NEW BIRD "EX-LV" TIMING CROWN AT CF INDUSTRIES

Presented By

Arthur W. Burt Market Manager Fertilizer Industry	AND	Randy Charlot Chief Process Engineer
BIRD BIRD MACHINE COMPANY An EnviroTech company		CF Industries, Inc. Plant City Phosphate Complex

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I. ABSTRACT

After researching the design history of Bird Machine Company's pre-separation timing crown against the success of the Prayon Belgium "AC" design abroad (Bird is a licensee of Prayon), a model of the "ideal crown for filter equipment retrofits" was developed. Direct field observation of the scaling characteristics showed a correlation of scaling to flow velocities and acid strength within the crown. CF Industries (CFI) and Bird reevaluated all the features commonly found in a phos acid distributor and made some surprising changes. A distributor with the New Art timing crown was constructed in Lakeland and installed at CFI's Plant City Phosphate Complex. The new crown significantly reduced equipment scaling problems, provided quicker filtrate separation rates, increased the maximum production rate, and reduced water soluble P_2O_5 losses.

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II. INTRODUCTION

A new pre-separation distributor assembly was recently placed into phos acid service here in Central Florida and, when opened for thorough inspection after six weeks operation, it was found to be free of scale. Significant performance benefits have been realized over the traditional distributor.

A. INSTALLED TIMING CROWN REACHES PRODUCTION LIMIT

Ever increasing production rates at CF Industries (CFI) had reached the hydraulic limits of their "A" train distributor valve. A serious scaling problem required extensive cleaning of the timing crown and vacuum system to be performed on a seven day cycle. A decision was made to replace the distributor.

CFI liked the properties of the Prayon top outlet "AC" valve over their current design e.g.

- internal separation, as opposed to a system of receivers
- increase hydraulic capacity
- low separation velocity
- better efficiency
- less likely to scale
- low pressure drop

Further, CFI was looking for a lower cost domestic supplier e.g.

- replace timing crown only, if possible
- interchangeable or readily available spare parts
- internals readily accessible for inspection, adjustment and service
- save on ocean freight
- minimum energy consumption
- utilize present auto lubrication system to supply the cell bearings and tiltarm rollers
- OEM turnkey installation

B. CURRENT PRE-SEPARATION DESIGN

Although an improvement over the conventional valve, the current design still required frequent cleaning. CFI had talked to users of the four "EX" valves in service and as a result of the scaling problems reported, inquired as to the physical design changes that would be incorporated into the new valve. CFI responded in a positive way to our new ideas and asked, if given the order, whether they could participate in the final design of the improved valve.

III. DISTRIBUTOR DESIGN HISTORY

A. GENERAL

The Bird Prayon Filter is a horizontal, rotating, tilting cell type filter developed in Europe by Société de Prayon of Engis Belgium. Prayon developed the filter for its own use in selling its process for making phosphoric acid (P_2O_5) from phosphate rock and sulfuric acid. Prayon is not a manufacturing company, but licensed others to build fertilizer plants using its process and to build its filters. Bird Machine Company won the license to build the Prayon filter in the Americas. Bird, like most of the other products we have licensed, started by duplicating the original European filter and then redesigned according to the U.S. market, including pursuing and getting patents.

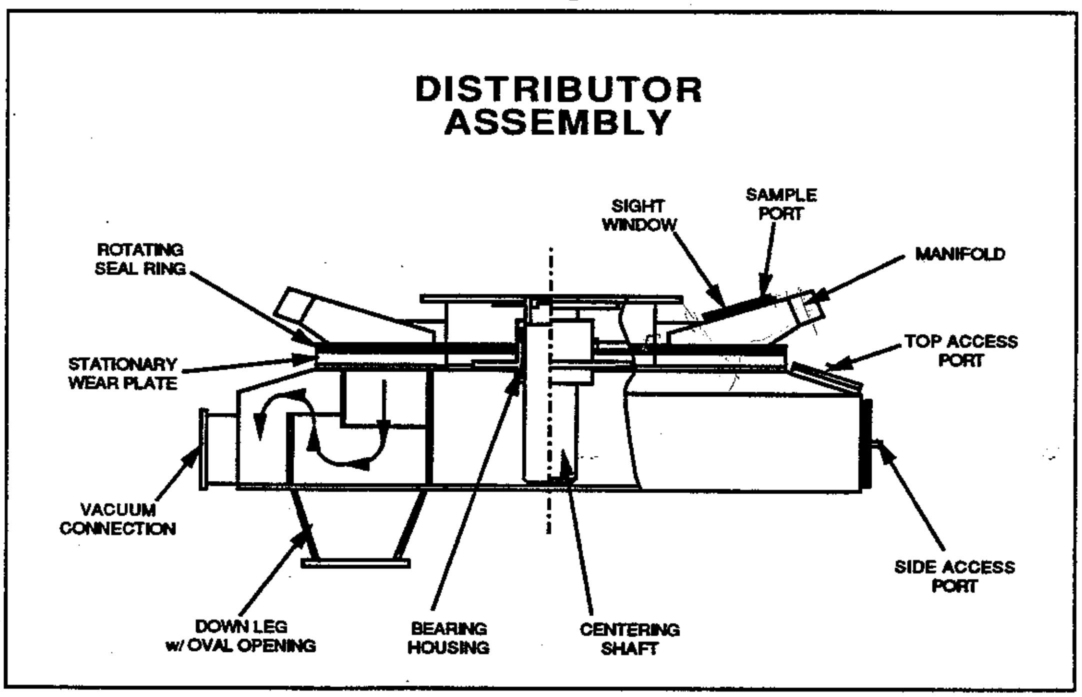
Many things have changed since Bird got into the Prayon filter business. The filter is constantly being used and applied in ways completely different from the initial concept, due largely to changes in the industry. The phosphate industry in the U.S. is very different from Europe. In the U.S., most plants are built right on the phosphate rock mine site and are immediately pushed beyond design limits, especially during fertilizer shortages. This results in speeds, loads, spillage and reduction in maintenance cycles that are considerably more than initial filter specifications.

The U.S. version of the Bird Prayon filter was in constant evolution as we incorporated changes to withstand these new conditions. In spite of the number of moving parts the Bird Prayon filter is a very forgiving piece of equipment - and will continue to function even with near zero maintenance and with many missing or broken parts.

B. DISTRIBUTOR MILESTONES

- ❑ 1960's - the conventional distributor's cast lead rotating manifold was upgraded to stainless steel
- ❑ 1971 - first pre-separation "AC" distributor with top aspiration Central-Prayon hemihydrate filtration
- ❑ 1980's - asbestos filled resin (Haveg) rotating seal rings on stainless steel phased out in favor of UHMW PE - then the material was rolled over "flip flop" putting the UHMW PE on the stationary wear plate with stainless steel rotating on top, resulting in increased utilization
- ❑ 1982 - first pre-separation "EX" distributor with peripheral aspiration
- ❑ 1993 - "EX" distributor redesigned for low velocity, thus "EX-LV" *(fig 1)*

Figure 1



C. THE DEVELOPMENT PROCESS

1. Bird embarked on a study to incorporate the virtues of the "AC" valve into a user friendly format that would be easy to retrofit domestically. The manifold on existing filters was raised immediately after stopping the feed to scrutinize the scaling characteristics. These observations showed a correlation of scaling to flow velocities and acid strength within the crown.

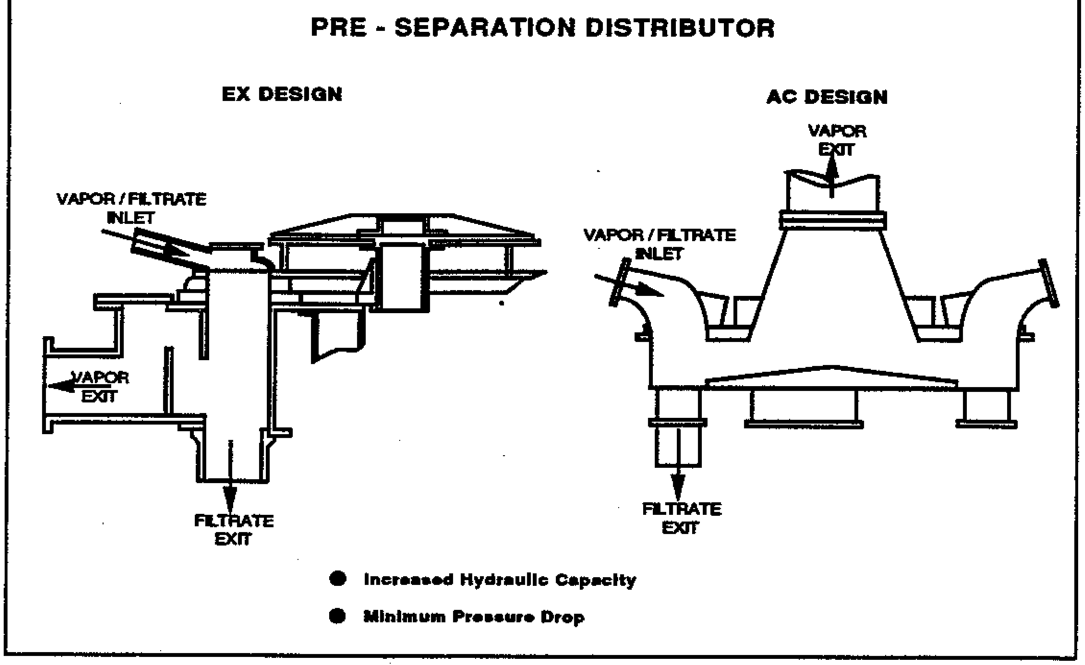
   It was determined to eliminate the windows used to evacuate the gas into the external chamber. The equipment users had expressed a strong objection to the presence of windows because of the frequent scaling in strong acid compartments. As scale formation reduced the window dimensions - both gas flow velocity and rate of scale formation increased.

