TWIN CITY **HEALTHCARE ENGINEERING** ASSOCIATION

February 14, 2019

MEETING AGENDA

TOPICS:

Benefits – of higher humidification for the healthcare industry
Code Compliance – current humidification codes
Application – where and how to implement humidification systems
Energy Effects – operating costs/modeling/cost savings

PANEL SPEAKERS:

Mike Puncochar – Welsh Construction (moderator)
Bob Dehler – MN Department of Health
Val Munshi – Gilbert Mechanical Contractors
Howard Hoffman – SVL
Matt Chmielewski – Xcel Energy
Nick Vanduzee – CenterPoint Energy

MIKE PUNCOCHAR, LEED GA, HCC

Welsh Construction
Project Manager

As a Project Manager, Mike Puncochar oversees shell and core and tenant improvement projects for Welsh Construction. He is in charge of managing the overall bidding, estimating, scheduling and construction process.

By incorporating clients' core values into day-to-day construction activities, Mike ensures that clients have an exceptional experience working with him. He also encourages an open line of communication between subcontractors, architects, engineers, the job-site superintendent and the client to keep the entire project team running smoothly. Our clients appreciate Mike's ability to finish time-sensitive projects within budget, while maintaining quality.

Mike brings 15 years of construction management experience, with numerous large-scale projects under his belt. Mike's portfolio includes an extensive two floor, 35,000-square-foot tenant improvement project for Pioneer Press in River Park Plaza and a 16,000 SF project for Synchrony Financial's new open floor plan office building in the Lawson Building, both in St. Paul, MN. Mike has also managed large warehouse builds and expansions for Minnetronix (50,000 SF) and Vibrant Technologies (73,000 SF). Most recently, he completed a demo and build-out for Central+Priority Pediatrics new clinic in Roseville, MN (11,500 SF).

Mike is always furthering his education to stay current on industry standards and innovation. He holds a master's degree in Business Administration and is a LEED® Green Associate, and has his Healthcare Construction Certificate (HCC). Mike is also a part of Twin City Healthcare Engineering Association (TCHEA) Board and is an active member of the Welsh Safety Committee.

ROBERT (BOB) DEHLER, P.E.

Minnesota Department of Health
Engineering Program Manager

Mr. Dehler is a professional engineer with over 22 years of engineering experience, including the last nine years at the Minnesota Department of Health. During his tenure, he has managed the engineering program for the last four years.

As the manager of the engineering services section, he is responsible for the plan review and inspections of construction in health care facilities throughout the state of Minnesota. The section enforces licensure requirements of the State of Minnesota and federal certification requirements of the Centers for Medicare/Medicaid Services (CMS).

Bob graduated from the South Dakota School of Mines and Technology with a degree in Civil Engineering and is a licensed engineer in the State of Minnesota and an active member of ASHE (American Society of Healthcare Engineers), NFPA (National Fire Protection Association and the Healthcare Guidelines Revision Committee (HGRC) of The Facility Guidelines Institute (FGI).

VATSAL (VAL) MUNSHI, P.E.

TWIN CITY HEALTHCARE ENGINEERING ASSOCIATION

GILBERT

Gilbert Mechanical Contractors, Inc.
Facility Engineering Director

Mr. Munshi is a professional engineer with over 45 years of engineering experience including the last 10 years at Gilbert Mechanical addressing primarily Health Care customers concerns of energy and associated operational costs. He has managed to establish Trade Ally relationships with Utility Companies and successfully utilized financial incentives offered by Utility Companies.

Val graduated from the North Dakota State University with M.S. Degree in Mechanical Engineering and is a licensed engineer in the state of Minnesota. Val also graduated from University of Minnesota with Executive MBA Degree.

Val's experience includes development of projects from the conceptual stage to successful Implementation and Operation as well as the Facility and Real Estate Management in the Commercial, Industrial and Government Sectors.

Val has received Energy Innovation award from Department of Energy, FAME Award from Association of Facility Engineers for Client, various professional awards from Honeywell and Alliant Techsystems.

Val worked with Minnesota Department of Health (MDH) and Utility Companies for Number of Major Hospitals/Clinics over last 10 years. The list includes 1. Health East Hospitals 2. Fairview South Dale 3. Buffalo Hospital 4. Ridgeview Medical Center and associated Clinics 5. Fairview Northland Clinics & Hospital 6. North Memorial Clinics and Hospitals and 6. Allina Clinics and Philips Eye Institute

Val is a member of Minnesota Healthcare Engineers Association.

HOWARD HOFFMAN

TWIN CITY HEALTHCARE ENGINEERING ASSOCIATION

SVL Inc.
VP, Business Development North America; Sales Engineer

Howard uses his utility knowledge, customer outreach experience, project management competencies and leadership skills in a management role assessing projects, creating strategic plans and optimizing processes to make decisions for future growth.

With a Bachelor of Science degree in Electrical Engineering from the University of Wisconsin and an MBA from Penn State, Howard brings a wealth of knowledge and experience from his 13 years in various aspects of the industry to his role at SVL.

As Vice President of Business Development for North America and Sales Engineer for SVL, Howard is responsible for developing North American dealer representatives and national accounts. He also monitors the installation base for energy savings and works with utilities on rebate programs, study funding and pilot programs within PUC guidelines.

MATT CHMIELEWSKI, P.E.

Xcel Energy
Efficiency Engineer

Energy engineer with 15+ years of experience in building energy efficiency projects. Analytical problem solver with a proven record of coordinating projects across borders, languages and disciplines in small to corporate business environments.

Provides project consultancy, building/campus energy simulation, engineering economic analysis, utility analysis, design specifications, engineering review, ASHRAE level I,II,III audits, big data collection and analysis. Areas of expertise include chilled water generation, cogeneration and geothermal solutions as well as air and waterside distribution systems (steam, heating water, chilled water). Enjoys working with the diverse interests and abilities of everyone invested in improving buildings' performance.

In his current role as Efficiency Engineer for Xcel Energy, Matt provides technical guidance to influence cost-effective and beneficial energy efficiency expenditures. Matt is Lead Engineer for the Commercial Refrigeration Efficiency program in Minnesota and co-lead of the Commercial Cooling and Energy Design Assistance programs.

He also develops and executes technical-financial models to ensure they meet state and corporate guidelines and can withstand regulatory scrutiny and influences programs' structure to validate rebate expenditures and maximize company's return on investments in the programs.

Matt is also a critical asset in developing and maintaining Xcel Energy's technical leadership and leverage expertise and relationships to maximize value for customers and trade partners.

