Condensation Control

NIA's 63rd Annual Convention
April 18–20, 2018

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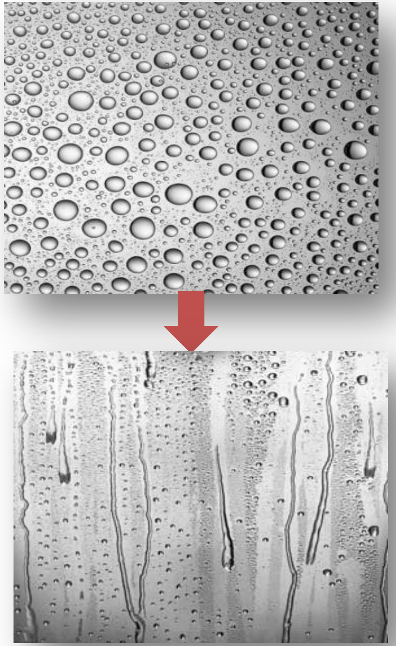
Condensation Basics

- **Relative humidity**: amount of moisture in the air compared to the maximum amount of water it can hold at the current temperature.
- **Dew point**: the temperature at which the water vapor condenses into liquid water.
- When the air can't hold all the moisture, **it condenses and turns into liquid "condensate."**

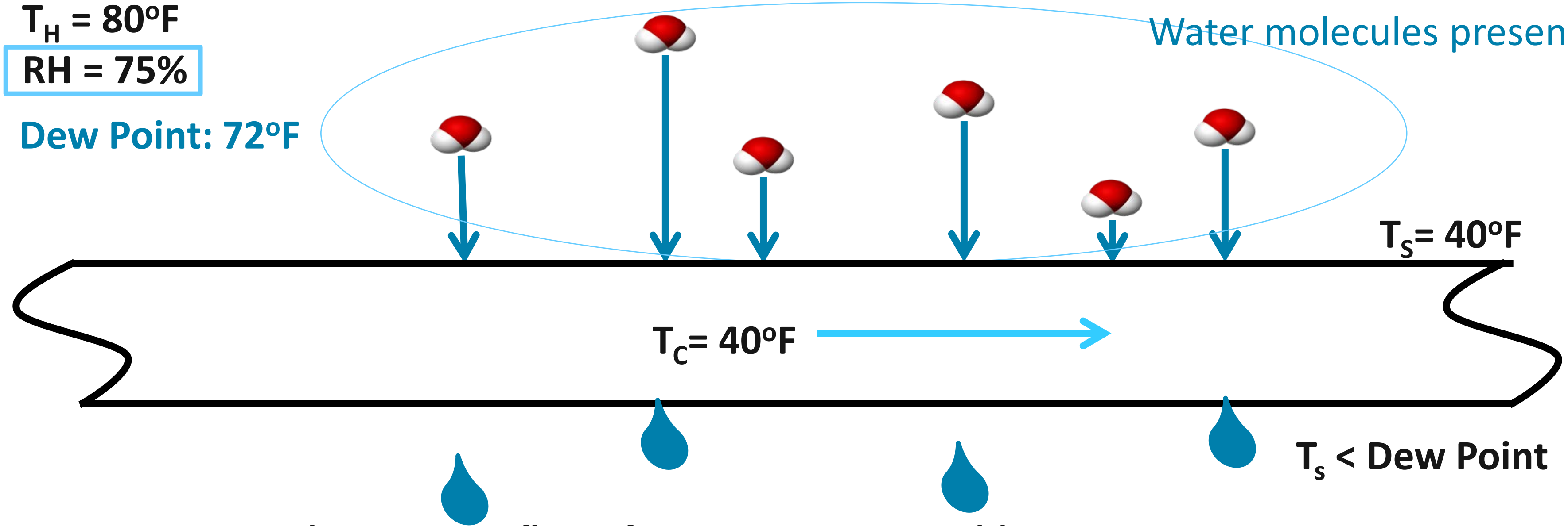
- Maintaining **the surface temperature above dew point is key** to condensation control.



