The BD Group Companies

BD Heat Recovery Division

BD Heat Recovery Division possesses the technology and experience necessary to provide proven and innovative solutions for a wide range of air preheating, heat recovery and emissions reduction applications. Whatever your requirements are, BD Heat Recovery Division stands committed to providing quality equipment and exemplary customer service at every phase of your project.

BD Environmental

Drawing from years of experience, BD Environmental Solutions specializes in design and supply of Flares, Thermal Oxidizers and Regenerative Thermal Oxidizers, and SRU Equipment. BD Environmental is able to provide your organization with engineered solutions focused on applications in the petrochemical, refinery, gas processing and Industrial plants.
Corporate Overview

The BD Group of Companies

BD Group Industries, LLC, is a worldwide energy solutions provider to the petrochemical, refinery and oil & gas industries delivering a diverse array of fired equipment products, technologies for emissions reduction and improved reliability in furnaces. BD Group Industries also offers technical field services and construction assistance through its subsidiaries, BD Heat Recovery Division Inc., BD Energy Systems, LLC and BD Environmental Solutions, LLC.

With engineering offices located in Seminole (Tampa), FL U.S.A., Ratingen (Dusseldorf), Germany, Houston, TX U.S.A., and Milan (MI), Italy, the BD Group of companies offers a synergistic product line and wide range of service capabilities to the petrochemical, refinery, oil & gas and environmental industries. For additional information on BD Group Industries companies and services please explore the individual websites of our companies.

BD Group Industries, LLC strength comes from its highly experienced engineers who have combined knowledge and experience in excess of 100 years specializing in fired equipment technologies, process and field services.
Ethylene Furnaces Design

BD Energy Systems, LLC – a world leader in plant revamps and modernizations based out of Houston, Texas, USA – has signed an agreement with Pycos Engineering PTE LTD giving BD Energy Systems access to the proprietary PYCOS kinetic simulator for conducting performance modeling of cracking furnace radiant designs. Additionally, the signed agreement gives BDE the exclusive rights to offer the patented “SRC” Super Radiant Coil Technology. This technology has shown to extend furnace run lengths between de-coke cycles and improve olefin yields.

Ethylene Furnaces Design

The Pycos Engineering S.R.L.
Overall Material Balance

and fuel consumption

The PYCOS kinetic simulation model is thoroughly proven, based on both pilot plant and operating plant experimental yield data. BD Energy Systems uses this model to provide complete firebox calculations considering radiant and convective heat transfer in conjunction with the cracking simulation, providing important parameters such as firing duty, process temperature, fireside temperature, and tube wall metal temperatures. In the following step, coking rates on the tube wall are calculated to assess coke deposition and run length. The PYCOS kinetic simulation model includes confirmation of parameters such as hydrogen balance and methane yield, which are key to the accuracy of ethylene yields.
SRC Super Radiant Coil Technology

Basic Principles

Furnace designers are continually working on the geometry and design of the radiant coil in order to improve heat transfer, reduce coking rate, improve olefin yields, and extend run-length.

In all ethylene plant cracking furnaces heat is transferred from the fire-box to the process fluid, through the tube wall, by three transport mechanisms: radiation, conduction, and convection. The heat transfer in conventional cylindrical tubes mainly combines three steps: a) radiation from the firebox to the outside surface of the tube, b) conduction through the tube metal wall, and c) convection from the inner tube wall to the process gas. Many enhancements have been proposed to improve the heat transfer performance using internally finned tubes or other surface profiles to increase the heat transfer surface and/or to reduce the inside film resistance. These enhancements focus on improving the convective heat transfer on the inside of the tube.

