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Glasteel® Parts
and Services
Rochester, New York



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REACTOR SYSTEMS

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Reactor Systems



Pfaunder Reactor Systems

Pfaunder's Engineered Systems Group has been providing custom designed, skid-mounted reactor systems to the chemical, specialty chemical, pharmaceutical, microelectronic and medical device industries for over 50 years.

Designs of complete reactor-based systems range in scope from small pilot plants to complete production plants and encompass many types of reactions in batch or continuous mode. Each system is custom designed to the customer's process requirements. Systems are designed for specific processes or as multipurpose systems.

Pfaunder has specialized design expertise in areas such as single fluid reactor jacket heat transfer, mixing technology, mass transfer, reactor pH control, skid-mounted system layout and PLC control systems. Pfaunder's experience in all design disciplines results in fully integrated, properly functioning systems which provide batch repeatability and product integrity.

A complete reactor system design includes specification of ancillary equipment required for the application, such as heating and cooling systems, columns, reflux/condenser units, vacuum systems, raw material handling equipment, instrumentation, controls, for example.

Pfaunder's Engineered Systems Group also specializes in design of glass-lined steel evaporation and distillation column systems, conical dryer blender (CDB) systems, Single Fluid Heating/Cooling (SFH/C) systems and Wiped Film Evaporator (WFE) systems.



About the cover....

Hastelloy® & Glasteel®
Pilot Plant Reactor System for
the Chemical Industry



3000 Gallon Glasteel® & 316SS
Reactor Systems for the
Pharmaceutical Industry



Pilot Plant Scale to Production Scale



Wiped Film Evaporator (WFE)

1.2 - 420 square feet
Short-Path Distillation
High Vacuum (0.001 mbara)
High Viscosity
Low Residence Time
Alloy Construction



WFE System

Performance Guarantee
Vacuum System Expertise
Skid-Mounted
Completely Piped & Wired
PLC Control Systems



WFE Test Facility

WFE, Falling Film, Distillation Column
10 - 500 PPH Feed
0.001 Torr Vacuum
357°C Heating
PLC Controlled
Analytical Laboratory

Additional Pfaudler Products



Pilot Plant Scale Reactor

with VMX In-Line Drive
20-500 Gallon with Mixing Systems that Geometrically Scale-Up to Larger, Production Size Reactors



Glass Lined Pipe Valves & Fittings



Production Scale Reactor

20-18,000 Gallon with ProSol Mixing Systems Featuring the Cryo-Lock® Family of Impellers and Tailored Mixing Solutions for Every Process Need



Single Fluid Heating Cooling Systems

-100°C to 350°C
Performance Guarantee
Improve Batch Repeatability & Quality, Protect Glass-Lined Equipment



Heat Exchangers/Condensers

Reactive Metals: Tantalum, Niobium & Zirconium



Conical Dryer-Blenders

4-255 Cubic Feet Alloy & Glass-Lined Construction

Features & Benefits

Typical Reactor & Column System Components

Reactor
Column
Decanter
Condenser
Heat Exchanger
Vacuum System
Reflux Splitter
Single Fluid System
Vent Condenser

Instrumentation
PLC Controls
Control Panel
Feed Tanks
Feed Pumps
Product Tank
Product Pump
Scrubber System
Chiller

Benefits of Pfaudler Skid-Mounted Systems

- **Fixed Price for Complete System**

Firm price proposal allows for accurate customer project cost estimates and no surprise extra costs at the end of the project.

- **Single Source Responsibility**

Pfaudler's project manager oversees each project from design through start-up to provide a complete functional system. The responsibility for all engineering and fabrication disciplines including mechanical (piping and equipment), structural and instrument/electrical is managed by Pfaudler to ensure a fully integrated and properly functioning system.

- **Fast Track Projects**

Pfaudler's detailed project schedule keeps customers informed of their project's current status. Pfaudler's engineers have the experience and resources to deliver each system on time.

- **Guaranteed Performance**

Single-source guaranteed performance, based on pilot plant tests and/or computer simulation, minimizes risk.

- **Significantly Lower Installation Costs**

Project costs are reduced due to highly efficient shop labor versus field labor. Skid mounting minimizes the chance of project overruns and delays due to costly field changes.

- **Shortened Down-Time for Installation**

Highly efficient shop labor also shortens the project schedule and skids can usually be installed in the field with utilities connected in days instead of months.

- **Compact Design with Ease of Maintenance**

Extensive experience with skid-mounted system design enables Pfaudler to design a system that is compact, yet easy to operate and maintain.

- **Future Portability**

Skid-mounted systems can be easily moved from one location to another.

- **Validation IQ/OQ Assistance**

As-built documentation and drawings required for commissioning and validation are provided. Pfaudler's engineers can provide installation and start-up commissioning assistance for IQ/OQ.

