Insulation Investment = Energy Savings and Exceptional Financial Returns

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ABSTRACT

Mechanical insulation from an energy savings investment perspective in commercial building and industrial applications, although important to facility operations and manufacturing processes, is often overlooked and undervalued. Whose fault is that, and why is that? For a variety of reasons, the knowledge base of mechanical insulation has eroded over the last 10 years. Combine that with insulation being taken for granted as to providing a simple one-time payback and you have identified the problem. This article will explore this problem and provide evidence; processes and resources for de-mystifying this proven, but often forgotten energy savings and emission reduction technology, simply known as insulation. With today's high cost of energy, our dependency on foreign energy sources; and our renewed focus on the environment, there has never been a more important time to think about insulation differently. You will leave asking yourself why you have not taken advantage of this technology before.

INTRODUCTION

Mechanical insulation from an energy savings investment perspective in commercial building and industrial applications, although important to facility operations and manufacturing processes, is often overlooked and undervalued. Whose fault is that, and why is that? For a variety of reasons, the knowledge base of mechanical insulation has eroded over the last 10-15 years. Combine that with insulation being taken for granted as to providing a simple one-time payback and you

have identified the problem. This article will explore this subject and provide evidence; processes and resources for de-mystifying this proven but often forgotten energy savings and emission reduction technology, simply known as insulation. With today's high cost of energy, our dependency on foreign energy sources, and our renewed focus on the environment, there has never been a more important time to think about insulation differently.

DEFINING MECHANICAL INSULATION

The scope of this article focuses upon "mechanical insulation systems"—insulation systems utilized for piping, equipment, vessels, ducts, boilers, and other similar mechanical equipment and piping applications in building—commercial and industrial applications. Said another way, "mechanical insulation systems" shall be defined to encompass all thermal, acoustical, and personnel safety requirements in:

a) Mechanical piping and equipment, hot and cold applications.
b) Heating, venting & air conditioning (HVAC) applications.
c) Refrigeration and other low-temperature piping and equipment applications.

WHERE IS THE KNOWLEDGE BASE?

The knowledge base of mechanical insulation systems at the engineering, architectural, and facility owner level has, in most cases, decreased over the last 10-15 years. The root cause can be summarized by a combination of attrition, right sizing, and multi-tasking. In addition, insulation is not a field that is attracting specialization in the engineering, architectural, or maintenance arenas. Mechanical insulation does not have the bells and whistles, computer chips, etc. that many other technologies have. This reduced knowledge base has led to the improper and under-utilization of mechanical insulation in many applications.

Mechanical insulation, although important to facility operations and manufacturing processes, is often overlooked and undervalued. National standards, universal energy policies, or generally accepted recommendations as to what should be insulated, what insulation systems

are acceptable for a specific use, and application best practices do not currently exist.

Development of mechanical insulation specifications or the selection of an insulation system is normally influenced by past practices or by the most knowledgeable person(s) in the decision chain or industry segment included in the design—selection process.

Past practices and knowledge?—Those topics produce many fundamental questions.

- Were past practices correct—did the insulation system perform to expectations? Were conditions, like the cost of energy, different five, ten or twenty years ago versus today? Are there new technologies or approaches that should be considered?
- Where can someone obtain unbiased information on what should be considered in designing, selecting, specifying, installing, and maintaining an insulation system?

Where is the knowledge source? Many, maybe most, engineering and architectural courses contain maybe one hour, if that, on mechanical insulation. The knowledge base in many engineering, architectural, and facility owner firms has eroded, and the insulation manufacturers who for years were the educators of the industry have for a multitude of reasons dramatically reduced their in-person communication and education efforts.

Combine all of these and you find the value of mechanical insulation is not being realized to its potential in reducing our dependency on foreign energy sources, improving our environment, improving our global competitiveness, and providing a safer work environment.

