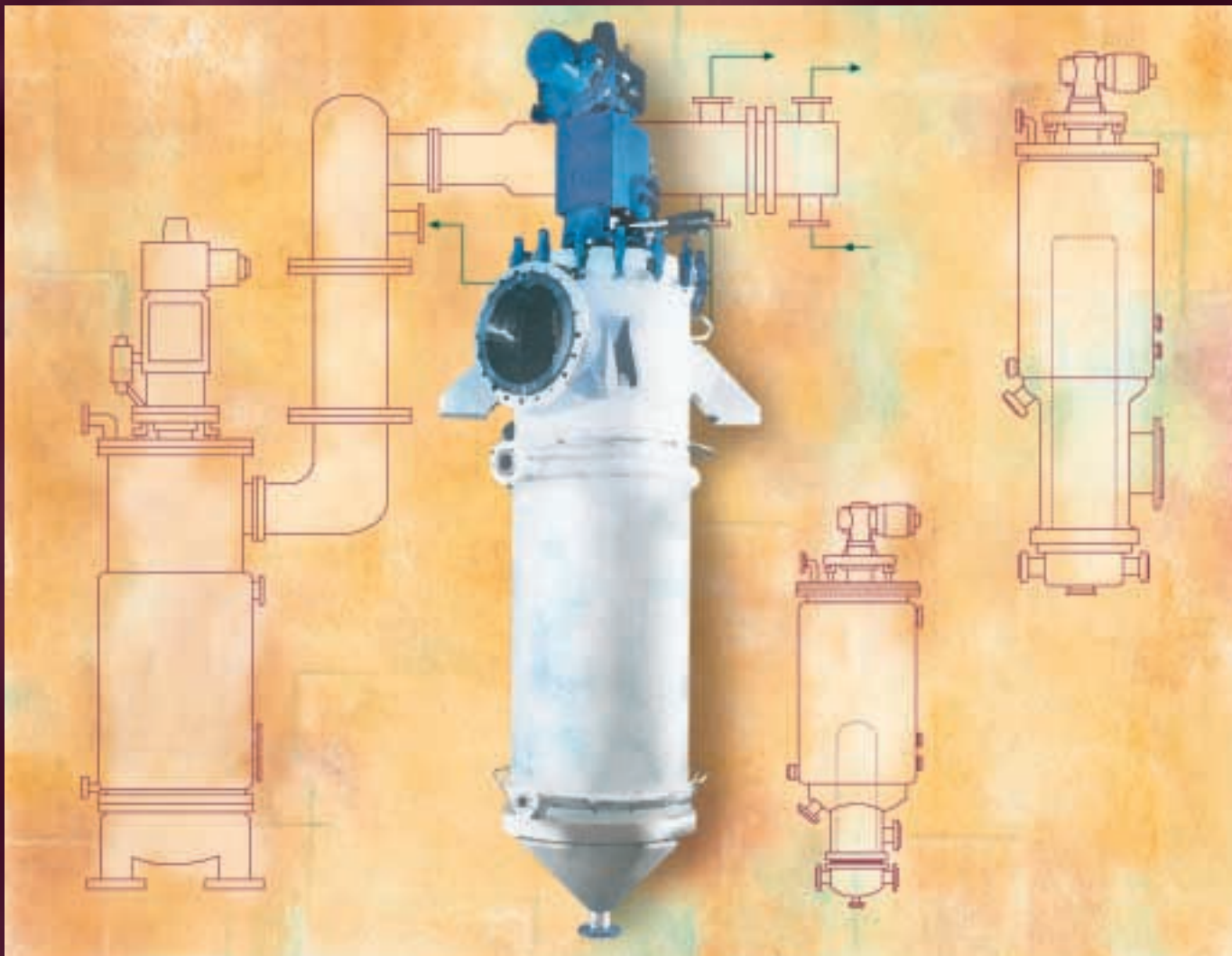
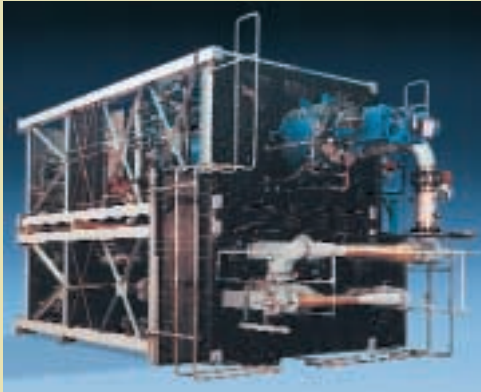