T_H = 80°F

RH = 75%

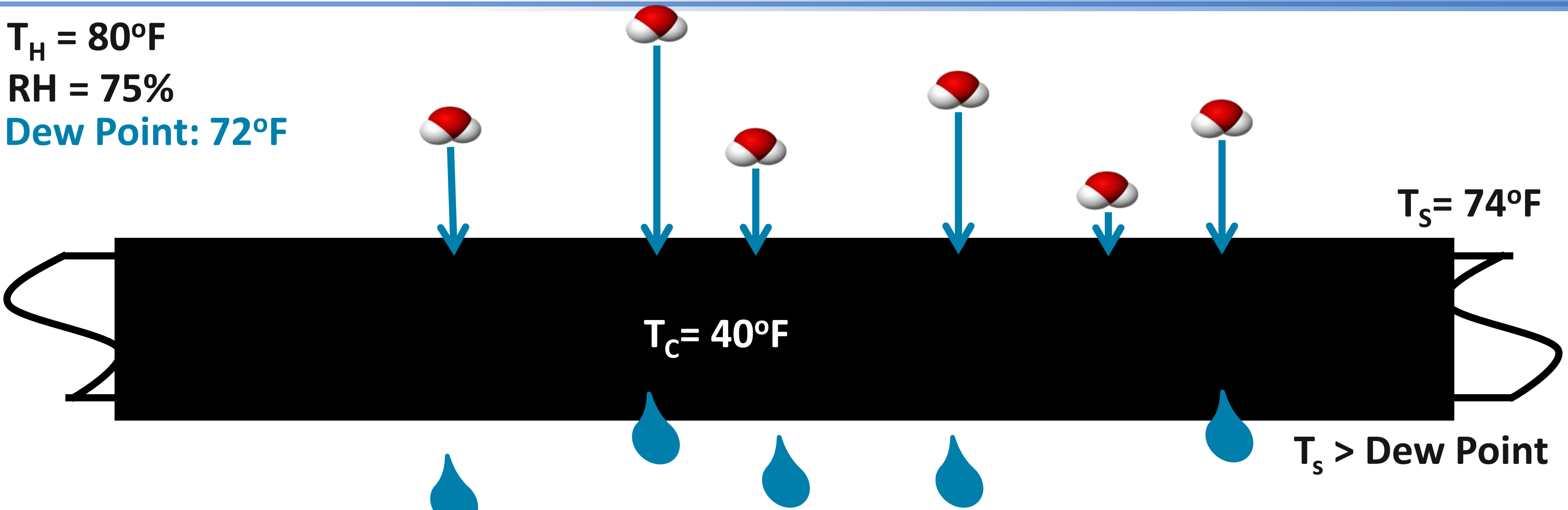
Dew Point: 72°F



Remember: Energy flows from Hot Area to Cold Area

How can this be prevented?

T_H = 80°F
RH = 75%
Dew Point: 72°F

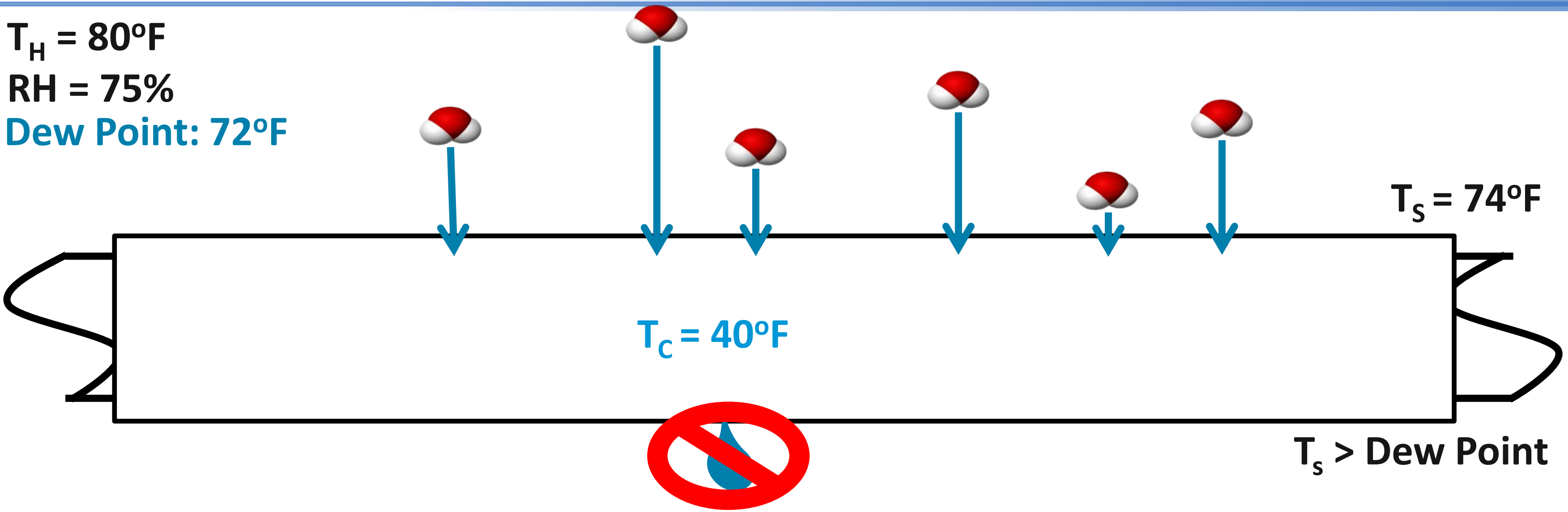


Add insulation to raise surface temperature above dew point.

