FACT SHEET

Master of Mechanical Equipment Engineering for Industrial Plants

Online Master of Mechanical Equipment Engineering for Industrial Plants

Who Should Attend?

This course is intended for graduates (or soon to be), designers, freelancers, technicians and engineers involved in calculation, design, selection, manufacturing, safety, quality and maintenance of systems and equipment in industrial processes.

Master Objetives

The main objective of this course is to transfer to participants the theoretical and practical skills required in projects, obtained from experience and sound engineering practices.

What to Expect?

The participants of the master will obtain the necessary knowledge for the design and calculation of the mechanical equipment object of this master, safe and economical designs, used in most industrial facilities and the oil & Gas sector.

Duration of the Master

The master has been designed to be completed with an average dedication of 550 hours in 50 weeks.

Methodology

Self-guided Hands-On

Available 24/7

“Learn by doing” concept

Non-scheduled sessions

Specialist Instructor available throughout the course

Included in the course

Study Notes

Summary Videos

Self-Assessment Quizzes

Case Studies with real Data Sheets

Design & calculation sheets

Part I: Introduction to Mechanical Equipment 10 hs

Lesson 1: Introduction to Mechanical Equipment

Introduction

Design of piping systems

Importance of the pipe system

Pipe specification

Layout in plan

Pipe flexibility analysis

Design of pressure vessels

Vessels

Reactors

Columns

Storage system design

Aboveground storage tanks

Spheres

Cigars or "Bullets"

Shell and Tube Heat Exchangers Design

Shell and Tube Heat Exchangers

Double Tube Heat Exchangers (Fin Tube)

Aero-coolers (Air Coolers, Air Fins, Fin Fans)

Plate heat exchangers

Part II: Design of Piping Systems (120 hs)

Lesson 1: Codes & Design Criteria

Applicable Codes

ANSI Code

ASTM Code

ASME B31 Code

Design Loads

Sustained Loads

Displacement Loads

Occasional Loads

Proposed Case Studies

- *Vocabulary and terminology*
- *ASME B31 Code Organization, Scope*
- *Design Loads*
- *Operating Conditions*

Lesson 2: Diameter & Pressure Loss

Flow of fluids in pipes

Properties of fluids

Flow of fluids

Energy conservation law

Pressure loss

Pressure loss in straight runs

Pressure loss in fittings

Proposed Case Studies

- *Application of energy conservation law*
- *Pressure loss in straight runs*
- *Pressure loss in fittings*
- *Optimal diameter calculation*

Lesson 3: Material Selection

Material selection

Corrosion types

Corrosion Allowance

Essential properties of materials

Allowable stress

Material designation

Most used materials

General requirements

Proposed Case Studies

- *Vocabulary and terminology*
- *Manufacturing methods*
- *Materials designation*
- *Allowable Stress selection*

Lesson 4: Piping Specification

Types of pipes

Schedule & Calibrated pipes

Joining methods

Components

Pipes, flanges and fittings

Valves specification

Piping class

Proposed Case Studies

- *Applicable specifications*
- *Commercial thicknesses*
- *Flange selection*
- *Piping class*

Lesson 5: Piping Insulation

Purpose of insulation

Selection parameters

Insulation Calculation

Effective thickness

Cold & hot piping insulation

Thickness selection

Insulation installation

Proposed Case Studies

- *Insulating materials properties*
- *Insulation thickness calculation*
- *Effective thickness calculation*
- *Insulation specification*

Lesson 6: Thickness Calculation

Stresses in cylindrical shells

Thin walled cylinders

Thickness calculation procedure

ASME B31.1 Formulae: Power Piping

ASME B31.3 Formulae: Process Piping

ASME B31.4 Formulae: Pipeline Transportation

ASME B31.8 Formulae: Gas Transport

Commercial thickness selection

Proposed Case Studies

- *Allowable stress selection*
- *Selection of pipe coefficients*
- *Thickness calculation*
- *Commercial thickness selection*

