UCEGO FILTERS

IN PHOSPHORIC ACID PRODUCTION

ERRATA SHEET

I. INTRODUCTION

1st paragraph: Should read---"UCEGO° Filter (A trade mark of Societe Rhone Poulenc.")

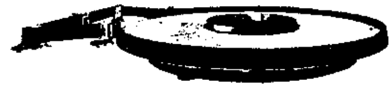
II. Page 5.

3rd paragraph: Delete all after; "began to take shape." Read: "All of these features were put together during the design study with the main objective being a horizontal table filter. The filter was named UCEGO° and trade marked by Societe Rhone-Poulenc, who remains the owner of the trade mark today.

III. REFERENCE LIST

Delete "Courtesy of F. Aoustin & Cie",
Read: "Courtesy of Societe Rhone-Poulenc."

Aoustin Murray, Inc.
UNITED STATES REPRESENTATIVE UCEGO® FILTRATION SYSTEMS



UCEGO FILTERS

IN PHOSPHORIC ACID PRODUCTION

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INTRODUCTION

THE F. AOUSTIN & CIE. AND AOUSTIN-MURRAY COMPANIES ARE VERY PLEASED TO HAVE THE OPPORTUNITY TO PRESENT THE UCEGO° FILTER TO THE MEMBERS AND GUESTS OF THIS CONVENTION.

IT IS THE INTENTION OF THIS PAPER TO PRESENT A BRIEF HISTORY OF THE FILTER, THE REASONS FOR IT'S DEVELOPMENT AND THE METHODS USED TO HELP SOLVE THE VERY DIFFICULT PROBLEMS OF PHOSPHORIC ACID PRODUCTION.

REFERENCES MADE HEREIN TO OTHER FILTER TYPES OR METHODS ARE STRICTLY IN THE GENERIC SENSE AND ARE CITED ONLY TO ILLUSTRATE THE REASONING FOR INNOVATIONS IN THE UCEGO° FILTER.

UCEGO° FILTERS IN PHOSPHORIC ACID PRODUCTION

I. UCEGO HORIZONTAL TABLE FILTER

A. HISTORY (1)

1. In 1953, Rhone-Poulenc (formerly Pechiney St. Gobain) devised a phosphoric acid manufacturing process which they patented in 1955 and which they have used successfully ever since.

2. They not only built plants in their own companies for their own needs but they also granted licenses to engineering companies who built plants throughout the world.

3. With Rhone-Poulenc constructing phosphoric acid plants in either their own or in associated companies, they were forced to buy a filter from among those available on the market.

4. They therefore used filters of all types, including tilting pan, tray-belt, continuous belt and table filters.

Unfortunately, filters available at the time had major disadvantages associated with the design concept. The outcome therefore, was sometimes poor yield, corrosion problems, limitations in practical sizes and high maintenance costs.

Being forced to modify, adapt, study and improve various types of filters used in its numerous plants, Rhone-Poulenc acquired a sound knowledge of filtration in general and phosphoric acid in particular. This is why they eventually decided to develop a filter, tailored to fit the needs of phosphoric acid production instead of trying to improve and adapt filters made by others.

In 1961, Rhone-Poulenc undertook a study with their associated company, Chimique Belge, to develop data pertaining to phosphoric acid production. In this study, they endeavored to be completely objective and scientific and to apply their findings to the construction of a filter to meet the demands of phosphoric acid production.

In order to define the parameters for the filter, let us first take a look at some of the basics of filtration.

II. REVIEW OF SOME THEORETICAL ASPECTS OF FILTRATION

A. MECHANISM OF FILTRATION

In the case of filtration of phosphoric acid slurry, a relatively thick layer of solids, or filter cake, is formed on the filter cloth.

As soon as the first layer is formed it acts as the filter medium and the effect of the filter cloth becomes more and more negligible as the thickness of the cake increases.

