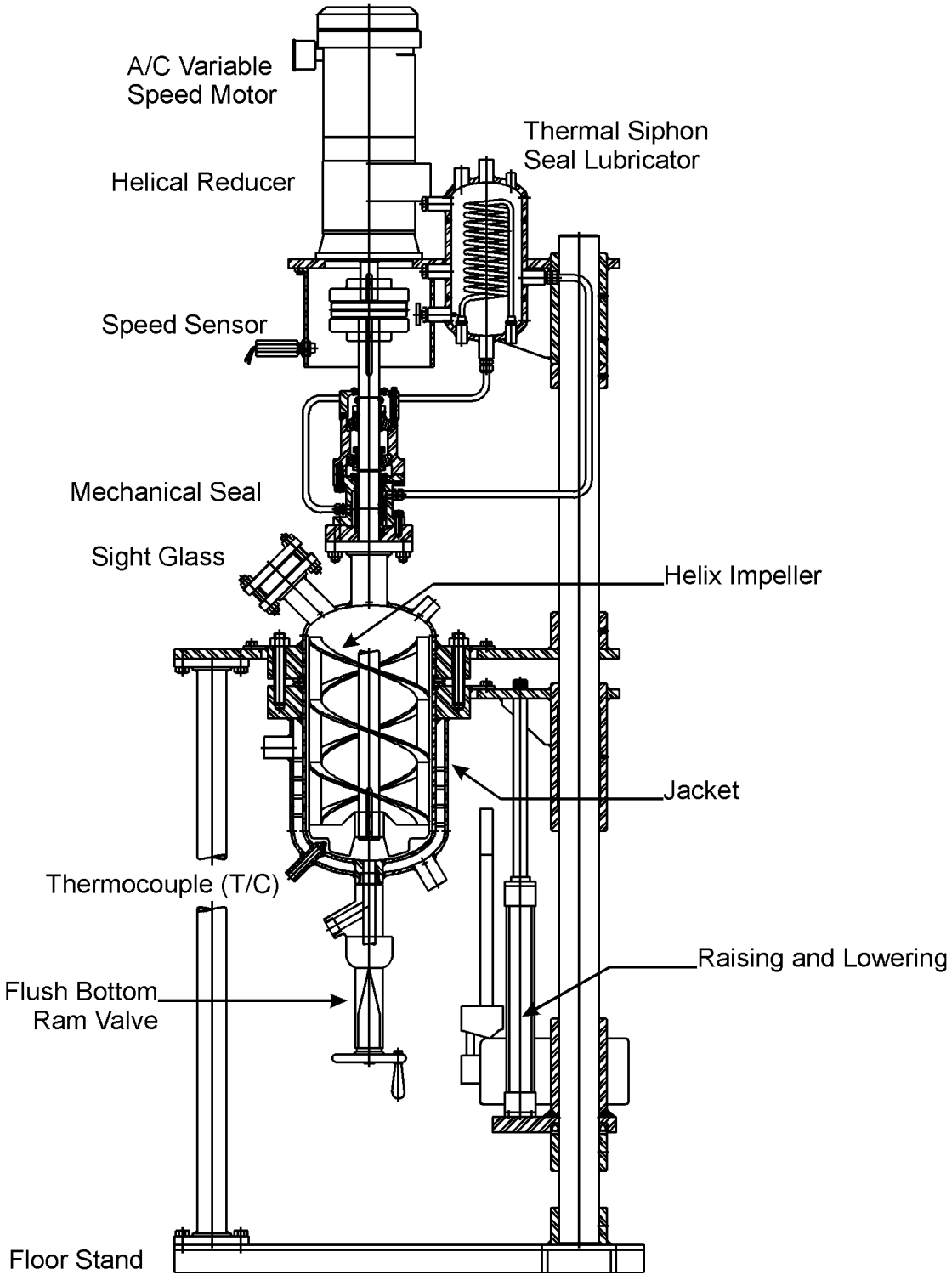
International Reactor Corporation

Bulletin 1100

Standard and Custom Reactors
for the Chemical Process Industries


A/C Variable
Speed Motor
Thermal Siphon
Seal Lubricator
Helical Reducer
Speed Sensor
Mechanical Seal
Sight Glass
Helix Impeller
Jacket
Thermocouple (T/C)
Raising and Lowering
Flush Bottom
Ram Valve
Floor Stand

International Reactor Corporation

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Pre-engineered Standard Components

Combinations of standard components create custom reactors. Pressure vessels, raising and lowering stands, agitator drives, impeller options, shaft seals and accessories provide capabilities for all types of chemical process applications. Even special reactors and process systems start with these pre-engineered components.