Super Radiant Coil (SRC) Technology Advantages:

- Increased heat transfer area / reduce volume
- Shortened residence time
- Enhanced heat transfer
- Reduced tube metal temperature
- Reduced coking rate / increased Run Length
- Reduced selectivity loss during the run length
- Avoidance of tube plugging

The Super Radiant Coil (SRC) cracking tube technology utilizes a larger diameter cracking tube equipped with an internal device. Heat transfer is enhanced with radiation from the inner surface of the outer tube to the internal device. This heat is then transferred to the cracking gas by convection. This effectively reduces the heat transferred to the cracking gas through the outer tube ID film. Combined with increased area of a larger diameter outer tube the flux rate through the film is drastically reduced, and consequently, the temperature drop across the film layer is also dramatically reduced. This reduces the degree of over-cracking and coke deposition on the inside of the tube. The metal temperature of the internal device is 80°C lower than the temperature of the outer tube, and the coke deposition over its surface is negligible.
Products

Steam Methane Reformers

Steam Methane Reformers remain our core market with our engineers having extensive experience encompassing process design, detailed design, and construction expertise of all major technology licensors. BD Energy Systems have executed more than 90 steam methane reformer projects which include lump-sum revamp and turn-key EPC projects and cover a full range of equipment supply and services:

- Engineering and capital supply of Steam Methane Reformers
- Furnace Relocations
- Catalyst tubes – Redesign and/or Replacement-In-kind
- Transferlines – Redesign and/or Replacement-In-kind (Water jacketed and Refractory lined)
- Convection Section Revamp – Design and Supply for higher overall thermal efficiency
- Combustion Air Preheaters – Engineering & Supply
- Selective Catalytic Reduction (SCR) System
- Selective Non-Catalytic Reduction (SNCR) System
- Low and Ultra-low NOx Burner Retrofits
- Tube Growth Monitor (TGM) System
- Firebox Tunnel replacement
  - Conventional Brick
  - Tunnel Optimal Performance Technology (TOP)
- Process and Feasibility Studies – Efficiency improvements & Capacity Increase
- Construction/Construction Advisory Services
- Turnaround Planning & Scheduling
- Start-Up & Commissioning Services
- Steam Methane Reformer Training
- Syngas Plant - Operations Review and Training
- Emergency Field Services and/or Supply of in-kind replacement of furnace coils or parts
- Engineering services – Redesign of firebox refractory, improvement of penthouse ventilation, etc.
Transfer Lines

BD Energy Systems over the years have executed engineering, supply and construction (EPC) of various types of Transfer lines for existing and new plants.

Transfer Line Variants:
- Dual Refractory Type
- Refractory Lined with External Water Jacket
- Refractory Lined with Metal Liner

Transfer Line Services:
- Detailed engineering package, including thermal design calculations
- Pipe wall thickness, stress calculations and pipe support design
- Mechanical flexibility analysis
- Refractory design and thickness calculations
- Fabrication and inspections in compliance with industry and local codes
- In-house licensed engineers to provide professional engineering checks and seals
- Installation of transfer lines
Our Selective Catalytic Reduction (SCR) systems feature industry-leading NOx reduction rates and efficiency capabilities that allow end users to confidently meet the increasingly strict requirements of regulating bodies worldwide.

Our systems utilize direct injection of anhydrous or aqueous ammonia into the flue gas upstream of a catalyst bed. The use of flow modulation devices such as Vortex Generating Mixers allow even distribution of reagent within the flue gas regardless of the complexity of the ducting, minimizing the amount of injection points and reducing the ammonia slip.

These highly variable systems can be installed as standalone units or upstream of an APH to guarantee that the performance of a given unit meets the specific needs of a project, regardless of application or reduction requirements. Each component to be provided is built to scale and extensively flow tested to ensure that after installation the unit will perform as designed.

With over a dozen SCR systems of different designs currently in operation at various petrochemical and refinery applications, BD Energy Systems is recognized as a leader in SCR equipment and technologies.

BD Energy Systems can provide SCR system using either aqueous or anhydrous ammonia. BD Energy Systems’ SCR system can reach up to 97% efficiency within a single reactor.
Advantages:
The lances are not inside of the furnace / flue gas duct and remain protected in vicinity of the wall. Retrofit easily possible.

