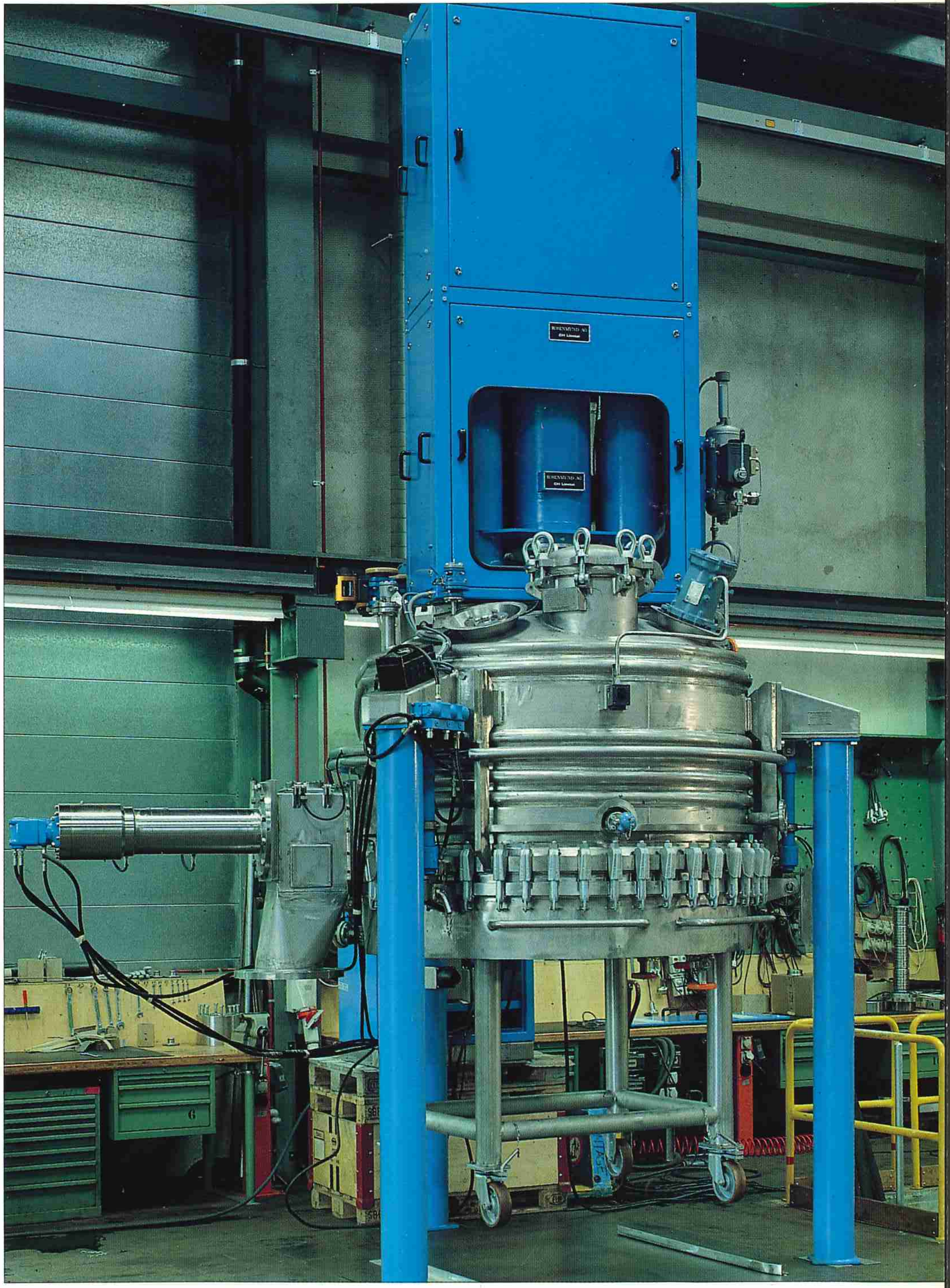
Rosenmund Filter®
Side Discharge

RSD 8910 US





ROSENMUND

Rosenmund Filter® Side Discharge

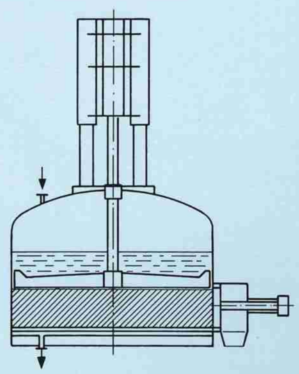
Benefits

The Rosenmund Filter® is installed for solid-liquid separation of suspensions and for washing and isolation of solids in the chemical, fine chemical and pharmaceutical processing industries. It can be used either for a dedicated product or as a multi-purpose unit.

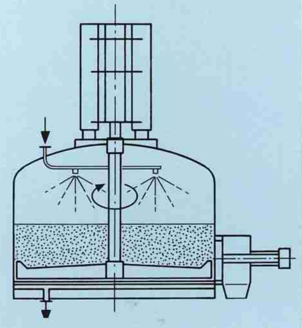
The side discharge filter is available as a filter-dryer, see bulletin RFT-S.

The side discharge filter is ideal for the following conditions:

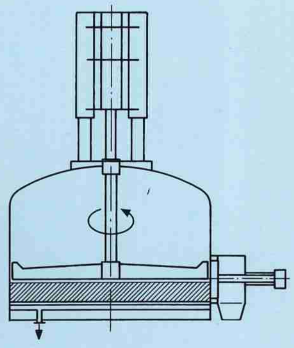
- frequent changes of product
- processes calling for the highest standards of particle-freedom and sterility
- limited clear height of building



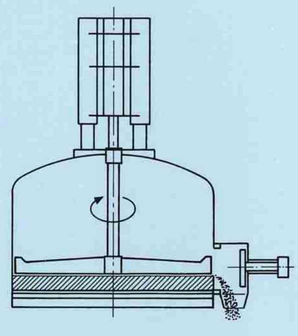
Charging and filtration:
vacuum or pressure



Washing:
re-slurry or displacement



Smoothing
and compressing

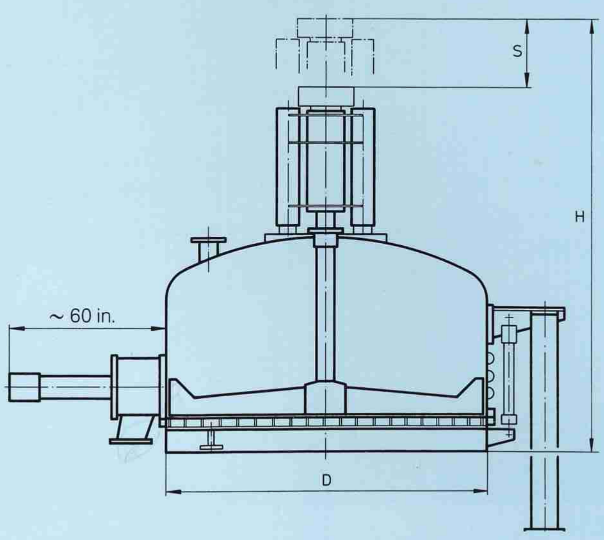


Discharging

Features

The Rosenmund Filter® with side discharge is equipped with a specially contoured beam-agitator and a patented metal sealing side discharge valve.

- The side discharge valve permits pressure tight shut-off after every product discharge without previous cleaning of the sealing surfaces, a distinct advantage in automated processing and contamination-free production.
- The special impeller (two- or three-armed) facilitates uniform agitation and discharge. The three-armed version has in addition a strong centering effect on the agitation system for improved stability. Both designs ensure a quiet and easily installed and maintained operation.
- ASME code vessels, 50 psig or 90 psig to full vacuum, in all grades of stainless steel, hastelloy and other alloys, are locally manufactured in the United States.
- Hydraulic power pack, electric or hydraulic motors and control system.
- Fully trained, locally based, Rosenmund service engineers are available for contract maintenance.
- Complete turnkey process systems, skids, and custom designs are available from Rosenmund Engineering Services.
- Laboratory and pilot test units are also available.
- Complete stock of spare parts, locally available.



Schematic diagram

Filter-Size m²	Filtration Area sq.ft.	Solids Vol. cu.ft.	Max. Liquid Vol. gal.	D in.	H in.	S in.
1	11	17	290	47	131	20
1,6	17	28	450	59	131	20
2,5	27	44	750	71	134	20
3	32	53	900	79	150	20
4	43	71	1400	94	156	20
5	54	88	1700	102	157	20
6	65	107	2000	110	159	20
8	86	170	3000	130	183	24
10	108	214	4100	146	187	24

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Front page photos: 2,5 m² unit in Hastelloy with «pharmaceutical finish»

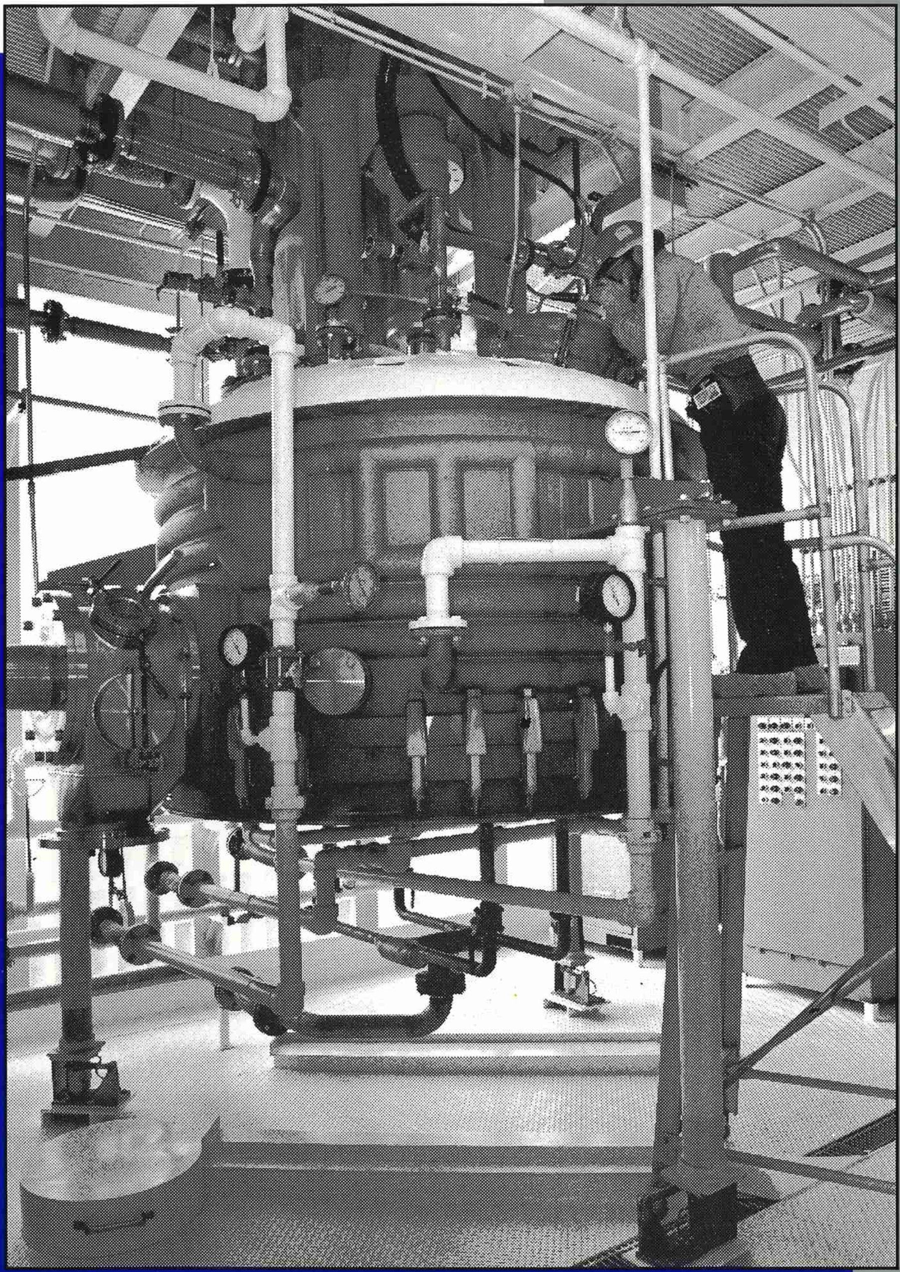
ROSENMUND INC.

Filtration, Drying, Vacuum Equipment & Engineered Systems

Installation & Equipment Highlights

3M² Rosenmund Filter® Side Discharge

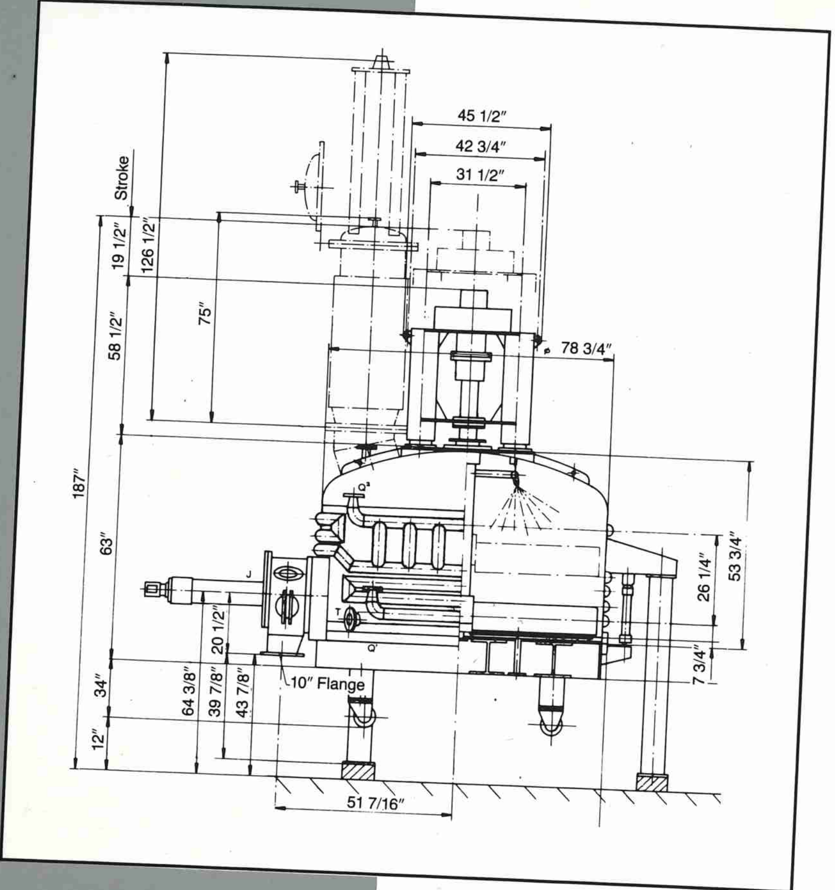
For details, please see reverse side.