Maximum flexibility of features with minimum complexity and expense is a benefit of complete pre-engineering. Agitator sizes are pre-determined for optimum performance and mechanical integrity. The problems are eliminated, without restricting possibilities.

Mini-Reactors

500 ml to 2 liter Sizes
Pressure to 75 psig (glass) or 100 psig (steel)
Design Temperature, 450°F
Stainless Steel and Glass
Turbine, Anchor, and Helix Impellers
Variable Speed Motors
Accessories

Custom Reactors

Special Vessels: cone bottoms, etc.
Pressures to 3000 psig.
Temperatures from -20°F to 650°F and beyond
Alloys: Hastelloy, nickel, Inconel, Monel, Cb-20, etc.
Special Impellers
Vessel Tilt Mechanisms
Sanitary Connections

Standard Reactors

1 to 100 gallon Sizes
Full Vacuum to 1000 psig.
Design Temperature, 500°F
Stainless Steel and Carbon Steel
ASME Code "U" Stamp
Turbine, Anchor, and Helix Impellers
Variable Speed Motors
Accessories

Reactor Systems

Temperature Control: Electric, Hot Oil, Steam, Hot Water, Cooling
Condensation: Reflux, Take-off, Column, Receivers
Material Feed/Transfer
Weight Control

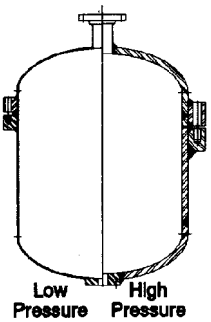
Pressure Vessels

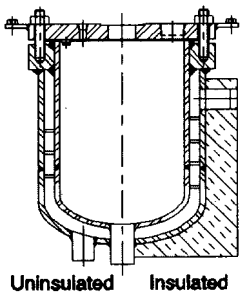
The reactor vessel is the main component of a pre-engineered package. Mini-reactor vessels are available in three nominal sizes: 500 ml, 1 liter and 2 liter; with designs for 100 psig at 450°F for stainless steel and 75, 50, and 30 psig at 450°F for the respective glass vessels. All top heads have full opening, bolted closures with the maximum possible threaded port openings for process requirements.

Standard reactor vessels are available in eight nominal sizes: 1, 2, 5, 10, 20, 30, 50 and 100 gallons; with different designs for 150, 300, 600 and 1,000 psig internal pressures. All top heads have full opening, bolted closures with adequate flanged and threaded openings for process requirements. Vessels are designed, manufactured, and inspected to meet the requirements of the ASME Boiler and Pressure Vessel Code.

Non-Jacketed

Non-jacketed vessels are used for applications that require limited heating or cooling, or with electric heat. Material thickness is determined by design pressure, temperature rating and materials of construction.



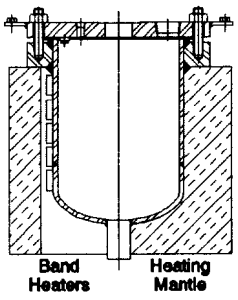


Jacketed

An external jacket is like a second pressure vessel surrounding the reactor on the sides and bottom. A spiral baffle channels heat transfer fluid through the jacket for efficient heating or cooling of the reactor contents. Insulation is also available.

Electric Heat

Electric heat can be provided by either a self-contained mantle or with band heaters and insulation. Insulation may be sealed in a stainless sheath for easy cleaning.

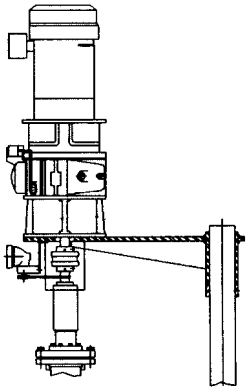


Agitator Drives

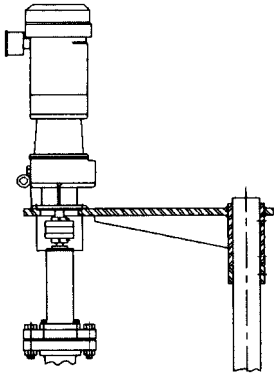
The agitation system usually consists of an agitator drive, a shaft seal and an impeller with shaft assembly. The agitator drive may include a motor, gear reducer and control components. The motor is typically electric and often explosion proof, although air motors or hydraulics may be used. The gear reducer converts motor speeds to more useful low speeds for agitation.