Disadvantages:
• NH3 distribution is difficult to predict. For aqueous NH3 and urea solutions large quantities of water are required, leading to loss of energy.

Equipment Features
• Lower Capital Cost
• Small Plot Plan
• Rapid Installation
• No Expensive Catalyst to Replace
• High Reduction Rates of NOx in appropriate conditions

Products

Selective Non-Catalytic Reduction Units (SNCR)

The Selective Non-Catalytic Reduction system is a proven technology that converts NOx into N2 and H2O by injecting reagents at high temperature without the need of a catalyst. The system can achieve surprisingly high reduction rates without the use of additional catalyst provided the process offers the correct temperature range.

In an SNCR, the reagents, typically aqueous ammonia or urea, are injected directly into the existing flue gas duct or fire box using water as a carrier in order to cover the entire cross section in the correct temperature range.

The SNCR is the simplest and most economical form of NOx-reducing technology and is best suited for applications where a modest NOx reduction of 30-40% is required together with tight schedules and limited plot space where the flue gas temperatures are high enough (895°C-1100°C) to promote the reactions. The SNCR can be further used in combination with a SCR system where the ammonia slip is used in a downstream SCR bed, so called “slip barrier”.

SNCR is the reaction of ammonia releasing reduction agents (ammonia water or carbamin) with nitrogen monoxide (NO) and nitrogen dioxide (NO2) at temperatures of usually 850-1050°C directly into the firebox and according to the following overall reaction:

\[
\text{Urea} + 2 \text{NO} + \frac{1}{2} \text{O}_2 \rightarrow 2 \text{N}_2 + 3 \text{H}_2\text{O}
\]

OR

\[
2\text{NH}_3 + 2\text{NO} + \frac{1}{2}\text{O}_2 \rightarrow 2\text{N}_2 + 3\text{H}_2\text{O}
\]

Spraying nozzles are injecting the NH3-Water solution into the flue gas. The water will evaporate and leave the gaseous NH3 to react with the NOx.

Advantages:
The lances are not inside of the furnace / flue gas duct and remain protected in vicinity of the wall. Retrofit easily possible.

Disadvantages:
• NH3 distribution is difficult to predict. For aqueous NH3 and urea solutions large quantities of water are required, leading to loss of energy.
Down-fired steam methane reformers generate hot flue gas at the arch burners. Flue gas flows downward through the radiant section, heating catalyst-filled tubes. At the radiant section floor, flue gas passes through the collection-tunnel-system side-wall openings and out to the Convection Section for additional heat recovery. Ideally, flue gas flow is uniform throughout the radiant box to increase tube temperature uniformity and maximize tube life.

Conventional tunnels constrain the flue gas to non-uniform flow, which is correlated to non-uniform catalyst tube temperatures and to accelerated aging. As a result, some tubes last 20+ years, while other tubes fail after a relatively short time. Often, problem locations develop causing rapid degradation of tubes and their replacements.

BD Energy Systems’ new patent pending Tunnel Optimal Performance (TOP) flow controlling tunnel technology achieves near-uniform flue gas flow and near-uniform tube temperatures in the tunnel region. Rather than varying wall-opening locations to control flow, openings are uniformly distributed throughout the entire tunnel system and flow control is achieved by varying opening diameter.

As an illustration, conventional and TOP tunnel system flow rates per tunnel-opening are compared. Conventional flows vary by +/-25% of average, whereas TOP tunnel flows vary within +/-2%. Where buttresses and expansion gaps preclude opening placement, no-flow regions exacerbate flow maldistribution. In addition, the new design includes more columns of openings, so velocity at the tube base is lowered. The first installation of a TOP designed flow-control tunnel system is scheduled in 2017.
Products

Waste Heat Recovery Units

Waste Heat Recovery Units can be used to produce additional steam or to heat process fluids, fuel, or combustion air utilizing the heat in flue gas streams. As experts in fired equipment, BD Energy Systems utilizes the high volume of flue gases coming from furnaces, boilers, and gas turbines to improve the plant's overall efficiency.