Installed at Syntex Chemicals Inc., Boulder, Colorado

Technical Specifications

3M² Rosenmund Filter® Side Discharge



Size	*3M²*
Type	*Side Discharge*
Filtration Area	*32 ft.²*
Working Slurry Volume	*725 gallons*
Solids Volume	*56 ft.³*
Design Pressure	*50 psig/full vacuum*
Design Temperature	*302°F*
Material of Construction	*316L Stainless Steel ASME Code*
Agitator	*Three-arm, S-Blade*
Solids Discharge	*Side, hydraulic valve*
Side Discharge Valve	*Rosenmund patented metal to metal sealing*
Filter Plate	*Simple heated 90 psig, 302°F*
Jacket	*Half-pipe coil 125 psig, 302°F*
Temperature Measurement	*Thermowell*
Dust Filter	*Blowback, bag-type*
Motors	*30 HP, hydraulic, agitator rotation 5 HP, hydraulic, all raising/lowering operations and valve open/close*
Weight (empty)	*20,000 pounds*
Installation Date	*June, 1989*

Application Details

Syntex Chemicals Inc., located in Boulder, Colorado, has installed this filter as part of its new multi-purpose manufacturing facility. The Rosenmund filter is used to produce pharmaceutical intermediates and final products. Filtration, displacement washing, re-slurry, drying, and automatic discharge are performed in the unit. Drying is accomplished by hot gas recirculation using an APOVAC® Vacuum/Gas Compressor System and by pulling vacuum either through the dust filter or the filtrate outlets. The simple heated filterplate and full jacket provides heat energy into the cake. The metal to metal side discharge valve allows continuous sealing without the necessity for between batch cleaning. To complete the installation, Rosenmund supplied the heat transfer module (HTM) and fully automated controls using an Allen Bradley PLC.

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RSD30689

Rosenmund Filter-Dryer®
Center Discharge - Heated Paddle System

RFT-P 9004 US

ROSENMUND

Rosenmund Filter-Dryer® Center Discharge – Heated Paddle System

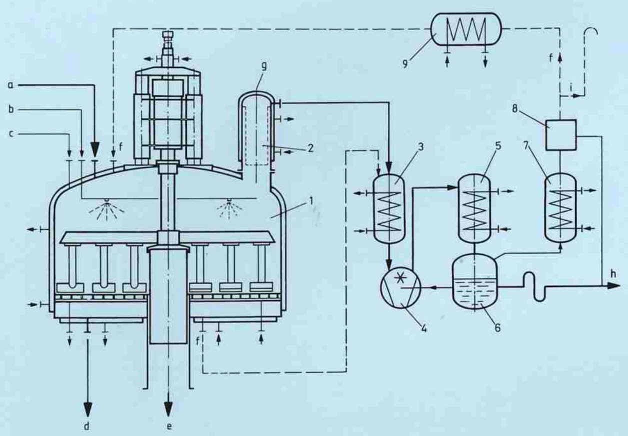
Applications

Rosenmund Filter-Dryers® can be employed wherever a drying stage follows filtration. According to application requirements, either contact drying (under vacuum) or convection drying (e.g. with closed nitrogen circuit) can be selected as the drying method.

The Rosenmund Filter® is ideally suited for drying. To provide maximum heat transfer into the product, three separate components of the filter are heated: vessel (wall, base, head), filter plate, and agitator system.

- The entire vessel can be jacketed with half-pipe coil for heating fluid or steam circulation.
- The filter plate is directly heated with steam or heating fluid.
- The agitator is heated by circulating hot fluid through aerofoil-designed paddles.

Complete turnkey process systems, skid packages (including heat transfer and vacuum/gas recirculation systems), and custom designs are available from Rosenmund Engineering Services. Pilot test equipment, for on-site testwork, provide detail characteristics and scale-up data for your process.



Benefits

- Filtration and drying in a single vessel
- Lower capital and maintenance costs
- Less plant space required
- Lower total installed cost
- Improved product quality with less product handling
- Single source responsibility

Key

1. Rosenmund Filter-Dryer® with connection for heating/cooling media, nozzles for slurry (a), wash-liquor (b), pressure gas (c), filtrate (d), product discharge (e), gas circulation (f)
2. Dust filter with heating jacket and nitrogen blowback system (g)
3. Pre-condenser
4. Ring liquid compressor/Vacuum pump
5. Ring liquid cooler
6. Ring liquid tank with condensate or overflow (h)
7. Exhaust gas /condenser with exhaust (i) and gas circulation connection (f)
8. Demister
9. Gas heater (for gas circulation)

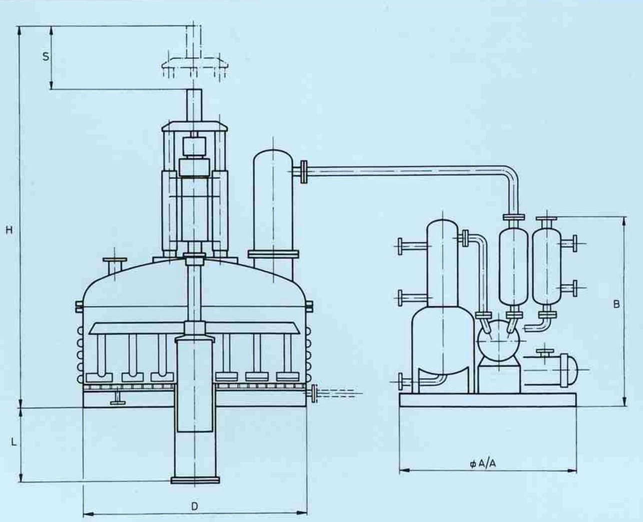
Process Designs

Pressure filtration: The compressor can generate the required pressure differential for filtration.

Dry blowing: After filtration, gas is blown through the cake from top to bottom (in a closed gas loop) to remove additional moisture prior to drying.

Convection drying: The cake is blown through from above with warmed gas, resulting in convective drying of the cake.

Vacuum drying: Solvent vapors pass through the dust filter and condenser into the vacuum system. Alternatively, vacuum is pulled through the filtrate outlets. Non-condensable gases are vented to the atmosphere via a vent condenser. The gas is solvent-free to meet applicable volatile organic compound emission regulations.



Filter Size sq.ft	Solids Vol. cu.ft.	Max. Liquid Vol. gal.	D in	H in	L in	S in	A in	B (approx.) in
32	53	1200	79	222	41	20	120	90
43	71	1800	95	228	38	20	120	90
54	88	2200	102	230	38	20	120	90
65	106	2600	110	232	37	20	120	90
86	141	4000	130	258	36	20	132	102
108	176	4200	146	262	35	20	132	102
129	212	6000	157	266	35	20	132	102
172	282	10000	173	270	35	20	132	102

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Front page photos: 4 m^2 Paddle Filter-Dryer, Heated paddle-agitator, Vacuum station

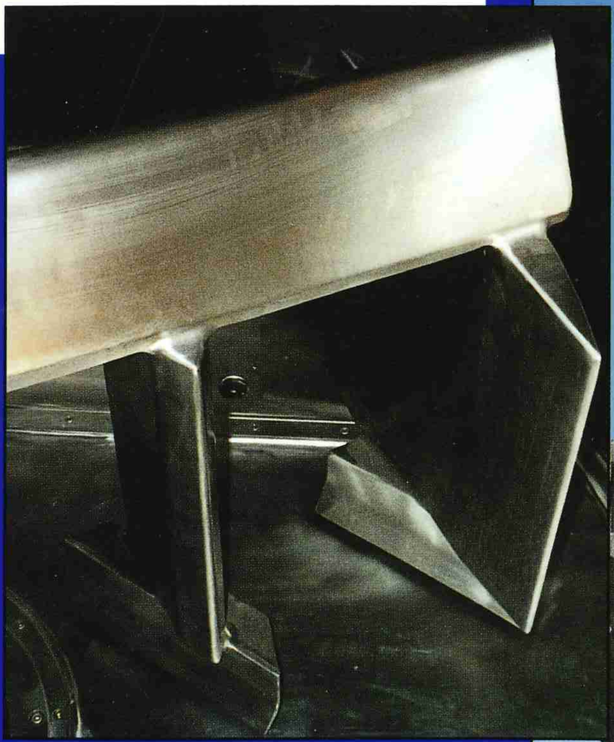
ROSENMUND INC.

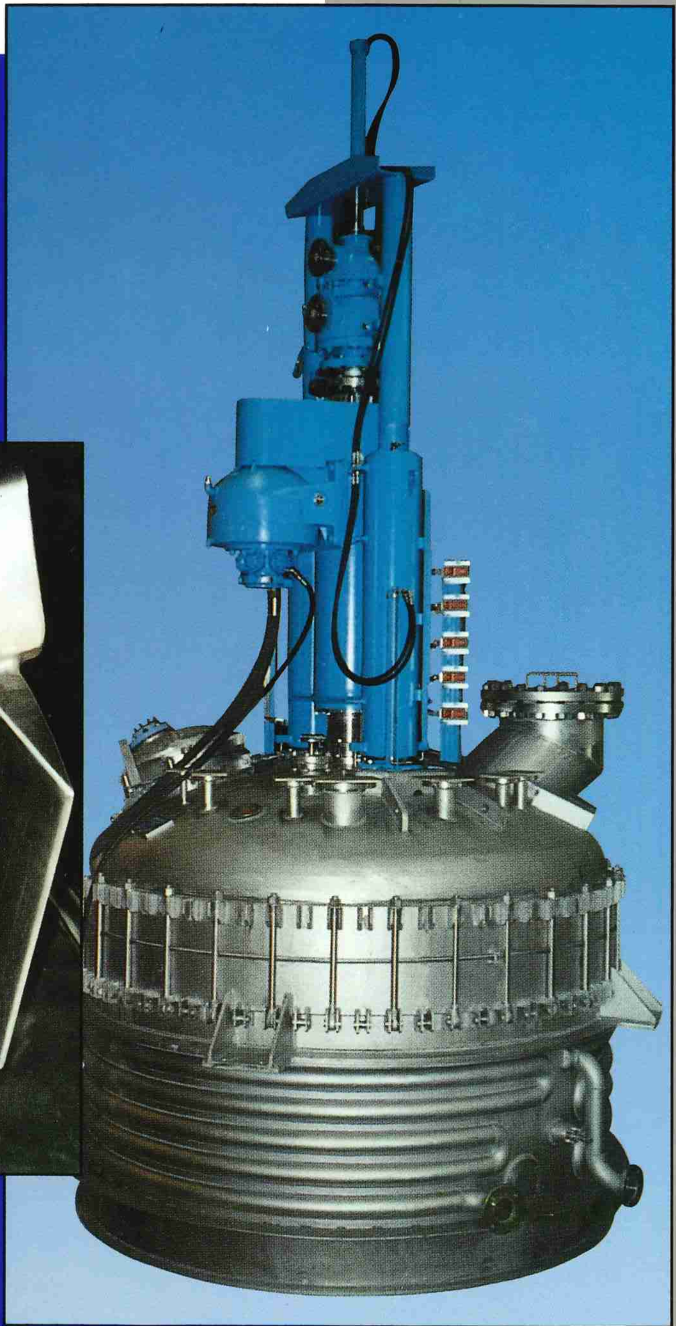
Filtration, Drying, Vacuum Equipment & Engineered Systems

INSTALLATION & EQUIPMENT HIGHLIGHTS

4M² Rosenmund Filter-Dryer® Center Discharge-heated paddle system

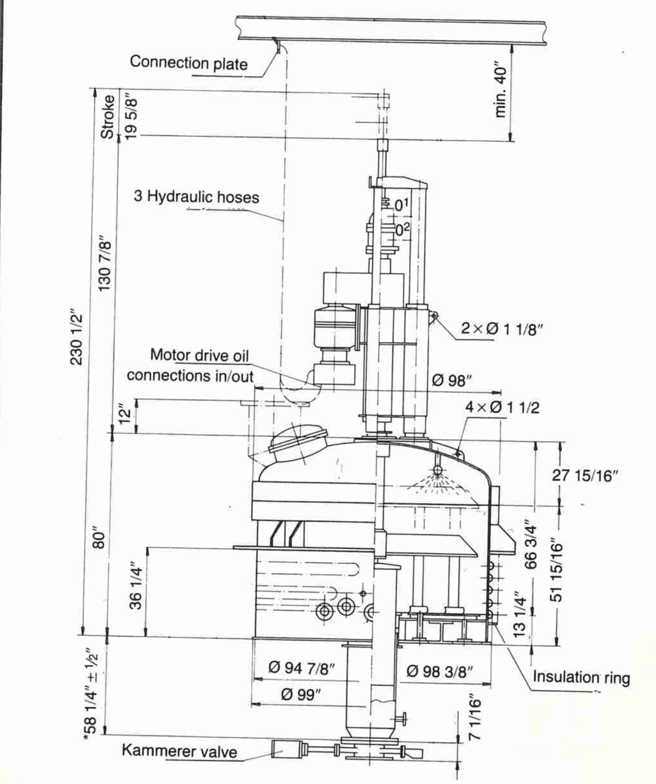
For details, please see reverse side.





Technical Specifications

4M² Rosenmund Filter-Dryer®
Center Discharge-heated paddle system



Size	*4M²*
Type	*Paddle Filter-Dryer*
Filtration Area	*43 ft.²*
Working Slurry Volume	*1200 gallons*
Solids Volume	*71 ft.³*
Design Pressure	*90 psig/full vacuum*
Design Temperature	*−20° to 370°F*
Material of Construction	*316L stainless steel* *ASME Code*
Agitator	*Three-arm paddle, heated*
Solids Discharge	*Center*
Filter Plate	*Simple heated* *150 psig, 370°F*
Jacket	*Half-pipe coil* *150 psig, 370°F*
Temperature Measurement	*Thermowell*
Dust Filter	*20 in blanked nozzle for future installation*
Motors	*30 HP, hydraulic, agitator rotation* *3 HP, hydraulic, all raising/lowering operations*
Weight (empty)	*24,000 pounds*
Installation Date	*July, 1990*

Application Details

This filter-dryer replaced existing centrifuges and multi-leaf filters and, in the future, will eliminate existing tumble dryers. The filter-dryer is being employed for three applications: two are for catalyst cleanup and disposal, where the filtrate (liquid) is the product and one where the dried cake is the product. The unit is equipped with a slurry outlet valve at the filter plate level for slurry/liquid discharge. A Rosenmund supplied PLC control system operates the filter-dryer. Rosenmund also supplied a Kammerer Knife Gate Valve to provide for a pressure/vacuum tight seal at the discharge tube. Installation benefits include flexible operation for different products, increased worker safety, increased productivity, and reduced hazardous waste disposal costs.

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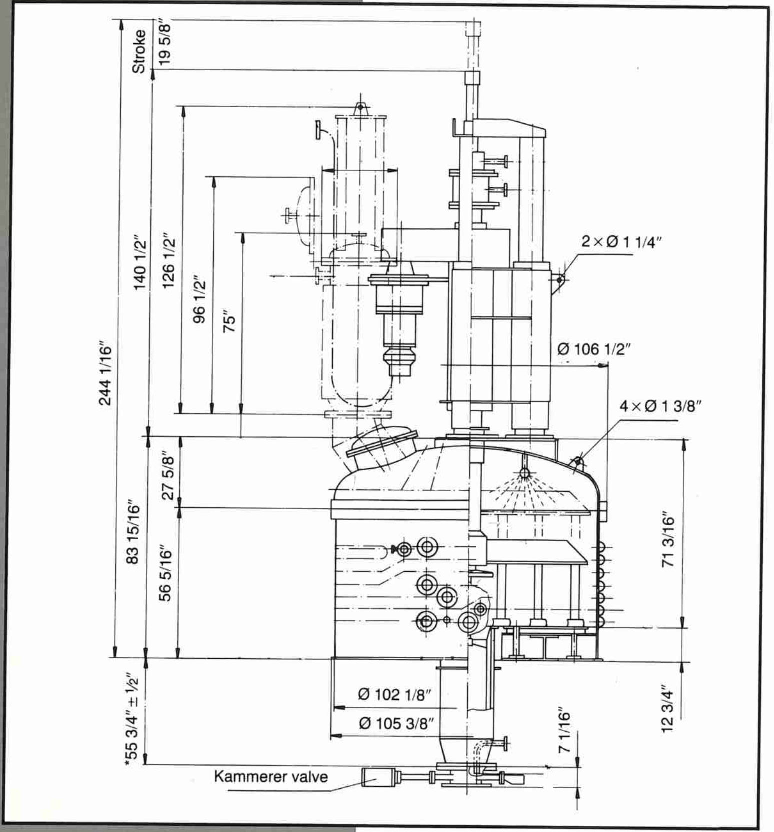
ROSENMUND INC.

