

ENGINEERING PRACTICE

VOLUME 2 NUMBER 7

OCTOBER 2016

SPECIAL FEATURE

Guidelines for Reducing
Corrosion Under Insulation and
Safety Consequences



IACPE
INTERNATIONAL ASSOCIATION OF
CERTIFIED PRACTICING ENGINEERS

WWW.IACPE.COM

ENGINEERING PRACTICE

VOLUME 2
NUMBER 7
OCTOBER 2016

ACADEMIC BOARD

Dr. Dominic Foo

Dr. Sivakumar

Kumaresan

Dr. Ir. Muaffaq A Yani

M.Eng

Ir. Drs. Muradi

Suwargina M.T

Ery Fatarina S.T, M.T

LEADERSHIP BOARD

Karl Kolmetz

William B. Lotz

Lin L. Choo



IACPE
INTERNATIONAL ASSOCIATION OF
CERTIFIED PRACTICING ENGINEERS

ABOUT

International Association of Certified Practicing Engineers provides a standard of professional competence and ethics. Identifies and recognizes those individuals that have meet the standard. And requires our members to participate in continuing education programs for personal and professional development.

In addition to insuring a professional level of competency and ethics the IACPE focuses on three major areas of development for our members: Personal, Professional, and Networking.

HISTORY

The International Association of Certified Practicing Engineers concept was formulated by the many young professionals and students we meet during our careers working in the field, running training courses, and lecturing at universities.

During question and answer sessions we found the single most common question was: What else can I do to further my career?

We found, depending on the persons available time and finances, and very often dependent on the country in which the person was from, the options to further ones career were not equal.

Many times we found the options available to our students in developing countries were too costly and or provided too little of value in an expanding global business environment.

The reality is that most of our founders come from countries that require rigorous academic standards at four year universities in order to achieve an engineering degree. Then, after obtaining this degree, they complete even stricter government and state examinations to obtain their professional licenses in order to join professional organizations. They have been afforded the opportunity to continue their personal and professional development with many affordable schools, programs, and professional organizations. The IACPE did not see those same opportunities for everyone in every country.

So we set out to design and build an association dedicated to supporting those engineers in developing in emerging economies.

The IACPE took input from industry leaders, academic professors, and students from Indonesia, Malaysia, and the Philippines. The goal was to build an organization that would validate a candidates engineering fundamentals, prove their individuals skills, and enhance their networking ability. We wanted to do this in a way that was cost effective, time conscience, and utilized the latest technologies.

MISSION

Based on engineering first principles and practical real world applications our curriculum has been vetted by academic and industry professionals. Through rigorous study and examination, candidates are able to prove their knowledge and experience. This body of certified professionals engineers will become a network of industry professionals leading continuous improvement and education with improved ethics.

VISION

To become a globally recognized association for certification of professional engineers.

WWW.IACPE.COM | INFO@IACPE.COM

KNOWLEDGE. CERTIFICATION. NETWORKING

LETTER FROM THE PRESIDENT

KARL KOLMETZ



TALENT AND ABILITIES

Every person has a special talent or ability. Some special talents and abilities include: Art, Music, Painting, Critical Thinking, Writing, Graphics, Physical Gifts, Public Speaking, Humor, Languages, Teaching, Problem Solving, and Juggling.

Wouldn't it be great for you to be gifted and talented? The truth is our choices in life lead to habits; some of our habits develop into special talents; and those talents become gifts. Our goal is to make sure the habits are creating talented gifts. Succeeding in our careers and life requires no special skills regardless of your talents or gifts, but there are consistent behaviors which help individuals turn into an effective member of the workforce.

1. Being On Time

Showing up on time requires almost no forethought, yet for one reason or another people find being prompt a challenge. Being on time is great, but arriving early gives you a competitive advantage. Both are better than apologizing for running late. Being prompt also indicates you respect your colleagues.

2. Work Ethic

You cannot teach someone to be a hard worker. This is something people must willingly strive to achieve on a daily basis in order to truly stand out in the crowd. Always thinking there is more that you can do will advance your career and life.

3. Attitude

Life is 10% what happens to you and 90% how you tackle everyday situations. Every day is a new day to choose and embrace a positive attitude for each situation you encounter. We cannot change our past; nor can we change how people will react. The only thing we can control is our own attitude.

4. Being Coachable

If you want to be successful you must let go of your ego and embrace the best ideas. For many people this is the biggest challenge; admitting your idea or approach may not be the best. One must keep in mind that history has proven new ideas and better procedures are constantly being developed. The key is having an open mind to recognize trends and changes. Being receptive to new ideas, even if they are not your own, is better than clinging to an idea solely because it was yours.

5. Giving to Others

All successful lives embrace helping others flourish. This requires no special talent other than love. Many of us are blessed far more than we deserve and we owe a gift of love to those less fortunate than ourselves. One day you will look back to discover the most rewarding times in your life have been when you helped others.

All the best in your Career and Life,

Karl

BECOME A CERTIFIED ENGINEER



IACPE supports engineers developing across emerging economies focusing on graduates connecting with industrial experts who can help further careers, attaining abilities recognized across the industry, and aligning knowledge to industry competency standards.

IACPE offers certification in the following engineering fields:
Mechanical, Metallurgy, Chemical, Electrical, Civil, Industrial, Environmental, Mining, Architectural, Bio, Information, Machine and Transportation.

WWW.IACPE.COM

NEWS

IACPE-Networking Meeting and Introduction to Refining Seminar in Indonesia



IACPE was busy in September. A Networking Meeting was held in Cilegon-Banten, for Cilegon Chapter. IACPE has 90 members in the Cilegon Chapter. On that occasion there were 18 members received their CPE I certificate as their finished Level I of the program.

IACPE conducted a seminar titled "Introduction to Refining" at the Institute Technology Indonesia, Serpong, Tangerang, Banten Province. Soon after the seminar was also given to more than 350 students at the University Wahid Hasyim Semarang, Central Java. Finally the seminar was presented at the University W.R Supratman, Surabaya, East Java. Mr. William B. Lotz, IACPE Vice President and Light Oil Compliance Manager at CITGO Petroleum Houston USA, was the seminar speaker.

IACPE Supports UHSID



IACPE supported the International Conference of Urban Heritage and Sustainable Infrastructure Development (UHSID) was held in University 17 Agustus 1945 Semarang, East Java in September.

Guidelines for Reducing Corrosion Under Insulation



By:

Karl Kolmetz CPE
KLM Technology Group

Muhammad Salem Abdul Ajes ST.,
CPE 1
KLM Technology Group

Reni Mutiara Sari ST., CPE 1
KLM Technology Group

Introduction

Like other natural events, earthquakes or bad weather, corrosion is a natural event that results in expensive damage that effects almost every industrial sector; Infrastructure, Utilities, Transportation, Production and Manufacturing, and Governmental Functions. Corrosion Under Insulation (CUI) is a problem in the industrial sector, including refining, petrochemical, power, industrial, onshore and offshore industries and it is a real threat to the on stream reliability of many of today's plants. Because the corrosion is hidden under the insulation, CUI tends to remain undetected until the insulation is removed for inspection or whenever loss of containment leaks occur.

Petrochemical industry and other industries have many thousands of meters of pipe that are insulated to prevent heat loss or heat absorption. Corrosion of steel under insulation is considered to be one of the major problems which has caused damage to the petrochemical industry, especially to the insulated equipment and piping systems resulting in failures and accidents.

CUI is occurring in the petrochemical industry and should be a special concern, because this type of corrosion can cause failures in areas that are not normally of a primary concern to an inspection program. The failures are often the result of localized corrosion and not general wasting over a large area. These failures can be catastrophic in nature or at least have an adverse economic effect in terms of downtime and repairs.

