

COURSE OVERVIEW ME0637

**Heat Exchanger
(E-Learning Module)**

Course Title

Heat Exchanger (E-Learning Module)

Course Reference

ME0637

Course Format & Compatibility

SCORM 1.2. Compatible with IE11, MS-Edge, Google Chrome, Windows, Linux, Unix, Android, IOS, iPadOS, macOS, iPhone, iPad & HarmonyOS (Huawei)

Course Duration

30 online contact hours
(3.0 CEUs/30 PDHs)

Course Description



This course is designed to provide participants with a detailed and up-to-date overview of heat exchanger. It covers the basics of thermodynamics and heat transfer including its application; the temperature and heat, units of heat, heat transfer fundamentals, conduction, convection, radiation and heat transfer; the enthalpy of evaporation or latent heat (Hfg), enthalpy of saturated steam, total heat of saturated steam and the steam phase diagram; the factors influencing heat flow, heat transfer basic equations for design, fouling and its effect; the heat exchanger design-detailed calculations; and the types of heat exchangers.

Further, the course will also discuss the heat exchangers development steps; the two stream exchangers, double pipe, shell and tube heat exchangers, condensers and compact heat exchangers; the plate and frame heat exchangers, cooling towers and types of wet-cooling towers; the mechanical draft cooling towers, spiral heat exchanger and flue gas/combustion air heat exchanger; the boiler types according to heat transfer; the heat exchanger selection; the plate and frame heat exchangers selection and its construction material; the advantages of the spiral heat exchanger, TEMA designation system, fixed head types, shell types, U-tube return bend heat exchangers and fixed tube sheet exchangers; and the floating head exchangers, organizations standards, TEMA code and TEMA designation system.



Moreover, the course will also discuss the different types of shell and tube heat exchangers; the heat exchangers selection guidelines, reboiler comparison and thermosyphon selection criteria; the heat exchangers maintenance; the heat exchanger linings and heat exchangers test for leakage; the heat exchangers inspection techniques and inspecting in-service units; the visual examination, ultrasonic cleaning, radiographic testing, ultrasonic testing, liquid penetrant testing, magnetic particle testing, eddy current testing and pressure testing; the boiler inspection and testing; the visual inspection for auxiliary equipment and hydrostatic pressure test; the new technology in heat exchangers; the industrial furnaces system, industrial process furnaces, how fired heaters work and integrated gasification combined cycle (IGCC); the fuel oils, fuel gas combustion furnaces, oxy-fuel combustion, mass emissions, gas velocity, stack temperature, dew point, gases, high stack temperature, stack gas sampling and carbon dioxide (CO₂), oxygen (O₂), and carbon monoxide (CO) tests; and the stack gases analyzer, combustion analysis, burners and combustion, air required in combustion and disposal of waste gases or vapors by burning.

During this course, participants will learn the boiler and boiler systems; the types, advantages and disadvantages of fired tube boilers; the boiler auxiliaries and de-aerators; the cooling towers, blow down system and steam system; the boiler design safety, safety valves, pressure relief valve principles of operation, static force balance, two ring design ring setting chart, dynamic force balances and range of steam pressure gage; the steam mains and drainage, steam quality and dryness, types of steam traps, mechanical steam traps and the basic principles associated with steam traps; the thermostatic type, thermodynamic types, fuel system equipment list, fuel oil heating, fuel oil flow bath, fuel oil burner types and fuel oil burner types; and the combination of gas/fuel oil burners, properties of burners, forced draft fans, draft system, combustion air system and flue gas analyzer.