Filtration, Drying, Vacuum Equipment & Engineered Systems

INSTALLATION & EQUIPMENT HIGHLIGHTS

5M² Rosenmund Filter-Dryer® Center Discharge-heated paddle system

For details, please see reverse side.



Size	*5M²*
Type	*Paddle Filter-Dryer*
Filtration Area	*54 ft.²*
Working Slurry Volume	*1530 gallons*
Solids Volume	*88 ft.³*
Design Pressure	*50 psig/full vacuum*
Design Temperature	*−20° to 350°F*
Material of Construction	*Hastelloy C-276 ASME Code*
Agitator	*Three-arm paddle, heated*
Solids Discharge	*Center*
Filter Plate	*Simple heated 150 psig, 350°F*
Jacket	*Half-pipe coil 150 psig, 350°F*
Temperature Measurement	*Thermowell*
Dust Filter	*Blowback, bag-type*
Motors	*40 HP, hydraulic, agitator rotation 5 HP, hydraulic, all raising/lowering operations*
Weight (empty)	*26,000 pounds*
Installation Date	*August, 1990*

Application Details

This pharmaceutical customer installed a 5M² Rosenmund Liquid Discharge Filter constructed in 316L stainless steel and a 5M² Rosenmund Filter-Dryer constructed in Hastelloy C-276. The first filter is employed for the filtration and washing of the two initial intermediate compounds which are both discharged as a slurry. The custom designed filter-dryer processes the finished product through a series of filtration, washing and drying operations. This installation, selected as an alternative to centrifuges and dryers, eliminates product handling, improves product yield, increases worker safety, and allows for sequential processing. Rosenmund supplied an APOVAC Vacuum/Gas Recirculation skid package, heat transfer module (HTM) and Kammerer Knife Gate Valve. A Rosenmund control system, based upon the Texas Instrument TI 305, operates each of the filters.

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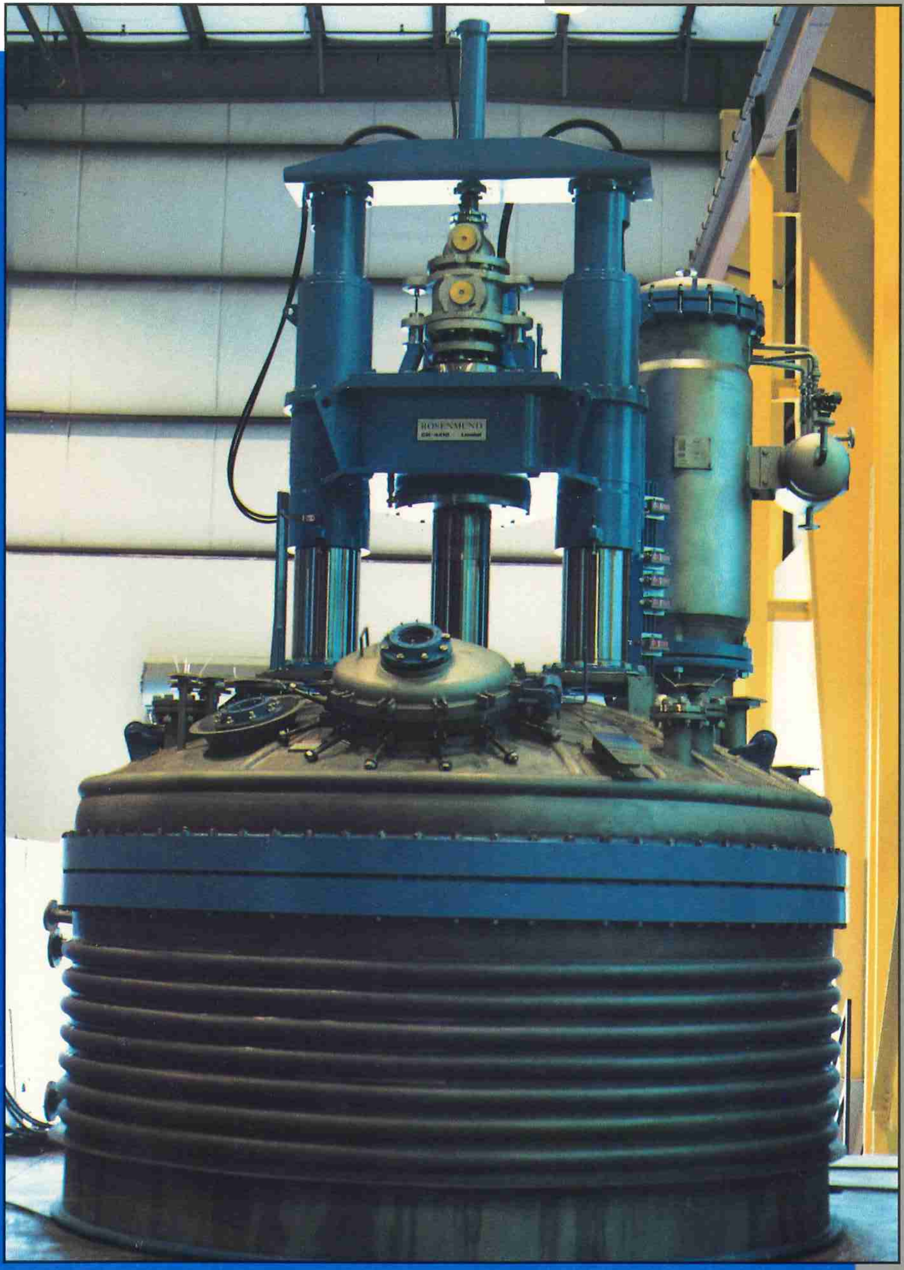
ROSENMUND INC.

Filtration, Drying, Vacuum Equipment & Engineered Systems

INSTALLATION & EQUIPMENT HIGHLIGHTS

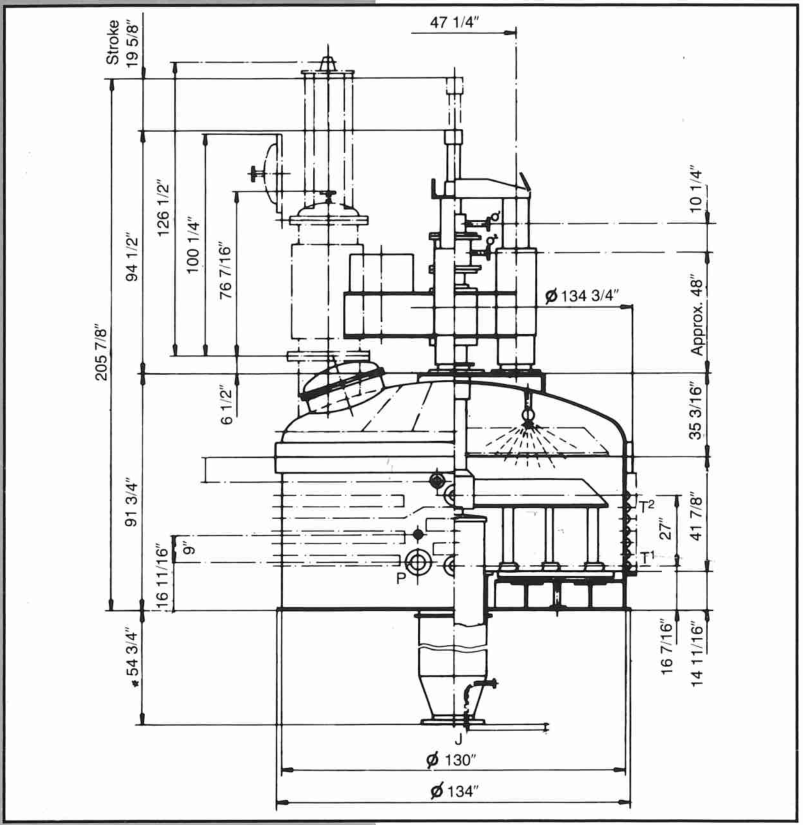
8M² Rosenmund Filter-Dryer®
Center Discharge-heated
paddle system

For details, please see reverse side.



Technical Specifications

8M² Rosenmund Filter-Dryer®
Center Discharge-heated paddle system



Size	*8M²*
Type	*Paddle Filter-Dryer*
Filtration Area	*86 ft.²*
Working Slurry Volume	*2400 gallons*
Solids Volume	*153 ft.³*
Design Pressure	*50 psig/full vacuum*
Design Temperature	*300°F*
Material of Construction	*316L stainless steel ASME Code*
Agitator	*Three-arm paddle, heated*
Solids Discharge	*Center*
Filter Plate	*Simple heated 90 psig, 300°F*
Jacket	*Half-pipe coil 90 psig, 300°F*
Temperature Measurement	*Thermowell*
Dust Filter	*Blowback, bag-type*
Motors	*40 HP, hydraulic, agitator rotation; 5 HP, hydraulic, all raising/lowering operations*
Weight (empty)	*46,500 pounds*
Installation Date	*August, 1989*

Application Details

The filter-dryer replaced existing centrifuge to dryer combinations at this pharmaceutical plant. The operator conducts filtration, smoothing, several displacement washes using different solvents and then dries this pharmaceutical intermediate to less than 0.1 percent moisture. Pre-drying is accomplished with initial hot gas recirculation using an Apovac® Vacuum/Gas Compressor System. Once the cake reaches its desired temperature vacuum drying begins with suction from above the cake through the dust filter and from below the cake through the filter media. The heated paddles stir the cake adding approximately 40 percent additional energy into the cake, which significantly shortens the drying cycle. The dried product is discharged into bins.

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ROSENMUND INC.

Filtration, Drying, Vacuum Equipment & Engineered Systems

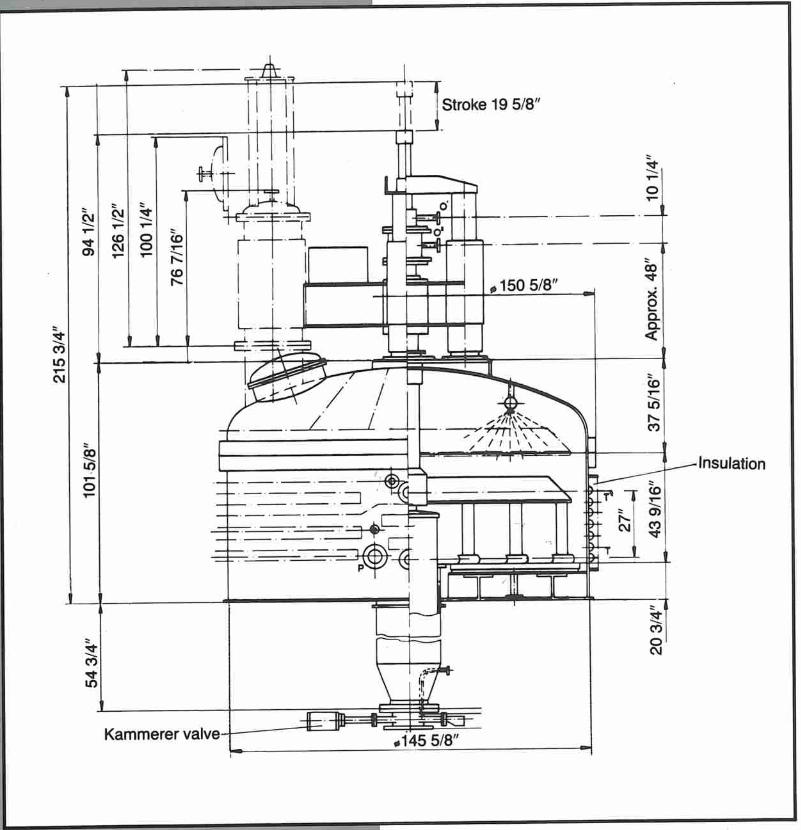
Installation & Equipment Highlights

10M² Rosenmund Filter-Dryer®
Center Discharge-heated
paddle system

For details, please see reverse side.

Technical Specifications

10M² Rosenmund Filter-Dryer®
Center Discharge-heated paddle system



Size	*10M²*
Type	*Paddle Filter-Dryer*
Filtration Area	*108 ft.²*
Working Slurry Volume	*3200 gallons*
Solids Volume	*180 ft.³*
Design Pressure	*50 psig/full vacuum*
Design Temperature	*300°F*
Material of Construction	*316L stainless steel ASME Code*
Agitator	*Three-arm paddle, heated*
Solids Discharge	*Center*
Filter Plate	*Simple heated 90 psig, 300°F*
Jacket	*Half-pipe coil 90 psig, 300°F*
Temperature Measurement	*Thermowell*
Dust Filter	*Blowback, bag-type*
Motors	*40 HP, hydraulic, agitator rotation 5 HP, hydraulic, all raising/lowering operations*
Weight (empty)	*50,000 pounds*
Installation Date	*May, 1990*

Application Details

This pharmaceutical installation conducts filtration, smoothing, washing and then dries this pharmaceutical intermediate to less than 1.0 percent moisture. To accomplish drying, the operator combines initial hot gas recirculation, vacuum drying through the dust filter and through the filtrate outlets, and stirring with the heated paddles. The heated paddles add approximately 40 percent additional energy into the cake, which significantly shortens the drying cycle. Rosenmund has completed the installation by supplying an APOVAC® Vacuum/Gas Compressor System, heat transfer module (HTM), fully automated PLC Control System, and a Kammerer Knife Gate Valve.

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Reprinted from ***Pharmaceutical Engineering*** *July/August, 1989.*

Combined Pressure Filter-Dryer Process Unit Improves Product Quality and Reduces Production Time

by Barry A. Perlmutter

A major U.S. pharmaceutical manufacturer produces two products through a series of reactions, filtration, washing, and drying steps in 12 and 18 hours, respectively. Current operation requires significant product handling as solids are transferred from floor to floor and building to building among reactors, centrifuges, and dryers. Bins, bags and carts are employed for movement. Test work demonstrated the feasibility of employing a single filter-dryer unit to replace existing equipment for reduced production time, improved yield and product quality, and minimized environmental and worker exposure.

This article begins with an introduction to Nutsche filtration and its use for the isolation of solid particles from liquid slurries. Topics include filtration pressure, elastic versus inelastic cake, cake heights, and filtration mechanisms. The article continues by examining product drying within a Nutsche filter. Drying techniques of vacuum or contact, convection, blow drying with hot gas, and gas recirculation are described. Environmental control strategies for volatile organic compounds and particulate dust are also discussed.

Test program methodology and test data from laboratory scale and pilot plant scale tests at the customer's site are illustrated. Data is included for filtration rates, washing cycles, and various drying techniques and sequences. Heat transfer coefficients are also calculated. The data is segmented for each product and then used to provide the necessary scale-up information for production models. The test work demonstrated the feasibility of employing a single filter-dryer unit to replace existing equipment for reduced production time, improved product quality, and minimized environmental and worker exposure. The paper concludes with a methodology for formulating a test program to analyze existing filtration, washing, and drying systems. Further, it shows how the data can be used to optimize operating variables, equipment and component selection, and overall system and process design.