Wiped Film Evaporator – WFE





103.4 sq. ft. WFE system, assembled and shipped horizontally



Multi-stage WFE skid-mounted system



Computer system at our test facility to control and monitor process parameters



Skid-mounted 8.8 sq. ft. WFE for solvent recovery



Special multi-product WFE with dimpled jacket



The WFE test facility can handle a wide variety of products

Process Technology

In essence, the Pfaudler Wiped Film Evaporator (WFE) is designed to continuously separate volatile compounds by introducing a mechanically agitated, thin film of feed material to a heated surface. The short residence time allows for efficient and reliable processing of a wide variety of high-boiling, heat-sensitive and/or viscous products.

High Reliability/Low Maintenance

The WFE has many well-proven mechanical features that assure years of reliable service. Some of these are the special entrainment separators, large internal condensers for high vacuum (short-path) operation, the elimination of a bottom steady bearing for the rotor, low motor horsepower and easy rotor removal and assembly for inspection and/or cleaning.

Wiped Film Evaporator (WFE) Systems

Pfaudler's Engineered Systems Group offers single-source responsibility for systems that will assure the proper and efficient operation of the WFE. Our highly experienced and creative project engineers will work closely with you to solve your process problems and take total responsibility for the performance of the WFE System.

Test Facility/Process Guarantees

Our WFE Test Facility, located in Rochester, NY, can process your product to demonstrate the utility of the WFE. Computer-controlled operating parameters allow us to handle many different product characteristics and provide data for a comprehensive report of the test results. Pfaudler can provide a process guarantee based on these test results that will ensure commercial success for you.

OPERATION OF THE WIPED FILM EVAPORATOR

The WFE operating features, such as high vacuum (short-path) distillation, short residence time and a highly agitated thin film of feed product on a heated surface, makes it ideally suited to handle a wide range of heat-sensitive, high-boiling and viscous materials.

Drive/motor and distributor/entrainment separator assembly **1**.

Feed enters at the top through the feed inlet nozzle **2**.

Rotating distributor plate disperses the feed evenly at the top of the heated shell **3**.

Slotted wiper blades spread, agitate and move the feed down and off the heated shell in seconds **4**.

Heat transfer under vacuum conditions, introduced by a heated jacket **5** surrounding the shell, causes volatile compounds to evaporate at reduced temperatures.

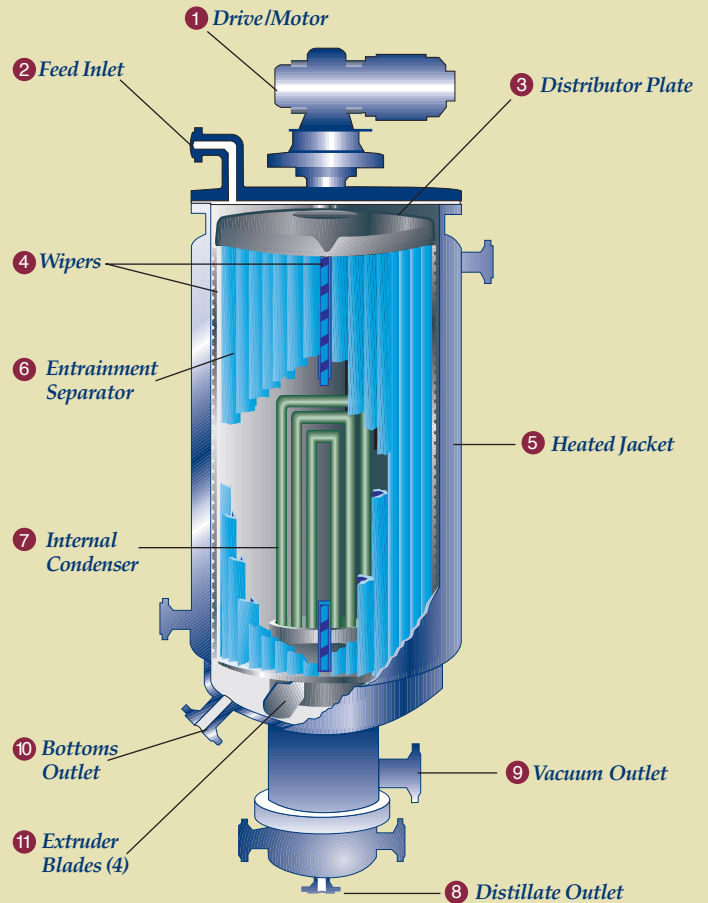
Vapor passes through the rotating entrainment separator **6** and condenses on the internal condenser **7** and flows out of the distillate nozzle **8**.

