VAV Systems

Design, Performance and Commissioning Issues

What is a VAV System and Why Do We Use Them

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Class Material Location

The slides and other supporting information for the class can be found at:

- http://www.av8rdas.com/pacific-energy-center-classes1.html
- They will be there until the next class, at which time they will be relocated down the page under the class title.

About using my spreadsheets and other resources:

- They are my tools vs. tools I developed to be used by others
- Use at your own risk; I provide them as a resource for you to use as a starting point
- You still need to understand how it works and fix it if it doesn't work for you

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Learning Objectives

After completing this course you should be able to:

1. Understand why we use VAV systems
2. Be familiar with the components in a typical VAV system
3. Understand how interactive VAV systems are with the loads and other systems and processes in the facility
4. Understand terminal units
5. Understand basic VAV control strategies

Agenda

1. Introduction – Why VAV and what is it exactly?
2. Terminal unit basics
3. Flow and pressure measurement
4. Minimum and maximum flow settings
5. Fan flow and static control
6. Supply and return fan flow management
7. Interactive exercises

What's In This Module?

- Why we do VAV
- Mathematical fundamentals of the VAV process
- Ripple effects of the VAV process
- What a typical VAV AHU looks like

Why a Focus on VAV Systems?

Because they are everywhere!

Why a Focus on VAV Systems?

PIER VAV Research Results

- *For large commercial buildings best practices could save $0.12 per square foot in fan energy*
- *For small commercial buildings (30,000 – 50,000 sq.ft.) best practices could save10-15% in energy cost over current approaches*

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The Fundamental Process at the Zone

Sensible Heat Equation

$$Q = 1.08 \times cfm \times \Delta t$$

Where :

Q = Load in btu/hr

1.08 = A units conversion constant

cfm = Flow rate in cubic feet per minute

Δt = Temperature difference in °F

Variable we are *trying* to deal with

- Load

  Most often gauged by the temperature of the zone relative to a set point (what we want)

Variables we *can* (hope to) control

- Temperature

  Constraints;

  - Space conditions
  - Coil discharge conditions

The Fundamental Process at the Zone

__Sensible Heat Equation__

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Variables we *__can__* (hope to) control

- Flow

  Constraints;

  - Peak load
  - Ventilation requirement

The Fundamental Process at the Zone

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Variable we are *trying* to deal with

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  Most often gauged by the temperature of the zone relative to a set point (what we want)

Variables we *can* (hope to) control

- Variable volume systems vary flow as load varies

Varying the Flow as Load Varies is Powerful

Why This Matters if You are Working with VAV Systems

Fan power is a function of flow and static pressure

$$bhp = \left(\frac{cfm \times static}{6{,}356 \times \eta_{fan_{static}}} \right)$$

Where:

$bhp =$ Brake horse power into the fan drive shaft

$cfm =$ Flow rate in cubic feet per minute

$static =$ Fan static pressure

$6{,}356 =$ A units conversion constant

$\eta_{fan_{static}} =$ Fan static efficiency; .40 = .60 for small fans,

.68 - .78 for large fans

Divide by motor efficiency and multiply by .746 kW per horse power to get killoWatts

Why This Matters if You are Working with VAV Systems

Static pressure is a function of flow

$$Pressure_{New} = Pressure_{Old} \times \left(\frac{Flow_{New}}{Flow_{Old}} \right)^2$$

Where:

$Pressure_{New}$ = The pressure you want to know in consistent units

$Pressure_{Old}$ = The pressure you know in consistent units

$Flow_{New}$ = The pressure you want to know in consistent units

$Flow_{Old}$ = The pressure you want to know in consistent units

Why This Matters if You are Working with VAV Systems

Thus:

$$Bhp_{New} = Bhp_{Old} \times \left(\frac{Flow_{New}}{Flow_{Old}} \right)^3$$

Where:

Bhp_{New} = The brake horse power you want to know in consistent units

Bhp_{Old} = The brake horse power you know in consistent units

$Flow_{New}$ = A flow rate you have selected and want to predict the brake horse power requirement for

$Flow_{Old}$ = The flow rate associated with the known brake horse power

Why This Matters if You are Working with VAV Systems

A Caveat: This applies to a fixed system and VAV systems are not fixed systems