Nutsche Filtration

Present day chemical processing requires a variety of solid-liquid separation techniques. One type of separation equipment is the classic agitated pressure Nutsche filter. This unit has been developed over the past 25 years from a simple pressure/vacuum filter into a sophisticated piece of equipment which is capable of performing many process operations including filtration, displacement washing, reslurry, smoothing and compression, drying, and product discharge either wet, dry or as a liquid.

Mechanisms of Filtration

Suspended solids are separated from a fluid stream by three mechanisms: inertial impaction, diffusional interception, and direct interception. For separating particles from a liquid, the predominate method is direct interception. In this case, the particles are removed because they are larger than the pores or holes in the filter medium. In deep bed or cake filtration, the solid material itself becomes the filter medium. Small particles are removed by the tortuous path the fluid takes through the filter cake. These particles are removed as follows:

- In the real world most suspended particles, even if quite small when viewed from some directions, are irregular in shape and hence can "bridge" an opening.
- A bridging effect can also occur if two or more particles strike an opening simultaneously.
- Once a particle has been stopped by a pore, that pore is at least partially occluded, and subsequently will be able to separate even smaller particles from the liquid stream.

Filtration Pressure

The optimal pressure applied depends very much upon the specific particle characteristics of the product. Particles are generally amorphous, and vary in shape from spherical to irregularly shaped. These parameters will determine the type of cake formation and hence filtration pressure. Figure 1 shows filtration speed versus filtration pressure. Experience has shown that the majority of filtrations are in the range of 20 - 35 psig. Along this range, the filtration speed flattens for an inelastic

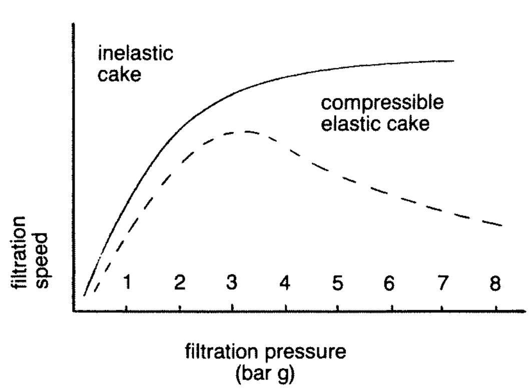


Figure 1. Filtration Rate Versus Filtration Pressure.

(incompressible) cake. The drop in filtration speed is even more dramatic for a compressible cake.

Cake Height

The feasible use of pressure filters begins with cake heights of approximately eight cm. In the majority of applications cake heights of 15 cm to 35 cm are used. Cake heights of larger than 50 cm are unusual, and filter sizing is always based upon cake height.

Filtration Media

The selection of the mesh size depends on the distribution of the particle sizes of the product and on the smallest particles present in a product, respectively.

The finest filter cloths have mesh sizes of around 20 microns. Considering the fact that the same filter cake has a certain filter effect, one accepts a product loss at the beginning of the filter cycle by using a larger, more rigid filter cloth (30 to 50 microns) which definitely offers a larger servicing period.

Alternatives to filter cloths include metal screens and multi-layer filter media. Metal filter cloths are more expensive than those made of woven polymer, but also have a corresponding longer service life. Multi-layer filter media are considered to be the solution to many filter problems. These are the most expensive but also provide a defined structure for long filter life, easy cleaning, and less vulnerability to damage.

Cake Washing

The ideal washing procedure is established by trials. Less porous, crystalline particles usually need a displacement washing while porous, lamina-like products are preferably washed through a reslurry washing. In many cases however a combination of both shows the best results.

Filter-Dryer Technology

In conventional processes the pressure filter is one link in a chain of processes.

Given that the filter, as a pressure vessel, is already of robust construction and is equipped with an agitator and quite often with heated walls, it is a logical progression to combine filtration with the following process step, drying. Product handling between operations is thus eliminated, and product loss, product contamination and environmental contamination are avoided.

Vacuum Contact Drying

To convert a pressure filter to a filter-dryer, the following modifications are necessary. First, heat transfer surfaces are examined. These include vessel walls, dome, base, filter plate and agitator. The agitator system is especially critical as between 30 - 50% of the heat transfer occurs through the heated paddles. Where a "pasty" phase is expected during drying, the agitator construction and the drive unit are to be correspondingly strengthened.

The agitator paddles, in a filter-dryer, are designed as streamlined blades with a large surface area, each equipped with mixing/smoothing shovel or paddles.

Ideally the filter-dryer is fitted with a variable speed drive unit of either frequency controlled electric motor or hydraulic type. Should a viscous phase occur during drying, the vertically adjustable paddle offers the special feature of self-regulation of the cut into the cake to the point where the maximum admissible torque is reached. As a result, the agitator automatically tends to work into the "pasty" product, until the viscous stage is completed and the agitator is once more in the lowest position.

Next, the filter medium should be selected. During the drying stage, the agitator paddles move with relatively little clearance from the filter plate (five - 20 mm). This has the effect of placing more stress on the filter medium than is the case during simple filtration. For this reason, laminated, sintered woven metal wire filter plates (multimesh) are recommended. The higher cost of this type of filter plate is compensated by increased service life.

Convection Drying

In convection drying, the heat is primarily conveyed by a hot gaseous medium such as air or nitrogen. Generally, two methods of convection drying are employed. The first is blow drying.

After filtration, the cake is blown through from above with warm air or warm nitrogen. The humidity in the cake is absorbed and carried away by the warm gas. In this case the filter mesh serves also as a "dust filter." This method is only suitable, within certain limitations, for drying porous product-masses. With compressible or fine grained products, the gas flow, even under high pressure, soon ceases and the drying operation stops.

The second method is via hot gas recirculation. Gas recirculation is generally from above the cake (downflow). The cake can be agitated or remain static depending upon the drying characteristics.

Environmental Controls

Finally, there are several environmental concerns when one is considering a filter-dryer. These are product particles and volatile organic compound (VOC) solvent emissions. To capture solid particles, a vapor dust filter is incorporated. To recover

1. Rosenmund Filter-Dryer with connection for heating/cooling media, nozzles for suspension (a), wash-liquor (b), pressure gas (c), filtrate (d), product discharge (e), gas circuit (f)
2. Dust filter with heating jacket and filter hose cleaned with purge gas (g)
3. Pre-condensor
4. Ring liquid compressor
5. Ring liquid cooler
6. Ring liquid container with condensate or ring liquid overflow (h)
7. Exhaust gas cooler/condensator with exhaust (i) and gas circuit connection (f)
8. Gas heater (for gas circuit)

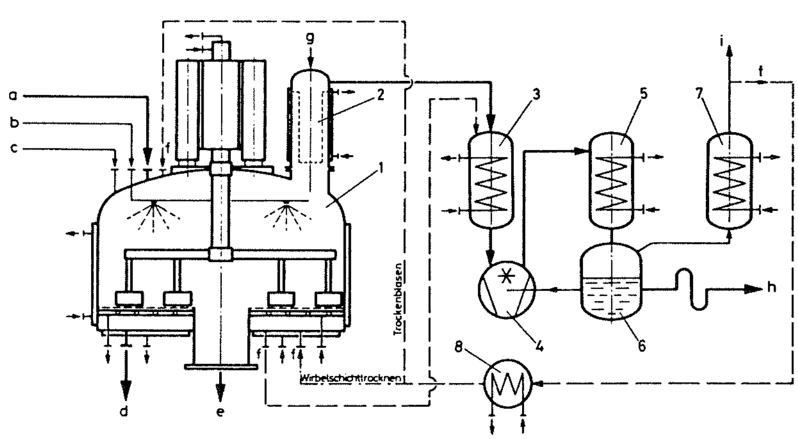


Figure 2. Schematic of the Rosenmund® Filter-Dryer Installation.

A total of 15 trials were conducted for the two pharmaceutical intermediates.

the VOC solvent emissions, a system consisting of a liquid-ring vacuum pump (LRVP), a liquid-ring cooler, and an exhaust gas cooler, has proved to be very successful. As a rule the vaporized solvent is used as the liquid-ring. Should a high vacuum be required in order to achieve low moisture content, the vacuum pump can be preceded by a gas ejector.

In the case of the requirement for hot gas recirculation, a closed circuit with integrated condensor, blower and gas heater is employed. Here again the LRVP system has proved to be reliable, with the liquid-ring pump being used as compressor (with an approximate two bar pressure differential). The cooled gas stream from the condensor is re-heated to drying temperature in a gas heating unit. Figure 2 shows a typical layout.

The similarity of the condensation and compression system makes the described variations easy to incorporate. The capital cost of the combined installation is only slightly higher, and is limited to the additional bypass valves and piping required to switch over from vacuum to gas circuit and the reverse. Combined filter-dryer installations are particularly suitable for multi-purpose plants where products with diverse properties (temperature sensitivity, solvent coefficients, etc.) are to be processed.

Filter-Dryer Test Program

The pharmaceutical manufacturer has, as its objective in this test program, to eliminate the solids handling of their two pharmaceutical intermediates. Bins, bags and carts presently transfer the products from floor-to-floor and building-to-building, between reactors, centrifuges, and dryers. Meeting this objective will allow the operator to reduce production time from 12 and 18 hours, respectively, improve yield and product quality, and minimize environmental and worker exposure.

Overview

On-site test work to eliminate solids handling was conducted using a Rosenmund® 0.6M² Center Discharge Paddle pilot filter and an Apovac® LRVP vacuum/gas compressor system. The test program provides data for optimizing filtration and washing times, cake height, drying times and heat transfer coefficients. The conclusion of the test program provides a guaranteed total cycle time as well as defined filter-dryer size and drying sequence.

Results

A total of fifteen trials were conducted for the two pharmaceutical intermediates. Table 1 details the type of data collected rather than the actual results themselves. The specific important results are described below. The tests gave an average of 0.03 - 0.09% LOD at a cake height for Product A of 42 centimeters and 45 centimeters for Product B. Bulk densities were calculated based upon dry solids weight just after initial filtration. Filtration and washing times were optimized based upon product quality concerns and cycle times.

Drying tests were done with heated jacket and base, using the Apovac® 136 to generate vacuum. Paddles were agitated but not heated. Before starting vacuum drying or agitation, the cake was blown with cold nitrogen for 15 minutes, followed by hot nitrogren recirculation with the Apovac for 30 minutes to heat the cake.

The calculation of the heat transfer coefficient "U" is shown in Table 2. Heat load is based on the quantity of water evaporated during vacuum drying. Time is based on vacuum drying only. Useable wall areas is based on measured cake depth. Product temperature is estimated to be halfway between the heating jacket temperature and the equilibrium temperature of water at the operating pressure. From the heat load, vessel wall and base area, and temperature difference between jacket and product, U is calculated. For the production model, U will be increased as heated paddle agitators will be incorporated along

A. Filtration
1. Filtrate, liters
2. Time, minutes
3. Filtration Rate, L/min-M²

B. Washing
1. Water Wash, liters
2. Time, minutes
3. Wash Rate, L/min-M²
4. Solvent Wash, liters
5. Time, minutes
6. Wash Rate, L/min-M²

C. Drying
1. Vacuum Drying Time, hours
2. Jacket Temperature, °F
3. Pressure, inches Hg absolute
4. Initial LOD, %
5. Final LOD, %
6. Yield, lbs. (dry)

D. Cake Depth, cm

Table 1. Pilot Test Data Collected on the 0.6M² Rosenmund® Center Discharge Paddle Filter-Dryer.

Dry Solids, lbs.
Initial LOD %
Final LOD %
Liquid Evaporated, lbs.
Heat Load, Btu x 10^5
Vacuum Drying Time, hours
Useable Wall Area, ft.²
Base Area, ft.²
Total Area, ft.²
Jacket Temperature, °F
Product Temperature, °F
Heat Transfer Coefficient: U = Btu/hr-ft.²-°F, is calculated from the above data.

Table 2. Data Used to Calculate Heat Transfer Coefficients from Pilot Tests.

with the heated walls and base. The heated paddles will add approximately 25 percent to the total heat transfer area.

Total Liquid to Filter, liters
Liquid Pumping Rate L/minute
Time, minute hour
Filtration/Washing Time, hour
Nitrogen Blow Through Time, hour
Drying Time, hour
Discharge Time, hour
Total Time, hours, is equal to the sum of the above times.

Table 3. Calculation of Batch Cycle Times.

Finally, Table 3 illustrates the calculation of the total cycle time for the process. It includes both slurry filling time and dry product discharge time. The single filter-dryer unit reduced the processing time of the two products by 22 and 38 percent, respectively.

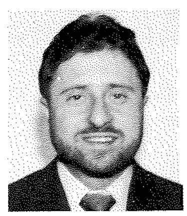
Test Program Methodology

Whether one is considering a filter or filter-dryer, a well-defined test program is required. The following are the important items to be covered prior to undertaking such tests.

1. Set objectives for process.
2. Determine application and process designs.
3. Product and slurry information including particle size distribution, existing data, new product data, other particle characteristics, etc.
4. Cake thickness and filtration rates in order to maximize thickness and minimize filtration rates. This should include selection of the proper filter media.
5. Washing steps including displacement wash, reslurry wash, solvent types. The goal is to maximize product purity while minimizing wash liquid.
6. Drying requirements including final moisture content, type of drying, sequence of drying, agitated versus static cake, drying cycles, heat transfer coefficients, and dry product yield.
7. Available utilities, space, product, slurry, personnel, etc.
8. Unique requirements: cleanliness, toxic or hazardous, equipment modifications, material compatability, insurance, other criteria.

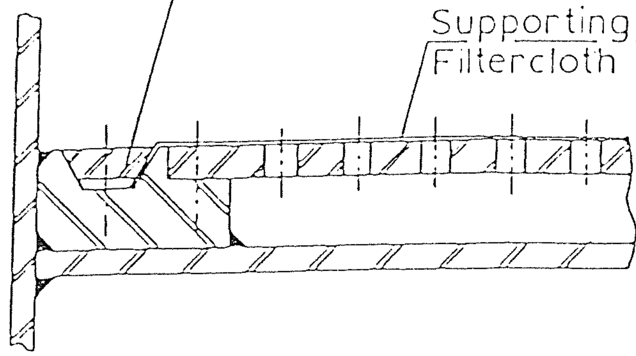
Conclusions

The technology of Nutsche filtration has progressed from a simple un-agitated open filter to its current level of a filter-dryer. The integration of this type of equipment into a production process requires an innovative approach to problem-solving and a willingness to carefully examine existing process steps. This pharmaceutical manufacturer conducted a specific test program to meet predetermined process objectives. Filtration, displacement and reslurry, and drying rates and sequences were optimized in relation to product quality concerns. The result is the installation of a cost-effective agitated pressure filter-dryer which reduces production time, minimizes product handling, improves product quality and yield, and decreases environmental and worker exposures to organic solvent vapors and solid particulates.

