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HVAC, Control, and Plumbing Systems for “Thermos Bottle Buildings”

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“Thermos Bottle Buildings” are now popular and practical. However, they have thermal properties so different from traditional buildings that they require a surprising re-thinking of the fundamentals of HVAC, control, and plumbing systems in order to optimize cost, performance, and maintainability.

Lyme Inn Intro

1. Thermos Bottle Buildings
    a) Description and examples
    b) Purpose: select appropriate systems
    c) Surprise! This is a revolution, the old answers don't work any more.

2. Review of System Options
    1. Terminal Units and Ventilation
        a) FTR
        b) radiant ceiling panels
        c) FCU
        d) Air Source Heat Pumps (ASHP)
        e) valence convectors
        f) unit ventilators
        g) AHU/RTU/UV economizer cooling
        h) ERV's
    2. Plumbing
        a) Central Hot Water
        b) Area Hot water

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c) point of use hot water
d) multiple temperatures required, 140, 130, 115, 100
e) Legionella
f) recirculation

3. Compare Building Types
    a) heating/cooling balance point,
    b) economizer, dewpoint

4. Three generations of buildings – introduction
    a) Leaky, ~20th Century until 1970's, 65 degree F balance point
    b) Insulated ~2000, 55 degree F balance point
    c) Thermos Bottle ~the way of the future and current "green" buildings, 25 degree F balance point

5. Characteristics of Leaky Buildings
    a)
        - High Heat Loss
        - Internal heat gains don't really matter
        - Large windows
        - High infiltration, ventilation sometimes omitted
    b) Results
        - high heat input needed even for steady state
        - high radiant disparity (cold windows and floors, hot heaters)
        - balance point 65 degrees F
        - economizer not important, in fact, ventilation not important
    c) Example of good HVAC system choices
        - Radiators under cold and drafty windows
        - or radiant floor – it will actually feel warm
        - ERV ventilation to minimum required – no economizer cooling
        - or openable windows – by the time you need to open windows (65F) it will be so

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mild that people won't mind having to do it.

6. Characteristics of Insulated Buildings
    a)
        - moderate heat loss
        - moderate internal heat gain
        - large windows
        - moderate infiltration
    b) Results
        - moderate heat input needed even for steady state
        - internal radiant disparity (cold windows, hot heaters)
        - balance point 55 degrees F
        - ventilation required
        - economizer important (but OA dewpoint often too high)
    c) Example good system choices
        - Unit ventilators
            - Constant air movement mitigates radiant disparity
            - Use dead band to control economizer properly
            - can be quiet (40 dbA at 3 ft.)
            - use CO2 to optimize ventilation

7. Characteristics of Thermos Tottle Buildings
    a)
        - very low heat loss
        - low internal heat gain
        - medium window area
        - very low infiltration
        - sometimes good control of solar heat gain
    b) Results
        - heat input required is very low
        - Radiant disparity and thermal stratification are very low

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- insignificant savings from Night Set Back
- balance point 25 degrees F
- ventilation required
- economizer or AC required (OA dewpoint usually not too high)

c) Example good system choices
- radiant ceiling panels
- valance convectors if AC is wanted
- fan coil units
- ASHP's
- need ventilation with ERV for normal use, low airflow
- economizer for cooling, high airflow if no AC.
- Problem: perfect ventilation equipment unavailable

8. Special spaces where the occupancy disparity is more important that the building type
   a) auditorium/gymnasium with bleachers/cafeteria/churche sanctuary
   b) highly variable occupancy, bimodal
   c) low occupancy
      - heat only
      - little or no ventilation required
        - no benefit to ERV because no ventilation
   d) high occupancy
      - high internal heat gains – cooling usually required (always in a Thermos Bottle Building), economizer therefore critical
        - little benefit to ERV except in summer
   e) control system can easily tell the occupancy by measuring room CO2

9. Domestic Hot Water
   - importance of Domestic Hot Water
   - large building: central and recirculation
   - small: 12kw instantaneous electric

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10. Controls and Simplicity

- importance of simplicity
- try to do without DDC controls
- easier to do with no night setback
- or air source heat pump with integrated controls
- but still need ventilation/economizer controls
- Efficiency Vermont slide

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