2. If the "AC" timing crown functions well without an internal wall, then why not eliminate the external wall on the "EX" crown, and with it the nuisance windows? *(fig 2)* Existing equipment could be updated with installation of the new timing crown only - this is possible because all the rotating components from the original unit are reusable. A cardboard model of the new timing crown was fabricated for a presentation to the customer. Needless to say, it was the subject of amusing remarks within the company.

3. Timing crown diameter and height dimensions were derived from velocity calculations based on a dry cake discharge format (two hoppers) and high end CFM vacuum pump requirements determined by the process. This allows Bird to have one standard timing crown size for each machine size. A wet cake discharge format (one hopper), having a larger active surface area and using the same vacuum pump, will benefit from even lower velocities. Most timing crowns will be sold for retrofit on older filters - therefore sizing will be by basic CFM and dry cake format active area, at the original 5CFM/F^2 specification.

   - 10500 CFM 30-EH
   - 9000 CFM 30-D
   - 8000 CFM 30-C
   - 6000 CFM 24-125
   - 5000 CFM 24-C

Figure 2



4. Standard supply:
   - cw rotation
   - cloudy port
   - three oval outlets - filtrates no. 1,2,3,
   - "flip flop" wear plates
   - dual vacuum system
   - three product washes
   - material SS 317L
5. Optional supply:
   - hydraulic lift system
   - steam inlets
6. Accessory items:
   - flange drive
   - wrench member
   - saddle brackets
   - stand pipe support
   - larger primary receiver
   - tension rods
   - turnkey installation

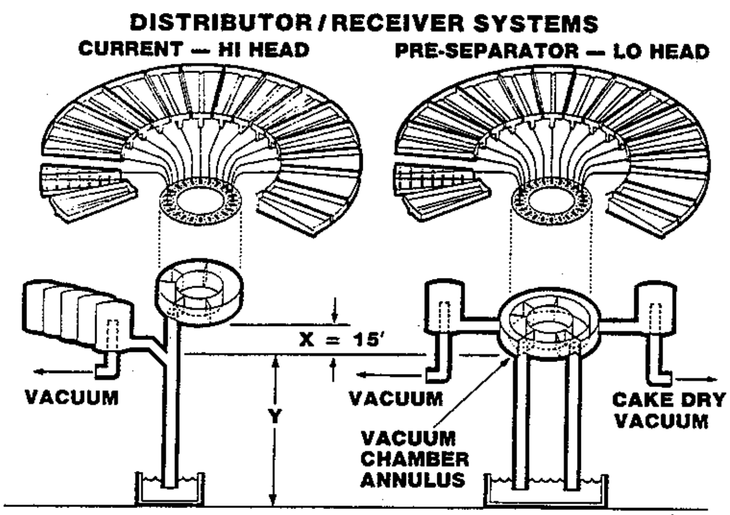
D. DEVELOPMENT AGREEMENT SIGNED WITH CFI, 20 JAN 93

E. CFI PLACED AN ORDER FOR THE FIRST "EX-LV" VALVE IN FEBRUARY 93

to be installed on their "A" Train - Bird model 24-C filter S/N PR 150 (1965). Because of the very high production demands anticipated for this filter, the next larger size distributor was selected - a model 24-125. This decision ruled out the option of installing only a new timing crown.

F. U.S. PATENT GRANTED MARCH 94 - INT'L PATENTS PENDING

Figure 3



	CURRENT	LO-HEAD
BAROMETRIC LEG — HEIGHT	15' + Y'	Y'
RECEIVER/SCRUBBER — QUANTITY	8	5

G. INSTALLATION 19 & 20 APRIL 93 (48 HOURS)

1. The new distributor required two receivers only - previously there were five. *(fig 3)* The cake dry receiver was reused and a new larger receiver was fabricated for the primary system to accommodate the combined gas flows that had previously been separate. CFI elected to combine the weak wash compartment with the cake dry compartment in the secondary vacuum system circuit. The annular primary vacuum chamber had two flanged outlets that were manifolded to a single receiver. Timing crown partitions are designed to be easily moved for compartment sizing. *(fig 4.1 & fig 4.2)*