Mechanical insulation is applied but rarely "engineered." With the best intentions, but not necessarily with thorough knowledge, many specifications have evolved over the years primarily based upon modification of old documents. This practice, combined with the lack of mechanical insulation educational and awareness programs as to the value in having a properly engineered, installed, and maintained mechanical insulation system, has led to the underutilization of mechanical insulation in energy conservation, emission reduction, process and productivity improvement, life cycle cost reduction, personnel safety, and work-place improvement applications.

It is not like there are no mechanical insulation resources available. There are several excellent "guide specifications," "handbooks,"

"standards," and "practices" that are and have been available for years. However, the effective use of those resources is based upon the premise that the user is aware of them, has access to them, and has some level of knowledge of mechanical insulation systems. That assumption may not always be correct.

The National Institute of Building Sciences (NIBS), in June 2005, formed the National Mechanical Insulation Committee (NMIC) for building and industrial applications to bring together major governmental agencies, private industry, and organizations concerned with the design, installation, and maintenance of mechanical insulation systems. NIBS and NMIC offer the opportunity for a constructive public and private partnership in the examination of topics related to mechanical insulation and providing education as to their findings and the merits and value of properly engineering, applying, and maintaining mechanical insulation systems.

The National Institute of Building Sciences (NIBS), www.nibs.org, is headquartered in Washington, D.C. It was authorized by the U.S. Congress in the Housing and Community Development Act of 1974. In establishing NIBS, Congress recognized the need for an organization that could serve as an interface between government and the private sector. The institute's public interest mission is: to improve the building regulatory environment; facilitate the introduction of new and existing products and technology into the building process; and disseminate nationally recognized technical and regulatory information.

NIBS is an non-profit, non-governmental organization bringing together representatives of government, the professions, industry, labor, and consumer interest to focus on the identification and resolution of problems and potential problems that hamper the safe, affordable structures for housing, commerce, and industry throughout the United States. NIBSs operates with a balanced blend of public and private funding and representation. This approach has enabled NIBS to bring together the nation's finest expertise available from the public and private sectors to identify and resolve issues affecting the building process

and to assure that no single interest area will dominate or hold undue influence over NIBS and its work, and assures the maintenance and free exchange of information.

Recognizing the problems related to the lack of knowledge with mechanical insulation the committee's first initiative was the development and continual updating of an internet-based *Mechanical Insulation Design Guide* (MIDG), available through the NIBS *Whole Building Design Guide*, www.wbdg.org/midg, on a no-cost basis.

MIDG is not another general "guide specification." It is a comprehensive one-stop knowledge resource to assist the novice or the knowledgeable user in the design, selection, specification, installation, and maintenance of mechanical insulation systems. MIDG was launched in January, 2008, and is the most comprehensive resource developed for mechanical insulation in decades. If you want to know something about mechanical insulation, visit www.wbdg.org/midg.

ENERGY CONSERVATION INVESTMENT

Insulation is the Rodney Dangerfield of the construction industry—it gets very little respect and is taken for granted. When designed, applied, and maintained properly, insulation is a powerful technology—one that provides long-lasting benefits. However, insulation is often overlooked or relegated to the bottom of the list and ignored. One reason may be that insulation systems have no moving parts, no bells and whistles, no computer chips, no fancy gauges—and certainly is not sexy. This technology is not some mysterious myth. The principles of insulation are simple and not necessarily revolutionary—possibly another reason why it is often overlooked. However, the bottom line is that insulation can provide in many cases an annual return on investment of greater than 100 percent. With energy efficiency and conservation and the reduction of greenhouse gas emissions priorities in today's world, maybe it's time to begin thinking about this underutilized, under-valued, and under-appreciated technology differently.

The most widely recognized and proven benefit of mechanical insulation is energy conservation, yet it is often the "forgotten technology." This article will examine why mechanical insulation as an energy investment should be a priority, especially if you are interested in an often unparalleled return on your investment.

Energy is often one of the most costly components of operating any building or manufacturing facility and its processes. A reduction in energy consumption reduces cost. Without exception, this is a continual objective of most companies. It may not be at the top of the list, but certainly within the top ten of corporate initiatives, along with safety, quality, shareholder value, and the environment. While insulation can be one of the easiest, fastest, and least costly technologies to reduce energy cost, it is often the last option considered.