Entrained droplets, impinging on the entrainment separator, are thrown back to the heated shell by centrifugal force.

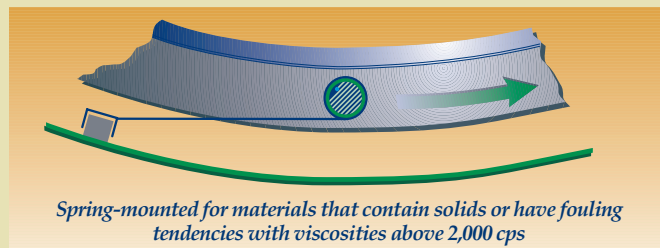
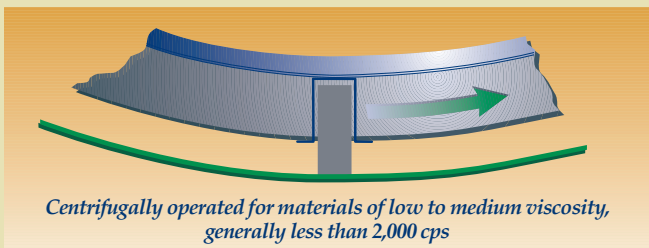
Non-condensibles flow through the WFE and exit via the vacuum outlet nozzle **9**.

The remaining bottoms stream exits the bottoms outlet nozzle **10**.

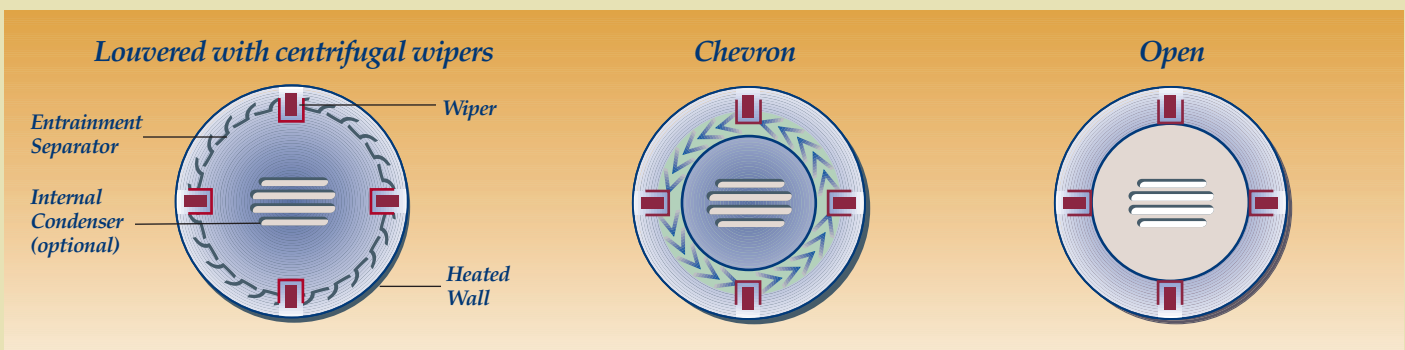
For viscous bottoms, optional extruder blades mechanically force the bottoms stream out of the WFE **11**.