Course Objectives

The course should serve the following overall learning objectives:-

- Apply and gain a comprehensive knowledge on heat exchanger
- Identify the main parts of heat exchangers
- Identify the types of heat exchanger
- Design of heat exchanger
- Identify the types of baffles
- Understand the general failure modes of heat exchanger
- Be familiar with resources requirement
- Identify the types and parts of fin fan cooler
- Understand the procedure of inspection, maintenance and repair of heat exchanger
- Discuss the basics of thermodynamics and heat transfer including its application
- Identify temperature and heat, units of heat, heat transfer fundamentals, conduction, convection, radiation and heat transfer

- Recognize enthalpy of evaporation or latent heat (H_{fg}), enthalpy of saturated steam, total heat of saturated steam and the steam phase diagram
- List the factors influencing heat flow, heat transfer basic equations for design, fouling and its effect
- Interpret heat exchanger design-detailed calculations including evaporation, condensation and separation processes
- Identify the types of heat exchangers including heat exchanger job, pre-heaters, vaporizers, chillers, evaporators, steam generators or waste heat boilers, coolers, condensers, surface condensers and cost contribution of heat exchangers
- Illustrate heat exchangers development steps and recognize the two stream exchangers, double pipe, shell and tube heat exchangers, condensers and compact heat exchangers
- Recognize plate and frame heat exchangers, flow arrangement within a PHE, air-cooled exchanger, air cooled heat exchangers/fin fans, plate-fin exchanger, cooling towers and types of wet-cooling towers
- Describe mechanical draft cooling towers, spiral heat exchanger, recuperators, furnace air heaters as regenerator and flue gas/combustion air heat exchanger
- Explain boiler types according to heat transfer, generation, superheater, evaporator, addition of fins
- Apply heat exchanger selection for a given process including the general points on material selection and pressure
- Perform plate and frame heat exchangers selection and identify its construction material
- Discuss the advantages of the spiral heat exchanger, TEMA designation system, fixed head types, shell types, U-tube return bend heat exchangers and fixed tube sheet exchangers
- Identify floating head exchangers, organizations standards, TEMA code and TEMA designation system
- Compare between different types of shell and tube heat exchangers including the differential movement between shell and tubes
- Review heat exchangers selection guidelines, reboiler comparison and thermosyphon selection criteria
- Employ heat exchangers maintenance, maintenance planning, precautions required and descaling maintenance
- Identify heat exchanger linings, heat exchangers test for leakage, vacuum joint testing gun, tube testing gun, explosive plugging, removable plugs, taper plugs and torq 'n seal® low pressure condenser plugs
- Review tube plugs installation instructions and discuss tube expanders, mechanical rolling, rolling motor, sleeving, retubing and hydraulic spear tube puller
- Explain tube bundles puller and bundle cut and employ heat exchangers inspection techniques and inspecting in-service units



- Discuss inspection codes, scope for heat exchangers inspection, cautions before starting, inspecting new construction or replaced parts, inspecting re-tubing, repairs and alterations
- Identify removable-bundle exchangers, U-tube exchangers, floating-head exchangers and standards of non-destructive testing
- Perform visual examination, ultrasonic cleaning, radiographic testing, ultrasonic testing, liquid penetrant testing, magnetic particle testing, eddy current testing and pressure testing
- Test pressures and temperatures and carryout boiler inspection and testing
- Interpret design/operating information for calculation and apply external visual boiler inspection, visual inspection for other parts of plant, nondestructive inspection and water quality survey
- Assess boiler plant conditions and perform visual inspection for auxiliary equipment and hydrostatic pressure test
- Identify code violations creates a safer environment, code updates for water level indicators and other common code violations
- Discuss the new technology in heat exchangers, printed circuit heat exchangers, advantages of PCHE, heat exchangers breech-locking, breech-lock™ technology and strip lining of high-pressure screw plug
- Explain corrugated tube heat exchangers, tubes scraping elements, new self-cleaning technology for heat exchangers and applications of self-heat exchangers cleaning
- Recognize new therm-x cleaning technology, types of furnaces, major parts, primary objectives in furnace system and critical design factors
- Interpret industrial furnaces system, industrial process furnaces, how fired heaters work and integrated gasification combined cycle (IGCC)
- Discuss fuel oils, fuel gas combustion furnaces, oxy-fuel combustion, mass emissions, gas velocity, stack temperature, dew point, gases, high stack temperature, stack gas sampling and carbon dioxide (CO₂), oxygen (O₂), and carbon monoxide (Co) tests
- Describe stack gases analyzer, combustion analysis, burners and combustion, air required in combustion and disposal of waste gases or vapors by burning
- Recognize boiler and boiler systems, steam boilers classification, tube-based boiler classification, boilers types based on tubes and boiler types according to heat transfer
- List the types, advantages and disadvantages of fired tube boilers as well as water tube boilers, boiler types according to heat transfer, water tube boiler and steam boilers
- Recognize total steam system, boiler piping, boiler external piping, non-boiler external piping and the difference between tube and pipe