NICK VANDUZEE

TWIN CITY HEALTHCARE ENGINEERING ASSOCIATION

CenterPoint Energy
Energy Efficiency Engineer

Nick VanDuzee, an Energy Efficiency Engineer, has worked for CenterPoint Energy for nine years. For CenterPoint, he calculates the potential energy savings for various residential, commercial and industrial systems for their Conservation Improvement Program (CIP).

Before joining CenterPoint Energy, Nick worked for Xcel Energy in their CIP department as well as at one of their power plants. He has also worked for Lennox Industries in Iowa and is a Mechanical Engineering graduate of Iowa State University.

MIKE PUNCOCHAR, LEED GA, HCC

TCHEA TWIN CITY HEALTHCARE ENGINEERING ASSOCIATION

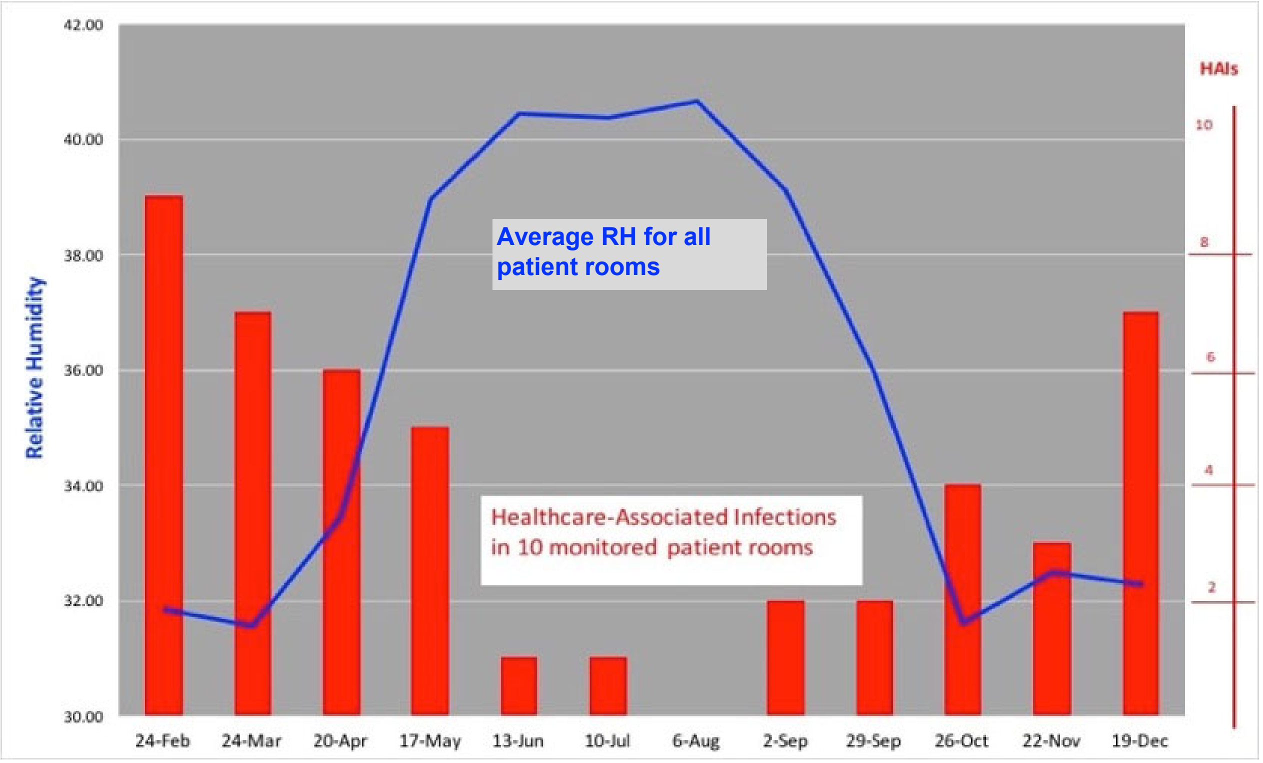
- What is an HAI? (hospital/healthcare associated infection)
- George Mills said 700,000 people get HAI's each year
  - 60,000-80,000 of those patients die
- What about people working in healthcare facilities?

MIKE PUNCOCHAR, LEED GA, HCC

What can be done?

- Use non-pharmaceutical method of raising RH levels in our building
  - ASHRAE Learning Institute (ALI) offered five full-day seminars and 15 half-day courses at the Winter Conference in Atlanta. The top attended courses were:
    - Humidity Control I: Design Tips and Traps;
    - Humidity Control II: Real-World Problems and Solutions;
    - Variable Refrigerant Flow System: Design & Application.
  - Mayo Clinic also had a presentation at the ASHRAE Winter Conference. It was titled **“The Impact of Steam Humidification on Influenza Virus in Preschool Classrooms”**

Dry Indoor Air Correlated With New Patient Infections!



Coefficients[a]

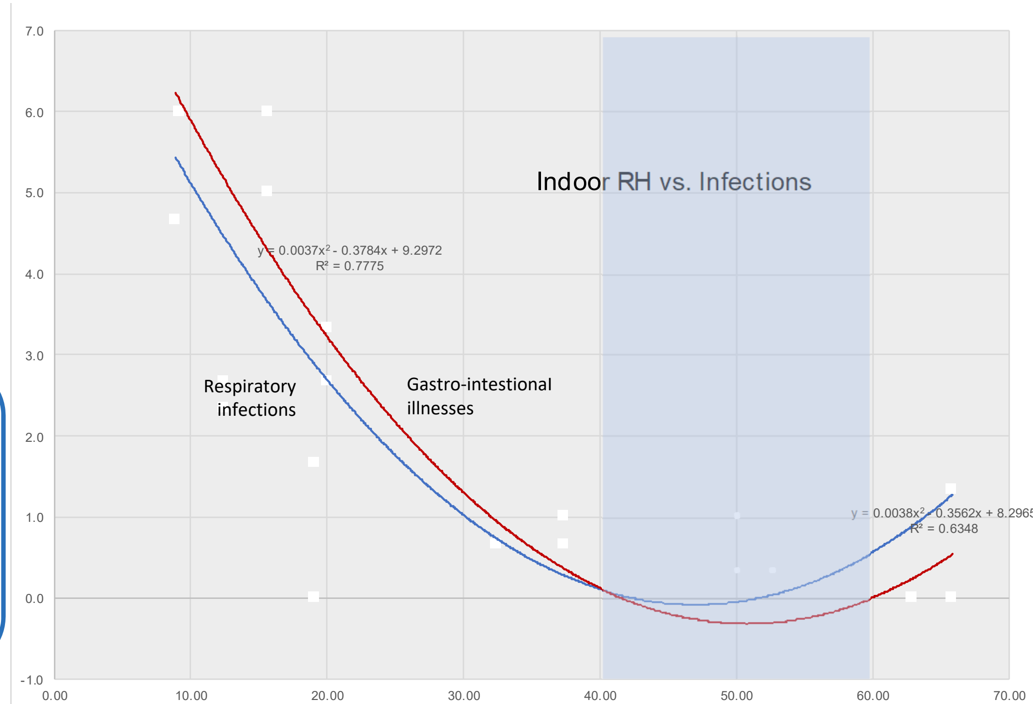
Standardized Coefficients		
Beta	t	Sig.
	-2.348	.023
-9.060	-2.396	.020