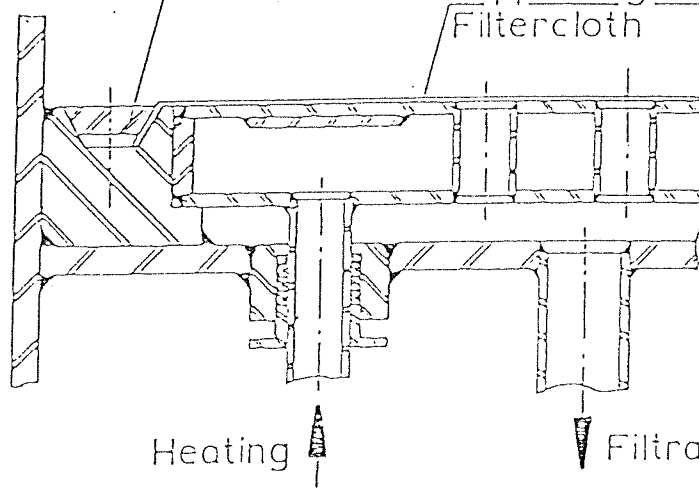


Barry A. Perlmutter is National Sales and Marketing Manager of Rosenmund, Inc., responsible for direct sales, marketing and new business development for Rosenmund products. Mr. Perlmutter has more than 10 years of plant and process experience in the chemical, pharmaceutical, environmental and process industries. Previously, he was a senior marketing manager with Pall Corp. Mr. Perlmutter began his career as an Environmental Scientist with the U.S. Environmental Protection Agency. He has published and lectured extensively on the science of filtration. Mr. Perlmutter holds a BS in chemistry, MS in environmental engineering and an MBA. He is a member of ISPE and PDA.

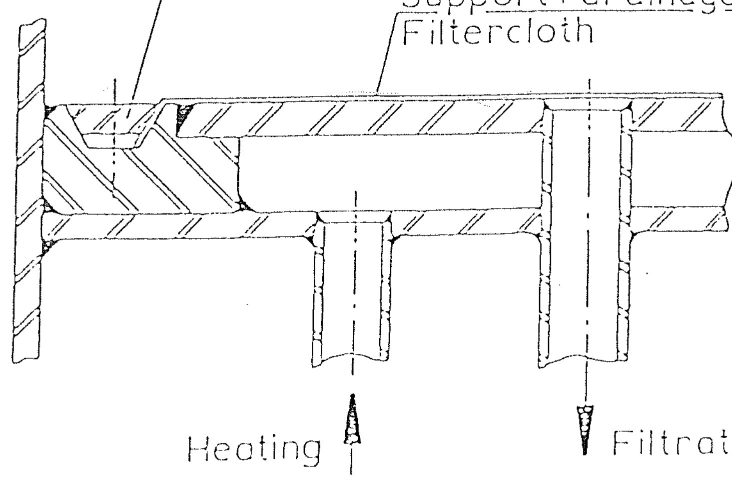
Standard Filterplate
Non Heating



Heated Filterplate
Shell and tube
„Complex system"



Heated Filterplate
Non perforated filterplate
„Simple system"



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FILTRATION AND DRYING SYSTEMS
TECH UPDATE
ROSENMUND INC.

Vol. 1, No. 3 September 1989

APOVAC® Vacuum Systems for Solvent Recovery Operations

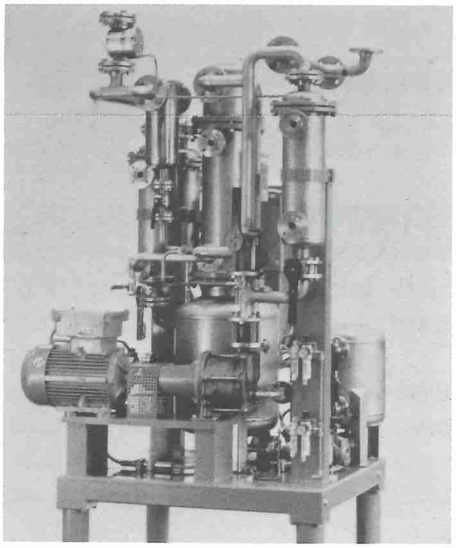
The pharmaceutical and chemical process industries are concerned with controlling vapor emissions for several reasons: to meet environmental regulations, for increased worker safety, and to minimize product losses. Various methods can be used including flaring and carbon adsorption. These techniques are end-of-the-pipe solutions and are not integral with the process operation itself.

APOVAC Vacuum System

An improved technique for the recovery of solvents during vacuum distillation, evaporation, and drying operations is the APOVAC vacuum/gas compressor system. The skid-mounted engineered package is based upon a single stage liquid ring pump as shown in Figure 1. The system allows for the recovery and reuse of clean solvent with minimum air emissions and zero liquid emissions.

APOVAC Operation and Benefits

Condensation of the solvent vapors is carried out in the pump itself. The condensate and remaining vapors pass through a ring liquid cooler, specially designed to achieve maximum contact and cooling. The chilled liquid is collected in the ring liquid tank for recirculation to the pump. The remaining vapors travel through an exhaust gas cooler where more vapors condense and flow counter-current back into the ring liquid tank. The exiting gas meets applicable solvent emission regulations. The process solvent, which is also the ring liquid, is recovered and reused with no liquid waste streams.


APOVAC 156

The vertical ring liquid cooler in the APOVAC design produces the lowest possible ring liquid temperature and therefore the lowest possible suction pressure. The design also cools the inert gas as it is forced through the ring liquid cooler tubes resulting in very low exit gas temperatures. These low gas temperatures, in conjunction with the exhaust gas cooler, provide for significantly greater condensation and solvent recovery than conventional vacuum recovery techniques. Finally, the APOVAC unit, because of its design, does not require an additional seal fluid circulation pump and control loop or interstage cooling, thus eliminating possible sources of leaks. The system, in conclusion, is low-maintenance and inherently safe to operate.

APOVAC® is a registered trademark of Sulzer Burckhardt Ltd.

APOVAC System Applications

Rosenmund Filter® and Filter-Dryer®

The APOVAC unit is installed with the Rosenmund Filter for vacuum filtration and vacuum drying. The APOVAC is also employed for gas recirculation drying and once-through gas blowing.

Drying, Distillation, Evaporation, Mixing and Reaction

The APOVAC unit is uniquely suited for these applications where single or multiple solvents are used. Typical solvents include methylene chloride, isopropanol, acetone, hexane, toluene, propylene glycol and water.

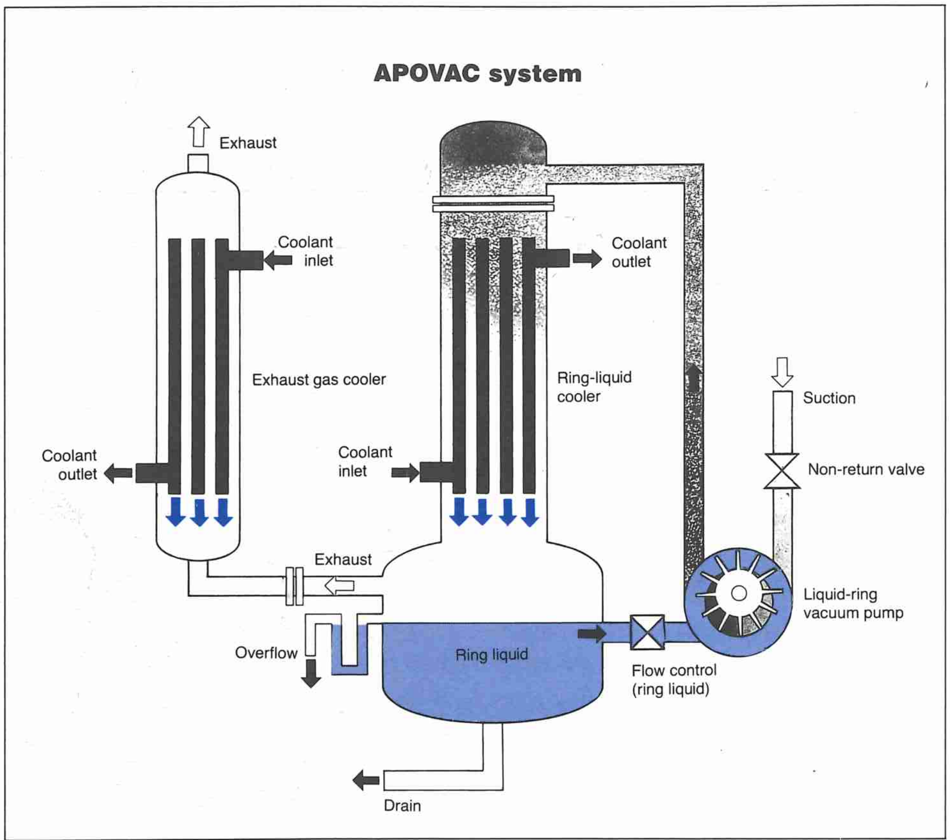


Figure 1: Schematic Representation of the APOVAC System

Next Issue: We Want to Hear Your Ideas.

The next issue of TECH UPDATE will be published in December, 1989 and will focus on the Rosenmund procedure for conducting filtration and drying tests.

In addition, we are looking for engineers who would like to publish an article in TECH UPDATE. The article could relate to Rosenmund technology or to solving a specific production problem with a unique approach. We want to hear your ideas. Look for details in the December issue or use the Response Card to submit your ideas.

We look forward to seeing you at the Chem Show in New York City, December 4th-7th at our booth, number 1457.

Neutralization

Corrosive, toxic, and odorous vapors can be neutralized with the APOVAC unit. In this case, the ring liquid is a pH-adjusted caustic soda or similar liquid. A static mixer is also employed upstream of the liquid ring pump for high scrubbing efficiency and to protect the APOVAC from fast corrosion.*

Replacement of Existing Vacuum Systems

The APOVAC unit can replace existing steam jets where there is high water usage, environmental problems, or inefficiencies. For conventional oil vacuum pumps, replacement with an APOVAC unit can eliminate oil contamination problems as well as the high maintenance costs associated with these systems.

APOVAC Test Program

APOVAC units are available in several different designs depending upon the specific application and plant conditions. Units are also available for lease at your plant site. Challenge Rosenmund to solve your vacuum system and solvent emission problems today.

*For further details on the static mixer design, please see "Better Absorption, Try a Static Mixer", Rader, Mutsakis, Koch Engineering Co., Grosz-Ruell, Maugweiler, Sulzer Bros., Ltd., Chemical Engineering, July, 1989, p. 137-142.

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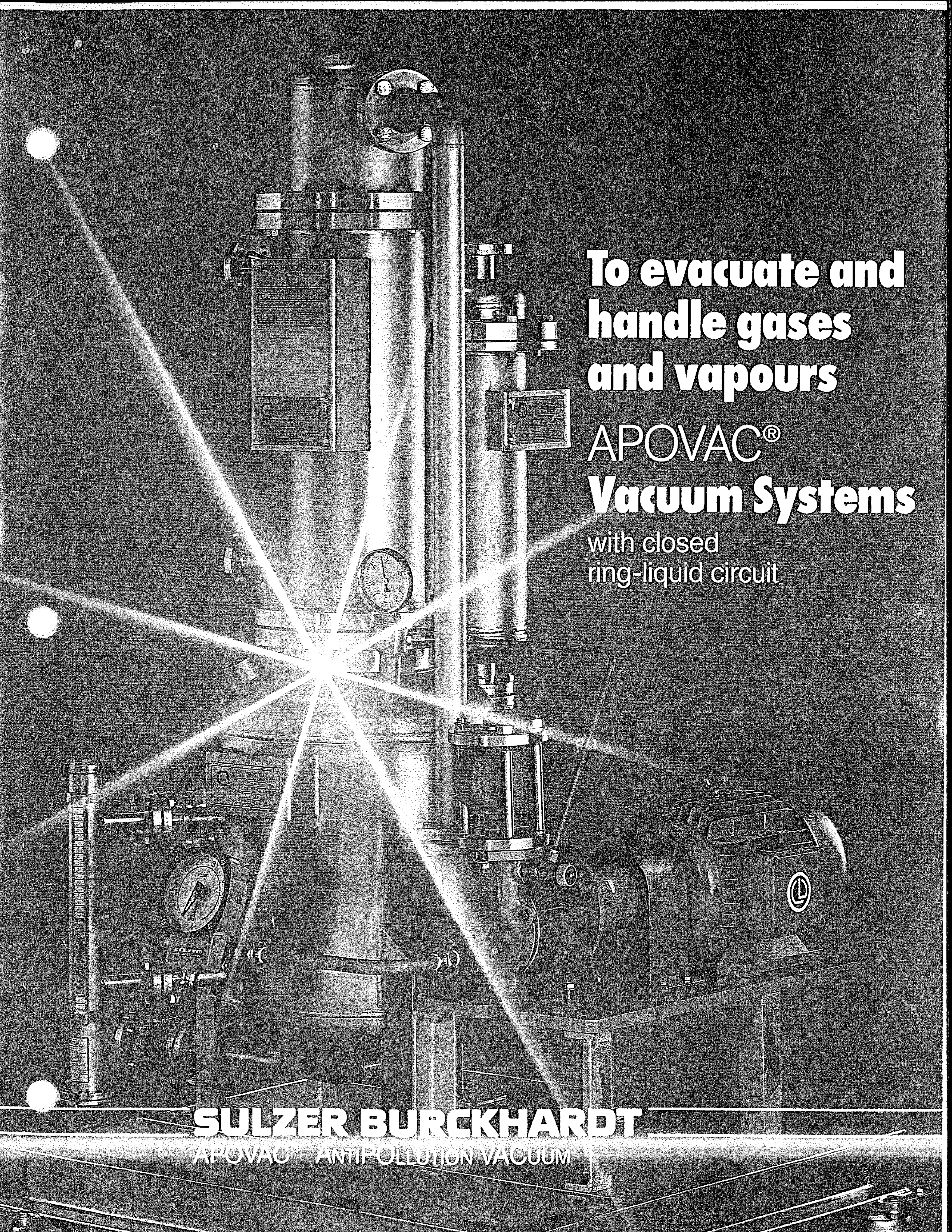


To evacuate and handle gases and vapours

APOVAC® Vacuum Systems

with closed ring-liquid circuit

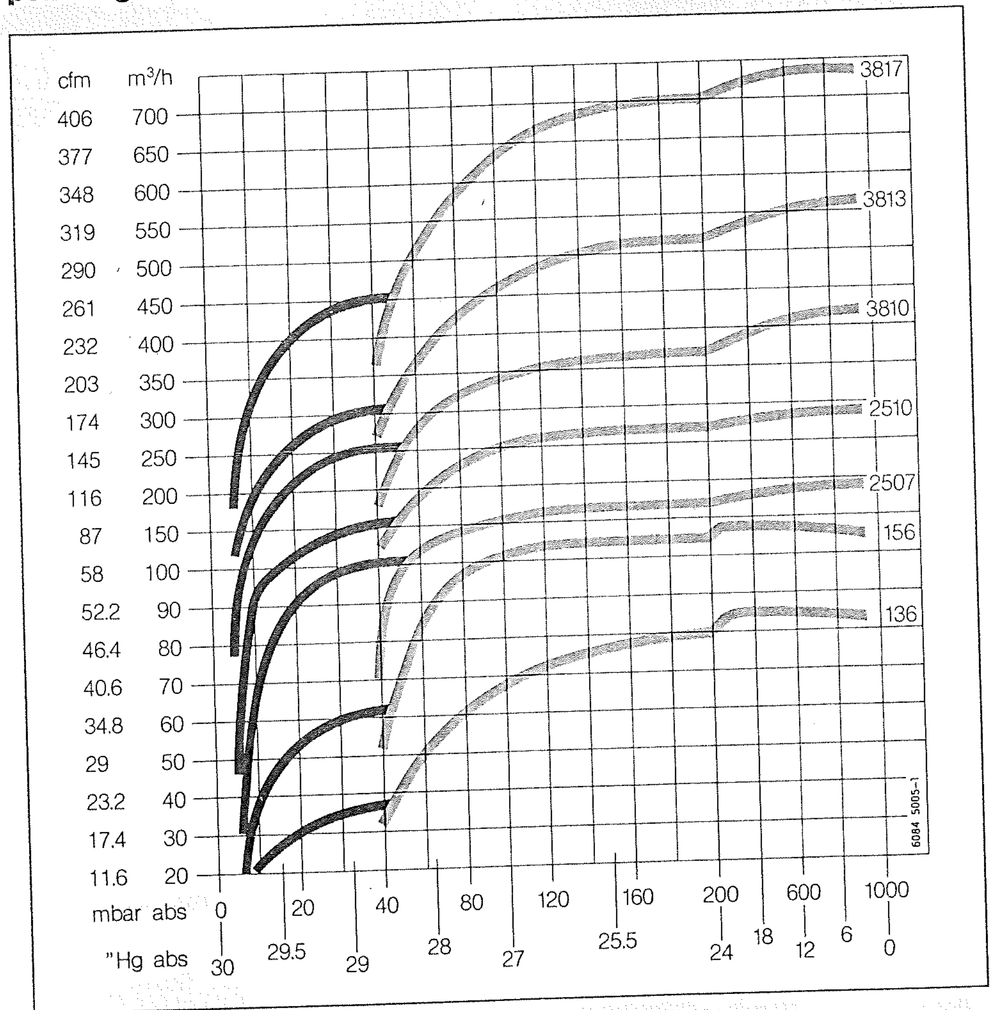
SULZER BURCKHARDT

APOVAC® ANTIPOLLUTION VACUUM

APOVAC®

For the evacuation of gases and vapours with recovery of the resulting non-contaminated and reusable condensate, for neutralization of acid gases without polluting air and effluent.