Lesson 7: External Pressure Design

Applicable Codes

Failure Mechanisms

Moment of Inertia of the System

Support Lines

System verification

Wall thickness and Stiffening rings

Best Practices

Proposed Case Studies

- *Thickness verification against external pressure*
- *Distance between support lines*
- *Design of Stiffening Rings: Case Study*
- *Pipe + Rings Verification: Case Study*

Lesson 8: Buried Piping Design

Introduction

Design Codes

Terrain Importance

Design Considerations

Loads Definition

Stress Verification

Failure Modes

Installation

Proposed Case Studies

- *Vertical Loads of the terrain*
- *Superficial Live Loads*
- *Ovalization and Induced Stress*
- *Stress due to flotation*

Lesson 9: Piping Layout

Basic Philosophy

Piping Layout Specification

Plot Plan

Equipment Location

Piping Arrangement

Distance between Equipment

Pipe Rack

Proposed Case Studies

- *Plant Access Requirements*
- *Minimum Distance between equipment*
- *Platforms & Stairs requirements*
- *Minimum distance between pipes*

Lesson 10: Equipment Interconnection

Importance of an adequate Layout

Equipment Interconnection

S&T Heat Exchangers

Air Coolers

Compressors

Pressure Vessels

Centrifugal Pumps

Instrumentation Piping

Proposed Case Studies

- *Basic Rules for a good design*
- *Interconnection with Heat Exchangers*
- *Interconnection with centrifugal pumps*
- *Interconnection with Pressure Vessels*

Lesson 11: Stress & Flexibility Analysis

Introduction

Stages in Flexibility Analysis

Thermal expansion of piping

Induced loads due to Thermal Expansion

Induced Stresses in the pipe

Pipe Allowable Stresses

Simplified Analytical Calculation

Proposed Case Studies

- *Thermal expansion calculation*
- *Induced force due to thermal expansion*
- *Turns to absorb the thermal expansion*
- *Expansion Loops calculation*

Lesson 12: Supports Design

Introduction

Supports functions

Classification

Commercial & Structural Supports

Types of Supports

Symbology

Location

Supports Selection

Proposed Case Studies

- *Supports Symbology*
- *Rigid & Flexible Supports Selection*
- *Structural Supports calculation*
- *Minimum distance between supports*

Part III: Design of Pressure Vessels 120 hs

Lesson 1: Introduction & ASME VIII Code

Configuration and design codes

Pressure vessel parts, Geometry definition

ASME BPVC – Boiler and pressure vessel code

Historical review, BPVC Sections

ASME BPVC Section VIII, Div.1

Scope, Code organization

ASME stamp

Code revisions

Proposed Case Studies

- *Vocabulary and terminology*
- *Key Concepts in Design Codes: Quiz*
- *ASME VIII Code organization, scope*
- *Key Concepts in ASME VIII: Quiz*

Lesson 2: Internal & External Elements

Internal attachments

Tray supports, Beds' support

Internal piping / distributors

Vortex breakers, Demisters

External attachments

Clips, Davits, Lifting devices

Insulation, Fireproofing

Platforms, Ladders

Proposed Case Studies

- *Vocabulary and terminology*
- *Identification of internal attachments: Quiz*
- *Identification of external attachments: Quiz*
- *Attachments weight estimation*

Lesson 3: Design Conditions

Design Conditions

Temperature, Pressure

Corrosion Allowance

Loadings

Permanent | Temporary

Cyclic | Local

Vessel Weights

Shell | Heads | Nozzles | Skirts

Proposed Case Studies

- *Key Concepts in Design Conditions Quiz*
- *Key Concepts in Loadings Quiz*
- *Vertical PV Weight Estimation: Case Study*
- *Horizontal PV Weight Estimation: Case Study*

Lesson 4: Material Selection

Material selection

Corrosion types

Corrosion Allowance

Essential properties of materials

Material designation

Most used materials

ASME Tables

General requirements

Proposed Case Studies

- *Vocabulary and terminology*
- *Materials designation*
- *Allowable Stress selection*
- *MDMT Verification*