What if the insulation is porous?

Water vapor will pass through like the insulation isn't even there!

T_H = 80°F
RH = 75%
Dew Point: 72°F



If the insulation is porous, a vapor retarder must be added.

This will help prevent moisture from entering the system and condensing.

What can you do?

- **When condensation occurs it is typically due to:**
  - Inaccurate design
  - Poor installation
  - System functioning outside design parameters
- **Key factors to control condensation:**
  - Proper Thickness
  - Select an insulation material with a **low water vapor permeability**
  - Confirm design conditions and calculations with industry or manufacturers' calculation tools

Moisture Ingress

- Moisture ingress is the absorption of water into a material.

Moisture Ingress

	PROPERTIES		PROPERTIES
Moisture Content	0	**+1%**	1%
Thermal conductivity (k)	0.275	**+7.5%**	0.296

- Resistance to moisture intrusion is key for the thermal efficiency: **every 1% moisture gain implies 7.5% loss in thermal value.**

Corrosion Under Insulation

- **Condensation trapped** between the surface of the pipe and the insulation **leads to corrosion.**

Corrosion under Insulation

	OPERATING PERFORMANCE	MAINTENANCE COST	INTEGRITY & SAFETY
CORROSION UNDER INSULATION	DOWN	UP	DOWN
NO CORROSION UNDER INSULATION	SAME	DOWN	UP

CORROSION UNDER INSULATION

NO CORROSION UNDER INSULATION

Mold

- **Mold can form** when the right conditions are met on the **surface of the insulation.**

Mold

What is mold?

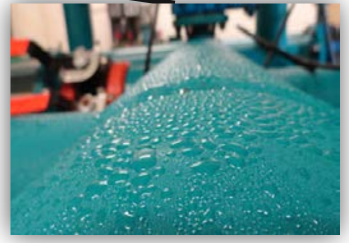
- Various types of fungi
- Grows in filaments
- Reproduces by spores

1: Michael Pugliese, *The Homeowner's Guide to Mold*

Mold

- **Mold needs three things to grow:**
  - Food
  - Optimum environment
  - Moisture

32F to 120F
70F to 90F

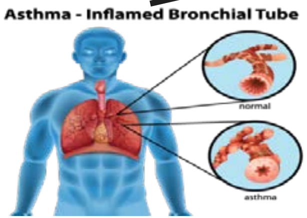


Source: Michael Pugliese, *The Homeowner's Guide to Mold*

Mold

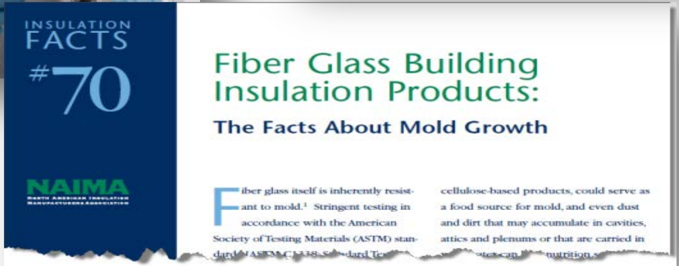
The issues with mold

- Allergies
- Rash
- Asthma
- Poor Air Quality



Source: Michael Pugliese, *The Homeowner's Guide to Mold*

Mold



INSULATION FACTS #70

NAIMA
NORTH AMERICAN INSULATION MANUFACTURERS ASSOCIATION

Fiber Glass Building Insulation Products:

The Facts About Mold Growth

Fiber glass itself is inherently resistant to mold.[1] Stringent testing in accordance with the American Society of Testing Materials (ASTM) stan-

cellulose-based products, could serve as a food source for mold, and even dust and dirt that may accumulate in cavities, attics and plenums or that are carried in

The American Red Cross and the Federal Emergency Management Agency (FEMA) suggest that fiber glass batts can be removed, dried and replaced if they are wet from clean water. They also suggest that cellulose (loose or blown-in treated paper) insulation can lose its antifungal and fire retardant abilities when wet and, therefore, should be replaced.[8] The U.S. Environmental Protection Agency (EPA), however, recommends that all wet insulation be discarded and replaced.[9] Although fiber glass can be reused in many circumstances, NAIMA suggests consulting FEMA,[10] EPA, the American Red Cross, or other reputable sources for specific guidance and definition of terms, before taking any remedial action. If, after consulting these organizations, a question still remains, NAIMA suggests consumers err on the side of caution and replace the wet insulation.