Variable speed is often essential to investigate the effects of speed on process performance and to adapt to fluid property changes.

Speed adjustment may be handled electronically with either variable frequency, alternating current or variable voltage, direct current controls and motors. Mechanical speed controls provide variable speed in combination with speed reduction and torque increase.

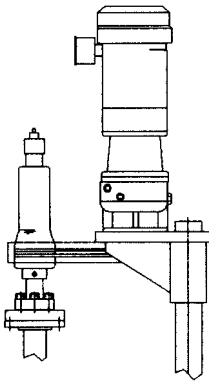


Mechanical Variable Speed Mechanical Seal



Electronic Variable Speed Mechanical Seal

The choice of drive options depends in part on the application. Electronic drives are usually lower cost with excellent features, including speed and load displays integral to the controls. Mechanical variable speed drives have advantages in high viscosity applications with high torque and low speed requirements.

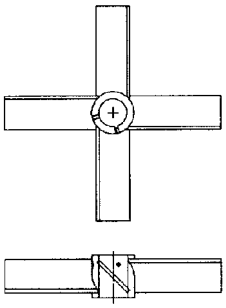


Electronic Variable Speed Magnetic Drive

Agitators

Turbine

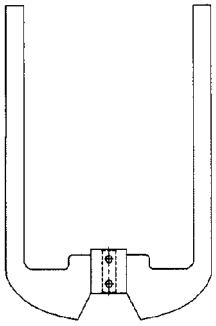
Turbine impellers are the most versatile and cost effective agitators for all but very high viscosity fluids and special applications.



A simple four-blade, pitched-blade turbine provides intense or moderate agitation, with excellent fluid motion throughout the reactor.

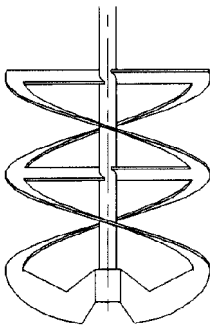
Anchor

An anchor impeller has mixed performance characteristics, with turbine-like simplicity and close-clearance wall motion. Intermediate viscosity fluids are sometimes difficult to control with a turbine in a small reactor. Temperature or viscosity changes near the wall may be better controlled with an anchor.



Helix

The helix impeller provides the greatest capability for the processing of high viscosity fluids. The blades sweep both axially and tangentially at the reactor wall. The helix provides both local and bulk fluid motion for excellent batch uniformity and heat transfer.



Special manufacturing techniques assure uniform pitch and close clearances for high performance and accurate scalability to larger reactors.

Special Impellers

Other turbine styles and special impellers, such as combination anchor and helix or a helix with auger, are available for nearly any application.

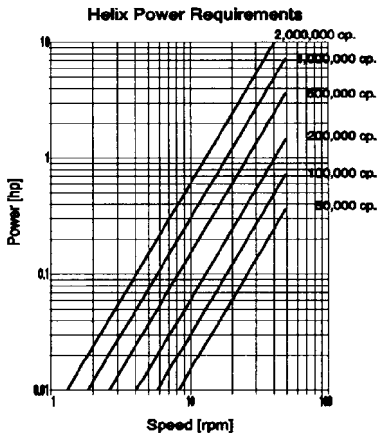
Mixing Technology

An essential part of the initial design of a reactor is the determination of basic agitator performance. Our reactor designs are backed by years of experience with all aspects of agitation technology and equipment design. This expertise helps assure successful reactors.

Impeller Power

Impeller power requirements depend on basic impeller geometry, application of the impeller within the vessel, fluid properties and operating characteristics. Many of these characteristics can be reduced to empirical correlations.

The application of correlations to equipment parameters are an essential part of the pre-engineering process. Estimates of impeller power and performance are available for all standard reactors, and can be developed for most custom applications.



Heat Transfer

Process performance often depends on good heat transfer design. Although heat transfer is more difficult to predict than impeller power, we can use heat transfer correlations to estimate heating and cooling characteristics of a reactor.

Vessel Design

Computerized programs are used to design the vessel with regard to parameters such as liquid level height to tank diameter ratio and vapor space (flooded volume) for not only the R&D/pilot plant reactor but also so that it is suitable for scale-up to production.