SOURCE: **Stephanie Taylor**, MD, M Arch, MD@taylorcx.com & **Michael C Tasi**, MD, MBA, Mtasi@mgh.harvard.edu

HARVARD MEDICAL SCHOOL

Respiratory and gastrointestinal infection rates were lowest at indoor RH 40–60%

Incidence of Infections



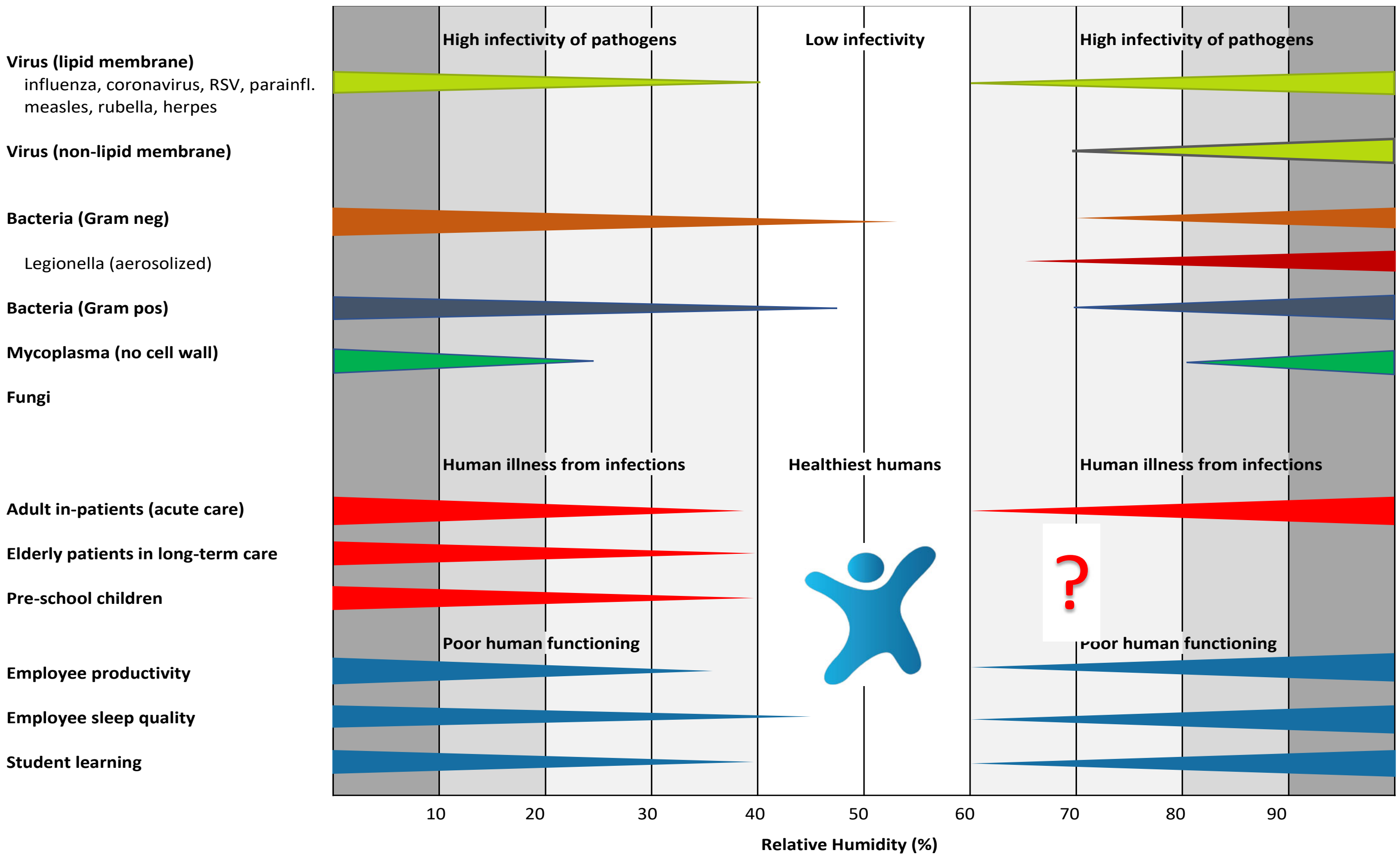
Indoor RH

- Respiratory and GI Infections were lowest when RH was 40–60%
- Trending was found with eye and skin infections
- No correlation was found with urinary tract infections

SOURCE: **Stephanie Taylor**, MD, M Arch, MD@taylorcx.com & **Michael C Tasi**, MD, MBA, Mtasi@mgh.harvard.edu

HARVARD
MEDICAL SCHOOL

1985 ASHRAE Sterling *et al*, Optimum relative humidity ranges for health = 40%–60%, 35 years later….. 2019



SOURCE: **Stephanie Taylor**, MD, M Arch, MD@taylorcx.com & **Michael C Tasi**, MD, MBA, Mtasi@mgh.harvard.edu

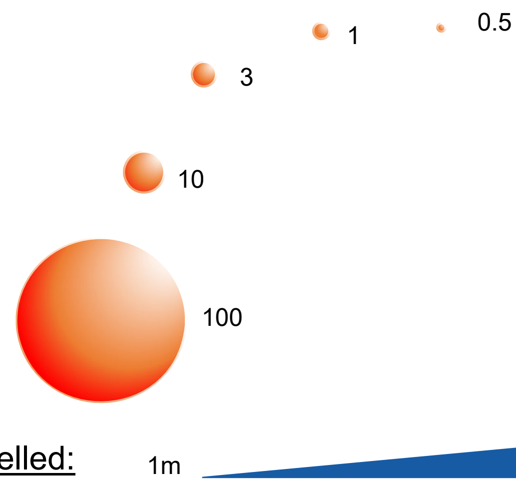
HARVARD
MEDICAL SCHOOL

Why does raising the RH level lower HAI's?