Suction capacity up to 725 m³/h (415 cfm) for vacuum up to 40 mbar (28.7" Hg) with ejector up to 6 mbar (29.85" Hg).



Performance curves show suction volume at given vacuum with tolerance of 10% at following conditions:
- Evacuation dry air at 20°C/68°F
- Compression to atmosphere
- Ring liquid: water 15°C/60°F at inlet
- Motors 60 Hz/Cs

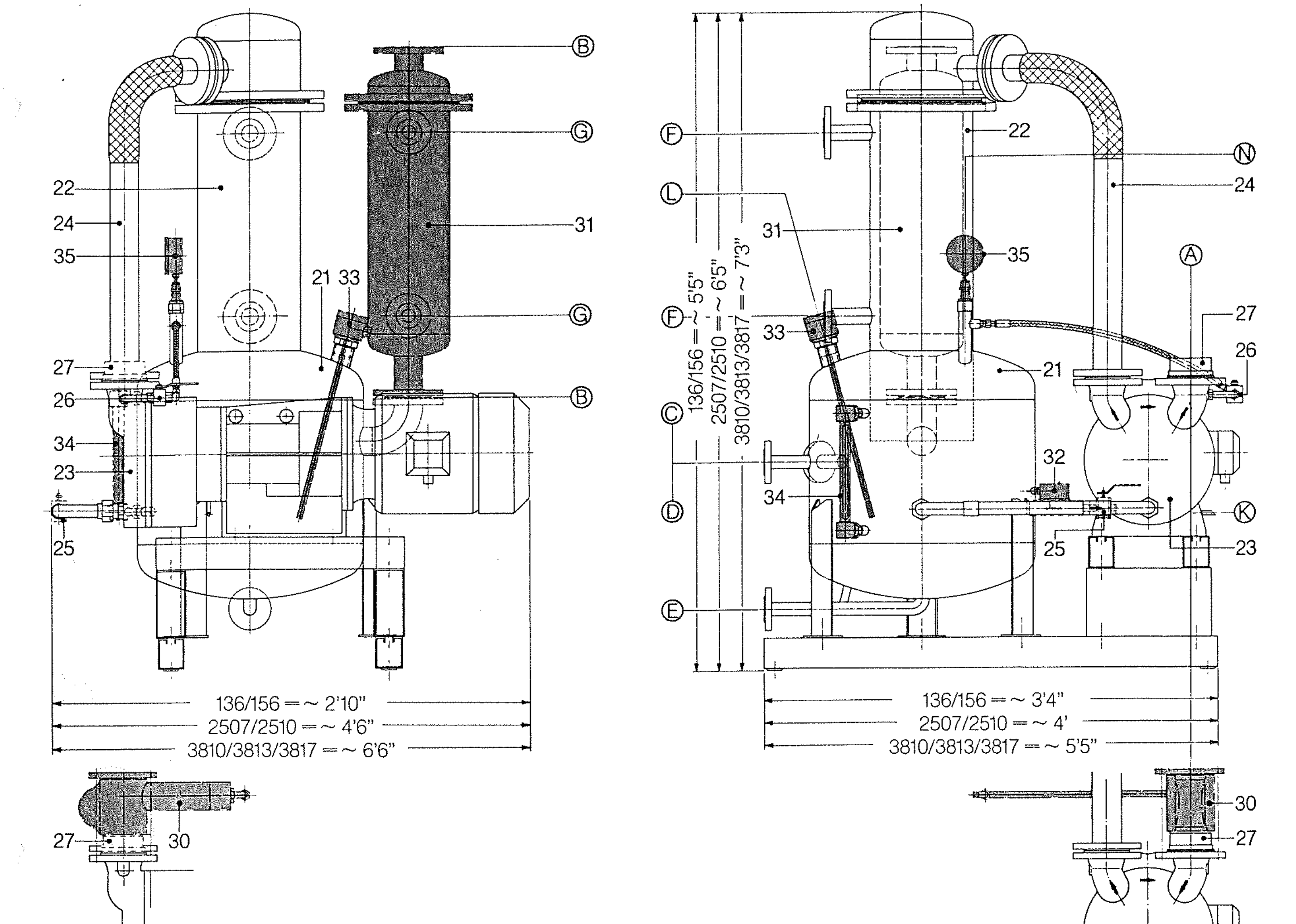
▬ = Performance curves **with** gas ejector
▬ = Performance curves **without** gas ejector

Technical data

Type	Maximum suction volume without gas ejector m³/h	cfm	Ring liquid circulation m³/h	gpm	Coolant at Δt = 4°C/7°F m³/h	gpm	Standard motors IP54 kW	HP	Motors for compressor duty up to 2 bar abs kW	HP	Nominal speed rpm	Weight with pump and motor approx. kg	lbs
136	84	50	0.25	1.1	1.0	4.4	4.0	7.5	4.5	7.5	3600	165	365
156	135	80	0.50	2.2	1.0	4.4	5.5	7.5	7	10	3600	190	420
2507	180	105	1.0	4.4	2.0	8.8	7.5	10	10	15	1800	380	830
2510	300	170	1.1	4.8	2.0	8.8	10	15	13	20	1800	430	950
3810	410	240	2.5	11	5.0	22	15	20	20	30	1200	1065	2350
3813	570	335	2.7	12	7.0	31	20	30	24	30	1200	1065	2350
17	725	425	3.2	14	7.0	31	25	40	33	40	1200	1130	2500

Ask for dimension sheets and installation diagrams for the APOVAC system selected.

Vacuum pump types according to data in separate pump leaflets.



Standard equipment

21 Ring-liquid tank
22 Ring-liquid cooler
23 Liquid-ring vacuum pump
24 Discharge duct
25 Ring-liquid pipe with Flow Switch
26 Manually operated vacuum control valve
27 Non-return valve

Accessories

30 Ejector with or without bypass
31 Exhaust gas condenser
32 Flow indicator with switching unit
33 Level monitoring (or control)
34 Level sight glass
35 Ring-liquid thermometer

6064 5006

Table of connections

All flange connections ANSI 150 lbs RF 316 LSS	APOVAC 136 + 156	APOVAC 2507 + 2510	APOVAC 3810 + 3813	APOVAC 3817
Ⓐ Suction branch	2"	2½"	3"	3"
Ⓑ Gas discharge	2"	3"	4"	5"
Ⓒ Filling connection	1"	1"	1"	1"
Ⓓ Overflow	1"	1"	1"	1"
Ⓔ Drain	1"	1"	1"	1"
Ⓕ Coolant in/outlet	1"	1½"	2"	2"
Ⓖ Coolant in/outlet	1"	1½"	2"	2"
Ⓚ Mechanical seal leakage	½"	½"	½"	½"
Ⓛ Level monitoring	1½" gas	1½" gas	1½" gas	1½" gas
Ⓝ Temperature indication	1" gas	1" gas	1" gas	1" gas

Construction materials

— Standard version, all stainless steel, 316L.

Subject to dimensional and design alterations

SULZER BURCKHARDT

T. Sobieszek

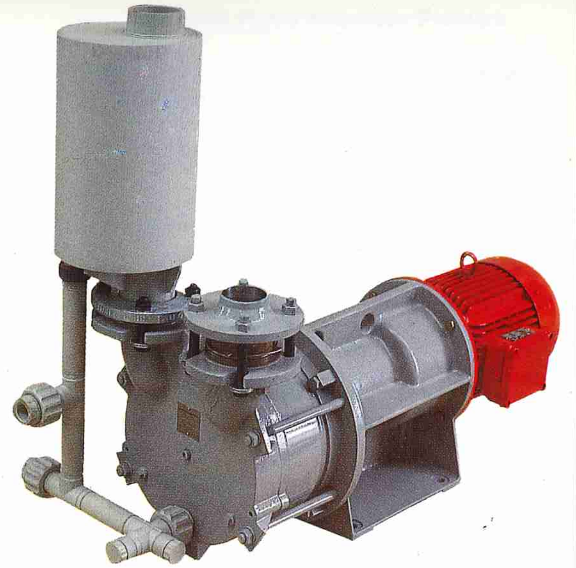
Environmentally-compatible Evacuation of Gases and Vapours

Reprint from the Sulzer Technical Review 4/1986

Environmentally-compatible Evacuation of Gases and Vapours

2148

T. Sobieszek, Sulzer–Burckhardt Engineering Works Ltd., Basle



1 Liquid-ring pump with IEC standard motor, non-return valve, separator and economy circuit.

Liquid-ring pumps are suitable for handling all kinds of gases and vapours, and may be employed as vacuum pumps or compressors.

By virtue of their useful properties (including their ability to handle vapours and liquids without incurring damage), liquid-ring vacuum pumps can be reliably applied for various requirements in chemical plants and process engineering.

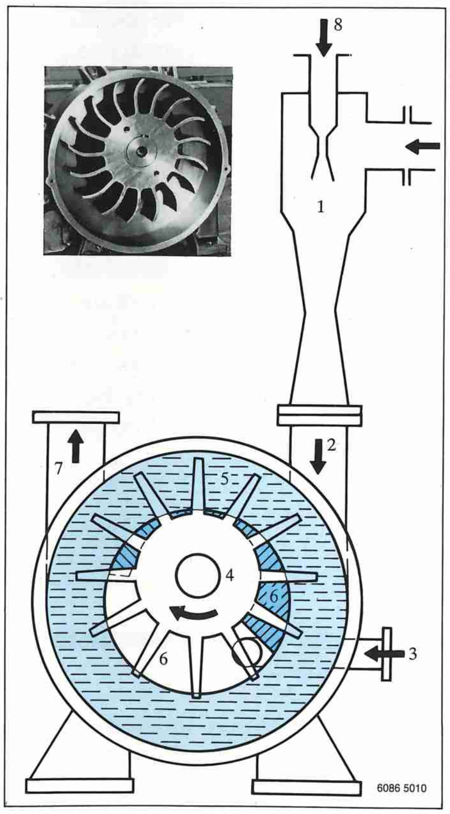
Many processes would be far more complicated and costly without the help of these pumps.

Liquid-ring pumps *(Fig. 1)* need no oil lubrication. They are rugged, simple and reliable. Once installed and put into operation, they can be virtually forgotten [1].

Two stage liquid-ring pumps manage 35 mbar at best.

To extend the suction pressure range down to 6 mbar, liquid-ring pumps are boosted by suitably matched gas ejectors upstream (*Figs. 3, left* and *4*).

With the help of a combination of liquid-ring pumps with gas ejectors and Roots blowers (COMBIVAC system) and by combining liquid-ring pumps with vapour ejectors, it is possible to operate in the medium-high vacuum range (*Figs. 5* and *6*).

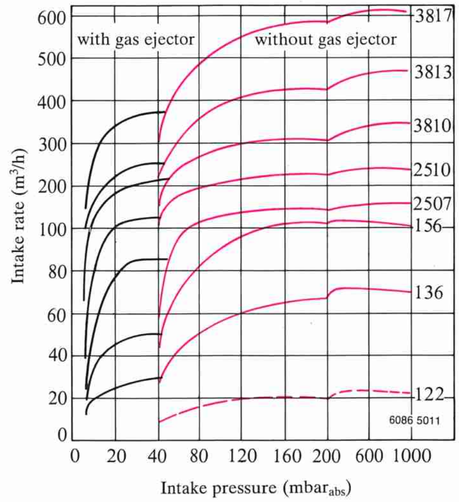


1 Gas ejector
2 Gas intake
3 Ring liquid inlet
4 Vaned rotor
5 Ring liquid
6 Crescent-shaped cavity
7 Gas and ring liquid outlet
8 Motive gas

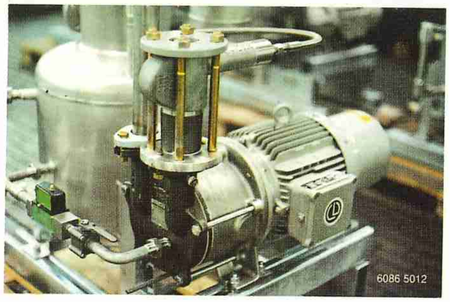
2 Operating principle of the liquid-ring pump with upstream gas ejector.

Mode of operation

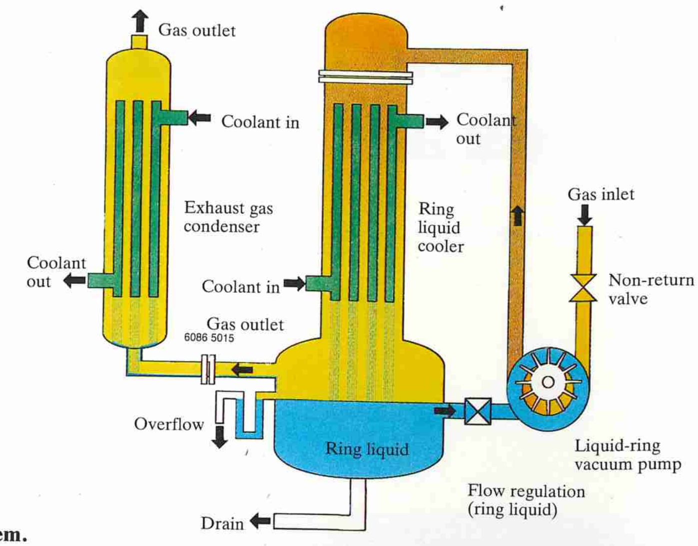
Figure 2 shows the basic principle. Liquid-ring pumps are multicell types with a vaned rotor arranged eccentrically. The gap between the rotor vanes and the casing is sealed by a liquid ring. Owing to the concentrically running ring, the space inside each cell varies during the course of a revolution, so that gases and vapours are sucked in and discharged again through appropriately positioned intake and discharge ports. The suction volume is a function of the free space available in the pump and the rev/min. With a single-stage pump of this kind, without the upstream gas ejector shown in *Figure 2,* operating with fresh water under optimal conditions a compression ratio of typically 1:25 can be attained (40 mbar vacuum, *Fig. 3*).