Shaft Design

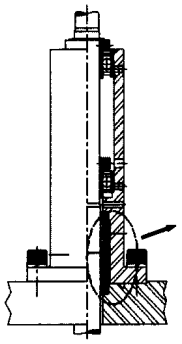
Computerized programs are used for shaft design with respect to critical speed (ratio of operating speed to 1st natural frequency), shaft deflection, torque, bending and fatigue.

Shaft Seals

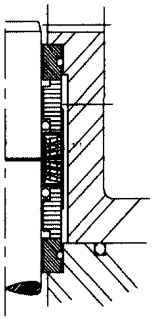
Mechanical Seals

The seal on the rotating agitator shaft is critical to the integrity of the pressure vessel. For small reactors, a mechanical seal provides reliable performance at a reasonable cost. The actual seal is between the very flat faces of a rotating washer and a stationary seat. A double outside seal, with seal fluid providing lubrication, cooling and a positive pressure against the reactor contents, is our standard.

Mechanical seals can be designed to fit in a compact housing to minimize interference with other fittings on the vessel head. A solid shaft provides maximum torque transmission and bending resistance to the shaft and impeller system.



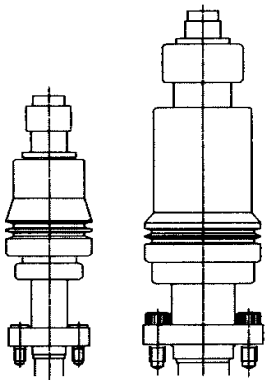
Seal Assembly



Seal Detail

Single, dry-running mechanical seals are a less expensive option for some lower pressure applications.

Magnetic Drives



A magnetic drive provides a positive seal between the vessel and the surroundings. The rotary motion of the drive is transmitted to the agitator shaft by a magnetic coupling, without rotating seal components. The magnetic drive eliminates wear on rotating seal parts and provides a positive static seal.

Other seal options are available: including stuffing box and lip seals for low pressures.

Auxiliaries

Hot Oil Systems

An integral part of a reactor system with a jacketed vessel is the heat transfer fluid and heating equipment. Process development applications require both versatility and performance. Hot oil systems, with excess capacity for maximum process performance, also have cooling capabilities to control temperatures.

Tempered Water Systems

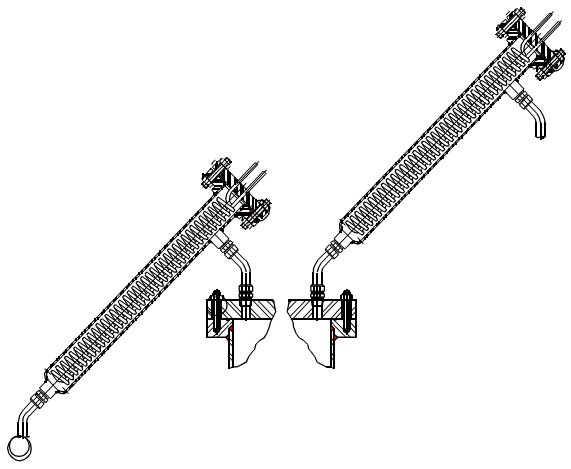
When steam is available and lower temperatures are needed, a closed-loop, recirculating, direct steam injector with split range control valves can be utilized.

Condensation Systems

Standards for modular components consisting of:

- condensers
- packed columns
- receivers
- liquid separators
- selection valving
- related piping

are available to customize the condensation/ distillation process.



Condensers may be used to remove or recover overhead vapors. Condensation may recover vaporized reactants, products or solvents, or the return of liquid as reflux. Coil in shell condensers with removable coils can be mounted for recovery or reflux operation.

Systems Engineering

Reactor Systems

Systems are a natural extension from combinations of components. Control, recording, and data acquisition capabilities can be added to any reactor with appropriate accessories. Complete pilot plants can be designed and built around a central reactor.

When a basic reactor is expanded to include:
- sensors
- process transmitters
- signal converters
- controllers
- final control elements

in a variety of analog/digital configurations and combined with the available auxiliary options, a system has been developed.

Other control elements that can be added include:
- alarms
- recording/data logging
- flow control
- level control
- weight control
- pressure control
- agitator control

Turnkey Reactors

Smaller reactors can be supplied mounted on casters complete with motor starter, etc. with a cord connector for portable use.