BD Energy Systems scope of work includes performance studies, engineering design services, supply of waste heat recovery units along with construction advisory and/or construction management including commissioning and start-up services.

Once Through Steam Generators

BD Energy Systems has experience with Once Through Steam Generators and their associated skid equipment for heavy oil enhanced recovery. Our company offers the full range of services necessary for the design, supply, and installation of OTSGs including: Engineering Design & Study, Project Management, Subcontracting, Scheduling & Planning, Quality Assurance & Control, and Supervision & Advisory Services.
Fired Heaters

As specialists in various process heaters, BD Energy Systems services include the analysis, design, supply, and construction of fired heaters for a variety of applications, including:

- Atmospheric Furnaces
- Vacuum Distillation Unit Furnaces
- Hot Oil Heaters
- Platforming Heaters
- Propane Dehydrogenation Heaters (PDH)
- Coker Heaters
- Process Gas Heaters (such as DRI Reheat/Reforming furnaces)
- Once Through Steam Generators (OTSG)

With an interest in improved thermal efficiency and reduced emissions, new and existing plants alike are increasingly wanting to explore the inclusion or addition of Low or Ultra-low NOx burners, SCR systems, and Air Preheaters. BD Energy Systems, together with BD Heat Recovery, a leading supplier of compact Combustion Air Preheaters, provides a full range of solutions for both existing and new fired heater projects. BD Energy Systems capabilities in executing a turn-key project worldwide offers great advantage to clients who wants to execute lump sum projects.
Steam cracking of saturated hydrocarbons is the common means for producing ethylene and propylene for the petrochemical industry. At BD Energy Systems, our engineers have experience in the design, construction, and operation of a range of steam cracking furnace technologies.

Services Offered:
- Engineering and capital supply of Cracking furnaces
- Transfer Line Exchanger (TLE) Replacement
- Operational & Run-Length improvements
- Radiant & Convection Section Revamp
- Addition of Selective Catalytic Reduction (SCR) system
- Construction Advisory Services
- Turnaround Planning & Scheduling
- Start-Up & Commissioning Services
- Process and Feasibility Studies
- Basic Engineering Packages
The Tube Growth Monitor (TGM) system measures the thermal expansion of reformer tubes, giving accurate information regarding operating conditions relative to tube metal temperatures. Further, because the TGM system detects changes in reformer tube metal temperatures earlier than current instrumentation that provides feedback to the DCS, the TGM system alarm trips before dangerous levels are reached. With early detection this allows for effective protection against tube overheating incidents, provided operators respond appropriately to the information fed by the TGM to the DCS in a timely manner. The TGM temperature alarms are readily apparent to plant operators and will prompt immediate action.

Use of the TGM data management software allows the reformer operator to more effectively utilize collected data in optimizing the CAPEX plan and OPEX maintenance budget. When analyzing the data the TGM sends to the DCS and proprietary software, one can detect areas within the radiant box that are operating at higher than normal temperatures. In turn, this information can assist in determining which tubes require inspection or potential replacement before a turnaround begins, potentially saving thousands in expenses during turnaround activities alone and can likewise have a profound economic impact in the avoidance of tube failures during operation.

Benefits of TGM™

- Real-Time overheating condition detection
- Efficient tube replacement decisions using real data
- Allows for effective decision making based on real data
- Optimization of Reformer operation
- Easy detection of hot spots
- Optimization of inspection by focusing on areas identified as problems
- Highly visible to operators for reference
- Flexible design allows for installation on a variety of reformer designs
- Proprietary data storage and retrieval software
Tube Growth Monitor™

Safety, Reliability & Maintenance Budget

In developing maintenance budgets, it is highly important to work with the best data when making informed decisions. The TGM grants the operator a comprehensive overview of the heating in the reformer. This can aid in decisions relating to turn-around activities, catalyst tube replacement, spare tube requirements, insulation inspections, and other activities. Using the information gathered by the TGM, engineers can better identify areas of concern and areas that need immediate attention.

