Insulation
The Forgotten Technology

Dayton Chapter
Dec 14, 2009

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Insulation, The Forgotten Technology

Discussion Topics – Learning Objectives:

• **The need and value to “Think about Insulation Differently”** – To obtain a better understanding and appreciation as to “Why Insulate”

• **Review evidence of the Power of Insulation – Energy Assessments**

• **How to quantify the value of this technology, simply known as insulation and**

• **Demonstration of the “Mechanical Insulation Design Guide” the most comprehensive mechanical insulation resource developed in decades**
NATIONAL INSULATION ASSOCIATION

- 55 year old trade association
- Representing all segments of the industry - contractors, distributors, fabricators and manufacturers
- United States industry voice and resource for mechanical insulation information in the, industrial, commercial, and mechanical industries
The Voice of the Mechanical Insulation Industry

“INSULATION OUTLOOK”

Free Annual Subscription
Defining Mechanical Insulation

MECHANICAL INSULATION encompasses thermal, acoustical, and personnel and life safety requirements in Commercial and Industrial applications:

> Mechanical piping and equipment, hot and cold applications
> Heating, Venting & Air Conditioning (HVAC) applications
> Refrigeration and other low-temperature piping and equipment applications
This is not a “state of the art” insulation system!
This is not a “state of the art” insulation system or maintenance procedure!
Insulation, The Forgotten Technology

Mechanical insulation is the “Rodney Dangerfield” of energy conservation.

“No respect” for the potential benefits of mechanical insulation or the potential Return on Investment (ROI)

Mechanical insulation is the “Forgotten Technology”
WHY IS INSULATION, THE FORGOTTEN TECHNOLOGY?

Simple - it is not sexy!

– Reduced knowledge base has led to underutilization and insulation systems being applied but rarely “engineered”

– No gauges

– No monitoring

– No computer chip

– Insulation is normally part of larger mechanical contract

The benefits are instantaneous, but invisible and taken for granted
Insulation, The Forgotten Technology

WHY INSULATE?

1. Energy Conservation
   • Energy
   • Economics
   • Environment
2. Condensation Control
3. Personnel Protection
4. Fire Protection
5. Process control
6. Freeze Protection
7. Noise Control
Insulation significantly reduces the energy required to run a facility and its processes.
Insulation significantly reduces the energy required to run a facility and its processes.

Many times energy conservation is only considered of importance in “hot” applications – that is not correct.

The temperature differences may vary which directly affects the degree of savings.

But, the savings and ROI on “below ambient” applications are real! Plus, other design considerations, such as condensation, may be equally important.

Hot Example
60F Ambient vs 350F Operating
290F Temperature Difference

Cold Example
80F Ambient vs -10F Operating
90F Temperature Difference
ASHRAE 90.1 Pipe Insulation Requirements -20 Yr History
ASHRAE 90.1 Duct Insulation Requirements - 20 Yr History
How much energy is being saved or lost with mechanical insulation?

How Big is the Opportunity?

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What about Commercial Facilities?

What About Industrial and Manufacturing Facilities?

IT’S BIG!

YET, MECHANICAL INSULATION GETS LITTLE RESPECT!

HOT – COLD – HVAC

IT IS CLEARLY A BIG OPPORTUNITY
Are these examples a normal occurrence?

350 F Un-insulated pipe

Ice forming due to improper design, installation & maintenance
Did you know?

It has been estimated that between 10% & 30% of all mechanical insulation is missing or damaged!