- List the accessories of boiler auxiliaries and interpret the main boiler systems, water system equipment list, boiler feed water system, feedwater system and feed water pump
- Discuss de-aerators, deaerator major take-a-ways, feed water heater, open feedwater heater, boiler vent, condensation and air-cooled accessories heat exchangers/fin fans
- Determine cooling towers, blow down system, steam system, steam system equipment list, design code of power boilers and how heat transfers to a boiler
- Describe economizer, studded tubes, sootblowers, evaporator, steam drums, steam separators, superheater, desuperheaters and attemperators
- Identify boiler design safety, safety valves, pressure relief valve principles of operation, static force balance, two ring design ring setting chart, dynamic force balances and range of steam pressure gage
- Explain steam mains and drainage, steam quality and dryness, types of steam traps, mechanical steam traps and the basic principles associated with steam traps
- Discuss thermostatic type, thermodynamic types, fuel system equipment list, fuel oil heating, fuel oil flow bath, fuel oil burner types and fuel oil burner types
- Describe the combination of gas/fuel oil burners, properties of burners, forced draft fans, draft system, combustion air system and flue gas analyzer

Who Should Attend

This course covers systematic techniques and methodologies in heat exchanger for project engineers, process engineers, plant and maintenance engineers and supervisors. The course is also useful to those generally knowledgeable on the subject, but who may require a refresher or update. No prior knowledge of heat transfer is required. Participants will be taken through an intensive primer of heat transfer principles as they apply to shell and tube heat exchangers.

Training Methodology

This Trainee-centered course includes the following training methodologies:-

- Talking presentation Slides (ppt with audio)
- Simulation & Animation
- Exercises
- Videos
- Case Studies
- Gamification (learning through games)
- Quizzes, Pre-test & Post-test


Every section/module of the course ends up with a Quiz which must be passed by the trainee in order to move to the next section/module. A Post-test at the end of the course must be passed in order to get the online accredited certificate.

Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course.

Certificate Accreditations


Certificates are accredited by the following international accreditation organizations: -

-  USA International Association for Continuing Education and Training (IACET)

Haward Technology is an Authorized Training Provider by the International Association for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 1-2013 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 1-2013 Standard**.

Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units (CEUs)** in accordance with the rules & regulations of the International Association for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

Haward Technology Middle East will award **3.0 CEUs** (Continuing Education Units) or **30 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

-  British Accreditation Council (BAC)

Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

Course Fee

As per proposal

Course Contents

- Heat Exchangers
- Course Objectives
- Basics of Thermodynamics and Heat transfer
- Heat Transfer & Its Application
- Temperature and Heat
- Units of Heat
- Heat Transfer Fundamentals
- Heat Transfer & Its Application
- Conduction
- Convection
- Radiation
- Heat Transfer:
- What is Steam?
- Enthalpy of Evaporation or Latent Heat (H_{fg})
- Enthalpy of Saturated Steam, or Total Heat of Saturated Steam
- The Steam Phase Diagram
- Steam Tables
- Factors Influencing Heat Flow
- Heat Transfer Basic Equations for Design
- Fouling & Its Effect on U
- Fouling
- Fouling Factor
- Table of pH Values
- HE Design-Detailed Calculations
- Definitions
- Properties & Definitions
- Evaporation
- Condensation
- Separation Processes
- Properties and Definitions
- Distillation