Infectious Droplets Shrink And Travel Far In Dry Air

Droplet diameter in microns (um)

Float time



41 hours – 21 days

1.5 hours

6 seconds

Distance travelled:

SOURCE: **Stephanie Taylor**, MD, M Arch, MD@taylorcx.com & **Michael C Tasi**, MD, MBA, Mtasi@mgh.harvard.edu

HARVARD
MEDICAL SCHOOL

MIKE PUNCOCHAR, LEED GA, HCC

What are the current RH (relative humidity) code requirements in Healthcare Facilities?

ROBERT (BOB) DEHLER, P.E.

- *S&C letters 13-25 and 15-27*
- *NFPA 99, 2012 edition*
    - *References ASHRAE 170, 2008 ed*
- **Hospital rules –** humidifiers capable of 55% at 75 degrees
- **ASC –** 50-60% rh in operating and recovery space
- **NH –** capable of maintaining 25-50% rh

MIKE PUNCOCHAR, LEED GA, HCC

Application – where and how to implement humidification systems

- The two systems of humidification we will discuss today are:
    1. Steam
    2. Adiabatic

Humidification Application in the Built Healthcare Environment

Memorial Sloan Kettering Cancer Center

Healthcare SYMPOSIUM

Steven Friedman, PE, HFDP, LEED AP
Director, Facilities Engineering Design + Construction
Memorial Sloan Kettering Cancer Center, New York, NY

HARVARD MEDICAL SCHOOL

Humidification Requirement Comparison

Ashrae Standard 170- Section 6.6 Humidifiers

Standard 170-2008

6.6 Humidifiers. When outdoor humidity and internal moisture sources are not sufficient to meet the requirements of Table 7.1, humidification shall be provided by means of the health-care facility air-handling systems. Locate humidifiers within air-handling units or ductwork to avoid moisture accumulation in downstream components, including filters and insulation. Steam humidifiers shall be used. Chemical additives used for steam humidifiers serving health care facilities shall comply with FDA requirements.[1] A humidity sensor shall be provided, located at a suitable distance downstream from the steam injection source. Controls shall be provided to limit duct humidity to a maximum value of 90% rh when the humidifier is operating. Humidifier steam control valves shall be designed so that they remain off whenever the air-handling unit is not in operation. Duct takeoffs shall not be located within the humidifier's absorption distance.

Standard 170-2013

6.6 Humidifiers. When outdoor humidity and internal moisture sources are not sufficient to meet the requirements of Table 7.1, humidification shall be provided by means of the facility air-handling systems. Steam or adiabatic high pressure water atomizing humidifiers shall be used.

6.6.1 General Requirements.

a. Locate humidifiers within air-handling units or ductwork to avoid moisture accumulation in downstream components, including filters and insulation.

b. A humidity sensor shall be provided, located at a suitable distance downstream from the injection source.

c. Controls shall be provided to limit duct humidity to a maximum value of 90% rh when the humidifier is operating.

d. Duct takeoffs shall not be located within the humidifier's absorption distance.

e. Humidifier control valves shall be designed so that they remain off whenever the air-handling unit is not in operation.

6.6.2 Steam Humidifier Requirements. Chemical additives used in the steam systems that serve humidifiers shall comply with FDA requirements.[1]

6.6.3 Adiabatic Atomizing Humidifier Requirements.

a. Humidifier water shall be treated with a reverse osmosis process, a UV-C sterilization light source and a sub-micron filter.

Informative Note: See ASTM D1193 Type III-Grade B for further information.

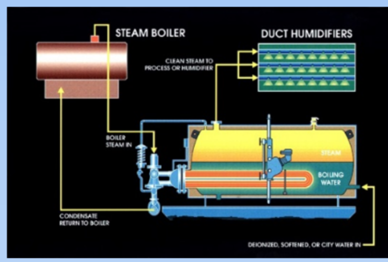
b. Treated humidifier water shall be continuously circulated from the source, to the humidifier valves. All valves, headers, and piping not part of the recirculation loop shall drain completely when not in use.

c. Ports suitable for testing water quality shall be provided in the treated humidifier water piping system.

d. Moisture eliminators shall be provided, as required, to prevent moisture accumulation in ductwork.

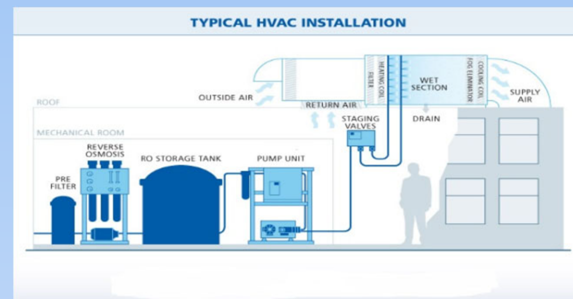
Humidification System Considerations

Clean Steam Generation



- Requires Energy Source
  - Electricity
  - Fuel Oil
  - Natural Gas
- Costly Piping/ Equipment
  - Fuel Oil Storage Tank
  - Authority approval for fuel use
- Large Physical Footprint
  - Structural implications
- Water Quality Control Issues
  - Domestic Cold Water use
  - Interaction with Equipment
- Large Water Consumption Application
- Added Heat Into Airstream

Adiabatic High Pressure Mist



- Requires Minimal Energy Source
  - Electricity
- No Utility Piping or Fuel Storage
- Smaller Physical Footprint
  - Lighter floor plate loading
- Water Quality Control Mitigation
  - UVGI- kill off of pathogens
  - Superior water quality
- Reduced Water Consumption
- No Heat Added to Airstream

Memorial Sloan Kettering Cancer Center

Case Study Comparison (120 Ton Air Handling System)

Key Aspects	Clean Steam Generation	Adiabatic High Pressure Mist
Energy Load	1,363 MBH 409 KW	8.53 MBH 2.5 KW
Total Energy Consumption	*3,495,500 MBH/Yr 1,048,650 KWH/yr	20,411 MBH/Yr **5082 KWH/Yr
Total Energy Cost	$34,000/ Yr	$25,000/Yr
Annual Water Usage	310,000 Gallons	235,000 Gallons
Annual Water Usage Delta	-75,000 Gallons	
Carbon Footprint Reduction	-62,000 Tons of CO2	
Annual Energy Savings	$9,000/Yr	

* Includes flushing energy losses, energy to raise water to 212 degrees F and distribution losses

** Includes make up energy and filter losses

Memorial Sloan Kettering Cancer Center

Comparative Conclusions

There are nearly 6000 licensed hospitals within the United States

Healthcare Institutions consume nearly 20% of total energy production.

1- Providing a proper physical vapor barrier for those program spaces that require strict humidity control is smart, cost effective, and leads to more stable humidity levels.