Lesson 5: Joint Efficiency

Joint Efficiency

Welded joints, Joint types

Service requirement

Welded joint evaluation

Joint efficiency value

Selection charts

The full or spot dilemma

Proposed Case Studies

- *Vocabulary and terminology*
- *Key Concepts in Joint Efficiency Quiz*
- *Vertical PV Joint Efficiency Selection: Case Study*
- *Horizontal PV Joint Efficiency Selection: Case Study*

Lesson 6: Internal Pressure Design

Design of parts under Internal Pressure

Stresses in cylindrical shells

Cylindrical | Spherical shells

Fabrication of shells

Types of Heads: Hemispherical, Elliptical heads

Torispherical heads, Flat heads

Fabrication of heads

Conical transitions | Toriconical transitions

Proposed Case Studies

- *Calc's of Cylindrical & Spherical Shells: Case Study*
- *Calc's of the different types of Heads: Case Study*
- *Calc's of Conical, Toriconical transitions: Case Study*
- *Calc's of Flat Covers: Case Study*

Lesson 7: External Pressure Design

Design of parts under external pressure

Support lines, Cylindrical shells

Shell under external pressure

Stiffening rings under external pressure

Spherical shells

Heads and conical transitions

Conical heads & transitions

Proposed Case Studies

- *Key concepts in External Pressure: Quiz*
- *Calc's of PV against external pressure: Case Study*
- *Design of Stiffening Rings: Case Study*
- *Shell + Rings Verification: Case Study*

Lesson 8: Nozzle Design

Nozzles

Nozzle Configurations

Standard flanges, Gaskets

Nozzle necks, Calculation

Reinforcement

Reinforcement requirement

Calculation methods

Self-reinforced and integral nozzles

Proposed Case Studies

- *Key concepts in Nozzle Design: Quiz*
- *Nozzle Neck Calculation: Case Study*
- *Reinforcement Pad Calculation: Case Study*
- *Self-reinforced nozzles Calculation: Case Study*

Lesson 9: Non-Standard Flange Design

Non-standard flanges

Design criteria, Load definition

Flange types

Bolts & Gaskets

Gaskets

Design of Non-standard flanges

Flange design steps

Sound engineering practices

Proposed Case Studies

- *Key Concepts in Non-Std Flange design: Quiz*
- *Types of Non-Standard Flanges: Case Study*
- *Calculation of Integral Flanges: Case Study*
- *Calculation of Loose Flanges: Case Study*

Lesson 10: Wind & Seismic Loads

External loads

Wind pressure

Seismic loads

Period of Vibration (POV)

Vertical vessels: skirt, legs

Horizontal vessels: saddles

Allowable stress & loads combination

Proposed Case Studies

- *Key Concepts in External Loading: Quiz*
- *Wind Pressure & Seismic Profile: Case Study*
- *Definition of loads action on the vessel: Case Study*
- *Base shear & overturning moment calc: Case Study*

Lesson 11: Supports for Vertical Vessels

Skirt design

Types of shell-to-skirt joint

Skirt thickness calculation

Skirt saddle design

Tall towers, Lugs

Legs design

Profile cross section, Legs standard

Verification of legs

Proposed Case Studies

- *Key Concepts in Skirt & Legs design: Quiz*
- *Design and Calculation of Skirts: Case Study*
- *Design and Calculation of Legs: Case Study*
- *Design and Calculation of Anchor Bolts: Case Study*

Lesson 12: Supports for Horizontal Vessels

Saddles design

Location of saddles

Components

Saddles standard

Verification of saddles

Anchor bolts

Thermal expansion

Proposed Case Studies

- *Key Concepts in Saddles design: Quiz*
- *Design and Calculation of Saddles: Case Study*
- *Shell Verification against over stress: Case Study*
- *Design and Calculation of Anchor Bolts: Case Study*

Part IV: Design of Shell & Tube Heat Exchangers 120 hs

Lesson 1: Intro & Design Codes

Introduction

TEMA Code

Application, Organization, Scope

HEI Code

Application, Organization, Scope

API 660 Code

Application, Organization, Scope

Comparison & Compatibility

Proposed Case Studies

- *Parts of a Heat Exchanger*
- *Key Concepts in Design Codes: Quiz*
- *TEMA Code organization, scope*
- *Compatibility between codes*