Figure 4.1

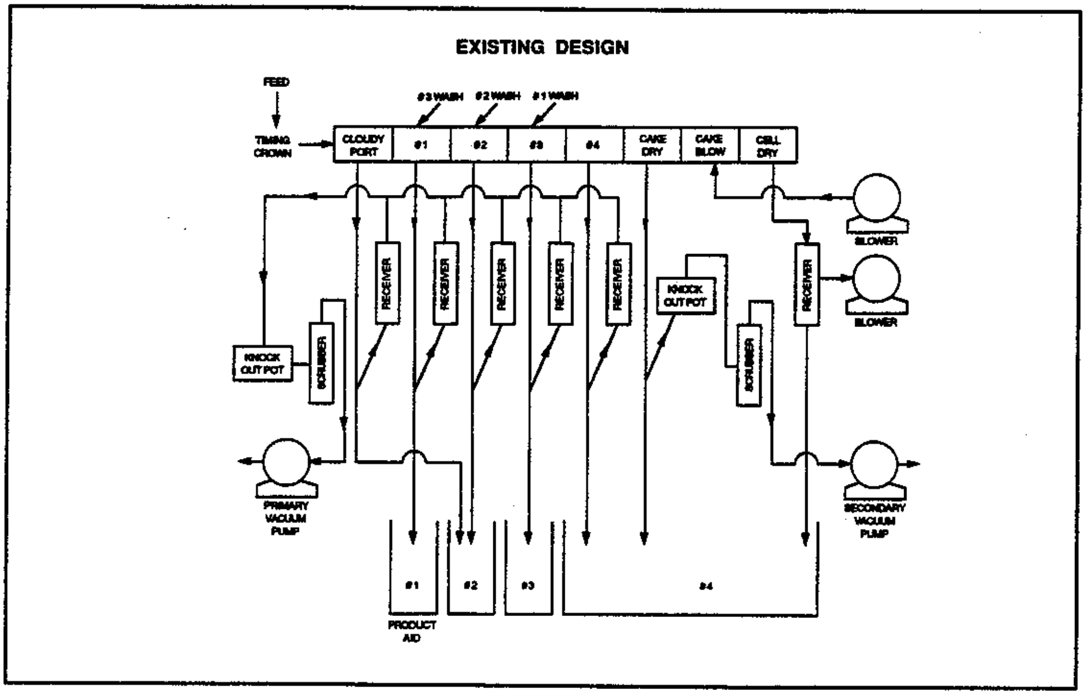
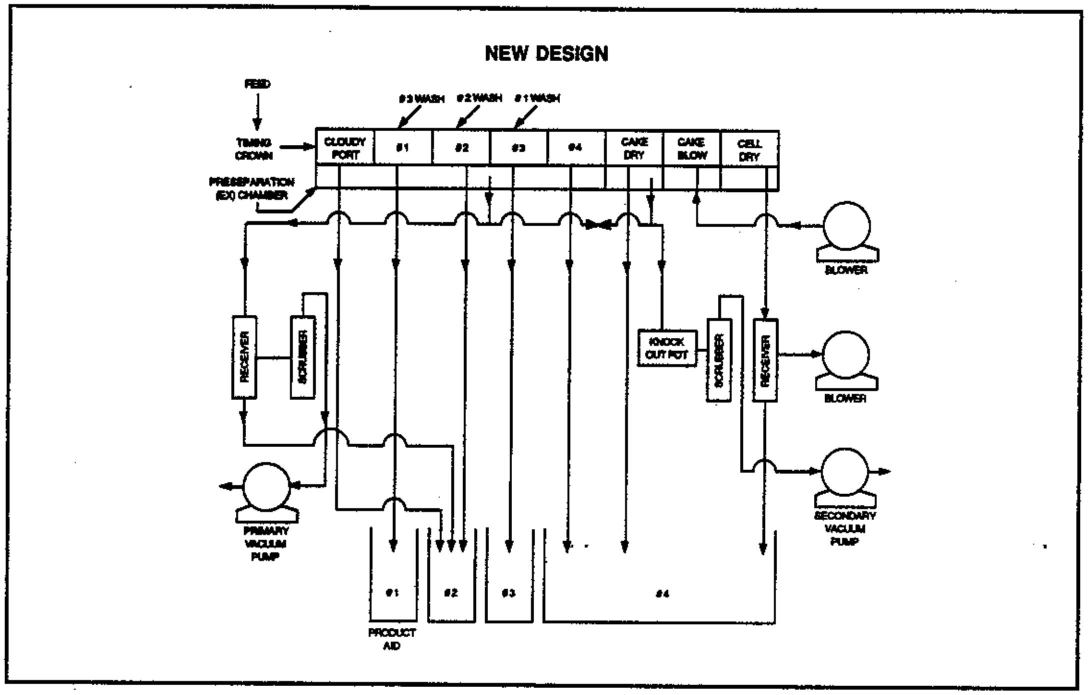
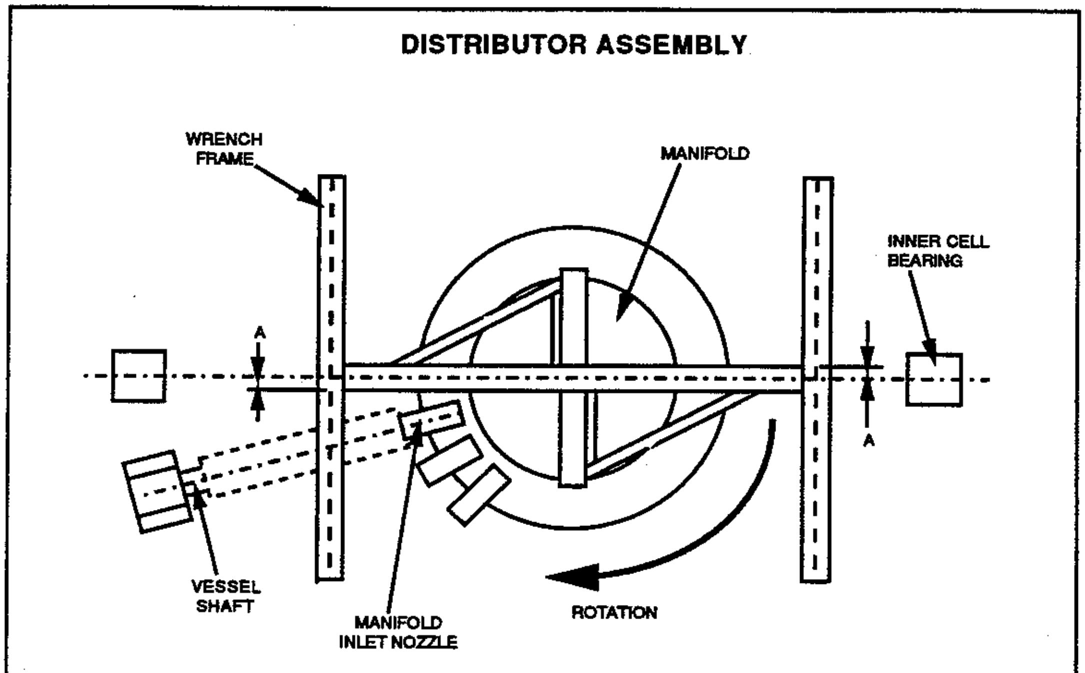


Figure 4.2



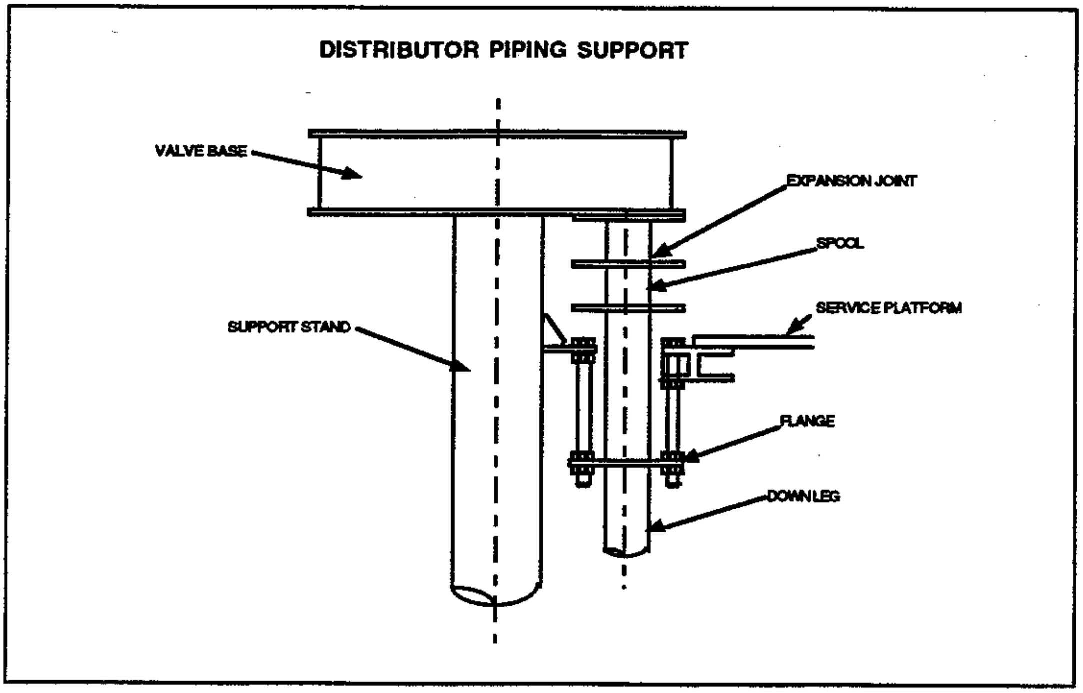
2. A new, larger diameter, centerline stand pipe support was installed to accommodate the selection of a bigger distributor. The filter rotating centerpoint was reestablished at the average center of the present inner anchor bolt circle. The manifold drive wrench member previously had shown about 20mm lateral movement in its brackets with each filter revolution, which indicated an eccentric condition existing between the rotating manifold assembly and the rotating carframe assembly. It should be stressed here that the fixed filter timing - that is the relative cell vessel position when the cake discharge blow or process vacuum is applied - is controlled by alignment of the manifold drive wrench member. *(fig 5)* The cell vessel outlet must rotate in direct communication with the manifold inlet.

Figure 5



3. The new, mechanically efficient, distributor was placed in service 26 April 93 - there were no vacuum leaks at the rotating seal. The barometric piping was supported independent of the timing crown. *(fig 6)* Note that (in most cases) vacuum leaks at the rotating seal are caused by piping load.

Figure 6



H. WHAT ARE THE EXPECTED BENEFITS?

- improved performance over the traditional distributor design
- production capacity increase
- provide quicker filtrate separation rates
- lower pressure drop will increase the filter cake surface dry area
- reduce water soluble P_2O_5 losses
- Efficiency - lower the residual specific gravity
- reduce severe equipment scaling problems
- shorten the weekly systems wash schedule

I. HOW DOES THE NEW VALVE WORK?

1. Pre-separation essentially incorporates the function of filtrate receivers into the distributor valve. A major portion of the filtrate is removed from the gases before they enter a centrifugal separator. The overall efficiency of separation is appreciably greater than what could be achieved with a gravity-type separator alone.

This is the basis for our distributor design for the pre-separation of filtrates. Pre-separation keeps apart the fluids that report individually to the central valve, while it has the ability to separate those which arrive as a suspension. Inertial separation is provided in two stages. The first occurs in the channel of the crown, where the gasses must turn through 180° to pass under the inner annular baffle, which communicates with the peripheral chamber. The second stage of inertial separation occurs in the peripheral chamber, as the gasses must again turn through 180° to pass over the outer annular baffle, which communicates with the multiple outlet ports leading to the centrifugal separator. *(fig 7.1 & fig 7.2)* The disengagement area is sized for minimum gas velocities. *(fig 8)*

2. Building height required for a new filter installation operating with a barometric leg is substantially reduced when selecting a pre-separation distributor. The traditional "Y" connection to the receivers is eliminated, and the timing crown (thus the filter) is installed at a lower elevation. *(fig 9)*

3. A number of years ago Bird sold filters to engineering contractors or clients who had experience only with Lurgi, Giorgini, and Eimco filters. For these filter installations the filter manufacturer had recommended that the filtrate and gases from the distributor be piped directly to the receivers. The separation of filtrate and gases occurred in the receivers, but this separation was accompanied by scaling which made it necessary to clean out the receivers after only one or two days of operation.