2- Potential energy/operational savings is much higher with an effective installation

3- Utilizing higher efficiency equipment contributes to reduced carbon footprint & emissions

4- Clean, controlled water purification humidification systems will contribute to the best possible outcome for patients, visitors, and staff in the healthcare environment.

Memorial Sloan Kettering Cancer Center

Comparison of Steam and Adiabatic Humidification for 120 Ton System

After evaluating Maple Grove Hospital with SVL, we found that currently, Low Pressure Steam is used for humidification to maintain 30% RH.

Issues:

- On cold days, existing Steam Boiler cannot maintain 30% RH.
- Potential Energy Savings using Adiabatic Humidification: Saving approximately $110K - $130K per year.
- The budget price to install the system in all 6 air handlers is $1,085,000, which includes the RO system, RO piping, fan walls, humidifiers, power wiring, control allowance, startup, training and permits.
    - This was based on keeping the systems operational by providing parallel systems when existing 6 systems are modified to replace steam humidifiers with Adiabatic humidifiers. Minimum space required to install Adiabatic is 36".
- Would consider Adiabatic when the expansion of the hospital is planned.

Energy Effects

- Operating Costs
- Modeling
- Cost Savings

Humidification in Healthcare

TCHEA - Matt Chmielewski, PE
Xcel Energy

2-14-19

Energy Effects of Humidification in Healthcare

- Whole-building Energy Model created for 8760 analysis

- Questions to be analyzed:
  - What is utility and energy impact of increasing minimum humidity levels above a 40% RH baseline?
  - How does performance of Adiabatic vs Steam-based humidification compare?

Example Project

Xcel Energy®

- 142,400 square foot healthcare facility
- Located in Twin Cities Metro
- ASHRAE 90.1-2013 compliant
- 319,000 CFM of supply air with an airflow weighted-average of 36% outside air.
- 2.2 CFM/ft2 design airflow

Air Handling Units			
	Design Supply Airflow (CFM)	**% Outside Air (Design)**	**Floor Area served (ft2)**
AHU1	126,000	24%	71,500
AHU2	84,000	22%	20,400
AHU3	25,000	100%	15,000
AHU4	41,000	21%	24,800
AHU6	43,000	76%	10,700
TOTALS	**319,000**	**36%**	**142,400**

Energy Model Specifications

Xcel Energy®

- Forced air heating, condensing boiler
- Water-cooled chiller, VAV air handlers with hot-water reheat
- Minimum RH% controlled, no control over maximum RH%
- Typical latent loads from people and processes
- Assumed that water consumed for *adiabatic* humidification is NOT heated above incoming city water temperature.
- *Steam* humidification - requires operation of high temperature/steam boiler
  - 5000 to 7000 hours of operation
  - City water must be heated from 50° to 212°F and then vaporized (steam).
- Gas Utility rate: $0.77 / therm

Electrical Rate Component	Rate
Energy Charge Summer On-Peak $/kW/Hour	0.083
Energy Charge Summer Off-Peak $/kW/Hour	0.047
Energy Charge Winter On-Peak $/kW/Hour	0.083
Energy Charge Winter Off-Peak $/kW/Hour	0.047
Demand Charge Summer On-Peak $/(Monthly Peak kW)	16.066
Demand Charge Summer Off-Peak $/(Monthly Peak kW)	2.586
Demand Charge Winter On-Peak $/(Monthly Peak kW)	11.638
Demand Charge Winter Off-Peak $/(Monthly Peak kW)	2.586
Simplified Rate:	**$0.0885/kWh**

Energy Model Specifications

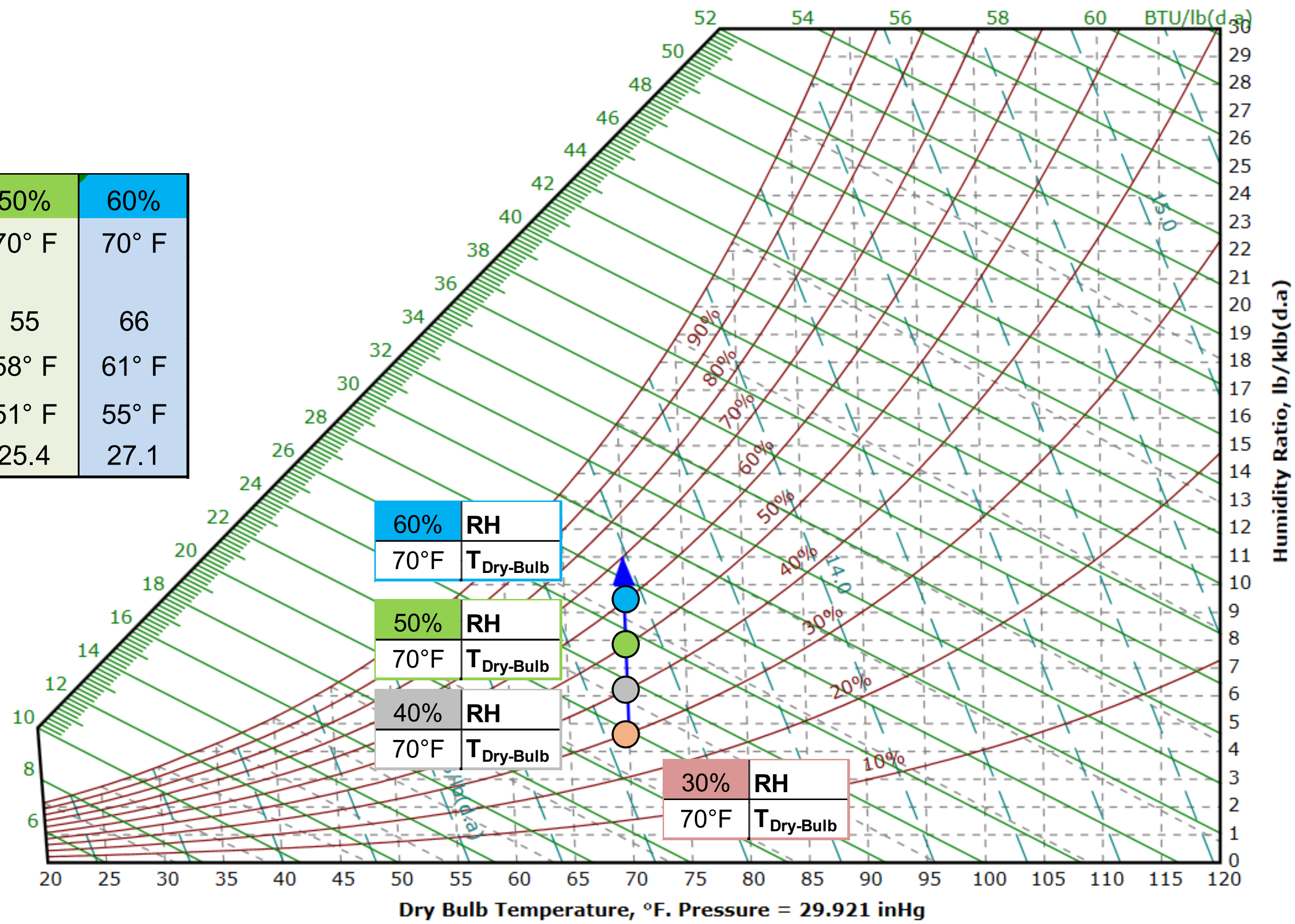
Xcel Energy®

Excluded from Energy Model:

- Water consumption and cost impacts
- O&M of additional equipment
- Removal of moisture (dehumidification)
- Additional fan energy consumption caused by increased mass of air
- CHW supply temperature reset
  - Higher RH% means less latent load on cooling equipment in summer, resulting in chiller energy savings

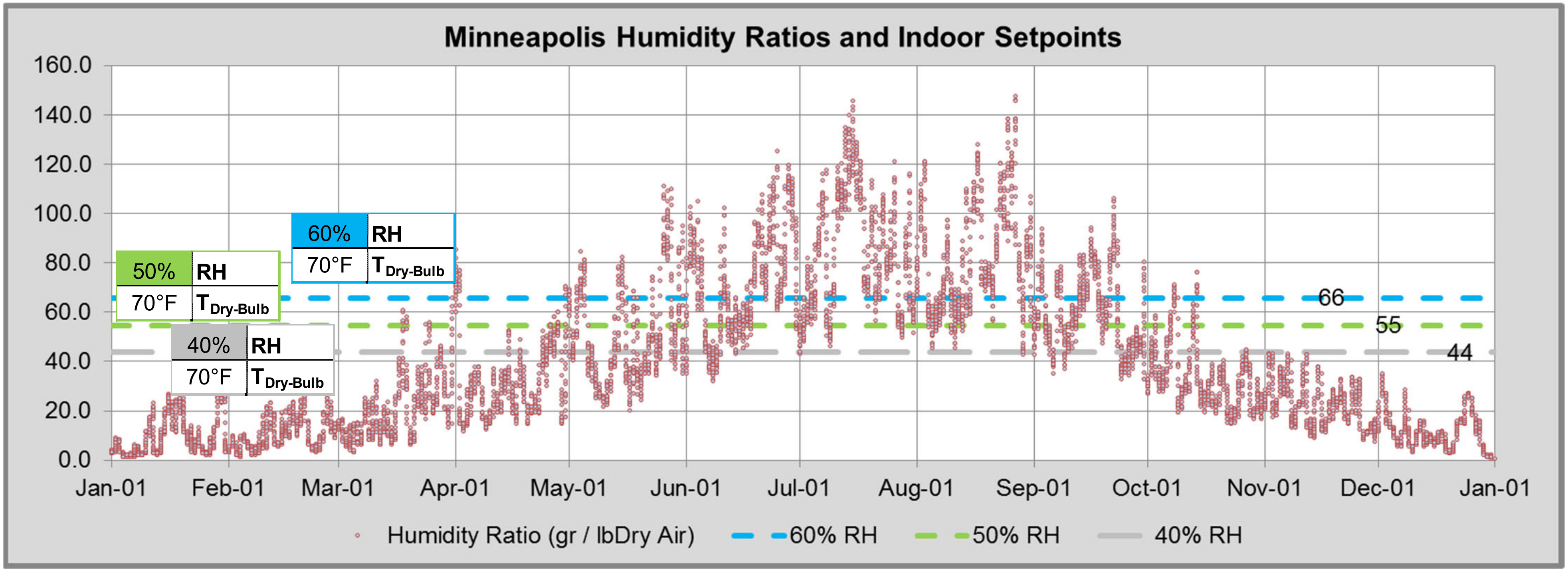
Properties of Air – Indoor Setpoints

Relative Humidity	30%	40%	50%	60%
$T_{Dry\text{-}Bulb}$	70° F	70° F	70° F	70° F
Humidity Ratio (gr / $lb_{Dry\ Air}$)	33	44	55	66
$T_{Wet\text{-}Bulb}$	53° F	56° F	58° F	61° F
Dewpoint (°F)	37° F	45° F	51° F	55° F
Enthalpy (BTU / $lb_{Dry\ Air}$)	21.9	23.6	25.4	27.1



