
 - Inter-connected with other building exhaust fans for building ventilation
 - Economizer function (dry bulb versus enthalpy)
 - Supply fan and exhaust fan
 - Balanced
 - Inter-connected with other building exhaust fans for building ventilation
 - Economizer function (dry bulb versus enthalpy)



Understanding Mechanical Systems, cont'd

- Ventilation

- 9.32, CSA F326, ASHRAE 62
 - Principle ventilation system interlocked with forced air system
 - Dedicated ventilation system
- HRV & ERV
 - Defrost cycle
- Passive HRV
- Exhaust fan only
 - Not code unless no combustion susceptible appliances
- ZRT – *Aldes* and no exhaust fans option
- HRVs in commercial buildings
 - Defrost cycle

- Humidification

- Flow through, drum, steam
- ERV
- Ambient reset humidistat



Mechanical Systems, Building Envelope & Energy Efficiency



- Effective insulation value used for calculating heat loss and heat gain
 - Considering thermal bridging
- Better building envelope (insulation perspective)
 - Smaller mechanical system
 - Heating and cooling
 - Harder to upgrade building envelope than mechanical system in the future
 - Better effective insulation values
 - Better windows
 - U value
 - SHGC
 - ER value
 - Better building envelope (insulation perspective), lower GHGs, operating costs and more importantly, more comfortable

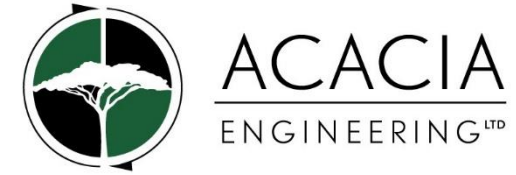


Mechanical Systems, Building Envelope & Energy Efficiency, cont'd

- What is heat loss calculation?
- What is heat gain calculation?
- Air leakage and blower door testing
 - What is a blower door test?
 - How is it conducted?
 - CGSB (withdrawn support) vs an “as operated”
 - Leaky home vs tight home
 - Leaky – dryer, cold draft, less comfortable
 - Tight – higher humidity levels, greater chance of issues with pressure problems in the home
 - Combustion spillage
 - Setting up the home (NRCAN guidelines)
- Humidification & dehumidification of a home



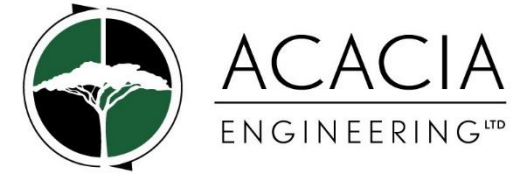
How do different Mechanical Systems Affect indoor Air Conditions (Moisture Content & Pressure)?



- Forced air
 - Closed combustion chamber versus natural aspirated
 - Natural aspirated draws air in from outside for combustion
 - Drying effect
 - Closed combustion chamber, no outside air into home for combustion air
 - House tends to have a positive pressure when operating due to make-up air
 - Solution is to operate exhaust fans when furnace fan is running
 - Make-up air
 - Positive pressure
 - Drying air
 - A/C
 - Drying and dehumidification



How do different Mechanical Systems Affect indoor Air Conditions (Moisture Content & Pressure)? Cont'd



- Ducting (supply air and return air)
 - Must have a return path, min. one per floor, ideally one per room
 - Undercuts doors
 - Fully ducted preferred
 - Current normal using joist cavities with a duct liner
 - Supply duct should be sealed and correctly sized
 - Duct sizing and pressure drop
 - Equivalent length
 - Ability to provide the right amount of conditioned (heat / cool / ventilation) air to the right areas of the home / building
 - Temperature control
 - Likely different for summer and winter



How do different Mechanical Systems Affect indoor Air Conditions (Moisture Content & Pressure)? Cont'd

- Hydronic heating
 - Infloor
 - Difficult to add moisture
 - Typically, a dedicated fully ducted HRV / ERV
 - Drying effect
 - A/C – mini split system
 - Drying of air
- Hybrid system
 - FCU and infloor
 - Same as forced air, can add humidifier
- Roof top units (commercial)
 - Supply only fan with mix box
 - Positive pressure
 - Inter-connected with other building exhaust fans for building ventilation
 - Economizer function (dry bulb vs enthalpy)
 - Drying effect
 - More people and therefore greater humidity



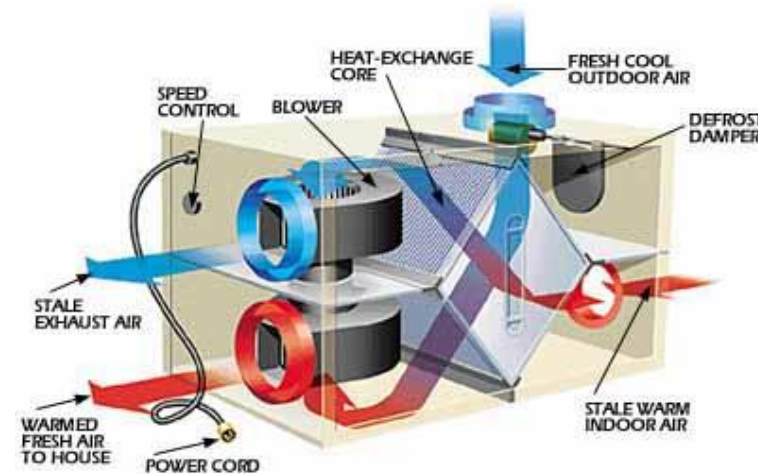
How do different Mechanical Systems Affect indoor Air Conditions (Moisture Content & Pressure)? Cont'd

