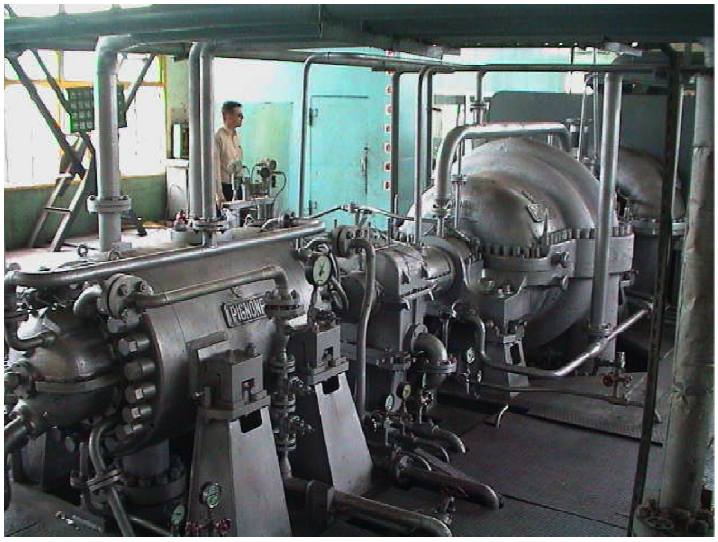
Trainer:
V. Srinivasan



API 577 DAMAGE MECHANISMS

Course Description:

Damage mechanism (also referred to as degradation mechanism) is a general term referring to any causes of problems or failures within process equipment. These can range from corrosion, to cracking, to heat damage, and everything in between.

When assessing damage mechanisms, one must take into account the current state of the equipment, as well as any potential damage the mechanism may cause later. A

good understanding of the variety of damage mechanisms that exist is a must for any mechanical integrity program.

Some of the most common damage mechanisms in the Ammonia/Urea plant, oil and gas industry, refining and chemical processing industries are:

- Wet H2S Damage, which can occur when atomic hydrogen from wet H2S corrosion reactions enters and weakens the steel.
- CO2 Corrosion, which is a form of degradation that occurs when dissolved CO2 in condensate forms carbonic acid, which corrodes steels.
- Corrosion Under Insulation (CUI), which occurs when moisture builds up on the surface of insulated equipment.
- Hydrogen Embrittlement, which happens when atomic hydrogen infuses into certain higher strength steels and causes them to become brittle.
- Brittle Fracture, which is the sudden, very rapid fracture under stress where the material exhibits little or no evidence of ductility or plastic degradation before the fracture occurs.
- High Temperature Hydrogen Attack (HTHA), a mechanism that can affect equipment that is exposed to hydrogen at elevated temperatures (at least 400 °F or 204 °C).
- Sulfidation Corrosion, a type of corrosion that occurs at temperatures above 500 °F (260 °C) due to sulfur compounds in crude.

Damage mechanisms are detailed and covered at length in API RP 571, Damage Mechanisms Affecting Fixed Equipment in the Ammonia and Urea Plants / Refining Industry. This document provides an in-depth look at over 60 different damage mechanisms that can occur to process equipment in refineries. It includes a general description of the damage mechanism, susceptible materials of construction, critical factors, inspection method selection guidelines, and control factor

Course Objectives:

The aim of this course is to provide the participants with an overview of the area of inspection, planning, fitness for service, damage mechanisms of piping, process equipment in accordance with API 579 and API571.

Furthermore the participants would learn how to identify damage mechanisms in accordance with API RP 571, evaluate the extent of damage and carryout FFS assessment at damage locations at plant equipment which are in service and to estimate the remaining life and extend the life of the equipment or to repair or replace the same.

Methodology:

Hand outs would be provided and teaching would be interactive through power point slides presentation with numerous case studies.

This training course emphasizes on Theory and Practical activities – participants will be divided into small activity groups to hold case-discussions, practical skill stations and required class demonstrations.

- Participants will be provided with individual and team exercises
- Course handouts and MS Power Point presentations
- Group discussions
- **Global case studies**

Percentage of Course Delivery

a) 50% class presentation
b) 30% group and individual exercise
c) 10% case study with an open room for client's site/open cases.
d) 5% mass media : move/videos
e) 5% assignments

Training material, practical exercise, case studies will be provided to each participant in the form of printed manuals and copy on flash drive

Percentage of Course Delivery

f) 50% class presentation
g) 30% group and individual exercise
h) 10% case study with an open room for client's site/open cases.
i) 5% mass media : move/videos
j) 5% assignments

Training material, practical exercise, case studies will be provided to each participant in the form of printed manuals and copy on flash drive.

Course Assessment:

- Pre-training assessment test;multiple choice questions.
- Post training assessment test; multiple choice questions. Same questions as in Pre-training assessment test.
- Individual assessment report will be handed over to the client.

Who should attend:

Inspection department personnel (supervisors and engineers), maintenance department personnel, QA & C engineers and production personnel.