Energy Conservation Seldom a Design Criteria

It is interesting to review the process for determining the design criteria for insulation on new construction or expansion projects verses the maintenance process and how priorities are established. In new construction, the primary driver in determining the insulation system is the process. Very seldom is the insulation system or thicknesses examined from an energy conservation perspective. Once a facility or plant is operating and the energy consumed is a reality, as opposed to a theory, it seems that compliancy or acceptance of the results outweighs examining actual results in comparison to original expectations. Proper and timely maintenance of an insulation system seems to be mostly reactionary verses proactive—not the correct formula for obtaining the best operating performance, providing a safe working environment, maximizing your return on investment, etc.

The cost of energy has dramatically increased over the last ten years, even the last 12 months, yet there is very little serious discussion given to upgrading insulation thicknesses that were designed and installed when oil was $25 or even a $100 a barrel. In addition, it has been estimated that between 10 to 30 percent of all installed mechanical insulation is either damaged or missing. That is a big number, even if you discount it by 50 percent. The question that must be asked is why are companies not upgrading insulation thicknesses to reflect today's and tomorrow's cost of energy and allowing missing or damaged insulation to exist when both situations can be corrected and provide a significant return on the capital employed or maintenance dollars expended?

Return on Investment (ROI)

The return on investment with an insulation initiative usually exceeds expectations. Many times the return is less than a year. It can provide a faster return than many of the fancier and more visible energy efficiency investments. In today's competitive and shareholder-driven bottom line world, insulation can make a difference. But it is not normally a board room discussion. Maybe it should be. Was your insulation system designed for 1958, 1978, or 2008? And with the most recent trends, are you planning for the cost of energy in 2018? You may be missing a significant investment—return on investment (ROI) opportunity.

Examples of energy inefficiency can be found within the Department of Energy (DOE)—Industrial Technologies, "Save Energy Now" (SEN) Program (www.eere.energy.gov.industry/saveenergynow or google Save Energy Now). The program is part of a national campaign by the DOE to help manufacturing facilities reduce energy and operating costs and operate more efficiently and profitably. Independent specialists trained in the utilization of sophisticated software assessment tools visit a plant and work with personnel to identify immediate and long-term opportunities for improving energy efficiency and bottom-line results. Mechanical insulation is one of the many opportunities that are examined.

Of the SEN assessment studies published to date, 53 percent have identified replacing, repairing, and upgrading the mechanical insulation as an opportunity of which 84 percent have estimated a simple return on investment in less than a year. Annual dollar savings in some studies were approaching $1,000,000, and many exhibited returns in less than four months. These third party—impartial assessments confirm the 10 to 30 percent missing/damage estimates and the return on investment opportunity.

Examples like those found with the SEN assessments can be found across all industries, large and small, from refining and power generation to food processing, and in below and above ambient applications. You need only examine your own facilities and begin to think about insulation differently to find an opportunity to increase profitability year after year.

Assessments Use 3E Plus® Software

The "Save Energy Now" program assessment specialists use the 3E Plus® software program to analyze mechanical insulation. 3E Plus®

is specifically designed to help the user understand and quantify the effects and benefits of insulation vs. bare surfaces. The "3E" part of the 3E Plus® name is an acronym for energy, environment and economics, the three major features of the program developed by the North American Insulation Manufacturers Association (NAIMA). The 3E Plus® Software Program can be downloaded *free of charge* at www.pipeinsulation.org. Listed below is an overview of the program features.