Lesson 2: Exchangers configuration

Shell & Tube Heat Exchangers

Tube Side | Shell Side

Main Elements

Types of Heat Exchangers

S&T Heat Exchangers Configurations

Tubes Arrangement

Number of passes in the Tube Side

Number of passes in the Shell Side

Proposed Case Studies

- *Conceptual Questions*
- *Identification of Main Elements*
- *Exchanger Type Selection*
- *Number of Tubes calculation*

Lesson 3: Design Conditions

Design Conditions

Loads

Sustained, Occasional

Cyclic Loads | Local Loads

Weight Estimation

Shell, Heads, Body Flanges

Tubesheets, Tubes, Nozzles

Supports | Insulation

Proposed Case Studies

- *Key Concepts in Design Conditions Quiz*
- *Unitary Weights Estimation*
- *Components Weights Estimation*
- *Design Weights Calculation*

Lesson 4: Material Selection

Material selection

Corrosion types

Corrosion Allowance

Essential properties of materials

Material designation

Most used materials

ASME Tables | General requirements

Proposed Case Studies

- *Vocabulary and terminology*
- *Materials designation*
- *Allowable Stress selection*
- *MDMT Verification*

Lesson 5: Joint Efficiency

Joint Efficiency

Welded joints, Joint types

Service requirement

Welded joint evaluation

Joint efficiency value

Selection charts

The full or spot dilemma

Proposed Case Studies

- *Vocabulary and terminology*
- *Joint Category*
- *Welded Joints Specification*
- *Joint Efficiency Selection: Case Study*

Lesson 6: Design of the Shell

External elements design

Cylindrical shells

Types of heads

Hemispherical | Elliptical | Torispherical

Flat Covers

Transitions

Conical transitions

Toriconical transitions

Proposed Case Studies

- *Calc's of Cylindrical & Spherical Shells: Case Study*
- *Calc's of the different types of Heads: Case Study*
- *Calc's of Conical, Toriconical transitions: Case Study*
- *Calc's of Flat Covers: Case Study*

Lesson 7: External Pressure Design

Design of parts under external pressure

Support lines, Cylindrical shells

Shell under external pressure

Stiffening rings under external pressure

Spherical shells

Heads and conical transitions

Conical heads & transitions

Proposed Case Studies

- *Key concepts in External Pressure: Quiz*
- *Calc's of PV against external pressure: Case Study*
- *Design of Stiffening Rings: Case Study*
- *Shell + Rings Verification: Case Study*

Lesson 8: Tube Bundle Design

Tube Bundle Design

Tubesheet

Tube bundle structure

Baffles: longitudinal | transversal

Heat transfer tubes

Tube – tubesheet joint

Floating heads

Impingement plate

Proposed Case Studies

- *Tube bundle configuration*
- *Tubesheet thickness calculation*
- *Transfer tubes thickness calculation*
- *Minimum thicknesses*

Lesson 9: Nozzle Design

Nozzles

Nozzle Configurations

Standard flanges, Gaskets

Nozzle necks, Calculation

Reinforcement

Reinforcement requirement

Calculation methods

Self-reinforced nozzles

Proposed Case Studies

- *Key concepts in Nozzle Design: Quiz*
- *Nozzle Neck Calculation: Case Study*
- *Reinforcement Pad Calculation: Case Study*
- *Self-reinforced nozzles Calculation: Case Study*

Lesson 10: Design of Body Flanges

Non-standard flanges

Design criteria, Load definition

Flange types

Bolts & Gaskets

Gaskets

Design of Non-standard flanges

Flange design steps

Sound engineering practices

Proposed Case Studies

- *Key Concepts in Non-Std Flange design: Quiz*
- *Flange geometry design*
- *Joint selection / characteristics*
- *Non-standard flange verification*

Lesson 11: Wind & Seismic Loads

Loads acting on Heat Exchangers

Wind Pressure

Shear force

Overturning moment

Seismic Loads

Period of Vibration (POV)