COURSE DETAILS:

Course title: Damage mechanisms

Fitness for service (FFS) is assessment is called for when equipment degrades in service and the degradation is beyond the corrosion allowance. Damage is different from simple corrosion allowance.
Damage is different than corrosion allowance. We expect fabrication and service induced flaws in service.FFS is to decide whether the aging equipment is safe for continued service and for how long?
The life cycle of a component is as follows

Design, Procure, fabricate, construct and commission to codes (ASME B31, ASMESec. VIII, API 620/650 etc

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Operate

↓

Systems and equipment degrade in service

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Risk based inspection

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Evaluate (FFS)

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Continue to run or repair/replace

Day 1:

Session 1
Introduction and course overview and Pretest

Defined aspects of damage mechanisms along with critical factors/parameters
Mech. & Metallurgical failure mechanisms
Selected damages which are more likely to be present in ammonia and urea plants - Graphitisation, n, temper embrittlement, sigma phase embrittlement and brittle fracture, Creep and stress rupture, thermal fatigue, short term overheating, Thermal shock, erosion/erosion-corrosion, cavitation, mechanical fatigue,

Session 2
Uniform or localized loss of thickness (various forms of corrosion) –selected corrosion mechanisms such as Galvanic corrosion, corrosion and under insulation, flue gas –dew point corrosion, caustic corrosion, ammonia stress corrosion cracking, Chloride stress corrosion cracking, hydrogen embrittlement

Day 2:

Session 1

RBI- overview and example calculation for RBI level 1 and 2 assessment of selected damage mechanisms such as brittle fracture, pitting assessment, hydrogen blisters and hydrogen damage assessment Creep assessment calculations as per API 579

Session 2
Inspection planning and inspection program for different risk levels for each damage mechanism
Mitigation measures to be taken which are in service as well as for new equipment (design review aspects).

Day 3:

Session 1
Review of the Damage Mechanism Master Document developed by Client and discussion
Session 2
Review of the Damage Mechanism Master Document developed by Client and discussion
Course recap and post test

Case studies such as the following shall be discussed, if time permits
Inspection and repair of ammonia vessel,
Improving reliability of Naphtha condenser in ammonia plant
Urea stripper leakage identification

Each session is of 2 hours duration with 20 minutes break. A day means a minimum of seven hours and 20 minutes excluding tea breaks and lunch.

List of Clients in Qatar:

Mesaieed

- QAFCO since 2001
- QAPCO
- QAFAC
- Q-Chem
- QVC
- QASCO
- QP Refinery

Doha

- Qatar Petroleum since 1997
- Qatar University since 1996

RasLaffan

- Dolphin Energy
- Qatar Gas
- Ras Gas
-

INSTRUCTOR'S PROFILE:

VisvanathanSivaraman has

Extensive work experience and has carried out major jobs for Urea and Ammonia (fertilizer plants)

- Failure investigation and root cause analysis of heater tubes as per API 579 for SAFCO, KSA
- Failure investigation of reformer tubes for FERTIL, UAE
- Replica metallography of reformer tubes for the presence of creep damage, SAFCO, KSA
- Replica metallography of reformer tubes for OMIFCO, Oman

Technical Qualifications:

Associate membership examination in metallurgical engineering from Indian Institute of Metals, Kolkatta, India (1987)

Master degree (MSc) in Physics First class (A grade) (1978), Madras University, India

Bachelors' degree (BSc) in Physics (1976) First class, Madras University, India

Senior Corrosion Technologist, NACE- Certification **ID# 27410**

APIRP571-Corrosion and Material professional- **ID# 54269**

APIRP577-Welding Inspection and Metallurgy Professional- **ID#56488**

APIRP578-Positive Material Identification (PMI) Using XRF &OES Technologies-**ID# 10657**

ISO 9001-2000 Lead auditor course

Academic Qualification :

PG Diploma in Business Administration (1982)

Skills summary :

- Technical Bid Evaluation of materials, review of technical procedures and project specifications
- Conducting seminars in understanding corrosion, welding metallurgy, material testing and non destructive testing
- Remaining life assessment of high temperature component
- Hands on experience in conducting corrosion and mechanical failure analysis of metallic materials to identify root cause, report preparation with recommendations to avoid future failures.
- Evaluation of corrosion rates for Oil/Gas service
- Identification of various corrosion mechanisms
- Corrosion control by cathodic protection and chemical inhibition.
- Corrosion monitoring by insertion of coupon and probes.
- Hands on experience in mechanical, (Tensile, CharpyImapct, bend, hardness) metallography and working knowledge of non-destructive testing of metallic materials and advanced site inspection services.(ToFD, MFL, IRIS)
- Material characterization based on microstructuresincluding creep damage assessment, fire damage assessment both on-site (replica metallography) as well lab based.
- Handling of research projects and development of new materials.
- Review of WPS, PQR and welding related project documents.
- Writing QA/QC procedures related to fabrication and welding operations.
- Conversant with various fabrication and inspection standards/Codes.
- Creep damage assessment of high temperature exposed components

Major courses conducted :

Client	Topic	Duration
IGTS, UAE	Failure analysis	3 days
IGTS, UAE	Basic corrosion	3 days
BCTS, UAE	Welding inspection	3 days
IGTS, UAE	Interpretation of MTC's	2 days
EXOVA, UAE	Failure analysis	3 days
IGTS, UAE	API 571	5 days
BCTS, UAE	API577	5 days

EIL, UAE	BASIC CORROSION	5 days
SHE-Q Club,UAE	Basic corrosion	3 days

Membership of Professional Bodies:

American Society of Metals (ASM) ID# 407176
NACE, Member ID# 182865
Life member of Indian Institute of Metals, Kolkatta, India
Member of Indian Institute of Welding, India
Member of SSPC # 1111147752

Papers Presented :

on"Remaining Life Assessment –An overview and the Role of Metallographic Methods" at the first Middle East Nondestructive Testing Conference and Exhibition during September 24-26, 2001 at Bahrain, organized by Bahrain Society of Engineers.

Presented a paper on "Four types of heat exchanger failures" at the 2005 Inspection Technical Exchange Meeting and Exhibition during December 12th and 13th 2005 conducted by Inspection Department of Saudi Aramco, Dhahran, Saudi Arabia