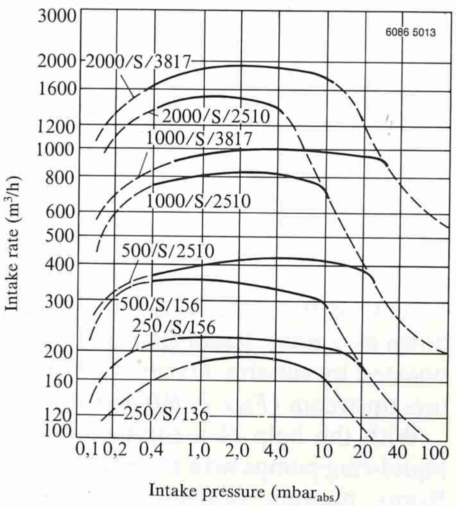
3 Performance curves of liquid-ring vacuum pumps with and (right) without upstream gas ejector.



4 **Liquid-ring pump with upstream compact gas ejector and integrated automatic bypass valve.**



7 **Apovac system.**

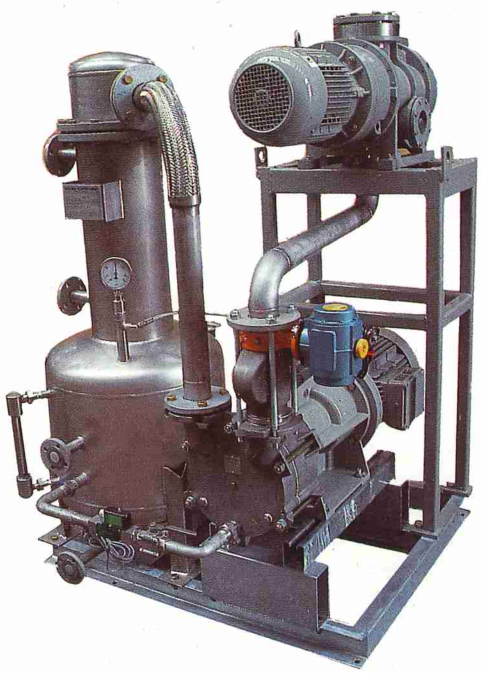


5 **Performance curves with working pressure ranges of standard Combivac vacuum units.**

Properties

The use of water as ring liquid in open systems is without problems, provided the water is not contaminated with corrosive, toxic and malodorous gases and vapours. If it is, the polluted water cannot be discharged to drainage but must be treated. In many cases water is not allowed as ring liquid for various reasons. Situations of this kind lead to a system with a closed ring liquid circulation (*Fig. 7*). On account of its environmental compatibility, we call this system Apovac (an abbreviation from "Anti-Pollution Vacuum system"). As ring liquid this system can use practically any fluid occurring from a process in the form of condensate (*Table 1*). It is particularly ideal for recovering solvent vapours. Corrosive, toxic and malodorous gases and vapours can be neutralized. The cooling water does not have to be treated again, since it is not polluted. The additional costs of such a system are soon offset by the economic benefits.

The variety of problems encountered in chemical process engineering calls for individual approaches, leading to answers best suited to the particular purpose. Just one example here is the L-Vac system (*Figs. 8* and *9*), which does not have a downstream exhaust gas condenser, though of course it could be fitted with one. This system is of simpler layout than Apovac. Both of them can accommodate specific user needs in the chemical industry (e.g. explosion-proof pump drives, corrosion-proof material for the pump, condenser and circulation tank or thermal insulation). The L-Vac unit is suitable for duties where recovery is not of prime importance, such as neutralizing acid gases with caustic soda solutions as ring liquid. Where the medium to be evacuated permits, it is also possible to operate with a water ring. As a rule the L-Vac is employed with ring liquids of high boiling point, and Apovac with low-boiling ones.

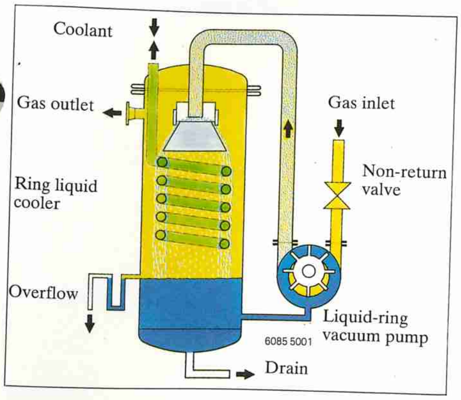


6 **Standard Combivac Type 1000/S/2510, with integrated Apovac system (intake capacity 800 m³/h, working pressure range 0.4 to 10 mbar, final vacuum 0.05 mbar).**

Environmentally-compatible operation

The use of vacuum units with integrated closed ring liquid circuits is indicated wherever liquids or solvents are employed as product processing aids but are removed again before the intermediate or end product is finished. Recovery is desired wherever possible.

To ensure gentle product treatment, this is accomplished at temperatures



◄ 8 **L-Vac system.**

Table 2: Exhaust gas load as percentage of 1 kg air

Ring liquid	(°C)	Circulation without gas cooling	L-Vac	APOVAC
Acetone	−15	19.8	14.4	6.3
Methyl alcohol	− 5	8.6	6.2	2.5
Toluene	+10	12.2	7.2	3.3
Butyl alcohol	+30	8.5	4.7	2.7

Table 1: Ring liquids used most in closed APOVAC circuits

Alcohols	
Methyl alcohol	CH_4O
Ethyl alcohol	C_2H_6O
Propyl alcohol	C_3H_8O
Butyl alcohol	$C_4H_{10}O$
Octyl alcohol	$C_8H_{18}O$
Butyl alcohol	$C_4H_{10}O$
Ethylene glycol	$C_2H_6O_2$
Glycerine	$C_3H_8O_3$
Cyclohexanol	$C_6H_{12}O$
Benzyl alcohol	C_7H_8O
Phenols	
Phenol	C_6H_6O
Ketones	
Acetone	C_3H_6O
Methyl ethyl ketone	C_4H_8O
Ethers	
Dimethyl ether	C_2H_6O
Diethyl ether	$C_4H_{10}O$
Furan	C_4H_4O
Inorganic compounds	
Water	H_2O
Sodium hydroxide (caustic soda)	NaOH
Halogenated hydrocarbons	
Methylene chloride	CH_2Cl_2
Chloroform	$CHCl_3$
11-dichloroethane	$C_2H_4Cl_2$
Trichloroethylene	C_2HCl_3
Chlorobenzene	C_6H_5Cl
Organic sulphur compounds	
Methyl mercaptan	CH_4S
Ethyl mercaptan	C_2H_6S
Aromatics	
Benzene	C_6H_6
Toluene	C_7H_8
Ethyl benzene	C_8H_{10}
Styrene (vinylbenzene)	C_8H_8
Others	
High temperature oils	
Polyethlene glycol	

lower than those tolerated by the product itself, in vacuum ranges allowing evaporation and withdrawal of the auxiliary fluids according to their own boiling characteristics.

From the aspect of recovery, it is desirable to provide a special vacuum unit for each process unit (mixer, dryer, filter, distillation column, reactor etc.) (*Fig. 10*) which:

– corresponds to the pressure ranges of the process,
– allows optimal recovery at the point of origin,
– causes the lowest possible exhaust gas load, in order to maximize recovery and minimize exhaust post-treatment costs.

9 **L-Vac Type 13/80 PMZF 2510 with partial ring liquid feed in pump suction branch for neutralization purposes.**

10 **APOVAC units installed in a separate room of a fine chemicals plant.**

If we examine the question of exhaust gas load due to solvents in the circulation systems described, assuming similar operating conditions, differences emerge which, today more than ever, must be taken into account when choosing a system (*Table 2*).

The conclusion to be drawn from this is that systems with efficient ring liquid and gas cooling cause 40 to 73% less exhaust gas load, allow higher recovery and accordingly demand less post-treatment outlay.

The immediate future will show how far future legislation to combat atmospheric pollution is going to affect the individual vacuum units at each process stage. The admissible ppm loads already fixed cannot be attained with conventional condensers alone by reason of the gas laws, and any further additional measures are ultimately a question of cost. Ω

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KÓCWIN, M.J. Liquid-Ring Pumps for Handling Gases and Vapours. Sulzer Technical Review (1973), No. 2, p. 63.

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Sulzer-Burckhardt

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Reciprocating process compressors, lubricated or non-lubricated, vertical or balanced-opposed
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Water-lubricated compressors
Liquid-ring vacuum pumps
Labyrinth-piston compressors

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Irradiation plants
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Locomotives and railcars
Electronic regulating and control devices
Industrial gears
Parts manufacture
Foundry products
Engineering of complete plants

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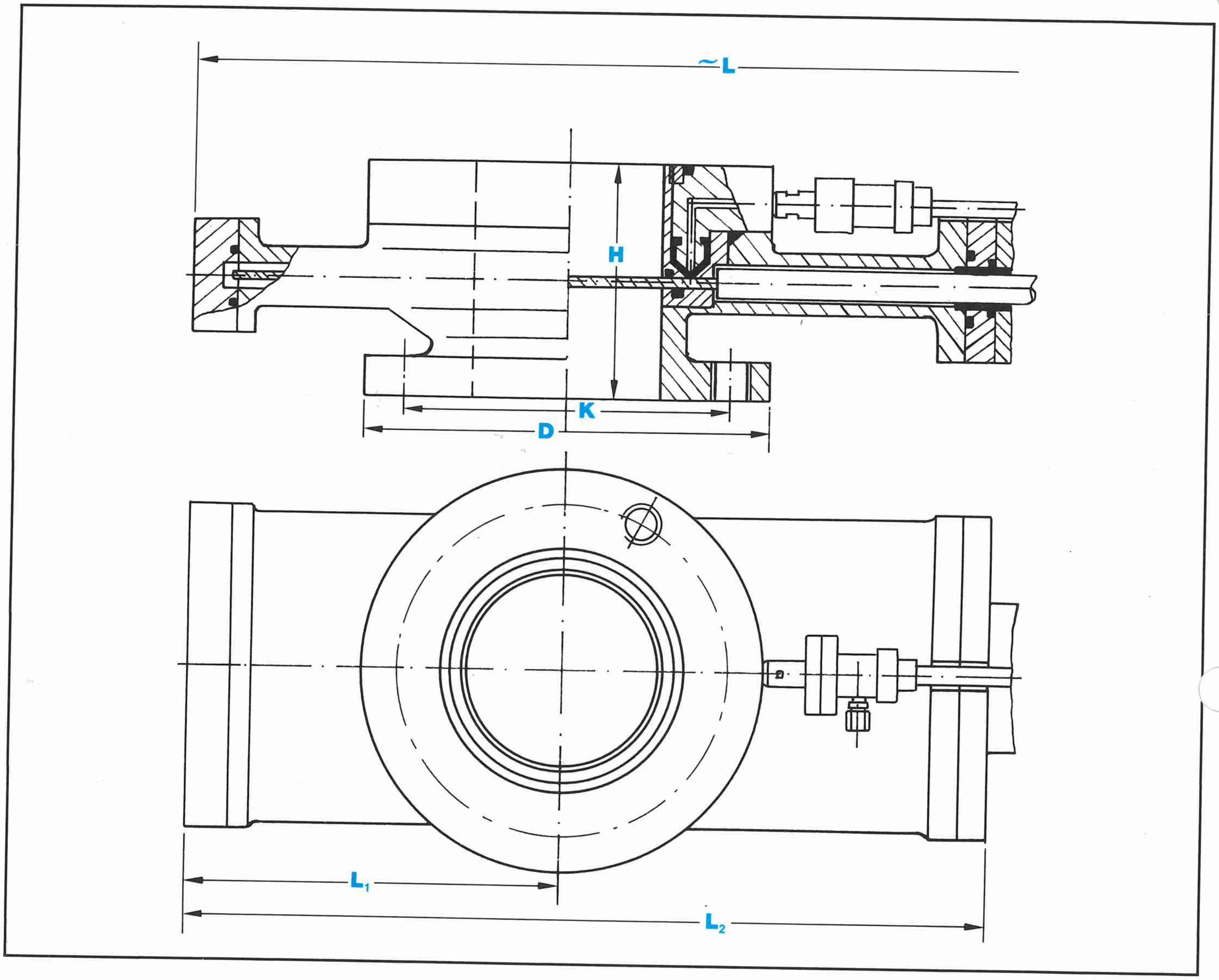
EMIL KAMMERER

KNIFE GATE VALVES from ROSENMUND



SIZE	1″	2″	2½″	3″	4″	6″	8″	10″	12″	16″	20″	24″	32″	40″
L	11.02	16.81	19.76	22.28	25.94	33.86	42.72	49.80	61.42	80.31	90.55	111.81	146.85	O/R
L_1	2.87	4.88	5.95	6.97	7.99	10.94	14.17	18.11	20.98	28.74	33.46	39.13	51.97	O/R
L_2	5.71	10.24	12.32	14.25	16.46	22.36	28.86	36.18	42.44	56.69	66.0	81.14	107.87	O/R
H	3.15	3.94	4.72	4.72	4.72	4.72	5.91	5.91	5.91	7.87	7.87	7.87	9.84	O/R
D	4.53	6.5	7.28	7.87	8.66	11.22	13.39	16.73	19.09	22,83	26.38	30.7	40.35	O/R
K	3.12	4.75	5.5	6.0	7.5	9.5	11.75	14.25	17	21.25	25.0	29.5	36	O/R

THE KAMMERER VALVE

INTRODUCTION

The Kammerer Knife Gate Valve range has been developed to meet the wide variety of needs presented by today's industry for a totally enclosed valve to handle particulate solids in all forms and sizes.

DESCRIPTION

The Kammerer valve comprises a totally enclosed body containing a moveable slide plate (knife) into which is cut an orifice of equal size to the valve bore. In the open position this orifice is in line with the valve bore and presents an uninterrupted opening. In the closed position the slide plate completely seals the valve bore to give total shut off.

Operation of the slide plate can be manual, pneumatic, hydraulic or electro-mechanical.

APPLICATION

Kammerer valves are specifically designed for systems containing particulate solids. The range of sizes that can be handled extends from dusts to greater than ¼″.

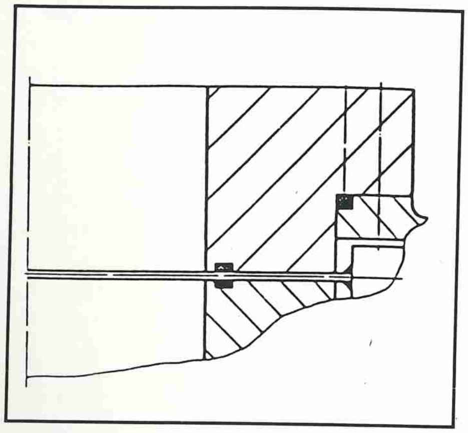
The simplest design is dust-tight across the slide plate while the most sophisticated design will hold vacuum to 10^{-5} torr or pressure to 600 psig.

SELECTION

Kammerer valves are divided into 5 main categories, each of which is described in detail. These are in increasing order of sophistication.