Implementation of safety procedures is a good tool in reducing incidents in the petrochemical industry. Over the past 5 years there have been many recorded CUI cases in the petrochemical industry. One of the safety incidents was in an Olefions Plant, on 13 June 2013 in Geismar, an unincorporated and largely industrial area 20 miles (32 km) southeast of Baton Rouge, Louisiana [1].

The phenomenon of CUI can reduced and controlled. This paper will review the guidelines for reducing corrosion under insulation and its safety consequences. The main goal in this paper is review the technical root causes of CUI, review best prevention practices, best inspection practices and a review historical safety incidents.

Definition of Corrosion :

Corrosion or sometime called rust comes from "corros" which means eating away. Corrosion can be defined as the destructive attack of a metal by chemical or electrochemical reaction with its environment. Deterioration by physical causes is not called corrosion, but is described as erosion, galling, or wear. Based on the reaction medium, corrosion can be divided into two types, namely wet corrosion and dry corrosion. Wet corrosion occurs if transfer ions from the cathode to the anode using a liquid. Dry corrosion do not use the ions such as iron metal attack by oxygen or by sulfur dioxide gas typically occurs at high temperatures.

Forms of wet corrosion can occur evenly or locally. Corrosion is prevalent in the immersion of ferrous metals in fluids. Forms of local corrosion can occur macroscopically and microscopically. The local corrosion that are macroscopically example include; corrosion of galvanized iron system events – zinc, corrosion – erosion, corrosion cracking, corrosion hole, exfoliation corrosion and corrosion melting. Examples of corrosion which are microscopic include; stress corrosion, corrosion fracture and corrosion between the grains.

Any corrosion process depends into two factors: temperature and oxygen in addition to the concentration of dissolved species. Corrosion is increased by increasing both factors, if the oxygen is not available then corrosion may not occur. This means that if we keep the environment beneath the insulation dry all the time, then no corrosion will occur. When precipitation becomes trapped on the metal surface by insulation, corrosive atmospheric constituents such as chloride and sulfuric acid gases can concentrate to accelerate corrosion.

History of Safety Incidents^[2] :

The aging infrastructure is one of the most serious problems faced by society today. In past decades, corrosion professionals focused primarily on new construction specifying materials and designing corrosion prevention and control systems for buildings, bridges, roads, plants, pipelines, tanks, and other key elements of the infrastructure. Today, as much of the aging infrastructure reaches the end of its designed lifetime, the emphasis is on maintaining and extending the life of these valuable assets.

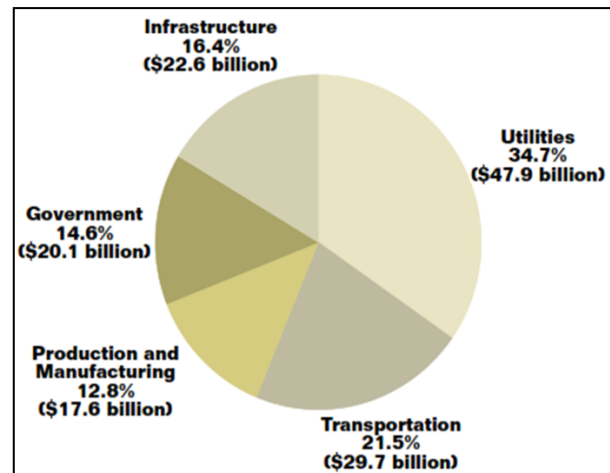


Figure 1 : Cost of Corrosion in Industry Categories.

Utilities, which supply gas, water, electricity, and telecommunications services, account for the largest portion of annual industrial corrosion costs. Direct corrosion costs total \$47.9 billion. These costs are broken down into the sectors of gas distribution, drinking water and sewer systems, electrical utilities, and telecommunication.

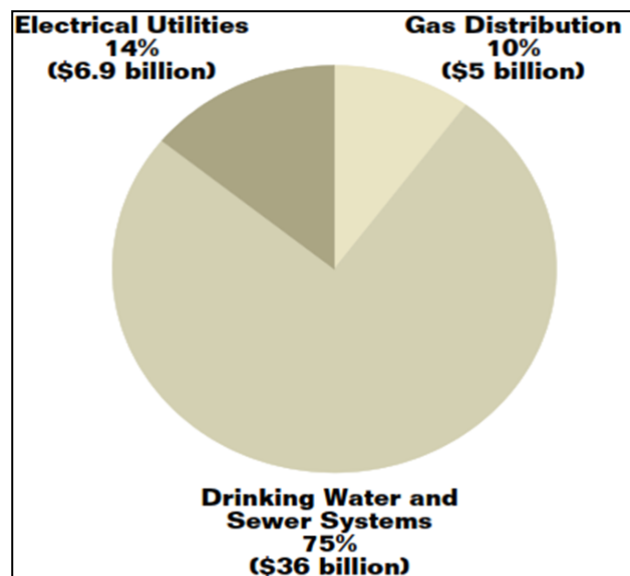


Figure 2 : Annual Cost of Corrosion in The Utilities Category.

These categories include industries that produce and manufacture products of crucial importance to the economy and its residents' standard of living. These include oil production, mining, petroleum refining, chemical and pharmaceutical production, and agricultural and food production. The total annual direct cost of corrosion for production and manufacturing is estimated to be \$17.6 billion.



**ENGINEERING DESIGN
SOFTWARE**

**SPECIALIZED TECHNICAL
ARTICLES AND BOOKS**

**DETAILED ENGINEERING DESIGN
GUIDELINES**

**PROJECT ENGINEERING
STANDARDS AND
SPECIFICATIONS**

**TYPICAL PROCESS UNIT
OPERATING MANUALS**

TRAINING VIDEOS

KLM Technology Group is a technical consultancy group, providing specialized services and training to improve process plant operational efficiency, profitability and safety. We provide engineering solutions by offering training, technical services, best

practices, and engineering designs to meet the specific needs of our partner clients. Since 1997, KLM Technology Group has been providing engineering, operations, and maintenance support for the hydrocarbon processing industry.

WWW.KLMTECHGROUP.COM

**Engineering Solutions, Standards, and
Software**

KLM

**Technology
Group**

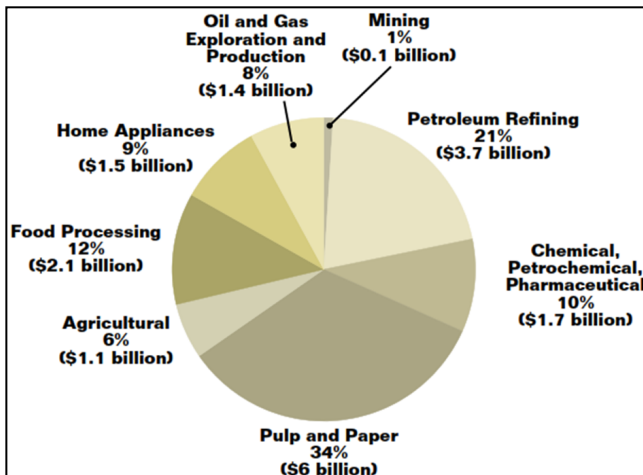


Figure 3 : Annual Cost of Corrosion in The Production and Manufacturing Category.

The transportation category includes vehicles and equipment, such as motor vehicles, aircraft, rail cars, and HAZMAT transport. The annual corrosion cost in this category is \$29.7 billion.

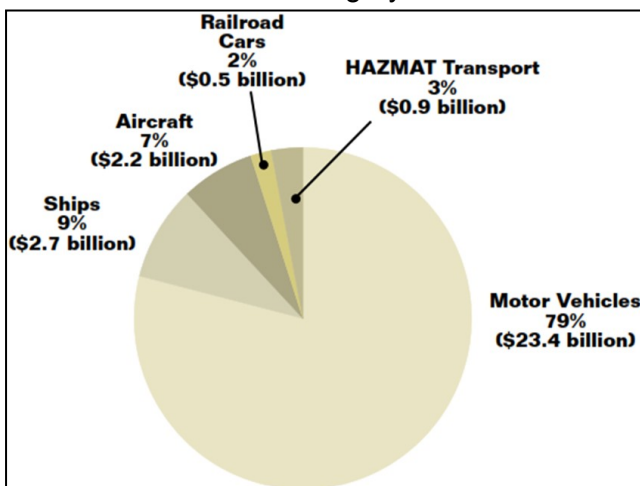


Figure 4 : Annual Cost of Corrosion in The Transportation Category.