   To decrease this scaling problem Bird followed Prayon's suggestion to recommend that the piping from the distributor go directly to the seal tanks and provide a "Y" in this vertical piping for a connection to the receivers.

Figure 7.1

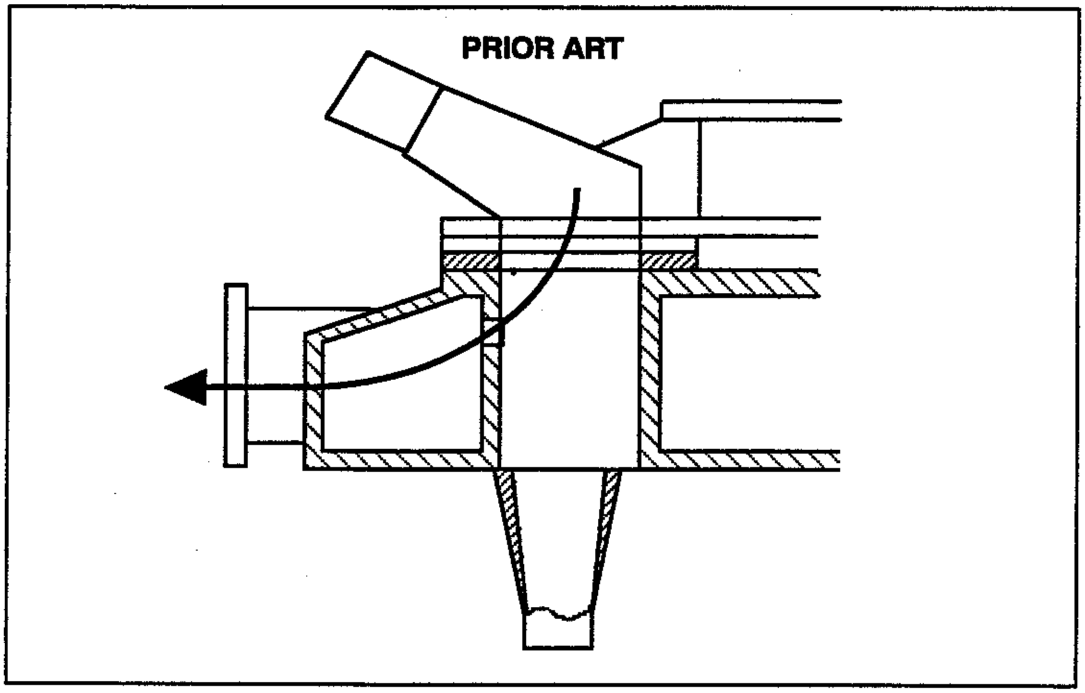


Figure 7.2

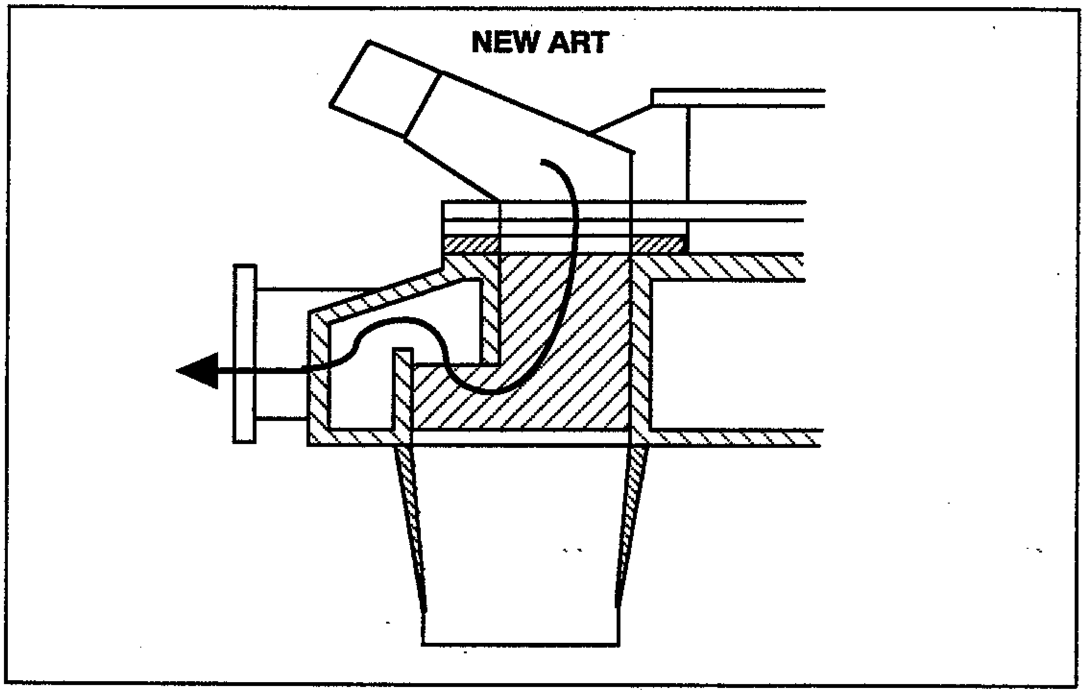


Figure 8

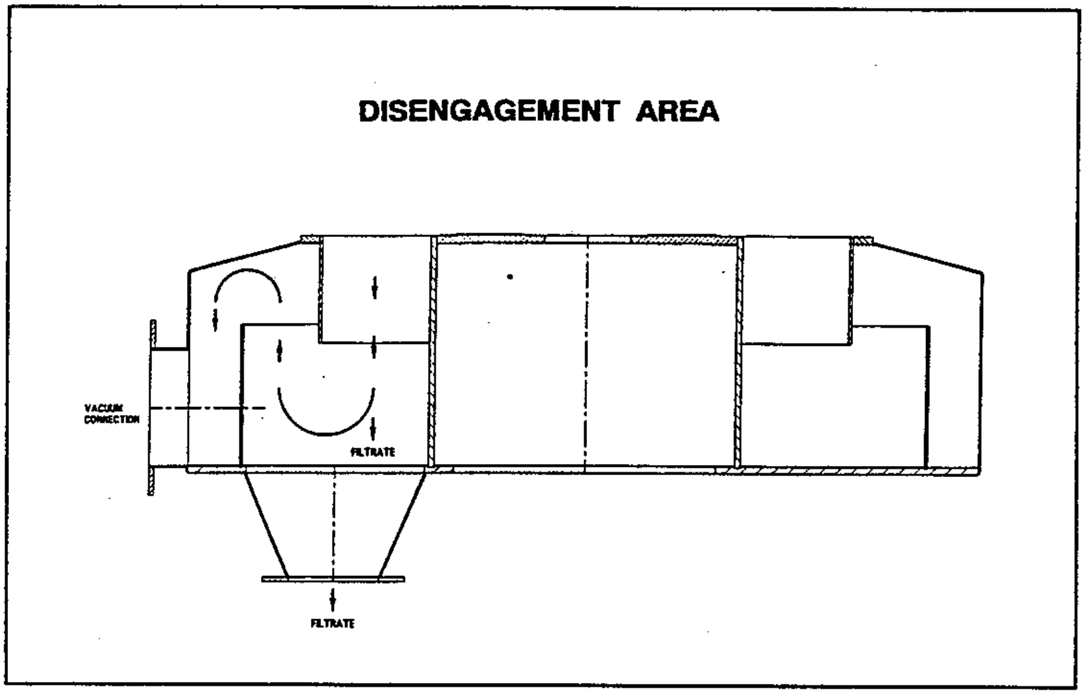
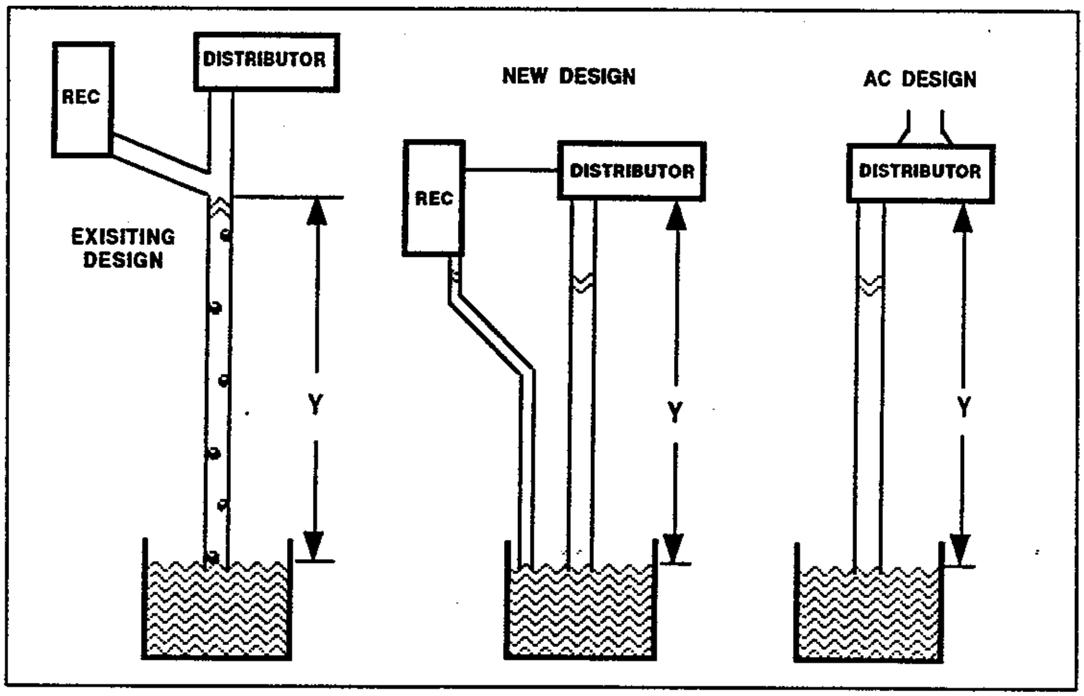