'G'
'GP'
'P'
'S'
'F'

These are described in the next two pages.



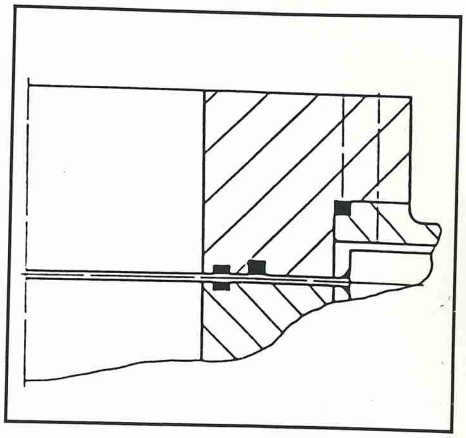
TYPE 'G'

Designed for dust-tight closure of process lines containing particulate solids where full bore opening and minimum valve thickness are required.

As in all Kammerer valves, the Type 'G' incorporates a hard steel slide plate with full bore orifice. The slide plate is located above a machined, hard steel or hard bronze guide ring. Mounted in the guide ring and in the upper housing above the knife are scraper rings to clean the slide plate. These scraper rings encircle the valve bore thus ensuring contact with the slide plate at all times. Close tolerance between plate and rings ensures that the plate is always clean. The hard steel slide plate guarantees a long service life. The Type 'G' valve is dust-tight across the slide plate but will withstand line pressures to 100 psig without leaking to the atmosphere.

The Type 'G' valve is recommended for fine, free-flowing solids. The valve should only be closed when the line is free of solids but will retain and prevent solids flow in the closed position.

The Type 'G' valve is available in sizes from 2″ to 20″ bore. As with all Kammerer valves, it can be closed in less than 2 seconds whether manually operated or fitted with an automatic operator.



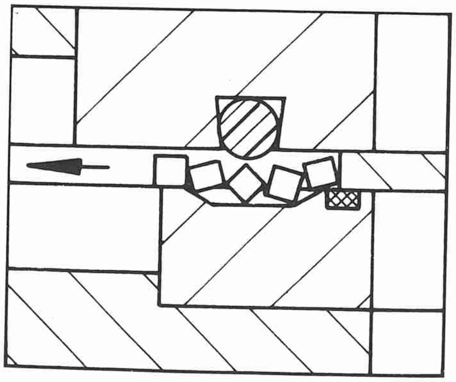
TYPE 'GP'

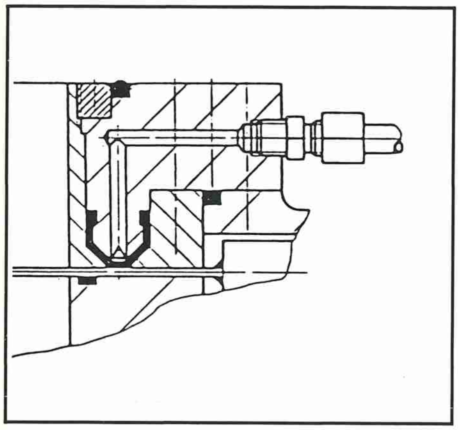
For granular abrasive materials, the type 'GP' is preferred. This valve is also suitable for low pressure systems involving gases, aggressive vapors or liquids.

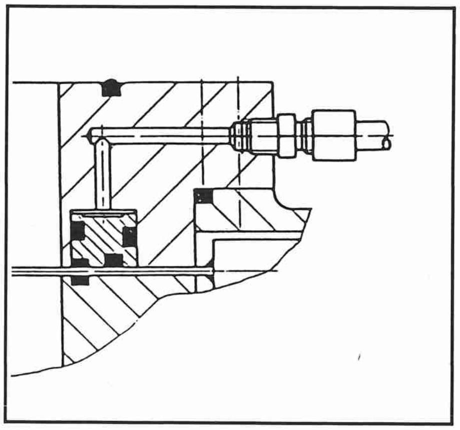
The Type 'GP', like the Type 'G', is pressure tight in the housing and stem opening to 100 psig while across the slide plate it will seal against 10 psig or 25 mbars vacuum absolute.

The Type 'GP' is especially suited for conveying systems where the slide plate has to cut through particles on closing. For this an O-ring seal is incorporated in the upper housing. Below this seal in the guide ring a small notch is cut. This allows granular material to pass the O-ring without damaging the elastomer (see below). Tests have shown that even after 2000 closures, the O-ring showed minimum abrasion.

Like the Type 'G', the 'GP' can be closed in less than 2 seconds even when manually operated.







TYPE 'S'
TYPE 'P'

For systems requiring a valve to seal against a pressure differential greater than 10 psig, then the Types 'P' and Type 'S' are recommended. Both valves share the same pressurized sealing system; only the method of applying pressure to the seal varies.

These valves are designed for systems where a very good seal is required against pressure or high vacuum. The Type 'P' and Type 'S' will seal vacuum greater than 1 torr absolute. Pressure differentials up to 60 psig across the slide plate can be sealed and the housing is tight to 150 psig.

Sealing is by means of a U-shaped elastomer seal which is pressurized once the slide plate is in the closed position and has ceased moving. The external pressure forces the U-seal against the stationary slide plate to create the required seal. At all other times the U-seal is relaxed away from the slide plate and there is therefore no wear of the U-seal due to the movement of the slide plate.

The Type 'P' is available manually operated only and incorporates a self contained system for pressurizing the U-seal.

The Type 'S' uses an external source such as compressed air to pressurize the U-seal.

Size details for the Type 'S' and Type 'P' are given on page 2.

TYPE 'F'

Where elastomers cannot be used, due to solvent attack or where the temperature exceeds 120°C (250°F) then the Type 'F' is preferred. The basic operation is identical to the Type 'S' or 'P' but the U-seal is replaced with a metallic piston located in the upper housing. The piston is sealed to the housing by means of O-rings and to the slide plate by means of Teflon seals. A solid Teflon piston can also be provided.

In the case of temperatures above 180°C (356°F), the Teflon can be replaced by high temperature materials. See Type 'FBK' on page 6.

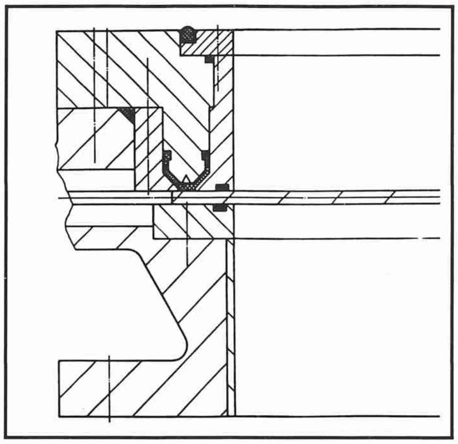
The Type 'F', Type 'S' and Type 'P' share a common body configuration and are available in sizes from 1" to 40" bore as detailed on page 2. As with the Type 'S', the Type 'F' uses an external source such as compressed air to pressurize the piston seal.

The Type 'F' is particularly recommended for use with vacuum dryers where there is a constant exposure to solvent vapors at elevated temperatures.

STANDARD VALVE VARIATIONS

The preceding 5 types of Kammerer valves are standard items in the size ranges indicated. The normal material of construction is 'Silumin', a chemically inert alloy of Al, Si, and Mg. It combines light weight with excellent chemical and abrasion resistance. All valves are standard with high chrome stainless steel slide plates and stems.

If stainless steel is required for contact surfaces, then the valve bore can be lined as shown below. Hastelloy, Monel, Inconel, etc. can also be used.

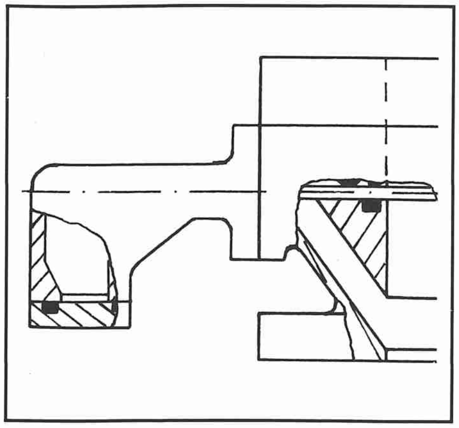


Valves are also available fabricated totally from any alloy desired. (see page 6.)

'KII' AND 'KIII' VARIATIONS

The standard valves are generally designed to seal process lines in which there is little or no solids flow when the valve is being closed. They are also not normally designed for sealing lines containing liquids where the liquid is the carrier phase, although they will handle wet solids.

To meet these special needs, there are two variations on the standard design, the 'KII' and the 'KIII', described on page 5. Both variations are available with the 5 types of sealing systems ('G', 'GP', 'P', 'S' and 'F') and should normally be specified with both designations — i.e., 'GKII', 'SKIII', etc.



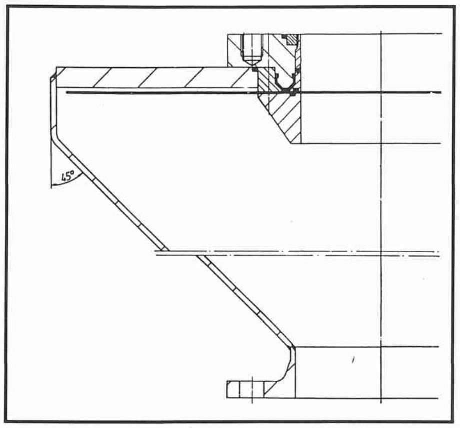
TYPE 'KII'

When it is necessary to close the valve through a stationary column of solids or when solids are passing through the valve as it is closing, then the 'KII' designed is preferred.

This valve is available with all five forms of sealing systems ('G', 'GP', 'P', 'S', and 'F'). The valve body is modified to incorporate an angled slot which intersects the path of the closing slide plate. Any material carried into the valve body, as the slide plate closes, has the possibility to drop, via the slot, back into the downstream pipeline. Any material not recovered in this way is caught in a chamber which is an integral part of the valve housing. This chamber can be cleaned out periodically. The valve is also equipped with purge connections so that an external gas source can be introduced into the body cavities to blow them clear, while the slide plate is moving.

This valve is normally mounted in vertical lines but can also be used in some inclined locations. It is not recommended for horizontal lines.

The 'KII' valve is available in all the same sizes as the standard valves, although dimensions may vary slightly. Materials of construction are the same as the standard valves.



TYPE 'KIII'

When handling a liquid, especially a viscous liquid, the standard Kammerer valves are not normally suitable as the liquid can enter into, and remain in, all the body cavities as the slide plate opens or closes. For this reason the 'KIII' design was developed to eliminate all cavities where liquids could be trapped.

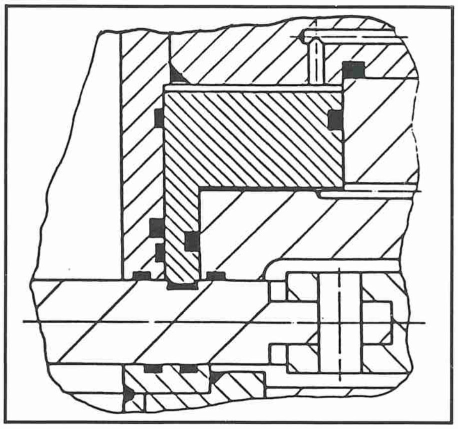
Essentially, the 'KIII' valve comprises the upper part of a standard Kammerer valve body, with a tapered hopper section welded below. The slide plate and spindle are exposed on the lower side to the hopper section. A cast, machined center section locates the slide plate and contains the sealing mechanism which can again be Type 'G', 'GP', 'P', 'S' or 'F'. The hopper section is straight-sided on its two long sides and tapered 45° at the ends. All crevices are eliminated and the valve can be used on the most viscous of liquids without leaving any product in the valve.

The 'KIII' valve is only mounted in vertical lines. Sizes range from 1" NB up to 40" NB. Materials of construction are carbon steel, stainless steel, alloys, etc.

SPECIAL VALVES

Kammerer valves are also available in many special designs to meet requirements not covered by the valves mentioned previously. As there are many variations, any special requirements should be referred to ROSENMUND INC. so that the best design can be submitted.

Two special valve designs have however become 'standardized' and are described below.

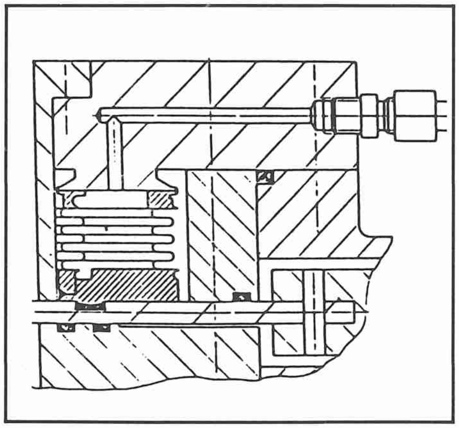


TYPE 'HD'

Specifically for high pressure use from 120 psig to 600 psig pressure differential across the slide plate, the Type 'HD' valve modifies the concept of the Type 'F'. The standard square piston is replaced with a thinner rectangular piston with a profiled surface indenting a gasket material located in the slide plate. The slimmer design of the piston allows greater pressures to be applied against the gasket, thus ensuring a good seal at high pressure.

Two gaskets are normally mounted in the slide plate; one around the orifice to seal the valve body when the valve is open, and one in the solid portion of the slide plate to seal the valve against the differential pressure when the valve is in the closed position.

The Type 'HD' is available in all standard sizes and can be fabricated in all weldable materials.



TYPE 'FBK'

The Type 'FBK' valve is designed specifically for high temperature applications above 500°F where there is also a need to seal against a pressure differential greater than 15 psig. The valve utilizes the same basic design as the Type 'F' but also includes aspects of the Type 'HD'. Temperatures up to 1500°F and pressures up to 450 psig have been successfully handled using this design.

All elastomeric and plastics materials are eliminated. The piston incorporates a profiled lower surface which indents into a high temperature gasket material set into the slide plate, as in the Type 'HD'. The pressure gas moving the piston is sealed from the valve body by means of a flexible metallic bellows welded to the upper surface of the bellows.

Again the 'FBK' design is available in all standard sizes and in all common weldable materials (subject to the temperature requirements).

MATERIALS OF CONSTRUCTION

Body	Silumin (Anodized surface finish also available)
	Cast Iron
	Cast Steel
	Stainless Steel
	Hastelloy
	Other Weldable Alloys
Slide Plate	High Chrome Stainless Steel
	Hastelloy
	Other Alloys
Stem	Stainless Steel
	Hastelloy
	Other Alloys
Guide Ring	Chemical Hard Bronze
	Stainless Steel
	Other Alloys
Seals	EDPM
	Buna N®
	Silicon Rubber
	Viton®
	Teflon®
	Grafoil®
	Italon®
Valve Bore Lining	Any Metal

RANGE

The following represent the limits obtained with Kammerer valves to date:

Pressure . . . . to 600 psig
Vacuum . . . . to 10^{-5} torr abs
Temperature . . . . to 1500°F

We specialize in making valves for individual requirements. Kindly indicate your requirements and we will be pleased to build your valve.

SIZE

Standard sizes are featured on page 2. For sizes not featured, please contact ROSENMUND INC.

Valves are available flanged ANSI 150, ANSI 300, BS, DIN 2502 or DIN 2632. Please contact ROSENMUND INC. for full details.

OTHER PRODUCTS

Also available in the ROSENMUND range of Chemical Process Equipment:

- The ROSENMUND® Filter
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