3E PLUS® INSULATION THICKNESS COMPUTER PROGRAM FEATURES

- Determines economic thickness of insulation based on return on investment for chosen fuel cost, installed cost, tax rates, maintenance, etc.
- Calculates the amount of insulation needed for personnel protection for various design conditions.
- Calculates the thickness of insulation needed for condensation control.
- Calculates greenhouse gas emissions and reductions.
- Determines surface temperatures and heat loss/gain calculations of individual insulation thickness up to 10 inches.
- Calculates bare vs. insulated heat loss efficiency percentages for horizontal and vertical piping, ducts and flat surfaces.
- Performs calculations for various flat surfaces, selected pipe sizes, and all standard iron pipe sizes from ½" to 48".
- Calculates heat loss/gain and outside insulation surface temperature for any insulation material provided the thermal conductivity, associated mean temperature, and temperature limit are entered by the user.
- Solves for outside-insulated surfaces temperatures for all types of insulation applications at different process temperatures and configurations.

The Bottom Line—
Mechanical Insulation is An Investment with Few Rivals

Energy conservation with the use of properly designed, installed, and maintained mechanical insulation, whether it is a hot or cold ap-

plication, is simply a "low hanging fruit" opportunity that should not be overlooked. Said another way, it is an investment that may have few rivals from a return perspective.

Many people believe an insulation investment opportunity than can provide a significant return on investment is only available in the industrial industry. That is not a correct assumption. The return opportunity is present is all applications, the degree of the return is the variable.

"Simple Payback" Is Not the Only Return Consideration

In today's business environment simple payback calculations are not the only measure for determining the return on investment. The time value of money and the increase in positive cash flow are also important items to be considered. Simple return on investment calculations should be expanded to include the financial impact of secondary benefits, life cycle costing, return on investment, net present value, and asset appreciation.

Analyzing and communicating the benefit of energy conservation initiatives, like an insulation energy management program, requires multiple levels of communication. Facility managers and engineers need to understand and endorse the initiatives, and, equally important, so does the CFO and CEO. Technical jargon, reams of specifications, and engineering calculations may be of great interest to plant operations, but will probably be boring to a CFO in minutes. CFOs are interested in the investment aspects the initiative and assume plant management and engineering have addressed the technical and practical application components.

Slight improvements in plant productivity and product quality may be as or more important than pure energy cost reduction. The conservative value of improved productivity, improved product quality, reduction product losses, or returns and reduction in production downtime should be considered. You need to perform the cost-benefit analysis of any proposed capital investment. The key word is of course investment, since a properly designed and installed insulation system is an investment and not an expense. This concept is the same whether you place the investment within an operating budget or capital budget.

"Simple payback" is a simple measure of the time it takes to recover capital spent on an investment. For example, if $150,000 in

insulation upgrades reduces production or operating—energy costs by $25,000 a month, the payback period is six months. As a basic measure of investment attractiveness, the payback period tends to be most compelling when the period is relatively short.

Simple payback periods do not reflect the value of the cost savings over time. Some people fail to consider that the savings from an insulation project represents permanent savings over an effective lifetime of X years.

A variation of a simple payback period which provides the annual return on investment is referred to as the return on investment percentage or ROI. The ROI on the simple payback example previously discussed is 200 percent. Sign me up—where do I invest? However, the ROI is greater because determining the ROI simply from the payback period ignores the time value of money.

Net present value (NPV) is a method of evaluating the profitability of an investment over the long term. By recognizing the time value of money and equating dollars from different years, net present value makes it possible to evaluate the value of long-term investments. Mechanical insulation, like many, if not all, energy efficiency initiatives, is a long-term investment.

If a company believes it can get 15 percent ROI, often referred to as the hurdle rate, for its money, then the energy savings initiative must beat that ROI to be seriously considered. Cash investments generally occur at the beginning of the project and the savings occur in future periods. Therefore the NPV calculation discounts the future cash flow since the company does not have it today. If the NPV from your insulation initiative beats the hurdle rate, than it should be considered. While the length of the analysis may vary from company to company, the NPV basics do not change. There are several components to this calculation; therefore, it is helpful to determine your company's NPV discount rate, method of calculation, and hurdle rate before presenting the financial analysis on any energy conservation initiative. If the simple payback calculation is any indication, an investment in mechanical insulation may easily exceed even the highest hurdle rates.