Figure 9



This decreased the frequency of cleaning scale from the receivers appreciably, but another problem appeared. The filters could not be operated at a vacuum level as high as they had been designed for without flooding the "Y" connection in the barometric piping. Fluid friction losses in the barometric piping had an insignificant influence on this condition, since this piping was always oversized appreciably to allow for some scaling to take place.

It was then postulated that entrained gas bubbles in the filtrate were causing the liquid level in the barometric piping to rise higher than contemplated in establishing the design elevations. With the previous arrangement, where none of the filtrate by-passed the receivers, there was more opportunity for disengagement of entrained air bubbles from the filtrate than with the "Y" connections used to pre-separate gases from the filtrate.

Tests were conducted at several installations to evaluate this postulation. Before conducting the tests, the piping was inspected to ensure that it was clean. One end of a length of transparent tubing was connected to the same vacuum source that supplied the receiver being evaluated. The other end of the tubing was immersed in the liquid of the tank, which provided a barometric seal for the receiver. The tubing was positioned vertically next to the barometric pipe, so that vertical distance between the liquid level in the tubing and the "Y" in the barometric pipe could be measured easily. The inspection port in the top of the receiver was provided with a transparent cover. With the assistance of a light it was possible to observe conditions inside the receiver while the filter was operating. The vacuum pump had been oversized - to draw a vacuum capable of raising the liquid level in the barometric seal pipe as high as the elevation of the "Y" connection for the receiver. The vacuum level was adjusted by a vent valve in the vacuum supply line.

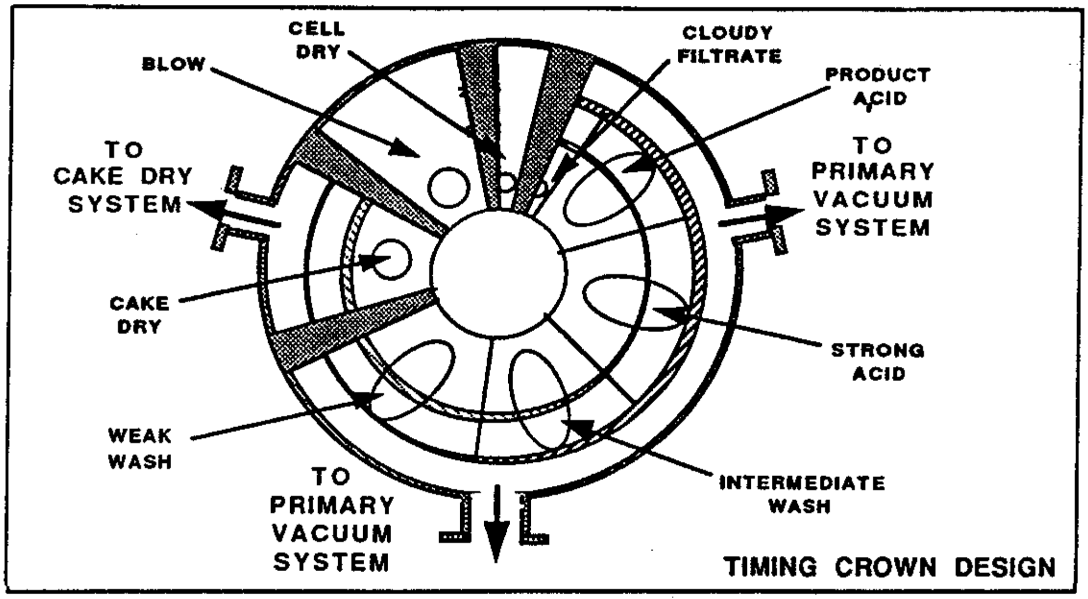
The vacuum level was raised until abnormally large quantities of liquid and foam were observed through the inspection port of the receiver. This indicated that the liquid level in the barometric pipe, connecting the distributor to the seal tank, had raised sufficiently to flood the "Y" connection for the filtrate receiver. The vertical distance between the liquid level in the transparent tubing and the "Y" connection was measured at this time. The liquid in the tube contained essentially no entrained gas bubbles since it was immersed in the zone, but away from the barometric pipe.

In all the tests it was indicated that the effective specific gravity of the filtrates, while in the barometric pipe, was reduced significantly by the entrained gas bubbles. The vertical distance between the liquid level in the transparent tubing and the "Y" connection to the receivers was no less than 1.5 meters in all instances and as much as 2.0 meters in several.

Conversely, pre-separation keeps apart the fluids that report individually to the central valve. The absence of entrained gas bubbles allows the liquid level in the barometric pipe, connecting the distributor to the seal tank, to be similar to the liquid level in the filtrate receiver seal leg. Recent development of the elliptical filtrate outlets reduces emulsion between filtrate and gasses at the top of the barometric leg. *(fig 10)* There is less heat transfer from the filtrate and the result is reduced scaling in the piping. The ellipses have been rotated 90° to a radial orientation that allows more land area for compartment sizing.

Relatively similar conditions for gas disengagement are present in both the Prayon or Bird distributor design for pre-separation of filtrates. The actual elevation of the filter to provide a barometric leg would depend upon the number and orientation to the receivers selected.

Figure 10



4. Performance being very similar - selection of the "EX-LV" design or the "AC" design timing crown depends on the type of project being considered. On a retrofit project it would be prudent to choose the OEM's improved design. Changing complete systems and auxiliaries could prove very costly and the learning curve returns to zero. Similar considerations follow a new expansion installation, as well as interchangeability of common spare parts such as UHMW PE wear plates and SS seal rings. Selection of a distributor design for a grass roots plant should consider the timing crown' s individual design features and characteristics.

"EX-LV" - BIRD U.S. DESIGN

- peripheral suction of gasses
- permits secondary vacuum pre-separation
- less vacuum load imposed on the wearing seal surface, bearing pressure on the "EX-LV" is less than on the "AC"
- less torque required to turn the manifold, "EX-LV" driving torque is less than the "AC"
- rotating center permits assisted manifold lift and auto lube system to cell bearings and control arm rollers.

"AC" - PRAYON EUROPEAN DESIGN

- central suction of gasses for primary vacuum
- lower level installation if equiped with only one vacuum circuit
- secondary vacuum is by conventional system
- internal volume less affected by scale formation
- external cloudy partition adjustment

5. The cell dry port vents air to remove the filter cloth ballooning, caused by the cake discharge blower, to prevent irregular cake formation in the feed zone. For a time consideration was given to expanding the role of the cell dry exhauster. It was thought that the effective filtration area could be increased by extending the cell dry port and allowing it to apply a low vacuum to each cell while slurry was being fed, rather than waiting until each cell was full before applying the main vacuum. This proved to be a mistake, since even the low cell dry vacuum was sufficient to draw small particles into the openings of the filter cloth, rather than allowing time for the larger particles to settle and "precoat" the filter cloth. Precoating also helps in minimizing solids content of product acid. In these installations it was indicated that the capacity of the filters increased 15-25 % when the exhausters were turned off.