Petroleum Segment – 21% Chemical Segment – 19%

This same characterization applies to basically mechanical insulation in all applications, some greater than others.
Oil Refinery Illustrative Example
Heat Loss Analysis

1.87 million lineal feet of insulated pipe, 21% of insulation is missing or damaged, 8” NPS @600 F Operating Temperature with 60 F Ambient Temp. w/ 5 MPH wind and 1 ½ “Mineral Fiber insulation system
### Oil Refinery Illustrative Example

#### Heat Loss Analysis

<table>
<thead>
<tr>
<th>Heat Loss, BTU/hr - LF</th>
<th>0</th>
<th>500</th>
<th>1,000</th>
<th>1,500</th>
<th>2,000</th>
<th>2,500</th>
<th>3,000</th>
<th>3,500</th>
<th>4,000</th>
<th>4,500</th>
<th>5,000</th>
<th>5,500</th>
<th>6,000</th>
<th>6,500</th>
<th>7,000</th>
</tr>
</thead>
</table>

The heat loss equates to 5,800 barrels of oil @ $50 per barrel

*$290,000* Lost per day

$522,000 @ $90 per barrel

$812,000 @ $140 per barrel

The same principle applies to all mechanical insulation applications!!!

*This is a BIG $-Dollar-$ opportunity – you cannot afford to overlook*

*This is a BIG number*

*Cut it in half, cut it by 75%*

*This remains a BIG number*
Oil Refinery Illustrative Example
Heat Loss Analysis

The heat loss equates to 5,800 Barrels of Oil @ $50 per barrel

$290,000 Lost per day
$522,000 @ $90 per barrel
$812,000 @ $140 per barrel

This is one refinery! – What about the power & process, pulp & paper, petro-chemical, manufacturing, food processing industries, etc?
• 717 Assessments complete (January 2, 2009)
• 180 Public Reports Issued
  51% have specifically mentioned insulation
• Total potential annual energy savings & emission reduction for all initiatives
  – $937 Million in energy cost savings
  – 87.2 Trillion BTU natural gas savings
  – 7.9 Million metric tons potential carbon dioxide – CO\textsubscript{2} emissions reduction
SAVE ENERGY NOW
INDUSTRIAL TECHNOLOGIES
PROGRAM
(Published results as of July 1, 2008)

**Insulation References**

Near Term (<1 yr. return) 82%
Medium Term (<3 yr. return) 15%
Long Term (>3 yr. return) 3%

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Missing, damaged, or uninsulated 70%
Upgrade or improve 30%
SAVE ENERGY NOW
NEAR TERM Insulation Initiatives

BAYER (2 Steam Plants), Institute, WV
By improving and replacing missing insulation on the steam and condensate lines – **Potential savings $926,000 per year**

BOISE CASCADE (Paper Mill), Jackson, AL
By replacing missing pipe insulation – **Estimated savings $80,000 per year, cost to complete the work $25,000 = Payback in 3.2 months**

DOW CHEMICAL (Chemical Plant), Hahnville, LA
By replacing, repairing and improving insulation on steam system - **Potential savings of $811,000 per year**

GENERAL MOTORS (Power Plant), Pontiac, MI
By replacing missing insulation and repair others – **Estimated savings of $298,000 per year**
GOODYEAR Union City, TN
A significant number of process units are partially insulated
Potential savings = $402,000 per year. Estimated cost to insulate ranges between $80-$200,000 = payback in 2 – 5 months. “This same opportunity can be applied to other company facilities”

MEAD WESTVACO, Silsbee, TX:
Commissioned an “insulation strike team” to go through the plant to repair areas of poor, damaged or missing insulation. They determined that reducing insulation heat loss by 10%, the savings would be over $486,000 per year.

UNITED STATES STEEL, Gary, IN:
Estimated that by using proper type, size and thickness of insulation and improving maintenance of the insulation systems Potential energy savings could be in excess of $1,500,000 per year
SAVE ENERGY NOW
NEAR TERM Insulation Initiatives

MITTAL STEEL, Weirton, WV
Hot water washing tanks are located throughout the facility, 50,000 SF of surface area. The surface temperature of these tanks is 140°F.
Assuming ½ the heat loss can be saved with an inexpensive – simple insulation system, the annual savings would be $371,000 + per year.