Shear force at the base

Overturning moment

Proposed Case Studies

- *Key Concepts in External Loading: Quiz*
- *Wind Pressure & Seismic Profile: Case Study*
- *Base shear calc: Case Study*
- *Overturning moment calc: Case Study*

Lesson 12: Design of Saddles

Saddles design

Location of saddles

Components

Saddles standard

Geometry definition

Verification of saddles

Anchor bolts

Thermal expansion

Proposed Case Studies

- *Key Concepts in Saddles design: Quiz*
- *Design and Calculation of Saddles: Case Study*
- *Shell Verification against over stress: Case Study*
- *Design and Calculation of Anchor Bolts: Case Study*

Part V: Design of Storage Tanks 120 hs

Lesson 1: Codes & Design Conditions

Design Codes

API 650 code

Code organization, Scope

Other applicable codes

Design conditions

Design loads

Internal and External pressure

Design temperature

Proposed Case Studies

- *Vocabulary and terminology*
- *Code organization, scope*
- *Design Loads*
- *Operating conditions*

Lesson 2: Material Selection

Material selection

Corrosion types

Corrosion Allowance

Essential properties of materials

Material designation

Most used materials

General requirements

Proposed Case Studies

- *Vocabulary and terminology*
- *Materials designation*
- *Allowable Stress selection*
- *MDMT Verification*

Lesson 3: Tank Shell Design

Design Considerations

One-foot calculation method

Thickness due to Liquid Level

Minimum Thickness

Fabrication requirements

Welding

Non-destructive examination

Hydrostatic Test

Proposed Case Studies

- *Material Selection, Allowable Stress*
- *Number and height of shell courses*
- *Thickness calc's*
- *Nominal plate thicknesses*

Lesson 4: Tank Bottom Design

Bottom plates design

Plates arrangement, minimum thickness

Annular ring

Width calculation, minimum thickness

Fabrication requirements

Plate edge finishing

Welding

Proposed Case Studies

- *Material Designation (shell, bottom, annular ring)*
- *Mechanical properties*
- *Annular ring requirement*
- *Bottom plate thickness & annular ring*

Lesson 5: Design of Wind Girders

Tank shell stability

Top ring

Self-supported roofs

Supported roofs

Tank shell stiffeners due to wind

Top and Intermediate rings

Profile selection

Proposed Case Studies

- *Top ring profile selection*
- *Top angle calculation*
- *Transformed height calculation*
- *Intermediate rings calculations*

Lesson 6: External Pressure - Vacuum

Design considerations

External pressure verification (Vacuum)

External pressure range

Tank shell verification

Load combinations: wind + pressure

Wind girders

Number of girders and spacing

Moment of inertia required

Proposed Case Studies

- *Transformed height calculation*
- *Design external pressure/Allowable calculation*
- *Number and spacing of rings*
- *Standard profile selection*

Lesson 7: Fixed Roof Design

Types of fixed roofs

Conical type

Dome & umbrella type

Fixed roofs configuration

Self-supported roof

Supported roof

Structure for supported roofs

Proposed Case Studies

- *Self-supported roof calculation*
- *Loads and plate thickness*
- *Supported roof calculation*
- *Frame & columns calculation*

Lesson 8: Floating Roof Design

Floating roof selection

External floating roof

Single & double deck roofs

Floating roofs appurtenances

Buoyancy – Pontoon design

Internal floating roof

Types of roofs

Design requirements, materials

Proposed Case Studies

- *Material properties*
- *Pontoon design*
- *Pontoon buoyancy verification*
- *Deck stress verification*

Lesson 9: Nozzle Design

Nozzle configuration

Standard flanges

Nozzle necks

Reinforcements

Nozzles in tanks

Tank shell nozzles

Tank roof nozzles

Cleaning nozzles

Proposed Case Studies

- *Material selection*
- *Material designation for components*
- *Flange selection / Rating*
- *Nozzle selection as per code*

Lesson 10: Wind Loads

Wind loads

Wind profile according to job site

Wind speed and pressure

Wind overturning verification

Impose loads

Overturning resistance

Tank sliding due to wind

Proposed Case Studies

- *Tank components weight*
- *Overturning moment calculation*
- *Resistant moment verification*
- *Tank horizontal sliding verification*