   With the cell dry port open during feeding, and no vacuum applied, the weight of the slurry forced the air under the wet filter cloth to exhaust through the cell dry port. Some of the initial filtrate would also get into the cell dry port, the quantity depending upon the speed of the filter and openness of the cloth. This minor quantity of initial filtrate has a high solids content and tends to scale in the cell dry port that is particularly vulnerable to scale since, in many cases, it drains out the side of the crown. Consequently, to deflate the filter cloth before slurry feed, an exhauster or some source of vacuum must be tied into the cell dry. The air is vented to remove the ballooning caused by the cake discharge blower, otherwise irregular cake formation will result.

6. The cloudy filtrate port minimizes product acid dilution coming from cloth wash water and no. 4 filtrate carryover, and minimizes solids content of the product acid. Some years ago customers discontinued use of the cloudy filtrate ports because, in many of the earlier designs, it was difficult to keep the cloudy filtrate port and/or lines operative due to scaling. In later designs where separate cloudy port receivers were installed and steam taps added to the distributor crown, scale problems were reduced. Today, many filters are being operated at rates far above design capacity with very little if any "surface dry" time between initial dewatering and strong wash dewatering. Under these conditions an appreciable quantity of initial filtrate (that could have been available for a cloudy filtrate cut) is dewatered with the strong wash, which reduces the quantity available far a cloudy port cut.

7. Typically the filter is equipped initially for a three wash system. This same equipment would suffice for a two wash system although, obviously, some of it would not be required had only two washes been specified initially.

   The objective is countercurrent piston displacement washing where the high strength acid coating on gyp crystals is ultimately replaced with pond water.

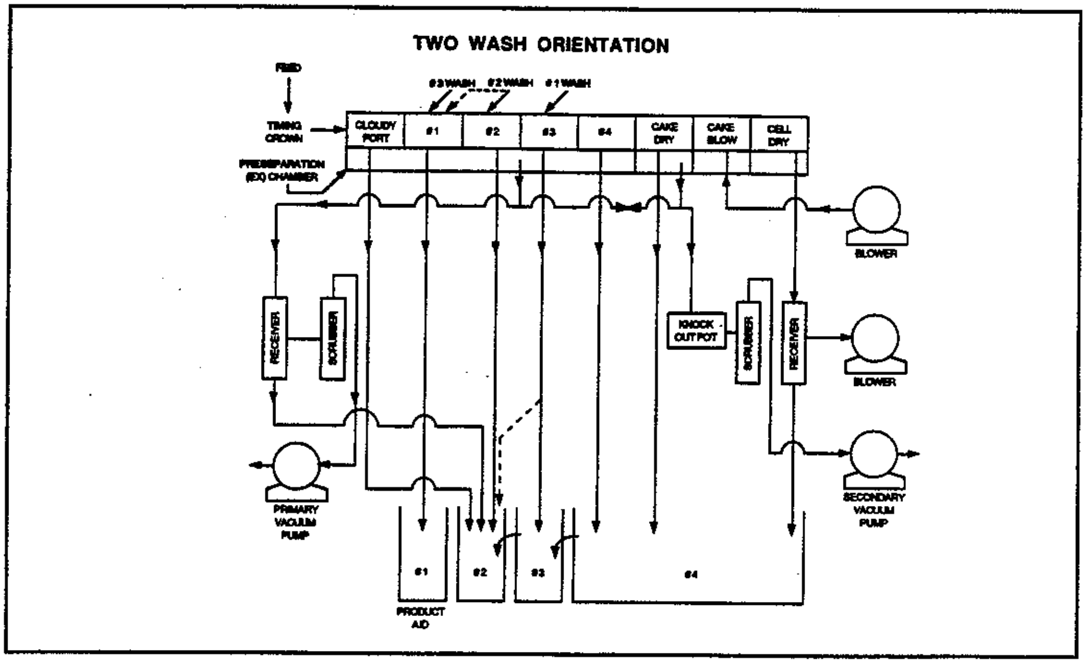
   A two wash system advantage is more available production - a two wash system penalty is, either higher P_2O_5 losses, or more water to evaporate.

   To explain what changes would be required to change a three wash system to a two wash system, it is first necessary to make a tentative designation of which filtrates go where in a three wash system. For a three wash system there would be four filtrate seal tanks. The #1 seal tank would receive the second fraction of filtrate collected from initial dewatering and, except for the portion that would be returned to digestion to maintain fluidity, it would leave the process as product acid nominally at 32% P_2O_5.

The # 2 seal tank would receive the first fraction of the filtrate collected from initial dewatering usually designated as the cloudy port cut. It would also receive the strong wash filtrate immediately following initial dewatering.. Both of these filtrates would be returned from #2 seal tank to the digestion system. The #3 seal tank receives the intermediate strength of wash filtrate that reports just after the strong wash filtrate. The #4 seal tank receives the weak wash filtrate that reports just after the intermediate strength filtrate and it also receives the filtrate from the final cake drying zone.

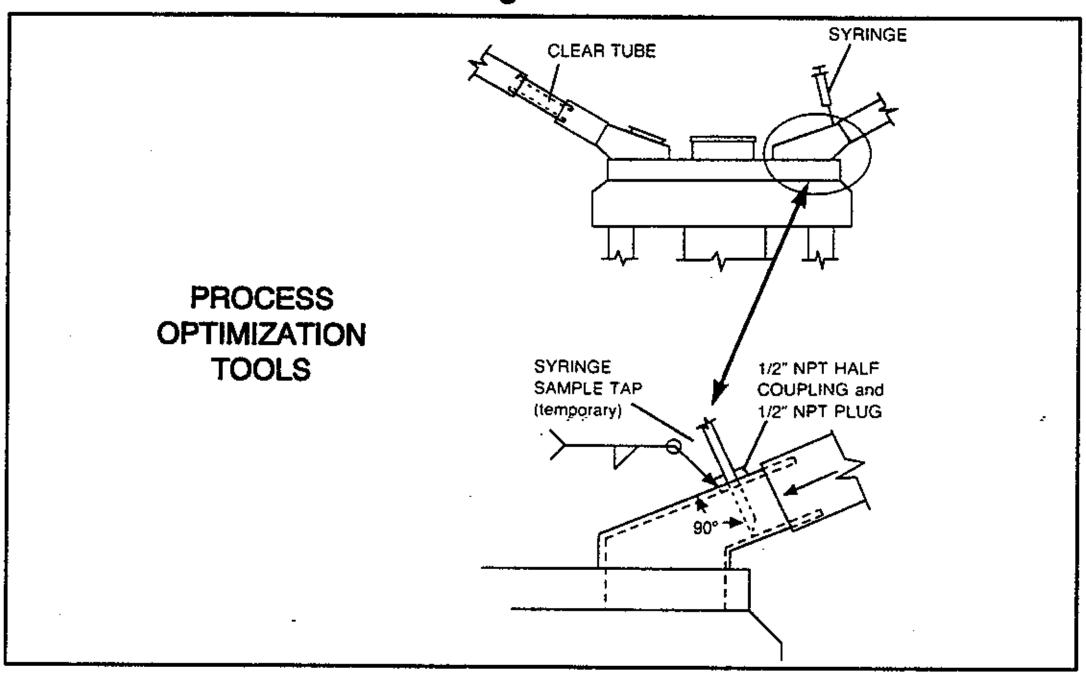
When comparing a three wash system to a two wash system, the relative time required for initial dewatering and also dewatering the water applied as the last wash would be very nearly the same. However, dewatering the strong wash liquor an a two wash system will normally take just about as much time as dewatering both the strong and intermediate wash liquors in a three wash system. When changing from a three wash system to a two wash system the best approximation would be to have the filtrates, normally designated as the strong and intermediate filtrates in a three wash system, both report to the #2 seal tank. The simplest way of accomplishing this is (1) have #3 seal tank suitably located and equipped to overflow into the #2 seal tank and (2) have sufficient flexibility in the hose connection on the wash box, which receives its flow from #4 seal tank, so that this wash box can be advanced far enough to apply wash soon enough after initial dewatering. Then (3) turn off the pump whose intake is connected to the #3 seal tank. It would also be possible to reroute one filtrate line to accomplish this, such as having the intermediate strength filtrate line report to the #2 seal tank - instead of #3 *(fig 11)* and allow the #4 seal tank to overflow into the #3 seal tank. In this case very little movement would be necessary as the #4 seal tank pump would be turned off and the pump connected to the #3 seal tank would transfer weak wash filtrate to the first wash box that would be approximately in the same position for either a two or three wash system. In this case less flexibility would be required in the connection to the wash box.