Corrosion Under Insulation (CUI)

Insulation is used to minimize heat loss, reduce costs and improve efficiency in vessels and piping systems. It may also be employed to minimize heat gain or to protect personnel from the risk of injury from hot or cold surfaces. Traditional insulation systems typically consist of an insulating material such as mineral wool or calcium silicate, which is then protected by an outer layer of cladding. Thin metal sheet or composite wraps are the most common cladding materials.



Figure 5 : Insulation^[3].

Corrosion Under Insulation (CUI) is one of the largest maintenance problems facing the petrochemical industry today. According to one specifier from a global oil company, problems such as major equipment outages and unexpected maintenance costs stemming from CUI account for more unplanned downtime than all other causes.

CUI is corrosion that occurs under insulated equipment. CUI is any type of corrosion that occurs due to moisture buildup on the external surface of insulated equipment. Any type of corrosion can occur under insulation the most common types of CUI are galvanic, chloride, acidic, or alkaline corrosion.



Figure 6 : Fenomenon of CUI.

Intruding water is the key problem in CUI. Special care must be taken during design not to promote corrosion by permitting water to enter a system either directly or indirectly by capillary action. Moisture may be external or may be present in the insulation material itself. Corrosion may attack the jacketing, the insulation hardware, or the underlying equipment.

For high temperature equipment, water entering an insulation material and diffusing inward will eventually reach a region of dryout at the hot pipe or equipment wall. Next to this dryout region is a zone in which the pores of the insulation are filled with a saturated salt solution. When a shutdown or process change occurs and the metal wall temperature falls, the zone of saturated salt solution moves into the metal wall.

Upon reheating, the wall will temporarily be in contact with the saturated solution, and stress-corrosion cracking may begin. The drying/wetting cycles in CUI associated problems are a strong accelerator of corrosion damage since they provoke the formation of an increasingly aggressive chemistry that can lead to the worst corrosion problems possible, example stress corrosion cracking, and premature equipment failures.

Types of Corrosion Under Insulation⁴¹ :

When using insulation, the corrosion resistance of the metal surface to be insulated is an important factor. The most frequently occurring types of CUI are :

General and fitting corrosion of carbon steel, which may occur if wet insulation comes into contact with carbon steel, particularly if acidic which can leach from the insulation material itself.

External Stress Corrosion Cracking (ESCC) of austenitic stainless steel, which is a specific type of corrosion mainly caused by the action of water-soluble chlorides from rainwater or insulation that does not meet material standards. Austenitic stainless steel is generally susceptible to this type of attack in the temperature range of 13 °C to 202 °C

The Technical Root Causes of CUI :

Causes of CUI are similar in most ways to other types of corrosion, with the largest difference being the environment. Steel corrodes when it is in contact with water and has a free supply of oxygen. When plant and pipework are insulated there is usually a space in which water can collect on the metal surface with access to air. The ingress of water into the insulation is often caused by one or more of the following :

- *Poorly designed and/or installed protective finish or cladding.
- *Cladding joint sealant breakdown.
- *Mechanical damage to the protective finish.
- *Cladding removed and not properly replaced (common around valve boxes).

Moisture combined with oxygen is the largest contributing factor to corrosion. The closed environment of the insulation material over the pipe, tank or equipment creates conditions that encourage build up of moisture and resulting corrosion. The corrosion is often times more severe due to the insulation not allowing evaporation and the insulation acting as a carrier whereas moisture occurring in one area moves through the insulation to another area causing the corrosion to spread more rapidly.

Warm temperatures normally result in more rapid evaporation of moisture and reduced corrosion rates, however a surface covered with insulation creates an environment that holds in the moisture instead of allowing evaporation. Traditional thermal insulation materials contain chlorides. If they are exposed to moisture, chlorides may be released into a moisture layer on the pipeline surface and pitting/stress corrosion cracking may result. Acids, acid gases and strong bases like caustics and salts are aggressive corrosive agents and will not only cause but also accelerate existing CUI.

The Best of Inspection Practices :

Current advancements in the corrosion field allow us to detect and control damage mechanisms such as CUI in pipeline systems through proper material selection, and by adjusting operating parameters, controlling corrosion environments, developing systematic procedures, and proper nondestructive evaluation methods.

Advancements in Non-Destructive Test (NDT) methods have enabled the process industry to carry out corrosion under insulation (CUI) inspection without removing insulation. These techniques can be used along with conventional techniques to provide cost-effective, comprehensive CUI inspection of piping networks. Some of the proven NDT methods are:

1. Infrared (IR) Thermography

Infrared (IR) thermography can be effectively used to identify wet insulation in pipelines. Compared to conventional moisture density gauges, IR thermography is more sensitive and faster. In addition, pipelines can be scanned from a distance, which avoids time-consuming construction of scaffolding works.

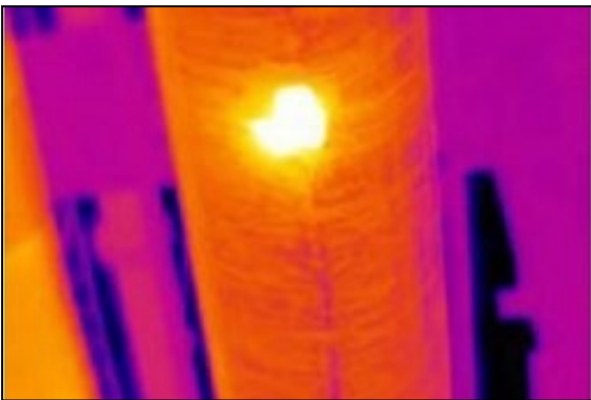


Figure 7 : Wet Insulation Identified By Infrared (IR) Thermography.

IR surveys are typically conducted for non-traced insulated pipelines, but they are also effective for heat-traced lines as well. Any wet insulation will retain heat longer than dry insulation. So two to three hours after sunset, locations where insulation is wet will be hotter than locations with dry insulation. This is the basic theory behind the technique. There are a few considerations when conducting IR surveys to detect wet insulation:

*The best time to conduct IR surveys to identify wet insulation is two hours after sunset. The evenings of sunny days are considered to be the most preferable time.

*The temperature difference between wet and dry insulation is not very large, so it is best to use a small temperature span to increase sensitivity.

2. Long Range Ultrasonic Testing (LRUT)

Guided waves are used in Long Range Ultrasonic Testing (LRUT) to scan pipelines which are otherwise inaccessible for inspection. Guided waves are propagated in a pipe wall from a ring of equally spaced ultrasound probes supported by a collar wrapped around the pipe. The ultrasonic waves are reflected by discontinuities such as girth welds, branches in pipeline circuit, and reductions in wall thickness (an indication of corrosion). These reflected waves are detected and then analyzed with the help of computers.

LRUT can typically scan a length of 60 m to 120 m if the line is straight. If the line is insulated, the length will be reduced, since absorption is greater with some kinds of insulation. Support locations, connections, and bends in pipelines further reduce the span of inspection. Even so, LRUT is considered one of the most effective tools in identifying CUI in pipelines where removal of insulation is difficult.