FRITO-LAY, Frankfort, IN
Adding insulation to bare pipes and fittings – $150 M estimated cost = annual savings of $80 M = simple payback of 1.88 years – medium term project.
SAVE ENERGY NOW
NEAR TERM Insulation Initiatives

• Coors Brewery, Golden, CO
• Dairyman’s Land O’ Lakes, Tulane, CA
• Foremost Farms, Richland, WI
• Leprino Foods, Lemoore, CA
• Welsh Foods, North East, PA

Replace, repair and improve insulation
Associated Milk Producers – Con Agra Foods – Hormel – Imperial Sugar – Kraft
Estimated energy savings, emission reduction and jobs created with improved maintenance and focus on mechanical insulation

A portion of the

Industrial – Maintenance Segment

<table>
<thead>
<tr>
<th>Plant Size</th>
<th>Energy Savings Billions ($)/year</th>
<th>CO Reduction Billion Lbs/yr</th>
<th>Payback (Months) ROI (*) (20 yrs)</th>
<th>Jobs (*) Created Preserved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large &amp; Medium</td>
<td>&gt; $ 1.9</td>
<td>&gt; 45.6</td>
<td>12.0 / 103%</td>
<td>12,069</td>
</tr>
<tr>
<td>Small (*)</td>
<td>&gt; $ 0.6</td>
<td>&gt; 15.9</td>
<td>9.6 / 135%</td>
<td>2,930</td>
</tr>
<tr>
<td>Total</td>
<td>&gt; $ 2.5</td>
<td>&gt; 61.5</td>
<td>11.3 / 109%</td>
<td>14,999</td>
</tr>
<tr>
<td>Distribution (*)</td>
<td></td>
<td></td>
<td></td>
<td>1,533</td>
</tr>
<tr>
<td>Total</td>
<td>&gt; $ 2.5</td>
<td>&gt; 61.5</td>
<td>11.3 / 109%</td>
<td>16,532</td>
</tr>
</tbody>
</table>

* Estimated by NIA
<table>
<thead>
<tr>
<th>Energy Conservation Option</th>
<th>Energy Savings, MMBtu/yr (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ft of insulation on 350°F pipe</td>
<td>14.4</td>
</tr>
<tr>
<td>1 car, 5% increase in mpg</td>
<td>3.7</td>
</tr>
<tr>
<td>1 compact florescent light bulb</td>
<td>0.9</td>
</tr>
<tr>
<td>1 ft of insulation on 180°F pipe</td>
<td>0.9</td>
</tr>
<tr>
<td>1 ft of insulation on 42°F pipe</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Energy conservation with the use of mechanical insulation - “Low Hanging Fruit” - is simply an OPPORTUNITY that should not be overlooked.

It is an investment that may have few rivals from a return perspective.

(1) Equivalent energy savings in Millions of Btu/yr (MMBtu/yr) of primary fuel.
Insulation reduces plant greenhouse gas emissions by reducing plant energy consumption.

This is a great example of why we need to think about insulation differently.
How USA’s Electricity is Generated

<table>
<thead>
<tr>
<th>Source</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>COAL</td>
<td>48.3%</td>
</tr>
<tr>
<td>NATURAL GAS</td>
<td>21.3%</td>
</tr>
<tr>
<td>NUCLEAR</td>
<td>19.2%</td>
</tr>
<tr>
<td>HYDRO-POWER</td>
<td>6.9%</td>
</tr>
<tr>
<td>SOLAR &amp; OTHER</td>
<td>3.3%</td>
</tr>
<tr>
<td>WIND</td>
<td>1.0%</td>
</tr>
</tbody>
</table>

U.S. Department of Energy (2008 through September)
Houston Chronicle, January 11, 2009
## Insulation, Is “Greener” than Trees

<table>
<thead>
<tr>
<th>Carbon Reduction Option</th>
<th>Lbs of CO2 per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ft of insulation on 350°F pipe</td>
<td>2,308</td>
</tr>
<tr>
<td>1 car, 5% increase in mpg</td>
<td>570</td>
</tr>
<tr>
<td>1 compact florescent light bulb</td>
<td>130</td>
</tr>
<tr>
<td>1 ft of insulation on 180°F pipe</td>
<td>109</td>
</tr>
<tr>
<td>1 ft of insulation on 42°F pipe</td>
<td>88</td>
</tr>
<tr>
<td>1 tree</td>
<td>50</td>
</tr>
</tbody>
</table>
The environment, along with energy conservation, is going to be, if they are not already, center stage in the financial and political arenas for years to come.