Condensation Case Study

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South Florida High-Rise Building

Timeline:

- Occupied in April
- By June, pipe insulation saturated with condensation:
  - **Dripping on the occupants!**

Problems caused by:

- 1" insulation with standard vapor barrier and foil
- **Occupied and under construction simultaneously**
- **Vapor retarder exposed to temperatures below dew point**
- **$20 million to correct!**

HOME > PIPING / PUMPING > INVESTIGATION INTO THE FAILURE OF CHILLED-WATER-PIPE INSULATION

Investigation Into the Failure of Chilled-Water-Pipe Insulation

Getting to the root of a $20 million failure in a South Florida high-rise

By WILLIAM A. LOTZ, PE; Consulting Engineer; Acton, Maine — Mar 1, 2011

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The chilled-water system in a South Florida high-rise went into operation in April. By June, the pipe insulation was saturated with water, and condensation was dripping on people's heads. The problem cost more than $20 million to correct. What went wrong?

Key to the pipe-insulation failure was the all-service-jacket (ASJ) vapor-barrier facer on the 1-in.-thick phenolic-foam insulation specified for the chilled-water pipes, which were up to 16 in. in diameter and operated at 45°F. Standard vapor-barrier jackets consist of a flame-resistant white embossed paper, glass-textile fibers, and a thin aluminum foil.

NIA National Insulation Association
THE VOICE OF THE INSULATION INDUSTRY™

Source: http://hpac.com/piping-pumping/investigation-failure-chilled-water-pipe-insulation

Conclusions

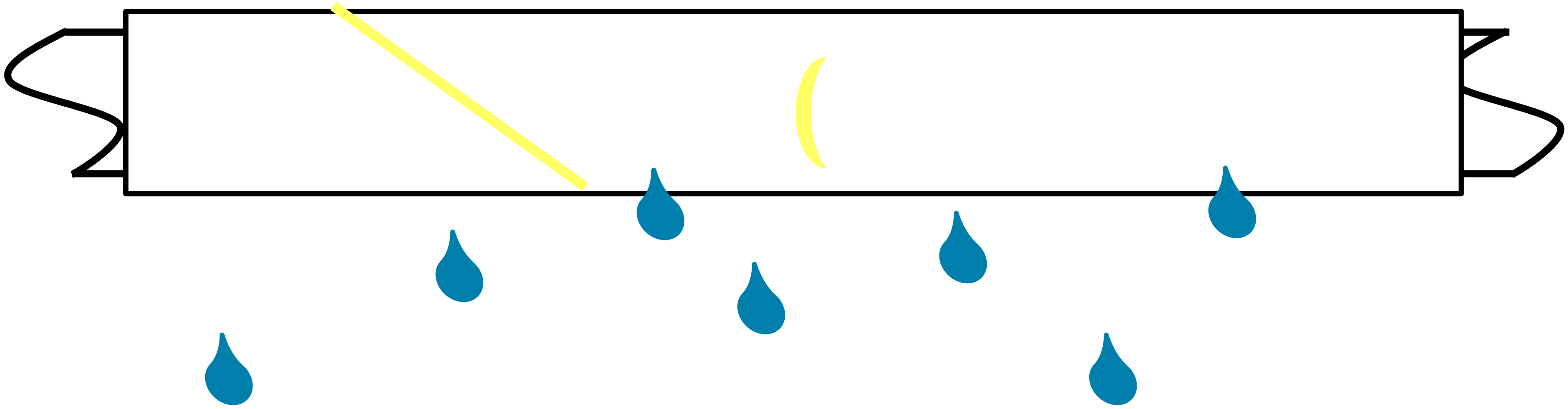
Proper condensation control requires:

- ✓ **Insulation of proper thickness so $T_s > T_D$**
- ✓ **Vapor retarder (if necessary)**

Conclusions

Condensation will occur if:

- ❌ Insulation is the wrong thickness so $T_s < T_D$
- ❌ Vapor retarder is compromised in any way



Conclusions

This may lead to:

- Moisture ingress
- Corrosion under insulation (CUI)
- Mold
- Poor air quality

- **Technical data sheets** and **white papers**
- **Thickness calculation reports**
- **Job stories** (real-life project case studies)
- **Any other specification or application needs**

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