Wiper Blade Designs (FDA Acceptable)



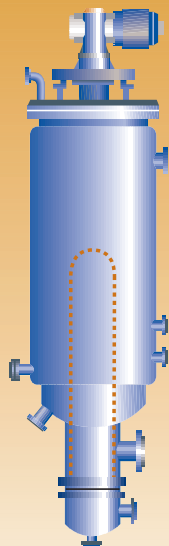
Entrainment Separator Designs (Top View)



DESIGNS FOR A WIDE VARIETY OF APPLICATIONS

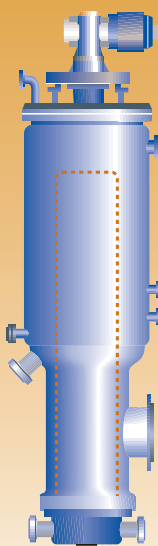
Short Path with Internal Condenser

Standard Vacuum



**Operating pressures
to 0.5 torr**

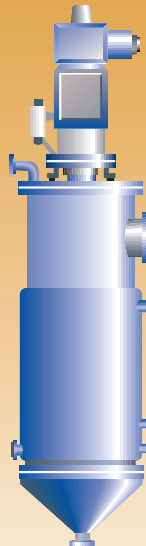
High Vacuum (Short Path)



**Operating pressures
to 0.001 torr**

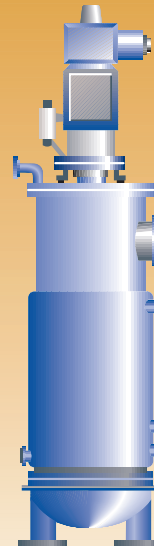
Top Vapor Outlet (Counter-current flow)

Top Vapor Outlet



**Operating pressures
to 1.0 torr**

High Viscosity



**Designed to handle high
viscosity products over
200,000 cps**

Unique WFE Design Advantages

Slotted Wiper Blades

Wiper blades effectively move the product down and off the heated wall in a matter of seconds.

Low Rotor Speed

High rotor speeds are not necessary. The high heat transfer coefficient, provided by the wipers, requires only a 97 rpm rotor speed on our 103.4 sq. ft. WFE. Lower speeds extend the service life of seals and other components.

No Bottom Steady Bearing

Unlike a typical fixed clearance blade design, the WFE rotor is supported entirely from the top drive and bearing assembly, all mounted to the main shell flange.

Low Horsepower Requirements

The low rotor speed significantly reduces horsepower requirements. The 103.4 sq. ft. WFE uses only a 7.5 hp motor. This will prove to be a significant savings when compared to the same size fixed clearance blade evaporator.

Expandable WFE Sizes

Additional thermal sections, for some models, can be installed above the original thermal section at your plant site to provide increased capacity.

Easy Rotor Removal

Any size WFE rotor can be removed and reinstalled in 30 minutes or less because there is no bottom bearing. Disconnect the motor leads, feed line and clamps, then lift the rotor out of the shell as one complete assembly.

Internal Condenser

WFEs with internal condensers minimize pressure drop between the heat transfer shell and the condenser. The high vacuum (short-path) condenser surface areas are approximately three times the jacketed heat area ensuring condensation and sub-cooling.

Efficient Entrainment Separators

Specially designed full-length entrainment separators for standard and high vacuum operation effectively remove entrained droplets from the vapor stream and improve the purity of the distillate product.

High Vacuum Operation

Our high vacuum design WFE can operate to vacuums as low as one micron (0.001 torr).

Bottoms Outlet

For viscous materials with high melting bottoms, the bottoms trough can be heated and extruder blades can be utilized to mechanically aid the discharge of bottoms materials.

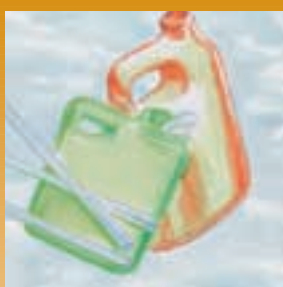
PRODUCT APPLICATIONS FOR THE WIPED FILM EVAPORATOR

The WFE is ideally suited to process hard-to-handle, heat-sensitive and viscous materials. These are just some of the many and varied products that are processed by WFEs.