- Course Recap
- Types of Heat Exchangers & Example
- What are Heat Exchangers for?
- Heat Exchangers (H-X)
- Heat Exchanger Job
- Pre-Heaters
- Vaporizers
- Chillers
- Evaporators
- Steam Generators or Waste Heat Boilers
- Coolers
- Condensers
- Surface Condensers
- Refinery Heat Exchanger Types
- Cost Contribution of H-X's
- H-X Development Steps
- Two Stream Exchangers
- Double Pipe
- Temperature Profiles in a Double Pipe Heat Exchanger
- Shell and Tube
- Shell & Tube Heat Exchangers
- Shell & Tube Heat Exchanger Classification
- Classification According to Flow Configurations
- Shell-Side Flow
- Complete Shell-and-Tube
- Condensers
- Fluid Temperatures When One Fluid Condenses or Boils
- Compact Heat Exchangers
- Plate & Frame Heat Exchangers
- Plate and Frame
- Plate Types
- Flow Arrangement within a PHE
- Air-Cooled Exchanger

- Air Cooled HE/ Fin Fans
- ACHE Bundle
- Plate-fin Exchanger
- Cooling Towers
- Types of Wet-cooling Towers
- Background
- Mechanical Draft Cooling Towers
- Spiral Heat Exchanger
- Recuperators
- Regenerators are Gas-to-gas
- Furnace Air Heaters as Regenerator Example
- Flue Gas/Combustion Air Heat Exchanger
- Flue Gas/Combustion Air
- Boiler
- Boiler Types According to Heat Transfer
- Circulation of water in Water-tube Boilers
- Generation
- Superheater
- Evaporator
- Addition of Fins
- HE Selection
- Heat Exchanger Selection for a Given Process
- General Points on Material Selection & Pressure
- Thermal Effectiveness in Choosing Material
- PT-HE versus ST-HE
- Plate & Frame Heat Exchangers Selection
- Construction Material of Plate & Frame HE
- Plate-fin Heat Exchangers
- PT-HE versus ST-HE
- Advantages of the Spiral Heat Exchanger
- Air Cooled HE/ Fin Fans
- Fin Fans
- Fin Fans Air Coolers

- Fin Types
- Why Shell and Tube H.E?
- Comparison Between Different Types of Shell and Tube HE
- Typical Maximum Exchanger Sizes
- Differential Movement Between Shell and Tubes
- Is the Tube Bundle Removable
- Is Replacement Bundle Possible
- Can Individual Tubes be Removed and Replaced
- Number of Tube Side Passes
- Is Double Tube Sheet Construction Permissible
- Are there Internal Gaskets
- H.E in Petroleum Industry
- Heat Exchangers Selection Guidelines
- Floating Head Exchangers
- Reboiler Comparison
- Thermosyphon Selection Criteria
- COURSE RECAP
- Shell and Tube HE & Standards
- Introduction
- Types of Shell and Tube Heat Exchangers
- TEMA Designation System
- Fixed Head Types
- Bolted Channel (Type A or L)
- Welded Channel (Type C, N and D)
- Bonnet (Type B or M)
- Shell Types
- U-Tube Return Bend Heat Exchangers
- Fixed Tube Sheet Exchangers
- Floating Head Exchangers
- Organizations Standards
- TEMA Code
- TEMA Type
- TEMA Designation System

- Why Shell and Tube H.E?
- Comparison Between Different Types of Shell and Tube HE
- Typical Maximum Exchanger Sizes
- Differential Movement Between Shell and Tubes
- Is the Tube Bundle Removable
- Is Replacement Bundle Possible
- Can Individual Tubes be Removed and Replaced
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- Are there Internal Gaskets
- H.E in Petroleum Industry
- Heat Exchangers Selection Guidelines
- Reboiler Comparison
- Thermosyphon Selection Criteria
- Course Recap
- HE Maintenance
- Maintenance Planning
- Precautions Required
- Reliability
- Refurbishing
- Fouling
- Scaling Problems
- Descaling Maintenance
- Heat Exchanger Linings
- HE Test for Leakage
- Condenser Leak Detector
- Vacuum Joint Testing Gun
- Tube Testing Gun
- Hydro Proof
- Plugging Heat Exchangers
- Explosive Plugging
- Welding Pins
- Removable Plugs