Expertise

Equipment Manufacturing

- 100+ Years Experience – Glass-Lined & Alloy* Equipment Manufacturing
**(including Tantalum & Niobium and high alloys such as Hastelloy®)*

Reactor System Design & Fabrication

- 50+ Years Experience - Skid-Mounted Reactor Systems Design and Fabrication

Single Source Responsibility

- Engineering Studies, Process Engineering, Design, Procurement, Instruments & Controls, Fabrication, Installation, Start-Up, Training, Service, Parts

Process Engineering

- Heat Transfer, Mixing, Fluid Flow, Distillation/Evaporation, Vacuum Systems
- HYSIS for process simulation, AspenTech® for heat exchanger design, column packing design programs, proprietary Pfaudler reactor heat transfer simulation programs

Instrumentation & Controls

- Instruments (Flow, Pressure, Level, Temperature, Weight, pH), PLC Control Systems, Operator Interfaces, Local Controllers

Multi-Material Expertise

- Glasteel®, Fluoropolymers, Stainless Steel, Hastelloy®, Inconel®, Tantalum, Fiberglass, Plastics...

Start-up/Commissioning

IQ/OQ/PQ Validation Support

Guaranteed System Performance

System Documentation

- Basis of Design
- Process Description
- Operating Instructions
- Utility Requirements
- Installation Instructions
- Equipment Specifications & U-1 Reports
- Equipment Drawings
- Equipment IOM Manuals
- Equipment Spare Parts Information
- Piping & Instrumentation Diagrams
- Piping & Instrument Diagram Legend
- Process Flow Diagram
- Equipment Layout
- Structural Steel
- Instrument Specifications
- Instrument Drawings
- Instrument IOM Manuals
- Instrument Spare Parts Information
- Piping Specifications
- Paint Specifications
- PLC Program
- System Drawings
- Piping Orthographic
- Electrical
- Instrument Loop
- Control Panel
- One-Line Electrical

All drawings available as AutoCAD® DWG or DXF files

Fabrication Details

Equipment

- Reactors, mixers, tanks, pumps, distillation columns, condensers, decanters, receivers, heat exchangers, vacuum systems, scrubbers.
- Pressure vessels designed per ASME code.
- Constructed of proper materials of construction for chemical resistance.

Structural Steel Skid

- Skids are structurally analyzed for earthquake, wind, live and lifting loads.
- Skids are galvanized, painted or are polished stainless steel for corrosion protection.
- Handrails, ladders and/or stairs are provided for elevated operating platforms.
- Galvanized grating or deck plate is provided on operating platforms.
- Removable grating sections are included for equipment removal or maintenance.
- Integral monorail hoist or jib crane for maintenance can be provided as an option.

Piping

- Process piping is flanged or welded to minimize leak potential.
- Common utility users are piped to a single header and skid tie point.
- All process and utility pipe lines are piped to tie points at the skid edge.
- System is hydrotested after fabrication to ensure leak free start-up.
- All carbon steel piping is painted.
- All piping is properly supported on the skid.

Instrumental/Electrical

- Extensive experience with instrument/electrical design for hazardous process areas.
- All instrument/electrical design meets NFPA and NEC codes.
- All instruments on the skid are wired in galvanized conduit to either a junction box or control panel mounted on the skid.
- All instruments are calibrated and control valve actions checked prior to shipment.

Projects

Example Reactor Systems....



Glasteel® Pilot Plant
Column/Reactor System



50 Gallon Reactor System
Glass-Lined Stainless Steel



300 Gallon Glasteel® Reactor System



Pilot Plant Reactor System
(2) 50 Gallon Glasteel® &
(2) 50 Gallon SS Reactors with Lift Stands