Catalyst tube replacement is the greatest area of impact on financial benefits of the TGM system. In standard practice, the catalyst tubes are inspected during turn-arounds. This can prove costly, as the conditions of the tubes remain uncertain prior to shutdown of the reformer. With data from the TGM system showing the operating conditions prior to shutdown, it becomes possible to identify areas of potential failure BEFORE turn-around activities commence. Turn-around inspection data can also be correlated to TGM data to "fine-tune" the results for accuracy, improving upon the advantages already provided by the TGM system.

Methodology

Currently, the remaining life of catalyst tubes is estimated using the following methods: turn-around inspection, operational incident replacement, end of life replacement, and examination of tube samples. All of these methods lack accuracy in representing the conditions of the tube population as a whole in the reformer. This inaccuracy can result in the reformer operator incurring very high and often unforeseen costs due to lost production time as a result of having to shut down the reformer to replace a ruptured tube. Overheating conditions capable of causing unforeseen troubles and costs can be mitigated with proper monitoring. Typical monitoring done in the DCS, controlled by algorithms and operators, is subjective and fallible and requires time for an experienced operator to interpret and make required adjustments to the operating system. In contrast, the TGM system’s active real-time monitoring adds a layer of protection, showing the current status of the reformer with almost no need for either interpretation or extensive experience.
Construction Advisory Services

Whether as part of an entire EPC package (new or revamp) or a turn-key project or as a stand-alone Furnace Construction Project, BD Energy Systems with its team of individuals having of 30+ years of, design and construction experience, is available to assist in completing construction activities in an efficient manner by developing the construction feasibility starting from:

Delivery Process:
- Engineering and Design phase
- Reviewing Logistics for transportation
- Fabrication of Modules
- Laydown Yards
- Crane review and set up with Engineered Lifts
- Coordination with other contractors and subcontractors at site performing work at the same time.

Scope of Delivery:
- Construction planning & scheduling
- Construction management
- Mobilization & Demobilization
- Preturnaround activity or Demolition
- Turnaround activity or Installation. All major construction elements required for mechanical completion of a furnace such as construction personnel, crafts, subcontractors, tools, trailers, cranes, specialty welders, riggers, NDE, refractory installation, etc.
Services

Furnace / Plant Relocations

BD Energy Systems, LLC is known for proven and successful relocation, upgrades and rebuilds on Steam Methane Reformers for Ammonia, Methanol, and Hydrogen plants.

The company has added experienced resources to be an Engineering, Procurement and Construction [EPC] company capable of dismantling, relocation, upgrade and rebuild services for entire Ammonia, Methanol, and Hydrogen plants.

The services include the know-how to assist and develop business case pro forma to compare grassroots versus relocated facilities. Our partnership approach focuses on providing information, tools and services to meet expectations and promote successful projects.

BD Energy Systems, LLC has the Frontend Loading [FEL 1,2,3] and Frontend Engineering Design [FEED] experience to develop, plan and execute projects on time and on budget. Current estimating personnel and models are up-to-date and have a low risk of project time and cost overruns.

With over 30+ years of individuals experience and over 90+ projects completed we have the demonstrated ability to assist you on your next relocation evaluation and project.

Relocation and upgrading of existing facilities offer a number of advantages over building new plants:

- Utilization of a known and proven design assures the plant’s production capabilities.
- Utilization of existing equipment that has been inspected and certified as Fit for Service can provide significant savings over new equipment.
- During the relocation and rebuild process an existing unit can be evaluated to incorporate known and proven upgrades for
  - Safety (New instrumentation to meet new codes, Evaluation of Process Safety Relief systems, new equipment and piping codes)
  - Environmental Emissions (to meet new permit limits)
  - Efficiency (Cost savings per unit of production)
  - Capacity (Increased Production)
- Faster time-frame to dismantle and relocate versus a new FEED design and long delivery of major equipment. This can translate into 1 to 2 ½ years of time savings – by completing and having production in operation. This speeds up the payback model and reduces the time period of paying construction interest.
BD Energy Systems works together with Mr. Steve Parrish of Parrish Process Services (part of BD Energy Systems, LLC) to generate a detailed overall plant Heat and Material Balance and bring in-depth experience on evaluating equipment performance in Syngas plants. This combination provides an edge to BD Energy Systems capabilities to provide invaluable recommendations to process and feasibility studies undertaken on existing plants.