- Taper Plugs
- Torq 'n Seal® Low Pressure Condenser Plugs
- The Torq'n Torq Seal N'seal
- Tube Plugs Installation Instructions
- Internal Expansion Plugs for Tubes in Heat Exchangers (Pop-A-Plug)
- Pop-A-Plug
- Perm-A-Plugs
- CPI Pop-A-Plug
- P2 Pop-A-Plug
- Remarks on Tube Plugging by Pop a Plug Techniques
- Steps to Pop a Plug
- Plug Removal
- Tube Expanders
- Mechanical Rolling
- Rolling Motor
- Sleeving
- Heat Exchanger Sleeve Designs
- Retubing
- Manual Tube Puller: Hand Spear Tube Puller
- Hydraulic Spear Tube Puller
- Tube Bundles Puller
- Bundle Cut
- For Single Tube Cut
- HE Inspection Techniques
- Introduction
- Inspecting In-service Units
- Inspection Codes
- Scope for HE Inspecting
- Cautions Before Starting
- Inspecting New Construction or Replaced Parts
- Inspecting Re-tubing, Repairs & Alterations
- Corrosion/1
- Corrosion/2



- Removable-bundle Exchangers
- U-tube Exchangers
- Floating-head Exchangers
- TEMA Type
- Floating-head Exchangers
- Standards of Non-Destructive Testing
- Visual Examination (VE)
- Ultrasonic Cleaning
- Radiographic Testing (RT)
- Spot Radiography
- Full Radiography
- Partial Radiography
- Ultrasonic Testing (UT)
- Liquid Penetrant Testing (PT)
- Magnetic Particle Testing (MT)
- Eddy Current Testing (ET)
- Pressure Testing (LT)
- Test Pressures
- Test Temperatures & Dwell Time
- Boiler Inspection & Testing
- Boiler Internal Inspection
- Internal Boiler Inspection Procedures
- Operational Inspection
- Design/Operating Information for Calculation
- External Visual Boiler Inspection
- Visual Inspection for Other Parts of Plant
- Non-Destructive Inspection
- Water Quality Survey
- Boiler Plant Conditions
- Visual Inspection for Aux Equipment
- Hydrostatic Pressure Test
- Code Violations Creates a Safer Environment
- Code Updates for Water Level Indicators

- Other Common Code Violations
- New Technology in HE
- Printed Circuit HE
- Advantages of PCHE
- HE Breech-Locking
- Breech-Lock™ Technology
- Strip Lining of High-Pressure Screw Plug
- Internal Threads on Channel
- Screw Plug HES - Stacked Exchangers
- High Pressure Screw-Plug Exchanger with Tube Bundle Inserted
- Breech-Lock
- Corrugated Tube Heat Exchangers
- Tubes Scraping Elements
- New Self-Cleaning Technology for Heat Exchangers
- Applications of Self HE Cleaning
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- Course Recap
- Types of Furnaces & Major Parts
- Primary Objectives in Furnace System
- Critical Design Factors
- Introduction
- Industrial Furnaces System
- Industrial Process Furnaces
- How Fired Heaters Work
- Description
- Radiant Section (Firebox)
- Convection Section
- Furnace Types & Systems
- Furnaces Classified by Type of Fuel
- Furnace Types
- PCC Power Furnace with Flue Gas Filters
- Cyclone Furnace for Coal Combustion (CFC)
- Fluidized-bed for Coal Combustion (FBC)