There is no question!

Insulation CAN HELP Reduce Polluting Emissions and Increase Available Carbon Credits.

One credit is considered equivalent to one ton of CO2 emissions.
The cost of cutting carbon in different ways
Marginal cost of abatement, examples €/t CO₂

Water heating
Cellulosic ethanol
Nuclear
Sugar-cane biofuel
Wind
Solar
Forestation
Carbon capture and storage in retrofitted coal-fired power stations
Switch from coal to gas for power generation

Fuel-efficient vehicles
Carbon capture and storage with enhanced oil recovery and new coal-fired power stations

Lighting systems
Insulation improvements
Fuel-efficient commercial vehicles

Abatement potential, gigatonnes CO₂/year in 2030

Source: Vattenfall
Properly designed, installed and maintained insulation can:

- Prevent condensation, which can be a major factor in mold growth and potentially be a safety hazard.
- Condensation or moisture intrusion can contribute to corrosion under insulation (CUI).
The insulation system must be designed to maintain the surface temperature above the dew point!!

Design the system under the worst case scenario not the best or normal and maintain the system in a timely and correct manner!
MOISTURE IS A ENEMY
CONDENSATION, MOLD OR
CORROSION UNDER INSULATION,
INCREASED OPERATING COST

CUI

Mold
Condensation problems are real and can lead to other problems!

Mold – Indoor Air Quality - Safety
Condensation problems are real and can lead to other problems!

Mold – Indoor Air Quality - Safety
MOISTURE IS A ENEMY!

YESTERDAY – TODAY

TOMORROW

We need to think about insulation differently!

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Respect the damage moisture can cause

- Before it develops! -
Insulation Improves Process Control

- Helps maintain design process temperatures
- Improves product throughput
- Maintains product quality and
- Lowers cost with lower energy consumption

Increased Profitability In Manufacturing
We need to think about insulation differently!
Protecting personnel from coming in contact with hot/cold surfaces or excessive equipment or other work place noise and life safety applications should be a focus of any Safety Program.

Insulation Provides Personnel Protection
PERSONNEL PROTECTION? SAFETY?

What better example than safety to Think About Insulation Differently
LIFE SAFETY
FIRE PROTECTION

Building Code Objectives:
• Prevent progressive building collapse – contain the fire to the area of origin
• Provide safe occupant egress
• Provide firefighter entry/operations/safety

Fire Resistance Rated Shafts/Enclosures

Protection of Ducts & Air Transfer Openings
LIFE SAFETY
FIRE PROTECTION IS SERIOUS BUSINESS

- Supply & Return Ducts
- Chemical Fume Exhaust Ducts
- Commercial Grease Ducts
- Linen/Laundry/Rubbish Chutes
- Stairwell Pressurization Ducts

“Fire stopping” – Penetrations & wall - Ceiling Joints
Insulation Can Improve Facility Life Cycle Costs
Insulation is a time tested and proven energy conservation investment.

**Insulation Can Provide a Significant Return on Investment (ROI)**

*Many times in less than 1 year and faster than nearly any other energy efficiency investment*

That all sounds good

**but how can you quantify the savings and return?**
3E Plus Insulation Thickness Computer Program

Determining your insulation needs has never been easier.