Figure 11



It should also be mentioned that if there is insufficient flexibility in the wash box piping to move the intermediate strength wash box up to the appropriate location of the strong wash box, the piping to the intermediate wash box could be rerouted to the strong wash box. This line is normally smaller and more accessible for rerouting than the piping used for the barometric legs.

Figure 12



In either of the two methods used in changing from a three wash to a two wash system, the location of the partitions in the crown should be checked during operation through either the clear vacuum tube *(fig 12)* or through the inspection window in the distributor manifold. It would not be necessary to remove the partition separating the strong and intermediate wash filtrates unless it was decided to take the #2 filtrate separator out of service. This separator would not have been supplied for only a two wash system and of course is not a factor in a pre-separation valve.

If this separator were taken out of service on an existing valve, then a partition only half as high as the full partition would be installed in a location between what would have been the strong and intermediate strength filtrates on a three wash system. This arrangement would allow the application of vacuum over the top of the half partition to the first part of the strong filtrate dewatering, while the bottom half of the partition would prevent the major portion of the strong filtrate flow from going down the seal leg that is still connected to the #3 filtrate separator. This arrangement would optimize separator efficiency and minimize scaling.

8. Primary and secondary vacuum systems - the main advantage of the dual pump system insurance of a high vacuum level in the product acid and cake wash filtration zones when there are surface dry areas on the filter. It is the flooded cake surface that creates the best pressure drop across the filter media. Excessive surface dry area is preliminary to cake cracking. With only one pump and a cracked cake, most of the external airflow through the cake will take the path of least resistance which is to short circuit through the opening; vacuum, and hence filtration efficiency over the entire filter, could be affected.

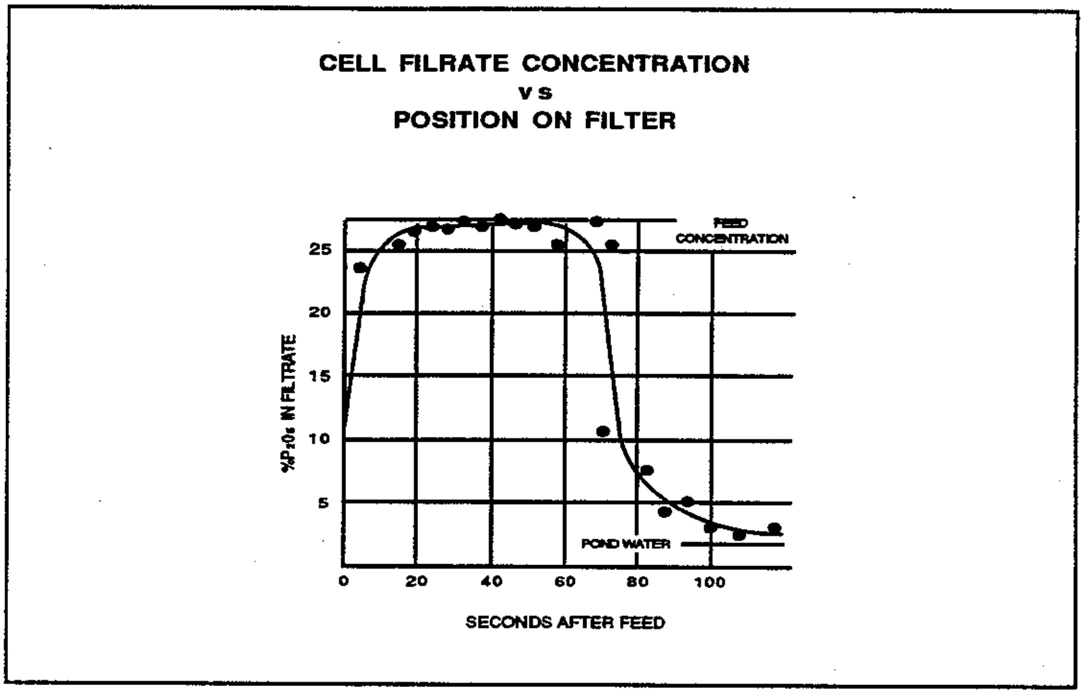
Recently most producers operate at very high rates which keep the cake mostly surface wet and the second vacuum pump becomes redundant.

In fact, the seal bridge between the two vacuum systems becomes a blind area lost to filtration. However, a plant with a single vacuum system must still have a spare pump available, since CL-4000 and CL-6000 series pumps are not stock items.

9. Bird is constantly evaluating customer experience and from this has developed a Filter Optimization Procedure that is available to users for the asking.

   Observations and sample analysis are used to compile a filtrate strength profile that is helpful to set up the filter's operating parameters. *(fig 13)*

Figure 13



'V. PROCESS EVALUATION OF NEW BIRD EX-LV CENTRAL DISTRIBUTING VALVE - CF INDUSTRIES

A. PROJECT OVERVIEW

The "A" Phosphoric Acid Plant at CF Industries Plant City Phosphate Complex is a 500TPD P_2O_5 Dorr - Oliver phosphoric acid plant with a 24C Bird Filter that was constructed in 1965. A new central distributing valve was needed because of the age of the valve, extensive filtration circuit scaling problems, and hydraulic limitations of the valve. CF Industries approached Bird with a request for a new central distributing valve with increased hydraulic capacity and improved filtrate separation efficiency. Bird's new design central distributing valve with low velocity pre-separation was openly embraced by CF Industries. The new valve was constructed and installed in the "A" Phosphoric Acid Plant in April 1993 as part of a filter improvements project. *(Table 1)*

TABLE 1

FILTER IMPROVEMENT PROJECT - SCOPE OF WORK

- **317L BIRD 24-125 EX-LV CENTRAL DISTRIBUTING VALVE**
- **48" 317L PRIMARY VACUUM RECEIVER**
- **36" 317L SECONDARY VACUUM RECEIVER**
- **16" 316L VACUUM HEADER**
- **12", 10", AND 8" UHDPE FILTRATE SEAL LEG PIPING**
- **SET OF 24C FILTER CELLS WITH INCREASED FILTRATION AREA**
- **CELL HOSES**
- **317L FILTER WASH BOXES INCLUDING A 4th WASH BOX.**
- **904L FILTER FEED BOXES**
- **180PSIG HP CLOTH WASH SYSTEM & 316L SPRAY HEADER**

Following completion of the project, 6 months of operating data was compiled for a project evaluation. The project was evaluated for filtration circuit scaling characteristics, increased P_2O_5 production capacity, and increased P_2O_5 recovery.

B. REDUCED FILTRATION CIRCUIT SCALING

Visual observations of scaling characteristics before and after installation of the new central distributing valve were made. Observations indicate a significant reduction in filtration circuit scaling. Reduced scaling has resulted in less plant down time for filtration circuit cleaning.

1. SCALING CHARACTERISTICS WITHOUT NEW CENTRAL VALVE

Before installation of the new central distributing valve the filtration circuit had extensive scaling problems. The worst scaling occurred in the zone of filtrate separation; the filtrate receivers, 45° elbows connecting the receivers to the filtrate seal legs, and the primary vacuum acid trap. Prior to the installation of a new central distributing valve all filtrate receivers and the acid trap were opened and cleaned on a weekly basis. The need for weekly cleaning of the filtrate receivers typically resulted in an extra half hour of down time per week.

2. SCALING CHARACTERISTICS WITH NEW CENTRAL VALVE

The first inspection of the new central valve after 1 week of operation revealed no scaling in the central valve or filtrate receivers. Visual inspections after 6 weeks of operation revealed minor scaling along the sides of the central valve's external chamber and the connecting vacuum header. A soft gypsum deposit in the bottom of the external chamber was found and is believed to be caused by backwashing through the filtration circuit into the central valve. The new primary filtrate receiver and acid trap had no appreciable scale formations. No physical cleaning of any equipment was required at the end of the first 6 weeks of operation. Over one year of operation has shown that cleaning in the external chamber of the central valve and connecting sections of the vacuum header is needed about once every 12 weeks. Scaling in the two filtrate receivers and acid trap is almost non existent.

C. INCREASED P2O5 PRODUCTION CAPACITY

The new Bird EX-LV Central Distributing Valve provided 12" diameter elliptical filtrate drains as compared to 10" concentric filtrate drains on the replaced valve. Larger size filtrate drains and internal filtrate/vapor separation provided increased hydraulic capacity for the valve. The new valve helped the plant increase its permitted production capacity by 13%. A 6 month comparison of actual production rates before and after completion of the filter improvements project indicated a 7% increase in average production rates. Production rates may increase further when restrictions in evaporation and wet rock grinding are overcome.