Larger reactors/small systems can be supplied skid mounted so that installation only involves utility connections.

Larger systems can be designed for modular installation with interconnection supervision supplied by International Reactor Corporation.

Computer Aided Engineering

Computer aided engineering, design and drafting are all part of the total equipment design process. The use of computers permits the rapid evaluation of equipment alternatives. The alternatives can be optimized and high performance designs assured. Computer generated drawings assure accuracy and rapid response to orders and approvals. Computerized techniques also help to price equipment based on actual costs.

Accessories

Torque Measurement

An important aspect of process development and mixing research is impeller power. Although general correlations exist for power requirements in simple liquids with known properties, process development may involve property determination and unusual liquids. A torque transducer in the agitator shaft can provide essential information about fluid behavior or mixing characteristics. A less expensive option is to use a power sensor with a tachometer.

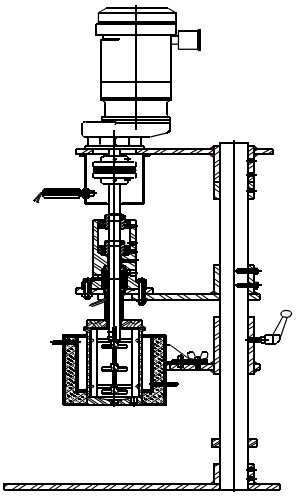
Seal Lubricators

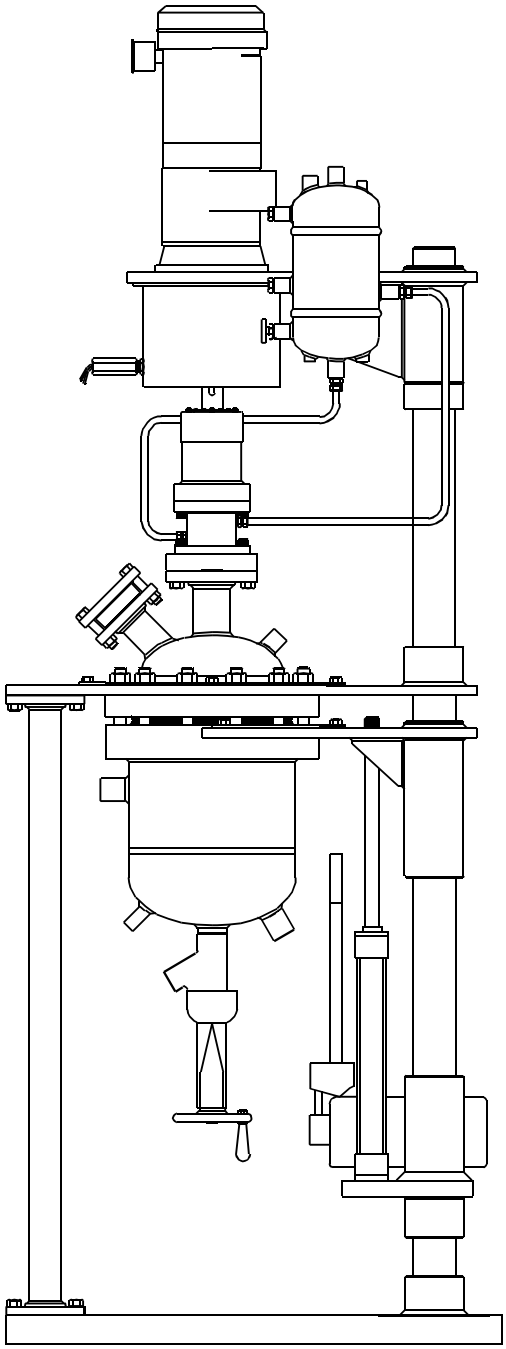
A thermal siphon seal lubricator is an external water cooled pressurized reservoir which works on the principle of thermal siphoning as a function of differential temperature of the barrier fluid.

The recirculating seal lubricator, with heat exchanger, provides a neutral fluid at a uniform pressure slightly higher than the mechanical seal chamber for lubricating and cooling of the seal faces.

Other Accessories

- Tachometers
- Thermometers & Thermocouples
- Pressure Gauges
- Valves - Charge and Drain
- Pressure Relief Valves
- Rupture Disks
- Dip Tubes
- Sparge Rings
- Cooling Coil
- Sight Glasses/Lights





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