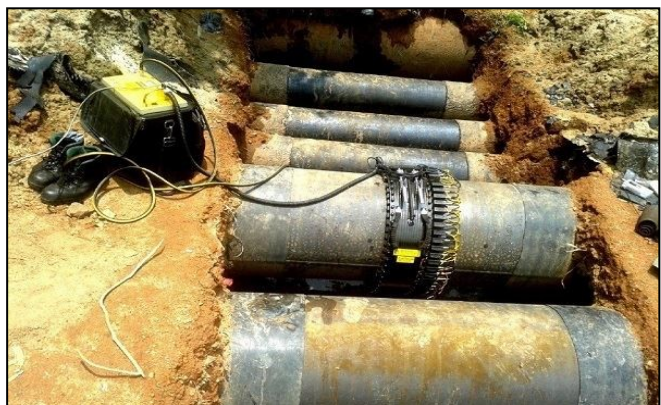


Figure 8 : LRUT Setup is Used for Both Buried Coated Pipelines and Insulated Pipelines.

The velocity of the guided wave is a function of the thickness of the medium and frequency (mode) of wave. CUI will lead to changes in thickness in the medium (pipe wall) locally. In addition to scatter and reflection, this will lead to mode conversion of the incident waves. Therefore, reflected waves will contain both incident wave mode, plus mode-converted waves. Detection of these mode-converted waves in a reflected signal is a strong indicator of discontinuities such as CUI in an insulated pipeline.

The interpretation of LRUT is difficult compared to tools such as IR survey and will often require a specialist. But it is the most reliable tool to inspect insulated pipelines at non-accessible locations, such as portions of pipelines passing under non-accessible culverts, buried piping and at road crossings, etc.

3. Profile Radiography

Profile Radiography is a proven technique to detect the internal wall thickness and reduction of small bore piping. The technology can also be applied to find CUI, provided that Source to Film Distance (SFD) is sufficient to cover the entire pipe diameter in one shot. This may become difficult when pipeline diameter is more than eight inches and there is insufficient clearance between pipelines running in a pipe rack.

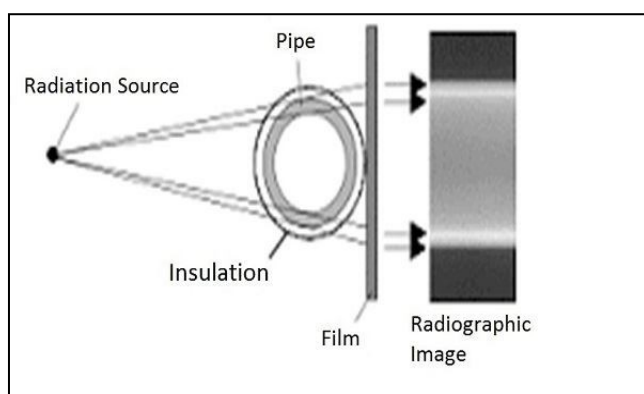


Figure 9 : Schematic of Profile Radiography Setup.

It is possible to scan pipelines of wider diameters by taking only a section of the pipeline in one shot. Consequently, multiple shots will be required to cover the full diameter of some pipelines, thus making the process more time consuming.

4. Computed Radiography

Computed Radiography (CR) uses similar equipment to conventional radiography except that in place of a film to create the image, an imaging plate (IP) is used. CR has the same inherent safety issues as conventional profile radiography.

The computerized images produced by CR allow easy data sharing and result in significant improvements in radiographic inspection productivity as well as faster identification of defects.



Figure 10 : CR Radiograph Showing Corrosion Deposits.

The image in Figure 10 was taken by computed radiography technique, showing corrosion deposits at the elbow of an insulated pipe. Wall thickness reduction is calculated using software. Before measurement, the software needs to be calibrated on reference wedges, such as a known-size steel ball or an identical pipe piece.

If effective cordoning is possible, computed RT is an effective tool to detect CUI without removing insulation. Another advantage of this method is data can be easily stored for future comparison or audit.

5. Pulsed Eddy Current (PEC) Testing

Pulsed Eddy Current (PEC) uses the principle of eddy currents. It consists of a probe that contains a transmitter and receiver. The transmitter is basically a coil to produce eddy currents in a conductor (in our case, the conductor is a metallic pipeline).

The probe is placed on insulation cladding and a magnetic field is created by passing an electrical current in the transmitting coil. This field magnetizes the insulated pipeline and creates loops of eddy currents on pipe wall. Then when anomalies are present, the pulse is cut, causing a sudden fall in magnetic field as the strength of eddy current decreases. The rate of decrease in eddy current is monitored by the PEC receiver probe, which is used to calculate the wall thickness. The decay of the eddy currents is proportional to the wall thickness.

Corrosion is calculated as the percentage reduction in wall thickness. Scanning is possible through any material that does not conduct electricity. Most insulation material, such as mineral wool, glass wool, etc. falls into this category. Scanning can be conducted on pipelines with operating temperatures as high as 500 °C (932 °F).

The sensitivity of PEC is low compared to radiographic methods because this method integrates over a large footprint. As a result, the smallest defect that can be detected has a diameter of about 50 percent of the insulation thickness (between 30mm and 120mm). PEC testing is therefore suitable for general wall loss, but isolated pitting defects cannot be detected. Therefore, PEC is ideal for scanning insulated carbon steel pipelines where corrosion is expected over a larger area.

be controlled. With using preventive strategies in nontechnical and technical areas as follows^[2]:

- Increase awareness of significant corrosion costs and potential cost savings.
- Change the misconception that nothing can be done about corrosion.
- Change policies, regulations, standards, and management practices to increase corrosion cost savings through sound corrosion management.
- Improve education and training of staff in the recognition of corrosion control.
- Implement advanced design practices for better corrosion management.
- Develop advanced life-prediction and performance-assessment methods.
- Improve corrosion technology through research, development, and implementation.

Other factors can be controlled effectively and three issues should be addressed as follows^[4]:

1. Protecting steelwork

The necessity of protection against corrosion must be determined for each individual plant and the appropriate measures have to be identified. Generally, the design of the insulation system and corrosion protection depends on the following parameters:

- Operation of the plant (continuous or interrupted/intermittent),
- Operation temperatures,
- Metals used (non-alloy, low alloy steel, austenitic stainless steel or copper),
- External factors.

Before applying the corrosion protection coating, the surface must be free from grease, dust and acid plus the priming coat should be roughened for better adhesion. Blasting is the recommended surface preparation method (for austenitic stainless steel, use a ferrite free blasting abrasive). Follow the coating manufacturer's processing guidelines.

2. Design and planning of the insulation work

The requirement of the planned insulation work must be factored in during the industrial plant design and construction phase. It is therefore advisable to involve all project managers at an early stage to preclude unnecessary and unanticipated problems during insulation work.

All preparatory work must be completed in accordance with the relevant insulation standard and if necessary, apply corrosion protection. Insulation material should be stored and installed in dry conditions. Various conditions must be fulfilled to ensure the insulation does not contribute to the corrosion of the steelwork later on.

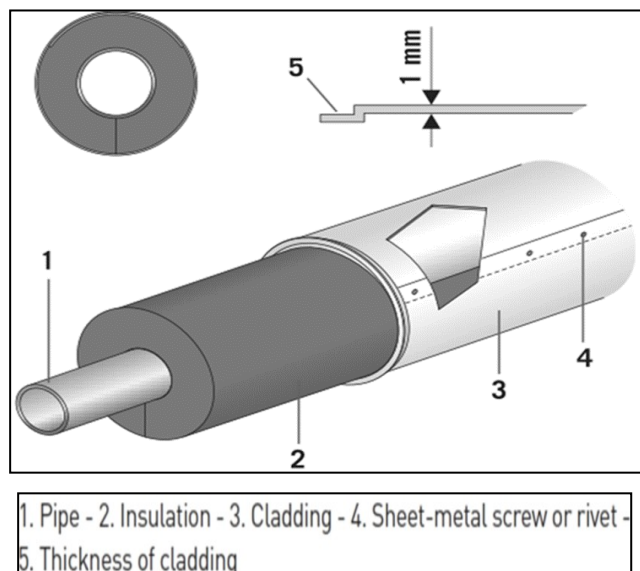


Figure 11 : Pipe Insulation

When making a considered insulation selection, it is important to think about not only obvious properties, such as the thermal conductivity or maximum service temperature of a product. To minimize risk of CUI, it is also important that the insulation does not affect the steelwork, does not absorb any water and is open to vapor, so that moisture can easily egress the insulation.