The US EPA/DOE EnergyStar program offers many software tools, including Excel files to analyze the financial value of proposed energy related improvements. The *free* EPA/DOE tools include:

CALCULATOR	URL
CFO	http://www.energystar.gov/ia/business/cfo_calculator.xls
Financial Value	http://www.energystar.gov/ia/business/financial_value_calculator.xls
Cash Flow Opportunity	http://www.energystar.gov/ia/business/cfo_calculator.xls
Building Upgrade	tp://www.energystar.gov/index.cfm?c=comm_real_estate.building ht_upgrade_value_calculator

ASSET APPRECIATION

A large number of facility owners are interested in any project that improves the sustained long-term profitability of their business. Reduced operating expenses, such as energy cost, equal better operating profit. The most interesting aspect of this bottom line improvement is that this cash flow is worth several multiples to the business. An extra $100,000 in cash flow could be worth six to ten times that amount to the value of the business. Properly designed, installed, and maintained mechanical insulation can easily provide sustained increased long-term profitability. This has been proven time and time again across all industries.

REDUCTION OF GREENHOUSE GAS EMISSIONS

"In our quest to dramatically cut greenhouse gas emissions and lessen our dependence on fossil fuels, we have overlooked the biggest source of emissions and energy consumption both in this country and around the globe: buildings and the energy they consume each year. Buildings and their construction account for nearly half of all greenhouse gas emissions and energy consumed each year." As with energy conservation opportunities, the commercial building segment is not often considered an opportunity for reducing greenhouse gas emissions. "The building sector is the key source of demand for energy and materials that produce by-product greenhouse gases… Buildings have a lifespan that lasts 50 to 100 years throughout which they consume

energy and produce emissions… buildings not only consume electricity produced at a central power plant, but will also directly burn oil, natural gas and/or propane in boilers, furnaces and hot water heaters. In fact, 58 percent of end-use energy needed to operate a building is consumed by the burning of fuel onsite."

The reduction of direct or indirect fossil fuel energy consumption derived from the use of mechanical insulation in the commercial building and industrial industry segments can reduce the number of pounds of greenhouse gas emissions currently being released into the atmosphere. This benefit is not considered in many applications. Why not? Many people do not relate the reduction of energy consumption to the reduction of greenhouse gas emissions.

Reducing polluting emissions also increases the potential availability of "carbon credits." Reducing greenhouse gas emissions can be financially beneficial versus burdensome. Plus, the public relations benefit cannot be ignored because it is the right thing to do. We may not in our life time experience the full effect of how years of emissions have, or will, influence the environment, but without action now, our children and grandchildren may. That is not a great legacy. The environment, along with energy conservation, is going to be center stage in the financial and political arenas for years to come.

How do you calculate this benefit into the return on investment or decision-making process? The answer will vary, depending upon the facility, carbon credits if applicable, regulatory requirements, etc. The 3E Plus® Program is an excellent tool for determining the impact that insulation can have on the reduction of greenhouse gas emissions. Using the same algorithms as those used for determining energy loss or gain, 3E Plus® allows the user to determine the impact that any repair or upgrade to an insulation system can have on the reduction of emissions if fossil fuels are used for the energy source. 3E Plus® calculates CO_2, NO_X and carbon equivalents (CE).

THE IMPORTANCE OF MAINTAINING AN INSULATION SYSTEM

One of the problems that exist in many industries is that insulation systems are not maintained in a timely and proper manner. Example after example has shown this an area where insulation energy conservation initiatives can provide a significant return on investment.

Not maintaining an insulation system in a timely and correct manner could be problematic for a number of reasons:

Safety: The condition of the insulation systems could lead to:

- Corrosion of the substrate under the insulation which could result in an product release.
- The increased weight of wet insulation and/or ice, depending upon the service and ambient conditions, could potentially cause the piping or equipment to exceed the structural design of the support hangers or other support systems.
- Continual dripping of water from the insulation being wet and or melting of ice which has formed on and in the insulation system could create a personnel safety concern.

Plant Environment and Regulations:

- Wet insulation and increased presence of water from melting ice or dripping from the insulation can, and has contributed to, the development of mold on and in the insulation system and in areas surrounding many of the adjacent areas.