- Energy
- Environment
- Economics

Disc are available or you can download the program

www.pipeinsulation.org
Developed by North America Insulation Manufacturers Association (NAIMA)

ENERGY
- Heat Loss/Gain
- Surface Temperature
  - Personnel Protection
  - Condensation Control

ECONOMICS
- Cost of Heat Loss/Gain
- Economic Thickness
- Payback Period

ENVIRONMENT
- Greenhouse Gas Emissions

Available for downloading at www.pipeinsulation.org
Developed by
North America Insulation Manufacturers Association (NAIMA)

Inputs Required:
Operating and Ambient Temperatures
Wind Speed
Type & Cost of Fuel, etc

Insulation Selection Options:
Geometry
Type & Thickness of Insulation
Finish (Aluminum etc)

Available for downloading at www.pipeinsulation.org
EXAMPLE

Heat Loss – Energy Conservation

- 8” NPS Steel Horizontal Pipe
- 350°F Process and 75°F Avg. Ambient Temperature
- 8 MPH Average Wind Speed
- Fuel Source – Natural Gas @ $10/mcf
- Operating Hours – 8,320/yr
- Insulation – Mineral Wool System with Aluminum Jacket
### EXAMPLE

**Heat Loss – Energy Conservation**

<table>
<thead>
<tr>
<th>VARIABLE INSULATION THICKNESS</th>
<th>HEAT LOSS (BTU/FT/YR)</th>
<th>ESTIMATED INSULATION COST ($/LF)</th>
<th>ANNUAL COST SAVINGS ($/LF)</th>
<th>PAYBACK (MONTHS)</th>
<th>CO2 EMISSION (LBS/FT/YR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BARE</td>
<td>23,180,000</td>
<td></td>
<td></td>
<td></td>
<td>3,376</td>
</tr>
<tr>
<td>1.5 INCH</td>
<td>1,200,000</td>
<td>$17.87</td>
<td>$267.80</td>
<td>0.8</td>
<td>174</td>
</tr>
<tr>
<td>2 INCH</td>
<td>954,900</td>
<td>$21.00</td>
<td>$270.80</td>
<td>0.9</td>
<td>139</td>
</tr>
<tr>
<td>3 INCH</td>
<td>679,100</td>
<td>$29.35</td>
<td>$274.10</td>
<td>1.3</td>
<td>98</td>
</tr>
</tbody>
</table>
Why is insulation maintenance looked at differently yet the evidence of its value is overwhelming and opportunity is so great?

- **Reactive vs Proactive approach – Time & Resources**
- **Lack of Knowledge -“No Respect”** – for Return on Investment or potential risk not recognized in short or long term
- **Just not a high priority – “status quo”**
- **Damage not identified early enough and repairs are often not done timely and correctly**

10-30% Missing or Damaged
Typical – Neglect Example, or Not?
“Non – Destructive Testing”

Non Destructive or Destructive?

Penetrating an Insulation under any circumstances Is a risk!

Not immediately repairing the area is just like throwing money out the widow
Typical - Damage Example, or Not?

Are there risks in not timely and properly maintaining an insulation system? - YES
The lack of or timely and proper maintenance can lead to a failed insulation system, which is problematic for many reasons:

\section*{Safety:}
- Corrosion of the substrate (CUI) which could result in an release of the pipe or equipment contents
- The increased weight of potential wet insulation could potentially cause the piping, equipment etc to exceed the structural design of the support systems
- Dripping of water from the insulation could create personnel safety concerns
Productivity:
The reduced efficiency of the insulation system is not allowing the equipment or process to function as designed thus resulting in decreased plant productivity and or increased cost of production.
What are the "Risks"?

Cost of Operations – Return on Investment:
A failed insulation system is increasing annual operating cost and life cycle cost verses the purpose for which it was intended:

- Increased energy consumption
- Increased production cost – lower throughput
- Corrosion under the insulation is decreasing the life of the substrate thus increasing life cycle and annual maintenance cost in multiple areas
- Deceasing the life of the equipment due to operational demands and the affect on the surrounding work area
- Creating unnecessary risk in multiple areas including employee and community safety and regulatory concerns.
MECHANICAL INSULATION