3. Maintenance and Inspection

To avoid unnecessarily complicating routine maintenance and inspection work, high maintenance areas must be taken into account, especially in the design phase. Removable insulation, such as coverings and hoods, could be fitted in such areas. Easy to remove coverings are recommended to allow rapid disassembly. Bolt are generally fastened with quick release clamps, which can be opened without special tools.

Removable covering or hoods are usually insulated from the inside. The coverings are fastened to the object with lever fastenings, which are fixed directly on to the covering or on to straps. Take the following suggested conditions into account when designing insulated coverings for fitting and flanges:

- The overlap distance of the insulated covering over the insulated pipe should be at 2".
- The pipe insulation should end at the flanges, leaving a gap equal to the bolt length plus 1.2" and should be closed off with a lock washer so the flange can be loosened without damaging the insulation.
- With valve, an extended spindle should preferably be fitted horizontally or below the pipe to prevent leakage along the spindle shaft.
- The cladding must be fitted to prevent the ingress of moisture in the insulation. On inclined or vertical piping, for example, mount rain deflectors above the removable coverings. If the ingress of moisture into the insulation is unavoidable, make 0.4" diameter drain holes in the removable covering.

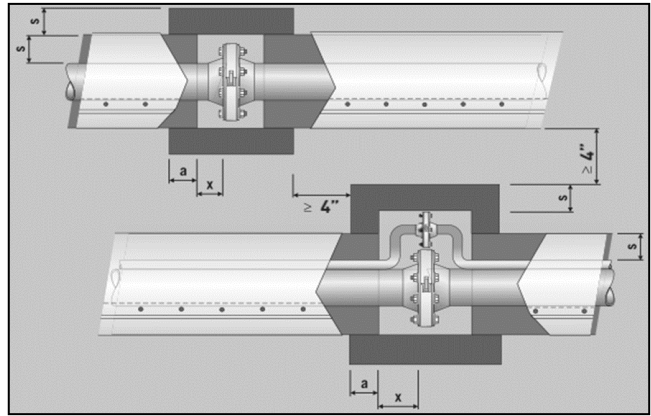


Figure 12 : Minimum Distance Within Range of Pipe Flanges.

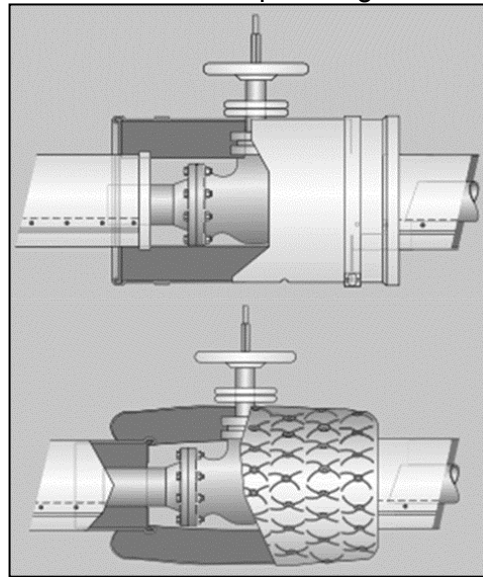


Figure 13: Insulation of Valve Should Be Designed with Removable Covering or Hoods.



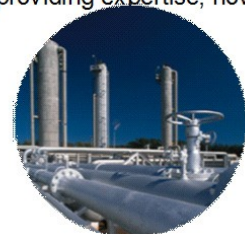
PT Dinamika Teknik Persada
provide Engineering Design to
the upstream and down-
stream sectors of oil & gas
industry:

- Processing plants
- Pressure vessels
- Heat exchangers
- Piping systems
- Onshore pipelines

PT. Dinamika Teknik Persada

is an Engineering Consultants focused on providing engineering and technical services to the oil and gas industry. We develop innovative and cost effective solutions and helping our clients to achieve high performance from their assets by providing expertise, novel methods and appropriate tools

- FEED to Detailed engineering Design
- Independent Design Verification
- Risk Assessments
- Asset Integrity Management



Address : Ruko Golden Boulevard Blok K No. 1-2

Jl. Pahlawan Seribu, BSD City, Serpong

Tangerang 15322 – Indonesia

Phone / Fax : +62 21 53150601

Safety Consequences^[6] :

A case of CUI in the petrochemical industry is the explosion in an Olefins Plant where two workers were killed and 114 injured. The explosion was triggered by the failure of a heat exchanger caused by piping corrosion under insulation. This was a small isolated corrosion location that had not been previously found.



Figure 14 : Incident in Olefins Plant^[1].

A high commitment from management for Environmental, Health and Safety (EHS) is required. Discipline that focuses on prevention of physical situations with the potential for human injury, damage to property or to the environment through the release of chemical energy in the form of fire, explosion, toxicity or corrosively.

Management direction to achieve the vision of the Process Safety Management (PSM) required some of the following:

- Establish formal organization to drive and monitor process with divisional ownership.
- Develop prescriptive "how to" PSM procedures.
- Appoint qualified person to fill key process safety roles.
- Plan and execute rigorous implementation of PSM requirement develop and provide standardized PSM tools and solutions globally.
- Establish PSM key performance indicators to monitor PSM performance.
- Establish a PSM corporate score card to drive accountability.
- Verify compliance by conducting global PSM focused audits.
- Governance process to sustain the PSM improvement process corporately.

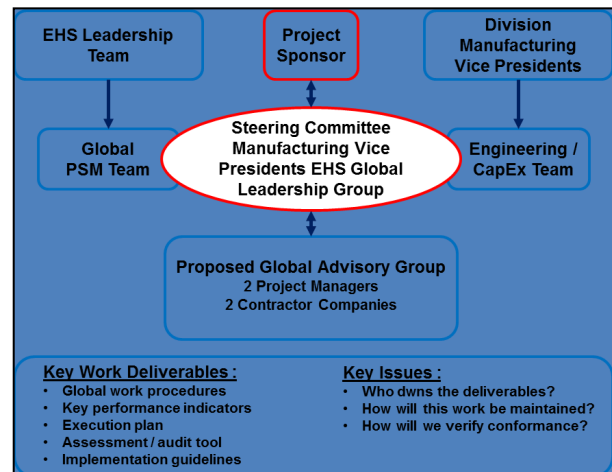


Figure 15 : Establishment of Formal Organization.

The three sequence of PSM procedures are as follows:

1. The first: Appointment of Qualified Persons, Process Hazard Analysis (PHA), PHA Revalidation, EHS Critically Assessment, Risk Management Procedure and Matrix, Target Assessment Methodology, Facility Siting, Management of Action.
2. The second: Operating Procedures, Design Verification, Pressure Relief System Design, Organization Change Management, Management of Change, Mechanical Integrity, Pre-Start-Up Safety Review, Process Safety Information.
3. The third: Process Fire Safety Management, Area Classification and Management, Design & Maintenance of Plant Trips (SILs), Alarm Management, Incident Investigation, Process Safety Variance Procedure, Control System Security.

The process of correct implementation of the PSM procedure can be raise the overall expectations and performance in process safety at each site, consistently communicate the content of each of the process safety procedures and expectations, and can to identify gaps in the facility's practices and develop gap closure plans.

1.Risk Based Inspection (RBI)

Risk Based Inspection (RBI) is a risk assessment and management process that is focused on loss of containment of pressurized equipment in processing facilities, due to material deterioration. These risks are managed primarily through equipment inspection.