Energy Loss and Greenhouse Gas Emissions:

- While wet insulation or ice do have some minor insulation value, the additional heat loss or gain from the failed insulation systems will result in increased energy consumption and greenhouse gas emissions.

Productivity:

- The reduced efficiency of the insulation system is not allowing the heating, refrigeration, and other equipment to function as designed, thus resulting in decreased plant productivity and or increased cost of production.

Cost of Operations—Return on Investment:

- The failed insulation systems are increasing annual operating cost and life cycle cost verses the purpose for which they were intended:
  - — Increased energy consumption and cost.
  - — 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 heating, refrigeration, and other equipment due to operational demands and the effect on the surrounding work area.

— Creating unnecessary risk in multiple areas, including employee, community safety, and regulatory concerns.

When evaluating the many energy efficiency and conservation initiatives that are available, you should consider all of these benefits or consequences in your short and/or long-term return on investment calculations. If history is a gauge, an investment in mechanical insulation maintenance is a "low hanging fruit" decision.

BARRIERS TO CONTINUOUS IMPROVEMENT WITH MECHANICAL INSULATION

Even when the overwhelming evidence as to the investment return opportunity, not to mention the other benefits, with implementing a host of mechanical insulation energy conservation and emission reduction initiatives there seems to always be barriers present. Following is a general listing of those barriers and areas to be avoided or addressed to be successful in implementing insulation improvement initiatives.

- Insulation energy conservation needs a "champion" within the company.
- People resources seem to always be a problem.
- Energy is often not a line of specific accountability.
- Energy is often 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.
- Lack of knowledge on how to evaluate and communicate the financial and other benefits of implementing the various initiatives.
- Pressure from competing initiatives.
- Good or best practices in one unit/plant is not easily and widely diffused in organizations.
- Insulation is not considered part of continuous improvement processes.
- The plant manager or CEO and CFO need to be part of the evaluation team and decision process, and the total return of investment, and other benefits, considered.

SUMMARY

To take full advantage of this forgotten technology, simply known as mechanical insulation, it is essential to begin thinking differently about insulation and the value it can provide. While mechanical insulation is neither sexy, nor an exciting topic of discussion, it is a resource that, when all the benefits are considered, should prompt the question "Why haven't we thought of this before?"

There are educational programs, software tools, and resources available to help explore the many benefits of mechanical insulation. An increased knowledge of mechanical insulation can provide, in many cases, an unrivalled return on investment opportunity in both the new construction and maintenance arenas. All of this while helping to reduce our dependency on foreign energy sources, helping our environment, and our economy. Not a bad formula.

References

American Institute of Architects (AIA), 2030 Challenge and Architects and Climate Change bulletin.

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.—2005 ASHRAE Handbook, Fundamentals I-P Edition, Chapter 26, Insulation for Mechanical Systems.

ASTM—Standard Practice for Estimate of the Heat Gain or Loss and the Surface Temperature of Insulated Flat, Cylindrical and Spherical Systems by the Use of Computer Programs, Standard 680.

North American Insulation Manufacturers Association - 3E Plus Insulation Thickness Computer Program, Pub. C12128/05 and Software Program.

National Insulation Association—The Power of Insulation and Insulation and The Forgotten or Lost Technology presentations.

National Insulation Association—Closing More Sales by Learning The Foreign Language of CFO's—Richard Lubinski, President of Think Energy Management. LLC.

The U.S. Department of Energy - Industrial Technologies Program, Save Energy Now, Partner Results.

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National Insulation Association (NIA) (www.insulation.org) is a fifty-year-old trade organization whose members specialize in contracting, distribution—fabrication, and manufacturing of mechanical insulation for industrial and building applications, refractory applications, environmental remediation, and other related services. NIA and its Foundation for Education, Training and Industry Advancement are committed to creating and providing educational and awareness programs as to the power of insulation. NIA's scope of activities includes working with private industry, federal and state government agencies, and strategic partner organizations.