Chemicals

Acid chlorides, amino-acid, bisphenol, caprolactam, chlorinated hydrocarbons, cumene hydrogen peroxide, acetic acid, dimethyl sulfoxide, dioctyl phthalate, dyes, ethanolamines, glycols, insecticides, petroleum sulfonates, plasticizers, urea, solvents, acrylates, isocyanates, herbicides, EPDM silicone oils



Polymers & Resins

Epoxy resins, latex, synthetic rubber, polystyrene, phenolic resins, adhesives, resin co-polymers, silicone polymers, urethane pre-polymers, styrene monomer



Pharmaceuticals

Amino acids, alkaloids, ascorbic acid, biochemicals, penicillin, Vitamin E, Vitamin C, steroid derivatives



Fats & Oils

Cotton seed oil, dimer and trimer acids, edible oils, fatty acids, glycerides, glycerin, mineral oils, paraffin, rosin acids, tall oil, fatty amides, palm oil



Food

Tomato paste, fruit nectars, chicken stock, fish protein, vanillin, corn syrup, whey, fruit purees, lecithin, marigold extract, milk solids



Other

Coal tar products, dye-stuffs, fire retardants, rubber coatings, paint wash solvents, lube oils, pitch petroleum wax, pyrethrum, PTA, catalyst concentration (2-EH)

The WFE is Designed to Carry Out These Operations

- *Deodorization*
- *Distilling*
- *Concentration*
- *Reboiling*
- *Solvent Recovery*
- *Stripping*

WIPED FILM EVAPORATOR TEST FACILITY

A Variety of Testing Options

Pfaunder's test facility, located in Rochester, NY, contains a variety of equipment that can be configured for virtually any application for test purposes or small toll runs.

WFEs can be run in series, a WFE can follow a falling film evaporator, a WFE can be used as a reboiler to a distillation column, or any other combination of the above equipment can be accommodated.

Available equipment includes:

- *Multiple Wiped Film Evaporators*
- *Falling Film Evaporator*
- *Distillation column*
- *Jacketed/agitated feed tank*
- *Hot oil system*
- *Steam boiler*
- *Vacuum blower*
- *Mechanical vacuum pump*
- *Vacuum vapor booster pump*
- *Tempered water circulation loops*
- *Heat exchangers for condensers, coolers, and heaters*



WFE Laboratory



Process area at our test facility



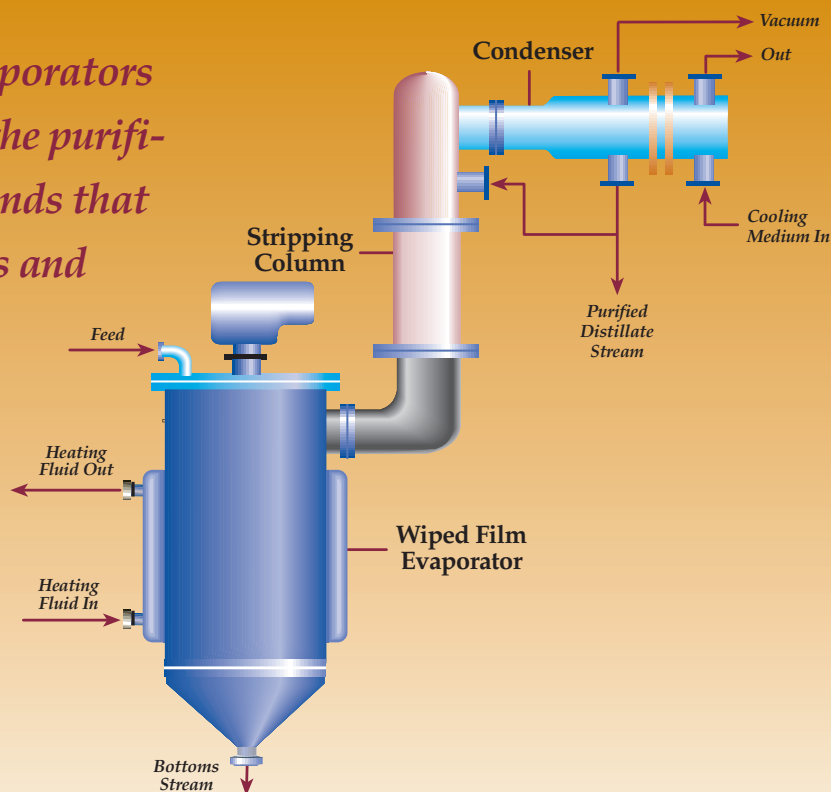
Control room

The entire system is highly instrumented. The majority of process parameters are controlled by a PLC system. The control system can be accessed through a DMACS operator interface on a PC located in the control room or through local operator interface screens located in the process area. All operating conditions are data logged and trends can be viewed on any of the operator stations.