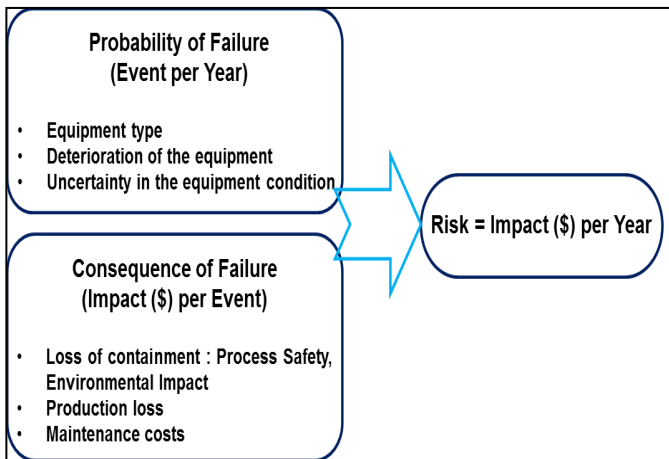


Figure 16: Risk Based Inspection^[9].

An integrated integrity management strategy will contain measures that address and mitigate the possibility of the root causes of failure. Design reviews, manufacturing quality assurance, operating training, and systems analyses are examples of such measures. In-service inspection is a backstop to prevent failure when a root cause has led to deterioration from the design intent or the as manufactured condition.

The process of risk based inspection should form part of an integrated strategy for managing the integrity of the systems and equipment of the installation as a whole. Its aim is to focus management action on prioritizing resources to manage the risk from critical items of equipment. Risk based inspection is a logical and structured process of planning and evaluation.

Inspection is also a priority for equipment where the fabrication, inspection or operating history is unknown, where there is inadequate maintenance, or where there is lack of the materials data required for assessing fitness for service. Risk based inspection involves the planning of an inspection on the basis of the information obtained from a risk analysis of the equipment. The purpose of the risk analysis is to identify the potential degradation mechanisms and threats to the integrity of the equipment and to assess the consequences and risks of failure.

First, the requirements for plant integrity management by RBI are established within the context of existing regulations, inspection codes and practices. Reviews the regulations, guidance and practices relating to risk assessments and RBI. Identify the systems, the system boundaries and the equipment within them requiring integrity management. Drivers, criteria and limitations for a risk based approach to inspection planning must be ascertained as RBI may not always be possible or appropriate.

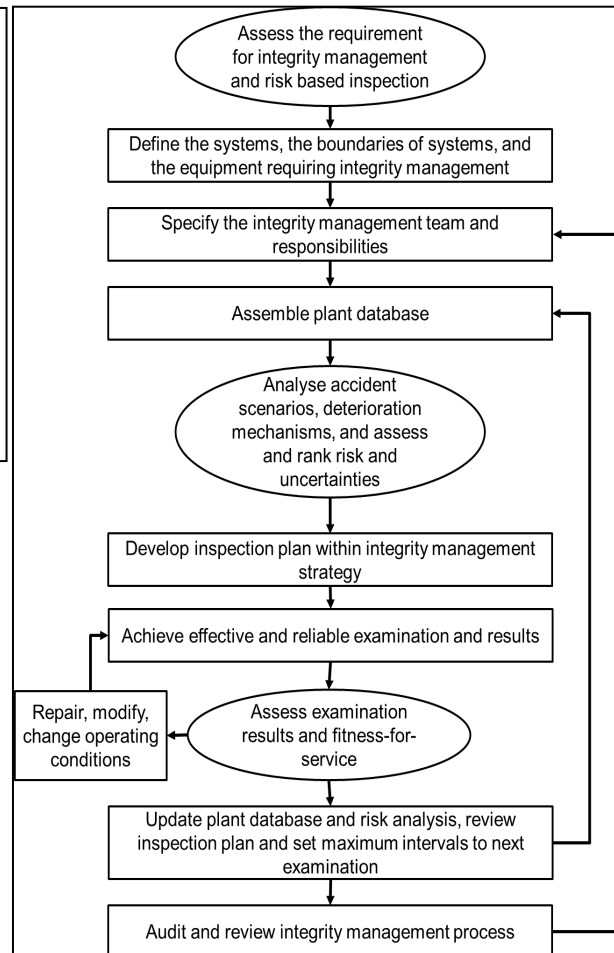


Figure 17 : Process Diagram for Plant Integrity Management by Risk Based Inspection^[8].

For risk based inspection, information and opinions from several functions and disciplines are normally needed. It is recommended that these were best obtained from a team of relevant individuals. Risk based inspection requires a wide range of information in order to assess the probability and consequences of equipment failure and develop an inspection plan. A plant database containing an inventory of the equipment and associated information is a useful way of managing the relevant data.

The information and associated uncertainties identified by the risk analysis about potential deterioration are used to develop an integrity management strategy and appropriate inspection plan.

In order for inspection to be an effective part of integrity management, the techniques and procedures used must be capable of achieving a reliable examination. The techniques and procedures must therefore be matched to the potential deterioration identified by the risk analysis.



Partners to the Top

Summit Technology Management is a technical consultancy group, providing specialized services and training to improve process plant operational efficiency, profitability and safety. We provide engineering solutions by offering training, technical services, best practices, and equipment to meet the specific needs of our partner clients.

- ☐ **Basic Design Packages**
- ☐ **Detailed Design Packages**
- ☐ **Commissioning of Process Units**
- ☐ **Process Engineering Studies**
- ☐ **Bench Marking of Process Units**
- ☐ **Regional Training Conferences & In-House Training**
- ☐ **Singapore & Malaysia Company Registration & Set Up**
- ☐ **Specialty Equipment: Distillation Equipment, Filter Skid Packages, Compressor Knockout/Scrubber Skid Packages, Mercury Removal Skid Packages**



www.summit-tech-mtg.com

Assessment of the examination results and fitness-for-service are essential parts of the RBI process. For equipment where fitness-for-service cannot be assured, repairs, modification or changes to operating conditions may be recommended.

2. Mechanical Integrity Program

Mechanical Integrity is the process of ensuring equipment is in satisfactory condition to safely and reliably perform its intended purpose. Mechanical Integrity programs have been an essential element of process Program Safety Management in the chemical and petroleum industries for decades. Although maintenance is a major part of a Mechanical Integrity program; Mechanical Integrity is not just maintenance. Mechanical Integrity covers the proper design, fabrication, construction or installation and operation of equipment throughout the entire process life cycle.

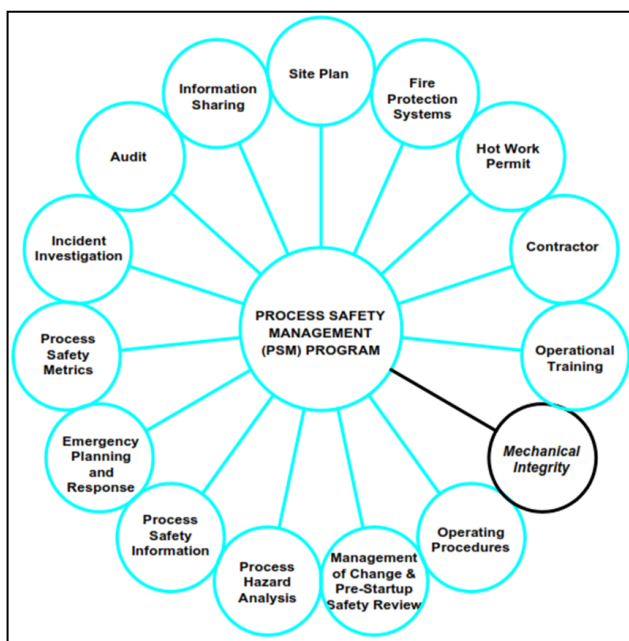


Figure 18 : Chart of PSM Program.