- Integrated Gasification Combined Cycle (IGCC)
- Fuel Oils & Fuel Gas Combustion Furnaces
- Oxy-fuel Combustion
- Mass Emissions and Gas Velocity
- Stack Temperature, Dew Point & Gases
- High Stack Temperature
- Stack Gas Sampling
- Carbon Dioxide (CO₂), Oxygen (O₂), and Carbon Monoxide (CO) Tests
- Stack Gases Analyzer
- Combustion Analysis
- Burners and Combustion
- Air Required in Combustion
- Disposal of Waste Gases or Vapors by Burning
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- Boiler & Boiler Systems
- Introduction to Boilers
- Boiler (Coal-gas-oil) Electricity Process
- Steam Boiler
- Steam Boilers Classification
- Tube based Boiler Classification
- Boilers Types Based on Tubes
- Boiler Types According to Heat Transfer
- Types of Fired Tube Boilers
- Advantages of Fired Tube Boilers
- Disadvantages of Fired Tube Boilers
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- Boiler Types According to Heat Transfer
- Water Tube Boiler
- Advantages of Water Tube Boilers
- Disadvantages of Water Tube Boilers
- Circulation of water in Water-tube Boilers
- Water Tube Steam Boilers
- Steam Boilers





- Boiler Types According to Heat Transfer
- Other Classification for Boilers
- Liquid Fuel Fired Boiler
- Total Steam System
- Boiler Piping
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- Boiler External Piping
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- What is ASME Stands for?
- What is the Difference Between Pipe and Tube?
- Difference between Tube & Pipe
- Boiler Auxiliaries, Accessories
- The Main Boiler Systems
- Water System Equipment List
- Boiler Feed Water System
- Water System Equipment List Consists of:
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- Boiler Feed Water Pump
- Centrifugal BFW Pump
- Why do we Collect Condensate?
- De-aerators
- Tray-type Deaerator
- Spray Type Deaerator
- DA's Functions
- Deaerator Major Take-a-Ways
- Feed Water Heater
- Open Feedwater Heater
- Open Feedwater
- Closed Feedwater Heater
- Boiler Vent
- Condensation
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- Fin Fans





- Cooling Towers
- Blow Down System
- Boiler Blowdown Heat Exchangers and Flash Tank
- Steam System
- Steam System Equipment List
- Design Code of Power Boilers
- How Heat Transfers to a Boiler
- Economizer
- Finned Tubes
- Fin Parameters
- Studded Tubes
- Generation
- Sootblowers
- Fixed Soot Blower
- Rotating Soot Blower
- Soot Blower Installation
- Soot Blower Pipe Inside the Boiler
- Evaporator
- Types of Evaporator
- Water Tube Steam Boilers
- Steam Drums
- Steam Separators
- Dry Pipe Separator
- Cyclone Separator
- Superheater
- De-superheaters
- Attemperators
- Boiler Design Safety
- Safety Valves
- Pressure Relief Valve Principles of Operation
- PRV Terminology – PTC 25 – 2008
- Static Force Balance
- Two Ring Design Ring Setting Chart





- Dynamic Force Balances
- Range of Steam Pressure Gage
- Steam Mains and Drainage
- Steam Quality and Dryness
- Water Hammer and its Effect
- Water Hammer How it Happens
- Branch Line Connections
- Steam Lines Erosion/Corrosion
- Steam Lines Expansion and Support
- Why Steam Traps?
- The Duty of a Steam Trap is to Discharge Condensate while not Permitting the Escape of Steam
- Types of Steam Traps
- Thermostatic Steam Trap
- Mechanical Steam Traps
- Basic Principles Associated with Steam Traps
- Why Steam Traps are Necessary
- Ball Float Steam Trap
- Inverted Bucket Steam Trap
- Thermostatic Type
- Thermodynamic Types
- Thermodynamic Steam Trap
- Fuel System Equipment List
- Fuel System
- Fuel System Equipment List
- Fuel Oil Pump Flow Bath
- Fuel Oil Heating
- Viscosity is Temperature Dependent
- Fuel Oil Flow Bath
- Fuel Oil Burner Types
- Furnace Burner Construction
- Fuel Oil Burner Types
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- Combination Gas/Fuel Oil Burners



- Properties of Burners
- Forced Draft Fans
- Draft System
- Draft System Equipment List
- Draft System
- Draft
- Induced draft operation
- forced draft operation
- Combustion Air System
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