Operating capabilities include:

- *50 to 1,000 lbs. per hour of feed material*
- *Vacuums to 0.001 torr*
- *Heating to 675° F.*

Pfaunder Wiped Film Evaporators are successfully used for the purification of organic compounds that are heat sensitive, viscous and have high boiling points.



WFE Systems Experience

The key to the successful use of the WFE is the proper selection and installation of ancillary equipment and instrumentation required to allow the WFE to operate at its full capability.

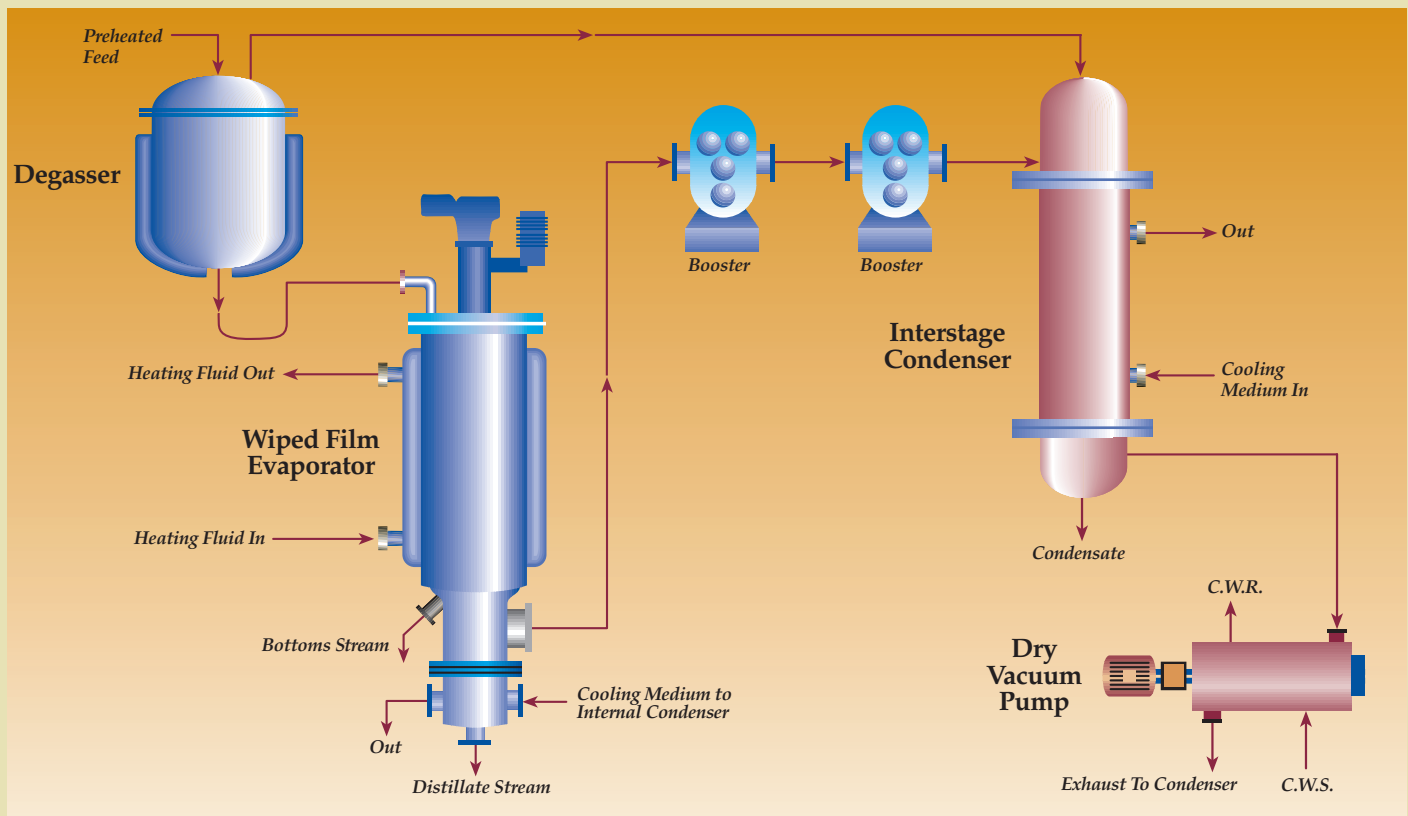
For more than 40 years, Pfaunder's Engineered Systems Group has been designing and supplying comprehensive WFE Systems to solve different processing problems for domestic and international clientele. Systems can vary in scope from simple to complex, multi-stage WFE Systems that include the following:

- Feed degasser
- Multiple WFEs
- Level tanks and pumps
- Tempered water systems
- Multi-stage vacuum systems
- Thermal fluid systems
- Utility and process piping
- Instrumentation and controls
- Modular assembly on support steel (12 ft. x 12 ft. x 40 ft. high)
- Operating/maintenance manuals

WFE Systems are our business. Our experienced project engineers will match your process objectives with a well-defined system that will satisfy all of your process and other special requirements.

Typical Applications for WFE/Column Systems

- Typical operating pressures in the range of 10-30 torr and, in special cases, as low as 100 microns.
- Distillation step previously done in batch reactor
 - Eliminates heat history and minimizes thermal degradation
 - Thin film improves stripping of VOCs
 - Higher operating vacuums
 - Efficiently processes viscous solutions
- Product quality improvement
 - Eliminates color bodies
 - Increases purity; minimizes impurities
 - Continuous operation
 - Low residence time eliminates thermal degradation
- Enhanced product recovery
 - Recovers additional bottoms product from overhead
 - Eliminates loss due to thermal degradation
 - Recovers additional distillate product from bottoms
- Separation of close-boiling compounds



Typical Applications for Short-Path WFE Systems

- Vacuum levels in the range of 0.001 torr to 0.5 torr
- Enhanced recovery of product from vacuum column bottoms
 - Thin film improves stripping
 - High operating vacuums reduce vaporization temperatures
 - Efficiently processes viscous solutions
- Edible oils
 - High operating vacuums provide low vaporization temperatures
 - Low residence time eliminates thermal degradation
- Vacuum pump oils
 - Separation of lower boiling hydrocarbon fractions
- Vitamin E purification
 - Removal of impurities
 - Multi-stage to provide several grades of Vitamin E
- Petroleum waxes
 - Multiple stages provide several fractions

Added Value of Pfaudler WFE Systems

- Expertise with WFE ancillary equipment
 - Vacuum technology
 - Transfer pumps
 - Instrumentation/controls
 - Thermal fluid heaters
- 40 years experience in designing hundreds of WFE Systems
 - Single source engineering responsibility
 - Performance warranty
 - Guaranteed on-time delivery
- Documentation
 - AutoCAD drawings
 - Equipment specifications
 - Instrument specifications
 - Piping specifications
 - Installation/operation manuals
- Start-up assistance/operator training
 - Anywhere in the world

ASSISTANCE AT EVERY STAGE OF YOUR PROCESS NEEDS

Evaluation of Your Application

Fill out our WFE Engineering questionnaire. Tell us your process objectives and provide us with your production requirements. Pfaudler will respond with a quick and accurate estimate of the size and cost of the WFE or complete system necessary to meet your needs.

Our quick response will give you the data necessary for you to analyze your budget for an accurate and timely payback analysis up front.

Contact Pfaudler for a WFE questionnaire.