Guidelines and best practices for compliance with this program are mainly based on Industry standards for piping in highly hazardous services. Piping systems in highly hazardous service shall be identified and registered; namely the steps required to place in the Mechanical Integrity system for future inspections. Mechanical Integrity is clear standards and external standards on inspection and maintenance of local organizations such as:

- Evaluation to determine if a potential spill under normal operating conditions could exceed threshold external authority reportable quantities. If the piping system has the potential to release highly hazardous chemicals in quantities greater than the threshold limit, then the piping system shall be registered.
- Explaining the party responsible for the steps of registration, inspection, and follow-up associated with the inspection program.
- Including specific expectation and reproducing the requirements inspectors should follow from external standards are critical for consistent global mechanical integrity inspections.

Mechanical Integrity programs cannot rely solely upon contract inspectors and need adequate involvement of plant personnel familiar with plant operations. Effective communications and involvement of persons familiar with all modes of operation within the plant is critical to develop a robust inspection plan.

An effective program to leverage learnings from other incidents should include discoveries of excessive corrosion or any other losses of mechanical integrity. Leadership and employees in petrochemical industry must be aware of the potential severity of CUI incident. This awareness must spark leadership and company Mechanical Integrity program steering team to launch a initiatives such as^[7]:

- A mandatory refresher training for all site and production plant leaders on the key elements and responsibilities under the corporate Mechanical Integrity program.
- The creation of a list of high priority CUI inspection locations, by technology, to be inspected as soon as possible.
- The creation and delivery of new CUI inspection training to train maintenance and operations personnel how to better identify areas susceptible to CUI.

The launch of an additional, one-time Mechanical Integrity program audits of all major sites. (The Mechanical Integrity program of each site should be audited as part of the sites' ongoing periodic EH&S audits. This special audit was intended supplement this auditing with a highly visible site-wide, Mechanical Integrity focused audit to respond to this near miss event.)

Process Safety Management systems and best practices rank as one of "the most important system" to prevent incidents. An effective mechanical integrity program would certainly be among the top systems.

Justifying the expense of an effective CUI inspection program is often challenging since to identify all areas of CUI requires an expensive process. But the failures prevented by an effective CUI inspection program are often very dangerous and they can occur in areas where there were no previous indications of corrosion.

Conclusions:

Corrosion Under Insulation (CUI) is a phenomenon that can't be avoided but can be reduced. Corrosion affects almost every industrial sector, Infrastructure, Utilities, Transportation, Production and Manufacturing, and Governmental Functions. To determine the occurrence of CUI, inspections conducted by several NDT methods can be utilized.

The design and specification of insulation, correct construction installation and preventative maintenance practices are the best prevention of CUI. By following appropriate strategies and obtaining sufficient resources for corrosion programs, best engineering practices can be achieved. Controlling corrosion requires expenditures, but the payoff includes increased public safety, reliable performance, maximized asset life, environmental protection, and more cost effective operation in the long run.

References :

1. https://en.wikipedia.org/wiki/Williams_Olefins_Plant_explosion.
2. *Corrosion Costs and Preventive Strategies in the United States*, NACE International, Houston.
3. <http://www.international-pc.com/products/temperature-resistant/corrosion-under-insulation.aspx>.
4. *Corrosion Under Insulation (CUI) : Industrial Technical Overview*, Roxul The Better Insulation, Milton.
5. *Corrosion Under Insulation of Plant and Pipework V3*, Health and Safety Executive, 2013.
6. *Driving Process Safety Management Performance*, Budd, Kevin., Huntsman Global PSM Manager, 2009.
7. *More Lessons "Re-Learned" from Corrosion Under Insulation*, Sampaio, Renato., Leite, Antonio Luiz M.V., The Dow Chemical.
8. *Best Practice for Risk Based Inspection as a Part of Plant Integrity Management*, Kenzie, B.W., Wintle, J.B., TWI, Cambridge, 2001.
9. *An Update on Risk Based Inspection : Bringing Focus on External Corrosion Under Insulation, Stress Corrosion Cracking and Other Damage Mechanisms*, Presley, Joel., Lloyd's Register Energy Conference, 2012.

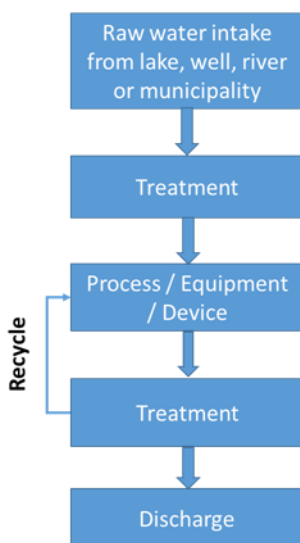
Advertisers

IACPE.....	Page 4
KLM Technology Group.....	Page 7
PT. Dinamika Teknik Persada.....	Page 13
Summit Technology Management.....	Page 16
CPPM Program.....	Page 19
CPSP Program.....	Page 21

Disinfection in Industrial Process Water

Keisha Antoine, PhD, PE
Antoine Technical Consulting LLC

Process water is the term given to water that is used in a variety of manufacturing operations such as: washing and rinsing; thermal management of process equipment; fire protection in sprinkler systems, etc. Typically, industrial water use mainly consists of use of process water in boilers, cooling towers and thermal electric generation. Although not technically “industrial”, water use can also include something as personal as the liquid cooling ventilation garment used by astronauts during a spacewalk at the international space station. In general, water is being use for thermal management, whether cooling or heating; fire protection; storage; or direct processing, where the water is itself used as part of the product being produced.

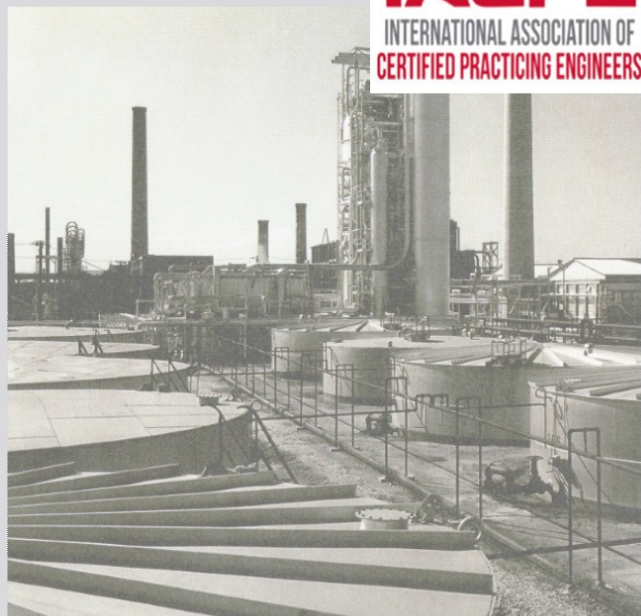


Referring to the high-level process water flow in Fig. 1, we can discuss the main ways that the microorganisms can enter the water supply. Microorganisms can enter through the raw water intake. By treating the water after intake, we can meet the process water quality requirements and provide overall defense against the threat of microorganisms. Use of recycled water containing process contaminations or the use of secondary wastewaters for makeup can also be an entry route for microorganisms, if these waters are themselves inadequately treated. Thus, it is essential to run an adequate treatment plan tailored to the water source and planned use. This treatment is often a combination of physical and chemical means and consists of the overall removal of the threat of the microorganisms initially, called primary disinfection, together with secondary disinfection where a maintenance dose (in chemical treatment) is administered at prescribed intervals to maintain a disinfectant residual to inhibit the growth of microorganisms.

CERTIFIED PRACTICING PROJECT MANAGER PROGRAM



The CPMP program requires specific combinations of knowledge and experience, as well as successful demonstration of project management competency through examination. Those who hold these certifications must continue to prove competency to maintain the credential they have earned with two hours of continuing education per year.