Typical evaluations include:
- Detailed audit at plant site
- Evaluation of tramp air in the furnace
- Evaluation of the plant steam requirements
- Evaluation of the existing flue gas or waste heat recovery coming from the primary reformer and turbines
- Evaluation of the natural gas consumption in the front end of the plant
- Evaluation of the process air system
- Evaluation of CO2 removal
- Evaluation of refrigeration system
- Evaluation of cooling water balance
- Evaluation of the hydraulic profile and pressure drop through the plant
- Evaluation of NOx requirements
- Evaluation of the fans associated with the Steam Reformer for increased production or energy savings
- Evaluation of the design parameters to current operating conditions
Services

Process and Feasibility Studies

With more than 90 projects executed, BD Energy Systems stands as a world leader in evaluating options for future revamps, evaluating efficiency and energy savings, and improving reliability of the existing plants. Our proven records on such revamps indicate the ROI for efficiency and capacity increase in plants <2 years. BD Energy Systems will be pleased to provide references for the projects executed. Regarding large Fired Heaters in the refineries and gas plants where efficiency is a target to achieve, BD Energy Systems have extensive experience in evaluating the best option for efficiency increases by carrying out a process model for the design case and comparing it to the current operating case. Tramp air issues (if any) and any losses in efficiencies are evaluated by BD Energy Systems, together with BD Heat Recovery Division, Inc., a leading supplier of compact Combustion Air Preheaters to provide a full range of efficiency and capacity increase solutions for both existing and new fired heater projects.

Standard Equipment Evaluations:
- Primary Reformer
- Secondary Reformer
- Shift Reactors
- Boilers
- Heat Exchangers
- Heater
- Compressors
- Turbines
- Fans
- CO2 removal system
- Converter
- Evaluation of various leaks
- Kickback valves
- Relief valves
- Bypass valves
- BFW into condensate
- Steam directly to surface condenser
- Instrumentation inaccuracies
- Catalyst bed for temperatures
With individuals having over 30 years of experience in different Steam Methane Reformers technology designs, construction, and operations, BD Energy Systems is well-suited to provide detailed planning and scheduling for plants having major turnarounds on their Steam Reformer furnaces and where these furnaces are the critical paths in the turnarounds. BD Energy Systems provides a detailed planning schedule, taking into account other equipment involved in the plant turnaround. BD Energy Systems turnaround planning services includes pre-turnaround, turnaround, and post-turnaround activities. This includes sequence of arranging the furnace and other plant equipment in scope of work in the laydown area to execute in an efficient way based on experience & lessons learned for installation with minimal time to keep track on proposed schedule.

As specialists in this field, BD Energy Systems are able to provide clients with more in-depth knowledge of the requirements of a successful turnaround unique to steam methane reformers. Having experience with a wide range of furnace designs, BD Energy Systems can offer these services to provide a smooth turnaround, from new plants experiencing their first turnaround to older plants with obscure or outdated designs.
Field Services and Spares

BD Energy Systems are well placed in procuring of materials on an emergency basis from world-wide sourcing due to the magnitude of procurement we carry out on projects involving boilers, fired heaters and high temperature furnaces. Whether the items are radiant tubes, tube sheets, or boiler coils, we are well placed to execute the project with in-kind replacement or a better design. Additionally with BD Energy Systems experts placed world-wide, we are well placed to attend sites to assist in technical field services.