

Diagnostic Measurement and Performance Feedback for Residential Space Conditioning Equipment

Building America Expert Meeting

26-April-2010

Held at NIST, Gaithersburg, MD



Agenda

- 9 am Welcome and Meeting Introduction
- NIST and USDOE Building America overviews
- 9:15 to 12:15 Presentations with Q&A time
- 12:15 to 1:00 Lunch break
- 1:00 to 1:45 Presentation with Q&A
- Group discussion to cover key questions
- Wrap up, action items, and follow-up plan
- 3 pm Adjourn meeting

Speakers and topics

- Dr. Haorong Li - University of Nebraska

Dr. Vance Payne - NIST

Fault detection and diagnostics

- Dr. William Healy - NIST

Sensors and measurement research

- Dr. Amr Gado - Emerson Climate Technologies

Sensors, controls, and human feedback interfaces

- Dr. Roy Crawford - Trane

Equipment manufacturer's perspective

Key questions

1. What measurements are needed to determine whether or not space conditioning equipment is operating properly and efficiently?

What accuracy is required for each measurement?

Key questions

2. Relatively low-cost sensors such as those to protect against over/under voltage and over/under pressure are currently in common use as standard or optional equipment. Is it possible to utilize these types of sensors in an expanded feedback system?

What are present manufacturer assumptions about these sensors' long-term durability and performance?

Key questions

3. Ideally, measuring the delivered heating, cooling, or dehumidification capacity relative to the energy consumed would allow real-time determination of the equipment operating performance. Sensors needed to determine a specific efficiency target would likely be unacceptably expensive. Is it possible to utilize or develop low-cost, durable sensors that would allow a meaningful determination that the equipment was operating within an acceptable tolerance range rather than at a specific efficiency target?

Key questions

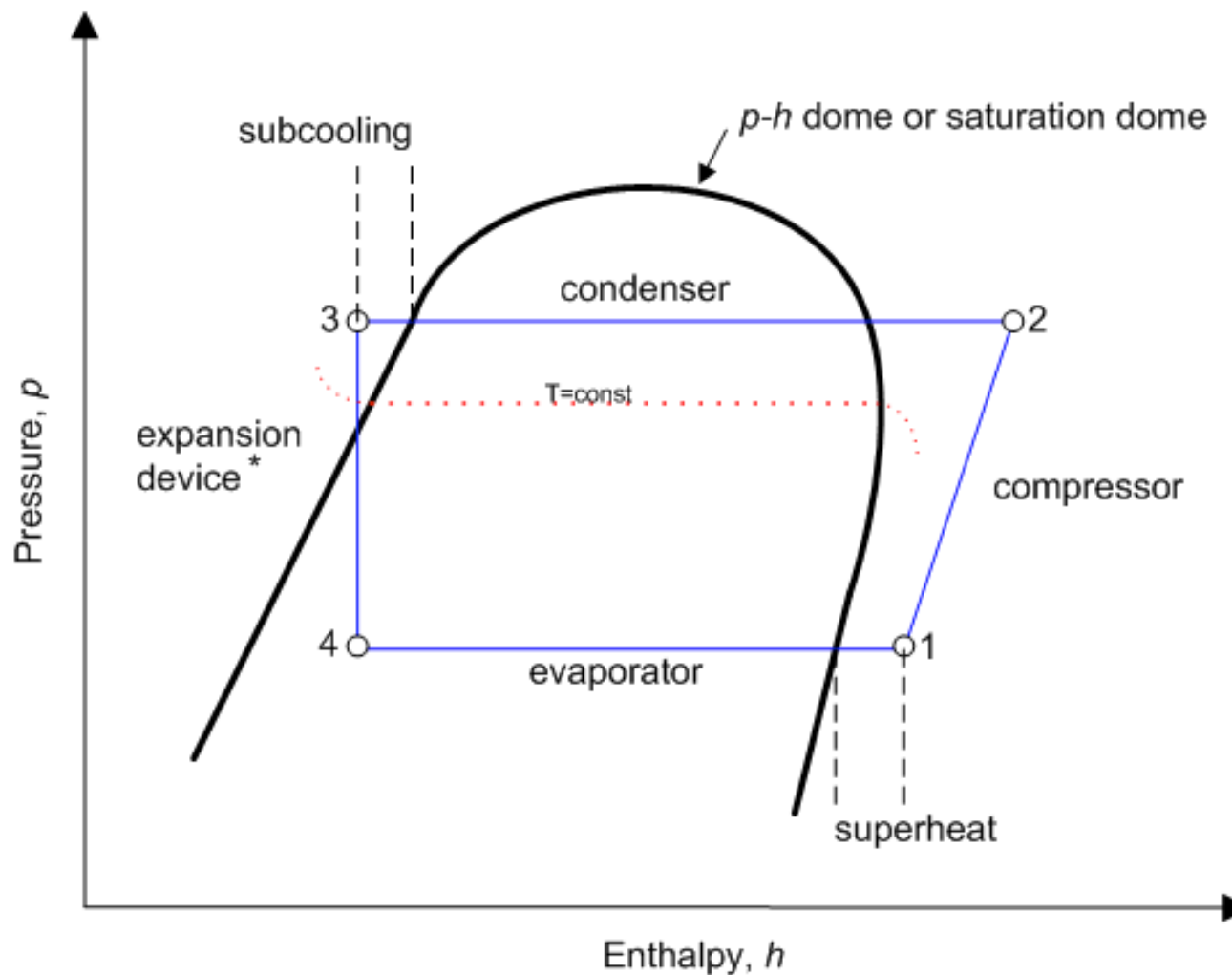
4. What level of feedback display would be needed to make the performance monitoring system effective?

Would a simple red light/green light system at the equipment be adequate to provide ample notice of good/bad performance, or would a more complex digital type display, perhaps integrated into a thermostat, or a smart phone type device be needed to be effective?

Key questions

5. What increase in cost would the market likely bear for this added performance monitoring information, and what would be needed to meet that cost target?

Vapor compression diagram



Measurements needed

Vapor Compression, Refrigerant side method											
									Comp Unit Power	AHU Power	Comp Mass Flow ¹
	P ₁	T ₁	P ₂	T ₂	P ₃	T ₃	P ₄	T ₄			
superheat	x	x									
subcooling (TXV)					x	x					
cooling+heating	x	x			x	x			x	x	x
¹ Refrigerant mass flow obtained from empirical compressor map											

Measurements needed

Air side method, Vapor Compression or Furnace								
					Comp Unit	AHU	AHU	Gas
	T_{sup}	RH_{sup}	T_{ret}	RH_{ret}	Power	Power	Airflow	Flowrate
vc, cooling+heating	x	x	x	x	x	x	x	
furnace, heating	x		x			x	x	x

Comparisons, Method Pros and Cons

Pros	Cons
<i>Refrigerant side performance monitoring method</i>	
The same sensors will facilitate refrigerant system fault monitoring and protection	Requires more measurement points
The same sensors allow refrigerant management and control	Will not accommodate furnace systems
More accurate measurement is likely	
Sensors would be factory installed and wired	
<i>Air side performance monitoring method</i>	
Requires fewer measurement points	The sensors cannot double for fault detection and protection of the vapor compression system
Provides direct rather than indirect measurement of heating or cooling effect	Temperature and relative humidity sensors would be field installed and wired
The same sensors will facilitate control of supply air temperature and space humidity	Measurement: 1) can be inaccurate if airstream is not well mixed; and 2) is more subject to varying installation conditions and installer error.
The same temperature and relative humidity sensors will accommodate both vapor compression systems and furnaces	