http://www.flycarpet.net/en/PsyOnline

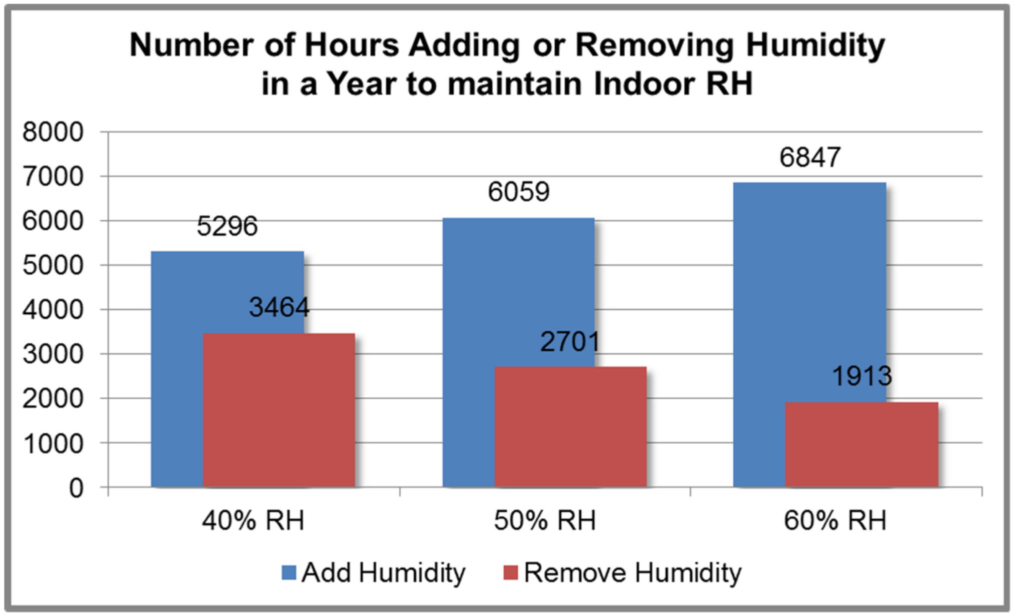
Properties of Air – Minneapolis

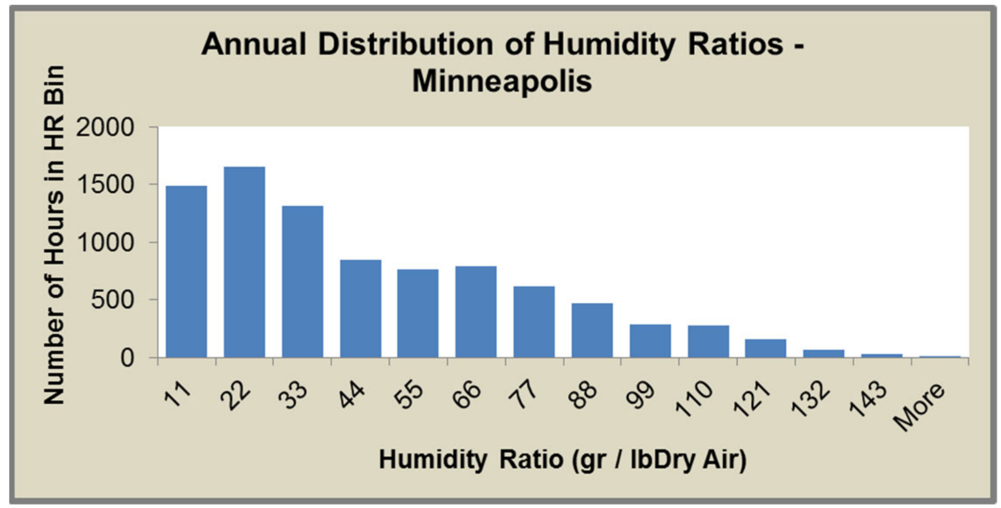


Outside air humidity ratios are below desired indoor HR for the majority of the year

Humidity Profiles – Minneapolis

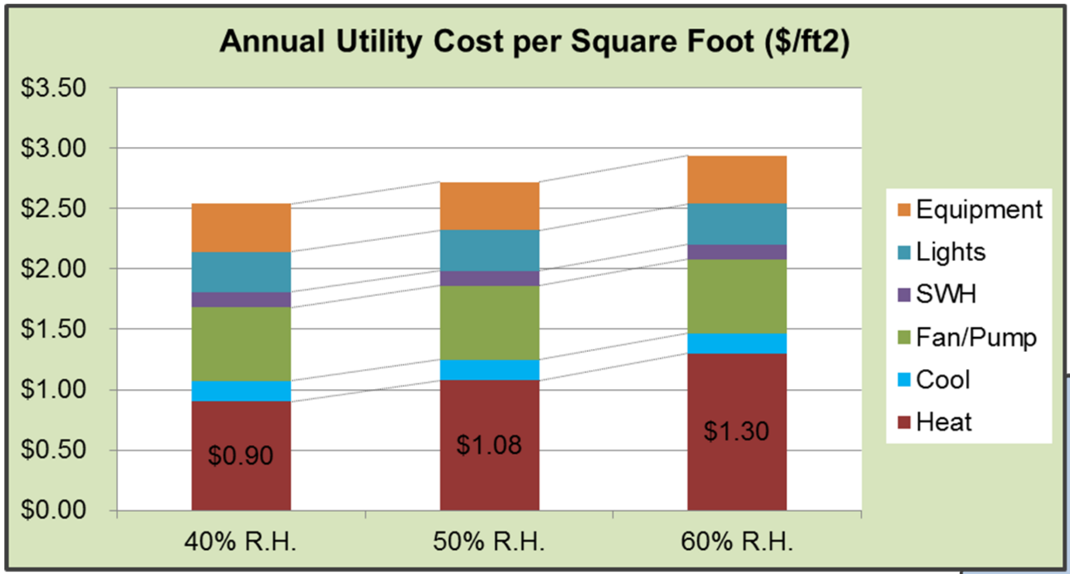
Xcel Energy®

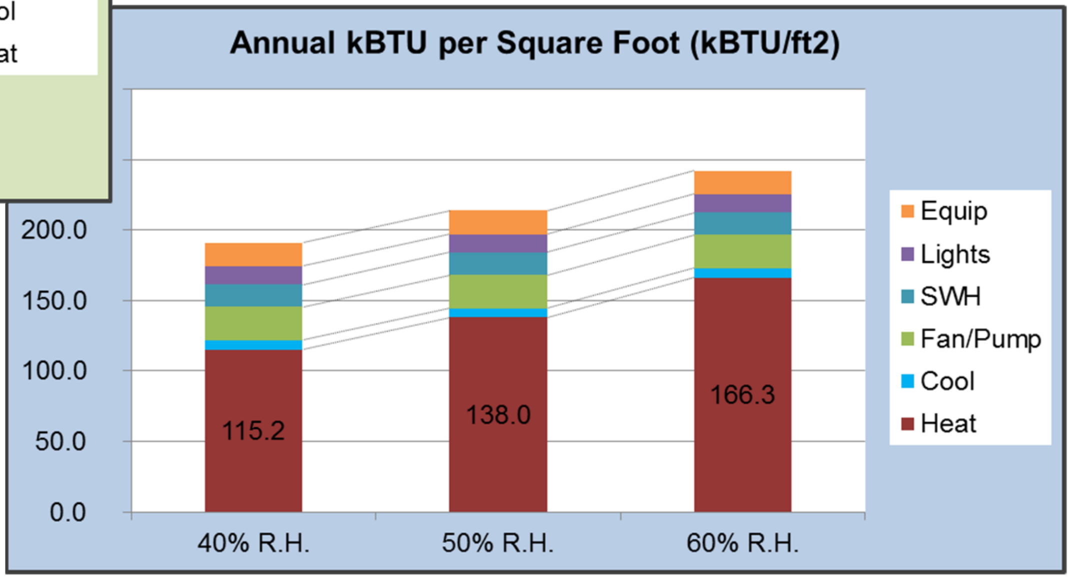




40%	RH	50%	RH	60%	RH
44	grains per $lb_{Dry\ Air}$	55	grains per $lb_{Dry\ Air}$	66	grains per $lb_{Dry\ Air}$

Steam Humidification Results





Steam vs Adiabatic Results

Steam Humidification

	40% RH	% change	50% RH	% change	60% RH
Peak Heating Plant Load (MMbh)	18.0	15%	20.8	11%	23.1
Gas (Therms)	321,500	17%	376,400	18%	444,600
Electricity (kWh)	4,120,000	0%	4,120,000	0%	4,120,000
Gas ($)	$ 249,500	17%	$292,100	18%	$345,000
Electricity ($)	$ 364,400	0%	364,700	0%	365,000
Total Annual Utility Cost	**$ 613,900**	*7%*	**$ 656,800**	*8%*	**$ 710,000**
Annual $/ft2	**$ 4.31**		**$ 4.61**		**$ 4.99**