D. IMPROVED P_2O_5 RECOVERY

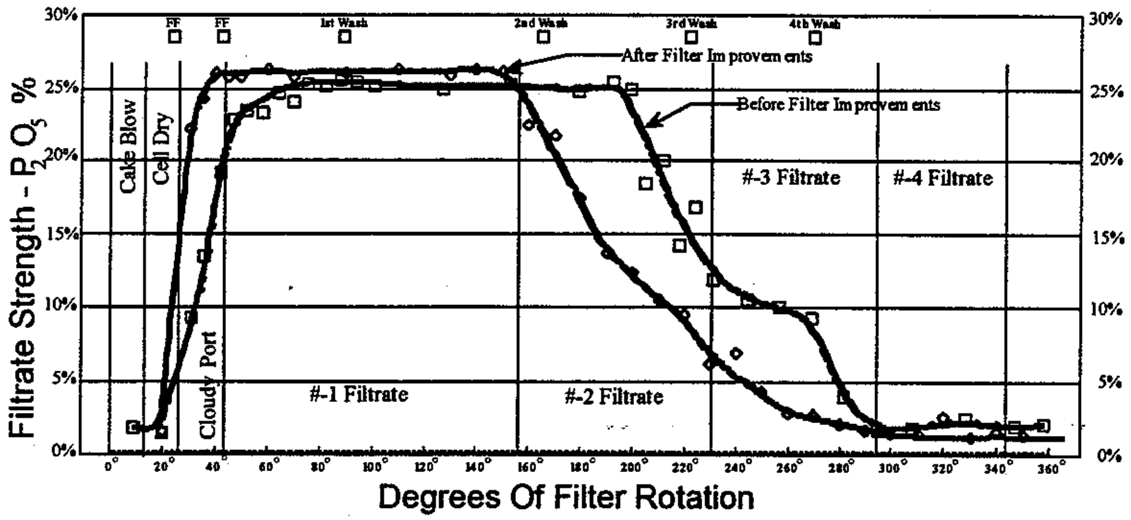
Comparative analyzes of filtration performance before and after completion of the "A" Phosphoric Acid Plant Filter Improvements Project suggests that the project resulted in P_2O_5 recovery improvements. Central distributing valve filtrate profiles, filtration circuit pressure drops, #4 filtrate specific gravities, and filter cake analyzes were used to evaluate P_2O_5 recovery.

1. CENTRAL DISTRIBUTING VALVE FILTRATE PROFILES

Profiles of filtrate strengths were developed by collecting filtrate samples with a 60ml syringe at 5° & 10° increments around the filtration circuit. A filtrate profile taken several days after completion of the filter improvements project was graphically compared to a pre-filter improvements profile. The graph showed a 20° shift in the filtrate profile curve for the post filter improvements survey. *(Figure 14)* The observed increase in filtrate drain rate and the lower indicated #4 filtrate P_2O_5's are believed to be indicative of improved P_2O_5 recovery in the filtration circuit. More recent filtrate profiles have shown a tendency to shift back toward the pre-filter improvements filtrate profile curves.

Figure 14

"A" Phosphoric Acid Plant - Central Distributor Valve Filtrate Profile
Pre/Post Filter Improvements Project Comparison



2. **REDUCED FILTRATION CIRCUIT PRESSURE DROPS**

A pre-filter improvements survey of the pressure drop between the primary vacuum pump and the cell hose indicated an average 2.6" Hg pressure drop. A post filter improvements pressure drop survey measured a 1.5" Hg pressure drop across the central distributor and filtrate receivers or 58% of the pre-filter improvements pressure drop. Lower pressure drops through the filtration circuit will result in a higher differential pressure across the filter cake, improved P_2O_5 recovery, and reduced scaling in the filtration circuit.

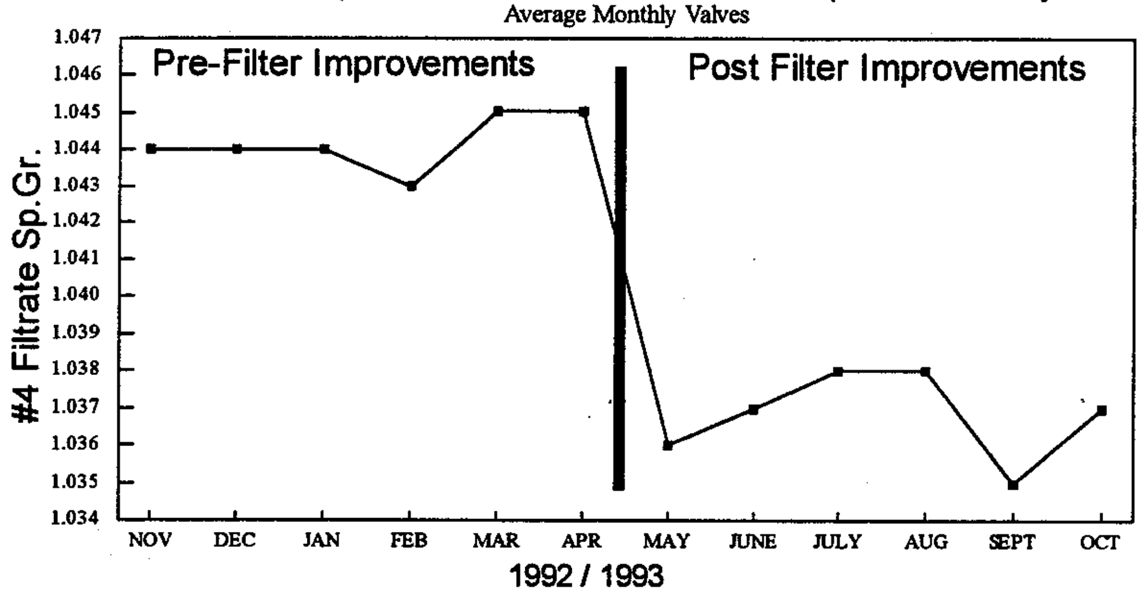
3. **LOWER #4 FILTRATE SPECIFIC GRAVITIES**

A comparison of 6 months of hourly #4 filtrate specific gravities before and after completion of the filter improvements project showed an average reduction in #4 filtrate specific gravities of 0.007. *(Figure 15)* Past correlations between #4 filtrate specific gravities and P_2O_5 recovery have indicated that the observed reduction in #4 specific gravity is associated with a 0.2% reduction in water soluble P_2O_5 losses. A broader 12 month comparison of #4 filtrate specific gravity shows the margin between the pre & post filter improvements periods narrowing to 0.003. However, production rates and filter wash water strengths were higher throughout the post filter improvements period.

Figure 15

"A" Phosphoric Acid Plant - #4 Filtrate Specific Gravity

Average Monthly Valves



4. **FILTER CAKE ANALYSIS**

Filter cake analyses were compared for a 6 month period before and after completion of the filter improvements project. Filter cake moistures averaged 7.4% lower in the 6 month period following completion of the filter improvements project. Water soluble P_2O_5 losses as calculated from filter cake analyses were found to be 8.9% lower in the post filter improvements period. These improvements in filtration occurred over the same time period that plant production rates averaged 7% higher.

E. EVALUATION SUMMARY

The new Bird EX-LV Central Distributing Valve was a major contributing factor to the success of the "A" Phosphoric Acid Plant Filter Improvements Project at CF Industries. The new valve eliminated extensive scaling problems resulting in reduced plant down time for cleaning. The new central valve was a contributor to increased production rates by providing increased hydraulic capacity, and reduced filtration circuit pressure drop. The new central valve also appears to have contributed to improved P_2O_5 recovery by improving filtrate/vapor separation, and increasing filtrate drain rates. CF is currently considering installing a new Bird EX-LV Central Distributing Valve on the "B" Phosphoric Acid Plant 30C filter during the turnaround scheduled for early 1996.

V. SUMMARY

Significant performance benefits have been realized

over the traditional distributor as listed below:

- **Increased Capacity** - production increase
- **Increased Efficiency** - residual specific gravity reduced
- **Increased Utilization** - inspection done each twelve weeks
- **Low Dilution** - higher product acid strength
- **Low Entrainment** - the timing crown, the primary and secondary receivers, as well as the connecting piping remain clean
- **Low Pressure Drop** - significant increase in filter cake surface dry area
- **Two Receivers Only** - previously there were five
- **Mechanically Efficient** - No vacuum leaks at the rotating seal

VI. ACKNOWLEDGMENTS:

1. RK Allison, Product Manager BMCO, retired
2. John Roos, Product Manager BMCO, retired
3. A. Davister, Director PRAYON, retired