- Roof top units (commercial)

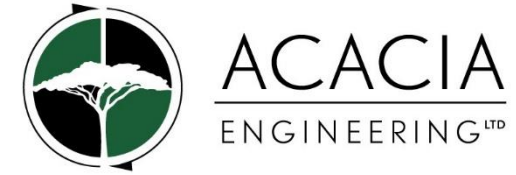
- Supply fan and exhaust fan
 - Balanced system
 - Inter connected with other building exhaust fans for building ventilation
 - Economizer function (dry bulb vs enthalpy)
 - Drying effect
 - More people and therefore greater humidity

- Ventilation

- 9.32, CSA F326, ASHRAE 62
 - Will dry the house
- HRV (balanced system)
 - Drying effect
 - Should be balanced
 - F/A intake shorter than exhaust add, therefore will likely create a positive pressure in a home
- ERV (balanced system)
 - Less of a drying effect
 - Should be balanced



How do different Mechanical Systems Affect indoor Air Conditions (Moisture Content & Pressure)? Cont'd



- Ventilation

- ERV (balanced system)

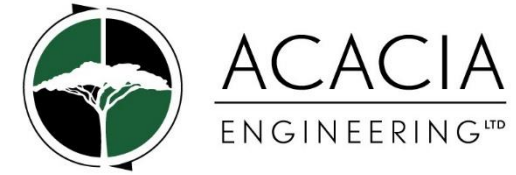
- Less of a drying effect
 - Should be balanced
 - F/A intake shorter than exhaust add, therefore will likely create a positive pressure in a home

- Exhaust fan only

- Not code unless no combustion susceptible appliances
 - Dries air
 - Sizing of exhaust fan duct very important
 - Often undersized



How do different Mechanical Systems Affect indoor Air Conditions (Moisture Content & Pressure)? Cont'd



- Understanding the effect of outside air in a home / building
 - Air leakage and ventilation
 - Drying effect
 - Psychometrics
 - High ventilation rates require more humidity to be added
- Humidification
 - Flow through, drum, steam
 - ERV vs HRV
 - Ambient reset humidistat
 - Control of humidity in the home

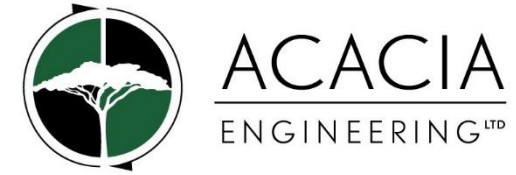


Possible Problems due to Mechanical Systems that may affect Building Envelope

- Humidity level too high
 - Symptoms
 - Condensation
 - Moisture getting into building envelope including ceiling spaces
 - Dust lines / spots
 - Cause (investigate)
 - Consider when it happens (weather conditions / season / change in weather)
 - Consider how the building is being used or change in use
 - Possibly install data loggers
 - Source of moisture
 - Humidity control set points
 - Exfiltration and condensation
 - Very tight building envelope
 - Pressure in building and at different levels
 - Mechanical system control and operation
 - Type of mechanical system
 - Pressures in the home at different levels



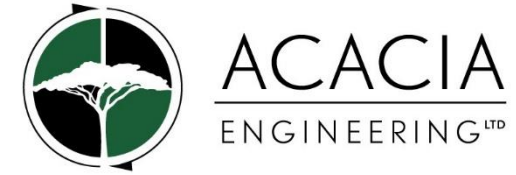
Possible Problems due to Mechanical Systems that may affect Building Envelope, cont'd



- Humidity level too high
 - Possible solution
 - Ventilation
 - Ensure exhaust systems are operating as designed
 - Balanced ventilation system (HRV / ERV)
 - Control strategy
 - Use what is in the home / building
 - Reduce amount of moisture being produced
 - Draft proof at high level
 - Eliminate penetrations into building envelope where possible
 - Manage moisture to prevent harm



Possible Problems due to Mechanical Systems that may affect Building Envelope, cont'd



- Cold rooms (uncomfortable spaces)

- Symptoms

- Uncomfortable
- Uneven temperatures

- Causes

- Drafts
- Lack of insulation
- Insufficient heat / cooling for the space
- Humidity levels to low
- Poor duct design or installation
- Unsealed ducts
- No R / A path
 - Doors not undercut

- Possible solutions

- Use IR to determine if there is an insulation issue
- Consider age of home
- Consider surface area
- Consider thermal bridging
- Complete a room by room heat loss / heat gain calculation
- Confirm volume of conditioned air going into space
- Confirm the R/A path
- Control strategy
- Continuous fan operation
- Balanced ventilation system
- Zone control
 - Electric vs gas heat (GHG and operating cost)



Possible Problems due to Mechanical Systems that may affect Building Envelope, cont'd

- Humidity levels too low
 - Symptoms
 - Cracking furniture
 - Static electricity
 - Hardwood cracking
 - Cause
 - Leaky building envelope
 - Too much ventilation
 - Insufficient humidification
 - Poor control strategies for ventilation and humidification
 - Naturally aspired mechanical system
 - Combustion air
 - Make-up air
 - Solution
 - Determine building envelope tightness
 - Draft proof
 - Add humidifier
 - Better controls