Lesson 11: Seismic Loads

Seismic Loads

Seismic Spectrum (accelerations)

Overturning moment & base shear

Vertical loads

Design loads verification

Resistant moment

Sliding verification

Freeboard requirement

Proposed Case Studies

- *Seismic parameter definition*
- *Tank components weight calculation*
- *Overturning moment & base shear calc*
- *Resistant loads verification*

Lesson 12: Tank Anchorage

Anchor bolts requirements

Wind loads

Seismic loads

Internal pressure

Tank uplift

Bolts number and cross-section

Chairs design

Proposed Case Studies

- *Anchor bolts requirement*
- *Factor J & sliding calculation*
- *Uplift load calculation*
- *Bolts number & cross-section calc*

Part VI: Final Master's Project 60 hs

Master Final Project

The end-of-master project consists of the design and calculation of the drive, conditioning, storage and injection system of demineralized water in gas turbines of a power generation plant.

To carry out the project, participants will have to:

- Size piping systems according to the required flow
- o Calculate the pressure drops of the system
- o Design and calculate the demi water storage tank
- o Select and design the support of the piping systems
- o Design and calculate the heat exchanger for water cooling
- o Design the nitrogen pressure vessel for water cooling.

Instructor

Senior Mechanical Engineer and Master in Business Administration (MBA). **More than 25 years of experience in design, calculation and fabrication of pressure vessels, heat exchangers, storage tanks, piping systems and structures in general.**

Duties of the above-mentioned positions cover the entire cycle of an equipment, **from the very conception, drawings, design and calculation, technical specifications, technical requisitions, vendor drawings, to the manufacturing phase and installation assistance**. Among the developed projects, clients such as SHELL, EXXON, REPSOL, CHEVRON, GALP, CEPSA, TUPRAS and SAUDI ARAMCO can be found.

Vast experience providing specific training sessions in both classroom and online approaches. More than 75 training courses carried out in different institutions and in-company, courses oriented to graduates, designers, engineers and experienced professionals.

Tailored Training

The most effective training is one that satisfies the needs of each company's business focus and deliverables. **We adapt our training programs to each specific requirement, offering bespoke solutions for each need.** The result, 100% tailored programs, developed to maximize the time investment and deliver tangible and intangible returns to the work teams.

After an assessment phase, a tailored training plan is designed jointly with the client. This plan is specifically tailored to meet the client's needs, focusing on effectively enhancing the capabilities of the work team. **We provide practical, dynamic and hands-on training,** making available the best instructors in each subject.

Arveng Training

Arveng Training has developed effective and practical solutions for today's industrial challenges by delivering specific, high-quality engineering courses utilizing three different approaches: classroom, online, and tailored training. We are proud to have imparted more than 500 classroom courses, 1800 online courses, and over 200 in-company sessions. Our training activities have benefitted over 6000 professionals, our greatest accomplishment of all.

We consider our students' time to be of utmost importance. For this reason, all our courses have been designed with the main objective of quickly improving the professional skills of the participants through our expert instructors in different disciplines. **We stimulate creativity, innovation, and initiative to make the participants inquisitive, bringing good engineering practices and lessons learned to the field, that benefits their professional lives in the long term.**

Our Company

Arveng Training & Engineering SL is a leading company providing Training and Engineering services based in Madrid, Spain. Our mission and vision are to be a leading training and engineering services company, providing our clients with the best in the sector. We are a team of highly motivated, talented, highly qualified professionals with over 20 years of experience. We aim to exceed expectations by offering efficient, innovative, cost-effective, and transparent services.

Established in July 2010, mainly oriented to the industrial sector, from the very beginning Arveng has always worked with closeness, responsibility, and commitment in all areas of activity.

Through experience gained by partaking in multidisciplinary engineering projects in sectors such as Petrochemical, Energy Generation, and Industrial, we provide answers and solutions to concrete requirements, making the effort to build long-lasting and mutually beneficial relationships.