A TIME TESTED AND PROVEN TECHNOLOGY

BUT.. IT MEANS CHANGE AND YES, THERE ARE BARRIERS TO CHANGE

Think About Insulation Differently
BARRIERS TO CONTINUOUS IMPROVEMENT
WITH MECHANICAL INSULATION

- Needs a “Champion”
- Management – the decision makers need motivation to allocate attention and resources
- People resources seem to be always a problem
- Energy is often not a line of specific accountability and not integrated with other business objectives
- Slow uptake on energy savings projects and implementing technical or specification recommendations
- The damage or cost caused by reduced focus on mechanical insulation is often not identified
- Lack of detailed knowledge on mechanical insulation systems
- Pressure from competing and often more “glamorous” initiatives
- Good or best practices in one unit/plant are not easily and widely diffused in organizations
- Insulation is not considered part of continuous improvement process

There has never been a better time than now to think about insulation differently
THE NEED FOR EDUCATIONAL AND AWARENESS PROGRAM AS TO THE “VALUE OF INSULATION”

OUTREACH INITIATIVE TO PARTNERS IN KNOWLEDGE
Launched January 2008

Mechanical Insulation Design Guide

A web-based resource intended to assist users with design guidance for mechanical insulation systems

www.wbdg.org/midg
The Mechanical Insulation Design Guide

- Developed jointly by:
  - The National Institute of Building Sciences
  - The National Insulation Association

www.wbdg.org/midg
National Institute of BUILDING SCIENCES

• A non-profit, non-governmental organization.
• Brings together representatives of government, the professions, industry, labor, and regulatory agencies
• Focus is on the identification and resolution of problems that hamper the construction of safe, affordable structures throughout the United States.
• Authorized by the U.S. Congress, the Institute provides an authoritative source and a unique opportunity for free and candid discussion among private and public sectors.
• Mission: to serve the public interest by supporting advances in building sciences and technologies
MIDG is part of the NIBS “Whole Building Design Guide”

www.wbdg.org

- The Whole Building Design Guide (www.wbdg.org) is an evolving web based resource intended to provide users with design guidance, criteria and technology for buildings

- The WBDG and MIDG are continually augmented with updated and new information and is structured as a “vertical portal”, enabling users to access increasingly specific information as they navigate deeper into the site

The WBDG and MIDG are available on a “no-cost” basis to all users
Six Main Sections:
1. Introduction
2. Design Objectives
3. Materials & Systems
4. Installation
5. Design Data
6. Resources

www.wbdg.org/midg
“On Line Calculators”

1. Service Temperature, By Product Type
2. Estimated Time for Fluid to Freeze in an Insulated Pipe
3. Temperature Drop – Fluid Flowing in a Duct or Pipe
4. Simple Thickness
5. Simple Heat Flow
6. Rate of Return on Investment & Emission Reduction

MIDG is the most extensive mechanical insulation resource developed in decades and it is free

www.wbdg.org/midg
MIDG
MECHANICAL INSULATION DESIGN GUIDE

+ASTM, GOVERNMENT AGENCIES, & OTHERS

MIDG
MECHANICAL INSULATION DESIGN GUIDE

NIA
National Insulation Association
www.insulation.org

ARCOM
MASTERSPEC

NAIMA
North American Insulation Manufacturers Association

HRSAE

MIDG USERS

PIP
Six Sections:
1. Introduction
2. Design Objectives
3. Materials & Systems
4. Installation
5. Design Data
6. Resources

www.wbdg.org/midg

Live demonstration
Summary

• MIDG is the most comprehensive resource on Mechanical Insulation available today
• MIDG is available at no cost
• Access MIDG at www.wbdg.org/midg
Insulation…

Good For Business!
Good For The Environment!
Good For The Economy!

We need to think about insulation differently!

NEW CONSTRUCTION,
RETROFIT & MAINTENANCE - SERVICE MARKETS
Insulation, The Forgotten Technology

Think About Insulation Differently

The National Insulation Association
12100 Sunset Hills Road
Suite 330
Reston, VA 20190
(703) 464-6422