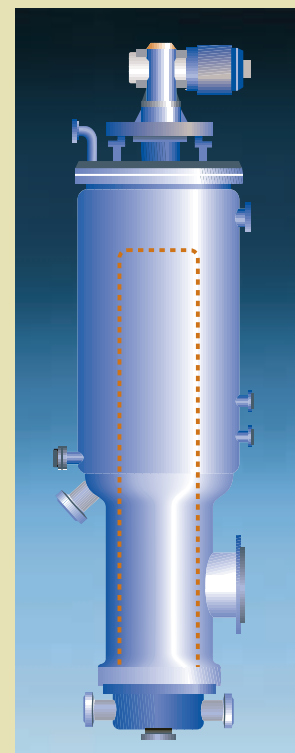
Computer Aided Process Review

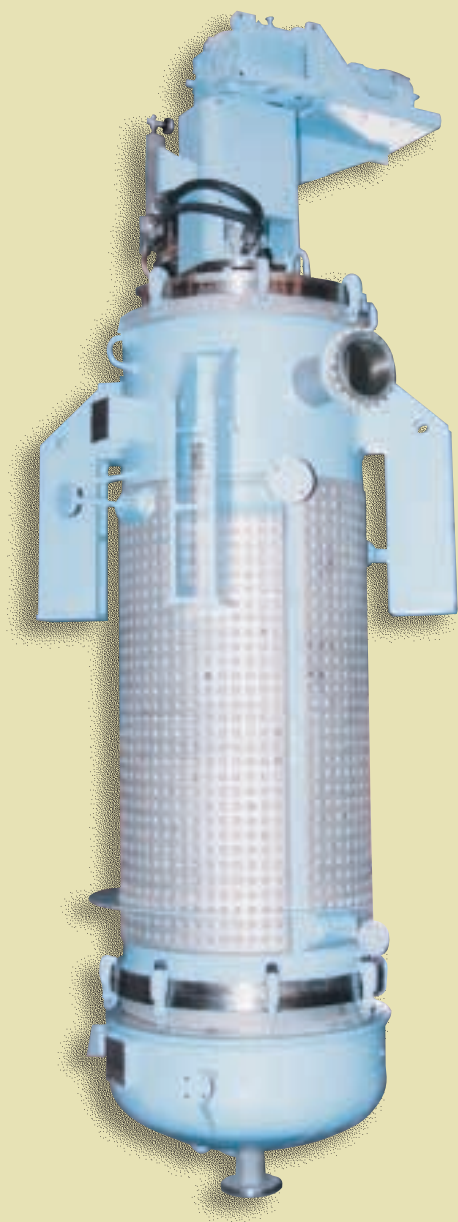
Pfaudler's proprietary WFE sizing computer programs, along with our years of experience, provide accurate sizing of commercial WFEs to satisfy your production requirements. Formal proposals for the WFEs can be prepared and sent to you within days.

Rental and Toll Runs

We offer 1.2 sq. ft. and 4.2 sq. ft. WFEs for your in-plant test work. This allows you to run extensive tests on a variety of materials at your convenience.

The WFE test facility is available for limited toll run work. Several hundred pounds per hour of feed material can be processed using the two 4.2 sq. ft. WFEs in series. Toll runs should require no more than 3-6 days of around-the-clock operation.





Special WFE Designs

Our creative design engineers will modify any standard WFE to suit your application. Special entrainment separator designs, internal condenser sizes, nozzle locations, special jacket designs such as dimpled or half-pipe and more can be selected to maximize your process results.

Standard material of construction is 316L stainless steel. Special materials can include alloy C276, AL6XN®, Monel®, alloy 2205 and others.

Multiple WFE Sizes/ Operating Capacities

Pfaunder offers a range of Wiped Film Evaporator sizes from 1.2 sq. ft. to 460 sq. ft. of heat transfer area. Throughput rates range from less than 100 lbs./hr. to more than 30,000 lbs./hr.

Customer Service and Parts Support

Customer service at the start-up and long after installation is a blend of in-plant experience and responsive engineering support when you want it. Fully trained field service technicians can assist you with any mechanical problem.

Our Parts Department maintains a complete inventory of WFE components that are available for prompt shipment.

We are always on call to provide you with assistance on any operational or process question. The Pfaunder Engineered Systems Group takes pride in providing you with the best engineered and best built Wiped Film Evaporator in the industry. You can be assured we will be there long after shipment and the start-up of the WFE. After all, Pfaunder has been in business since 1884.



SB39-100-5

Pfautler, Inc.
Rochester, New York

Pfautler-Balfour Ltd.
Leven, Scotland



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