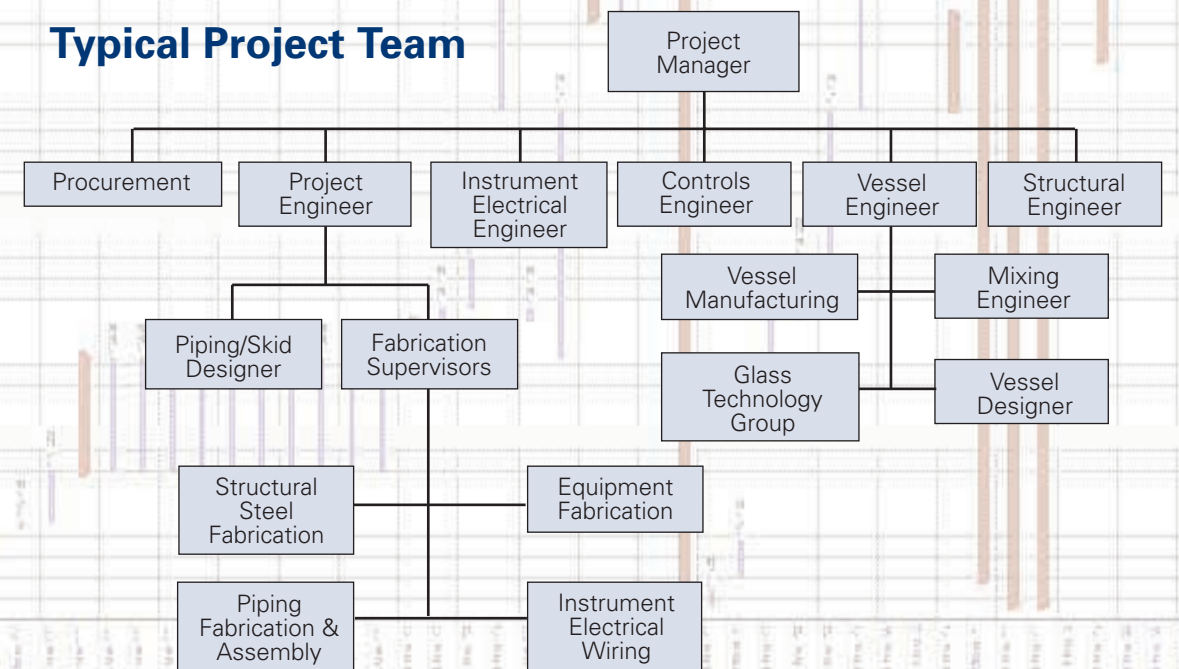
500 Gallon Glasteel®
Reactor System

Project Management

Project Management

Pfaudler's project manager serves as a single focal point for all aspects of the project including engineering, design, procurement, fabrication, and start-up. This ensures that all components are designed correctly and operate as a fully integrated, properly functioning system. This tight project control results in lower costs, shorter schedules, on-time deliveries and faster, easier start-up.

Typical Project Team



Capabilities

Process Design

- Piping & Instrumentation Diagram & Process Flow Diagram development
- Complete system design provides integration of all components
- Options evaluated for the most efficient and cost-effective solution
- Proper materials of construction selected for corrosion resistance and cost control
- Computer simulation for optimizing operating conditions & equipment configurations
- Equipment sizing (columns, condensers, exchangers, pumps, vacuum systems)
- Pipe line sizing and specifications
- HAZOPs and/or safety reviews



PLC Controls

- Pre-Programmed, Mounted & Wired in a Panel
- Essentially Unlimited Analog & Digital Input & Output
- Networking Capabilities for Connections to SCADA System
- On-Line & Off-Line & Remote Programming
- Integral PID Control Loops
- Wiring Diagrams, Panel Layouts, Instrument Loop Diagrams, Software Program and Hardware Specifications

Complete documentation provided including Wiring Diagrams, Panel Layouts, Instrument Loop Diagrams, Software Program and Hardware Specifications.

Engineering Studies

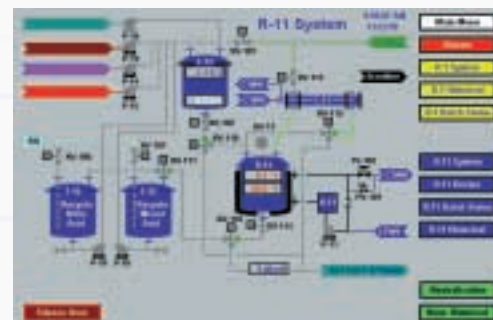
Pfaunder engineers will complete preliminary engineering and investigate design options to provide the most efficient and cost effective design for your system.

The following preliminary documentation is provided with the study:

- Piping and Instrumentation Diagram
- Flow Diagram
- Equipment Index
- Instrument Index
- Utility Requirements
- Equipment Layout
- Firm Price Proposal

PC Operator Interface (HMI)

- Windows Compatible SCADA/HMI Software
- Historical Trending
- Easy Downloading of Data into Reports and Batch Records
- Pre-Programmed for Multiple Batch "Recipes"



Silence Horn

Testing Services

State-of-the-art Pilot Plant Test facility located in Rochester, NY. Process parameters are controlled by a PLC system. A PC-based HMI provides current operating conditions, trend screens and logs operating data for downloading into a data base.



Glasteel® Reactor System

- 30 gallon reactor
- Packed column
- Condenser
- Reflux splitter
- Receiver
- Liquid ring vacuum pump
- Single Fluid Heating/Cooling System
- PLC controls with touch screen
- Class I, Division 2 rated
- Full vacuum to 150 psig pressure
- -20 to + 500°F temperature
- Available for extended test work at customer's plant site

Glasteel® Conical Dryer Blender System

- A rotary double-inverted cone design ensures thorough mixing and fast, gentle drying of heat sensitive products
- 2.6 cubic feet operating capacity
- Filter plate can be installed to allow washing of solids prior to drying
- Vacuum levels down to 1 mmHG absolute
- Steam, hot oil or tempered water heating
- Comprehensive test report
- Scale up to production models can be predicted
- Available for extended test work at customer's plant site