Adiabatic Humidification

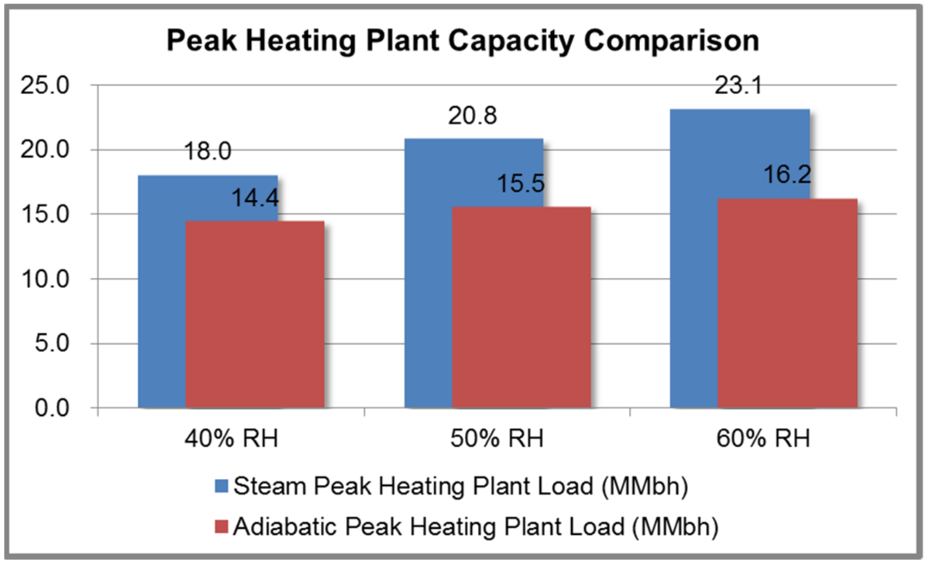
	40% RH	% change	50% RH	% change	60% RH
Peak Heating Plant Load (MMbh)	14.4	8%	15.5	4%	16.2
Gas (Therms)	250,500	5%	262,000	6%	278,600
Electricity (kWh)	4,130,000	0%	4,140,000	0%	4,150,000
Gas ($)	$ 194,400	5%	$203,300	6%	$216,200
Electricity ($)	$ 365,500	0%	366,100	0%	367,000
Total Annual Utility Cost	**$ 559,900**	*2%*	**$ 569,400**	*2%*	**$ 583,200**
Annual $/ft2	**$ 3.93**		**$ 4.00**		**$ 4.10**

- Adiabatic Humidification energy rate between 1.8 and 2.0 Watts/lb H_2O

Considerations

- How does a $$$/ft2 annual operational cost compare to the expected benefit of reduced Hospital-Acquired Infections?
- Be Careful with buildings containing chilled beams.

Relative Humidity	30%	40%	50%	60%
Dewpoint (°F)	37° F	45° F	51° F	55° F



Questions

Energy modeling by The Weidt Group:

Vinay Ghatti

Jim Douglas

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Energy Efficiency Engineer

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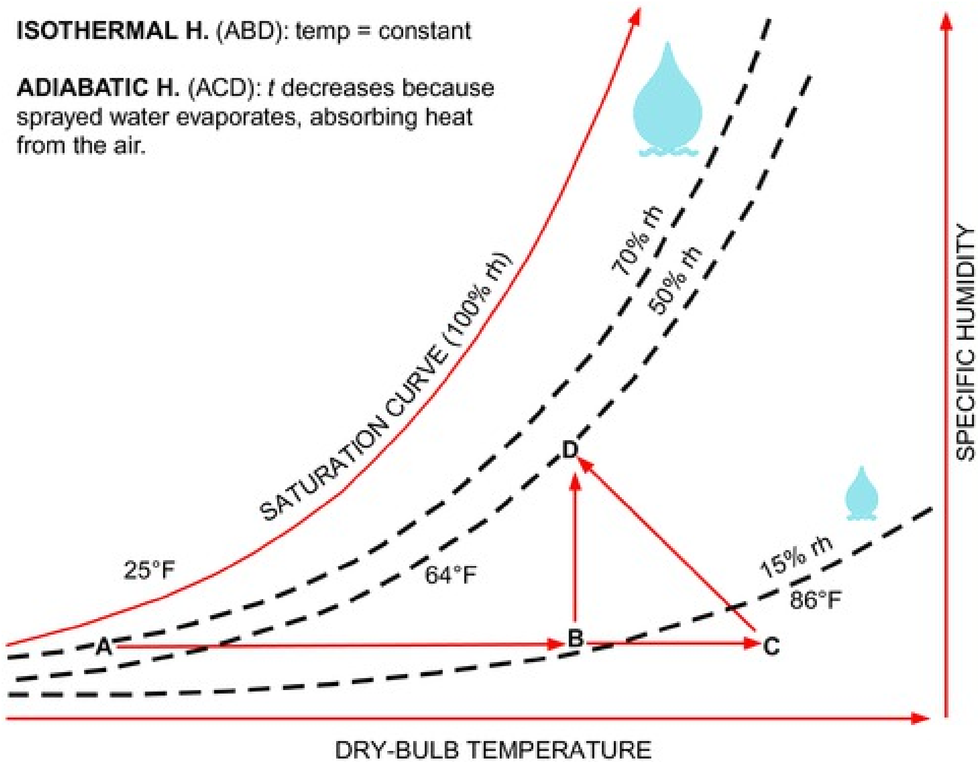
Gas utility rebate potential for adiabatic humidification

Nick VanDuzee, Energy Efficiency Engineer

2/14/2019

Gas savings for adiabatic humidification



Source: 2016 ASHRAE Handbook, HVAC Systems and Equipment, Chapter 22 “Humidifiers”

Gas savings for adiabatic humidification

CenterPoint Energy

- In the heating season the energy needed to get the RA/OA to the SA is equal whether one uses adiabatic or steam humidification methods.

- Because of this, we (CenterPoint Energy, the gas company) can't rebate adiabatic humidification by itself.

- There may be electrical savings from cooling and/or fans and pumps by implementing adiabatic humidification – see the electric utility.

Gas savings for adiabatic humidification

CenterPoint. Energy

- However, if there are OA reductions and/or combustion efficiency increases that are happening along with the adiabatic project, we can look at incentivizing the gas savings associated with those components.

- For those measures, let us know the incremental cost to implement these OA or combustion efficiency projects along with any energy savings calcs and if the payback is between 1 and 10 years, we can potentially pay a custom rebate.

Thanks for coming!