Requirements

- ◆ The requirements to enter the CPPM Program are:
- ◆ Three years of formal training in Science, Technology, Engineering or Mathematics (STEM). Those without three years formal STEM training must pass CPE Level I.
- ◆ Three letters of recommendation from your associates who have knowledge of your study/work history and ethics

www.IACPE.com

In any case, wherever water is used, it is important to consider the removal of biological organisms in finished water, that is, the water that has undergone treatment, for the following reasons:

1. To prevent or mitigate biofilm formation. The presence of biological organisms can lead to the formation of biofilms, which in turn can lead to such process issues as reduced hydraulic diameter, reduced flow, reduced heat transfer and thus increase fuel usage in heat transfer equipment, like boilers. In cooling towers, biofilms are regions where microbes feed and find a place to propagate. These microbes are often harmful to human health as the water provides a way to release the microbes in aerosolized form leading to respiratory illnesses, like Legionnaire's disease. In fact, the presence of biofilms in process equipment in general, whether pipelines or pumps, provides sites for microbiologically induced corrosion. This phenomenon can lead to leaks and tuberculation and therefore shortened equipment lifespan. Ultimately, biofilms prevent smooth process operation, can negatively affect human health, and can shorten equipment life.
2. To enable discharge of process water after use to a receiving body in accordance with EPA National Pollution Discharge Elimination System (NPDES) or EPA NPDES delegated state guidelines (in the case of states authorized by the EPA to administer permits. TX is an NPDES delegated state).
3. To meet the quality required for process water use or reuse in the process and in the prevention of 1) above.

The killing of pathogenic organisms in water is a process referred to as disinfection. Disinfection can be carried out via physical or chemical methods – often a combination of both means are employed. Physical means of biological treatment can include filtration, reverse osmosis, sponge pigging (in pipelines) and UV dosing. Whether used by itself as a primary disinfectant or as secondary disinfection with a primary chemical disinfectant, UV dosing is becoming more popular as a means of biological control given ever-tightening compliance regulations on biocide residual concentrations in the finished water and in water to be discharged (effluent). Oftentimes, however, the term disinfection suggests the use of chemicals, termed biocides; it is the use of biocides which will be our focus for the rest of this article.

The goal of biocide use is to prevent the formation of biofilms and to inhibit the existence of pathogens. It is best to stop biofilms from even forming; however, this is very hard to do as the build-up of the biofilm begins immediately after the metal or water-contact material is immersed in the aqueous environment. Judicious choice of the bill of materials can reduce the proclivity to form a biofilm, though not eliminate it. A biofilm is a gel containing ~95% of water and a matrix of exopolysaccharidic or extracellular polymeric substances (EPS) suspending microbial cells and inorganic waste. The build-up of biofilm begins when the planktonic or mobile bacteria in the water stream become adhered to the water-contact equipment surface and become sessile (non-mobile). In this state, the bacteria start to propagate, creating a biofilm which protects the propagating bacteria beneath. It is much easier to kill the bacteria while they are still mobile for when they are under cover of the biofilm, the biocides must now penetrate a very thick, heterogeneous, protective layer to kill the bacteria.

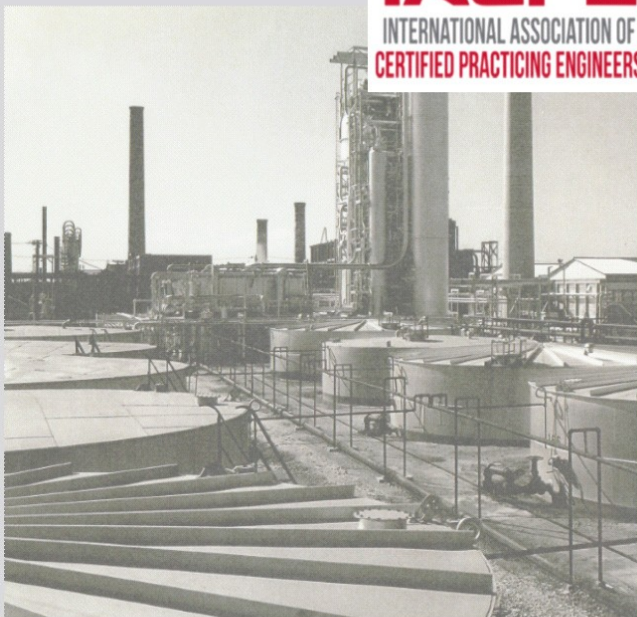
Biocides can be of several types: oxidizing, non-oxidizing or surfactants, biodispersants and biopentrants. Oxidizing biocides like chlorine, ozone or sodium hypochlorite are an essential component to maintaining a disinfected system for drinking water, cooling tower systems and surfaces. They kill microorganisms through the process of oxidation and are applied continuously or intermittently in the water treatment process. It is worth noting that the use of chlorine, regardless of application method, is by far the most ubiquitous biocide in use for disinfection and is very effective against *Legionella* bacteria. It is also effective in algae control.

For more broad spectrum, biological control, oxidizing biocides can be used in tandem with non-oxidizing biocides when considerations such as elevated water pH, removal of algae, fungi and anaerobic bacteria are present. Non-oxidizing biocides are usually shot-fed as required. Examples of non-oxidizing biocides are isothiazolines, DBNPA and carbamates.

CERTIFIED PRACTICING SAFETY PROFESSIONAL PROGRAM



The CPSP program requires specific combinations of knowledge and experience, as well as successful demonstration of safety competency through examination. Those who hold these certifications must continue to prove competency to maintain the credential they have earned with two hours of continuing education per year.



Requirements

The requirements to enter the CPSP Program are:

- Three years of formal training in Science, Technology, Engineering or Mathematics (STEM). Those without three years formal STEM training must pass CPE Level I.
- Three letters of recommendation from your associates who have knowledge of your study/work history and ethics

www.IACPE.com

When a biofilm already exists, biodispersants and biopenetrants are used to loosen the biomass and break them down to be flushed out of the system. Their action allows for the oxidizing and non-oxidizing biocides to go to work and kill the pathogens that have been protected by the biofilm. These types of biocides are usually shot fed and applied when heavy duty cleaning is required or to maintain a clean system. Examples of biodispersants and biopenetrants are: DTEA II, DMAD and polyquaternary amines (which are also non-oxidizing biocides).

Regardless of biocide type there are drawbacks to their use: oxidizing biocides are corrosive and can form disinfectant byproducts (DBPs) with organic material naturally present in the raw water. DBPs, in the form of trihalomethanes, are themselves contaminants and must not exceed maximum contaminant levels (MCLs) set by the regulating entity. Oxidizing biocides are also ineffective against anaerobic bacteria, the culprit behind microbiologically induced corrosion. Non-oxidizing biocides tend to be more effective in high pH environments and are not as effective in the presence of high organic loads or heavy metals.

Finally, to assess the effectiveness of the disinfection program, the treated water effluent is tested for an indicator organism to ensure that its concentration is below the permit limits. There are several choices of indicator organism; however, the one selected depends on the eventual use or discharge site of the water. Note that in accordance with 30 TAC 309.3(h), TX changed the indicator organism from fecal coliform bacteria to *E. coli* for freshwater discharges and *Enterococci* for saltwater discharges.

Biography

Keisha Antoine obtained a B.S. in Chemical Engineering in 2001 and a M. Eng. and PhD in Materials Science & Engineering in 2004 and 2007, respectively, all from Lehigh University. She is the holder of one patent and is a registered professional engineer in the state of NY. Keisha has nearly 8 years of industrial experience working on glass processes and functionalization, carbon footprint and energy analyses at Corning Incorporated, a Fortune 500 technology company. In 2015, Keisha went into private practice and opened her own technical services consulting firm, Antoine Technical Consulting LLC, providing process design, scale-up and water management solutions to manufacturers principally in the chemical process industries. She is a current member of the American Institute of Chemical Engineers (AIChE).

A large industrial refinery or chemical plant at night, illuminated by numerous bright lights. The structure features tall distillation columns, complex piping, and multiple levels of walkways and platforms. The sky is a deep blue, and the overall scene conveys a sense of intense industrial activity.

IACPE
INTERNATIONAL ASSOCIATION OF
CERTIFIED PRACTICING ENGINEERS

www.iacpe.com