This cake is composed of an agglomeration of small particles of more or less regular form. It is porous, i.e., in the interior of the mass there are small capillary passages linking the upper surface with the lower surface. The liquids to be filtered flow through these capillaries. This flow is laminar and therefore obeys Poiseuille's law. (2)

B. FROM A THEORETICAL STANDPOINT - (2,4) - FOR A GIVEN SLURRY THE PRODUCTION IS:

1. Directly proportional to the amount of vacuum at a constant cake thickness.

2. Inversely proportional to the cake thickness at a constant vacuum.

3. Proportional to the square root of the speed of rotation of a given filter at a constant vacuum; therefore, it was imperative to strive for a filter which would provide for maximum speed of rotation while maintaining a heavy cake with minimal vacuum loss.

With this in mind, it was next necessary to understand the characteristics of the material to be filtered, as well as the operating conditions under which filtration had to be achieved and establish the goals to be reached.

C. SLURRY CHARACTERISTICS

- high solids
- temperature to P_2O_5 boiling point
- scaling development on surfaces
- abrasive
- corrosive
- fumes

D. OPERATING GOALS

- clear filtrate
- avoid acid dilution
- low water soluble P_2O_5 losses
- utilize simple and economical equipment
- high filtration rate per unit area
- eliminate filter size limitations
- have versatile and continuous operation
- minimized maintenance
- simple to operate

III. COMPARISON OF THE MAIN TYPES OF FILTERS (1)

With these various parameters we have just seen setting the stage, the next step was to objectively chart all the filters which were currently available on the market and to select characteristics of each which were desirable. For each type of filter studied, each of the required characteristics is rated:

1 - very good
2 - good
3 - satisfactory
4 - poor
5 - very poor

The characteristics were based on evaluation of results obtained from the actual operation of filters in Rhone-Poulenc and Associates' plants.

The first column of the table shows the main features which would be required of the new filter. For example, it can be seen on the first line of the table that the highest speeds (i.e., corresponding to the thinnest cake for a given production), are obtained on the drum filter, the table filter and the continuous belt filter.

Also, note that these filters are unique from the others in the continuity of their construction (no separate mechanical moving compartments). The continuous filtration surface is therefore recorded as a point of high interest.

On the second line, it is observed that the best filtration is obtained with a small vacuum box (i.e., a small perimeter in relation to the filter area under vacuum).

Naturally, all the observations were studied to a greater depth than can be shown in the table. During the study, a picture of the ideal filter began to take shape. All of these features were put together during the design study and the main goals were defined.

With the help of F. Aoustin & Cie., the future manufacturer, partial models were built and tested so as to define the best shapes, flow rates, mechanical expansions and stresses, in particular, those created by the vacuum.

Extensive testing to establish corrosion rates and abrasion resistance was made. Finally, all the details were related to the requirements of the future user and his maintenance staff.

All that remained was for the manufacturer, F. Aoustin & Cie., to prepare the detailed drawings and to develop and qualify procedures for the selected alloys.

		Drum	Tray-belt	Continuous belt	Tilting pans	Table with fixed edge	Characteristics recommended
Production Capacity	Speed	VG	S	G	G	VG	Continuous surface
	Vacuum mm Hg	G >500	VP <500	P <500	S >500	S >500	Compact vacuum box
	Maximum useful surface m2	G 100	VP 18	P 40	VG 167	P 35	Avoid straight filters
EXTRACTING EFFICIENCY	Distribution of slurry	VG	S	VG	S	G	Small height of fall
	Evenness of cake	G	S	VG	S	G	Avoid filter pans
	Washing volume	VP	G	G	G	G	Flat surface
	Number of washes	P	G	G	G	G	Flat surface
	Distribution of washes	VP	S	G	S	G	Continuous surface
	Effect of edges	VG	P	S	P	G	Continuous surface
	Separation of filtrates	S	VG	VG	S	S	Short time for filtrates to flow
	Adjustment of wash boxes	VP	P	P	G	G	Handle at one point only
	Adjustment of vacuum box	S	S	S	S	S	Means of adjustment at start-up
Operation	Effect of poor slurry	VG	G	G	G	VG	High speed filter
	Cloth wash	S	G	VG	G	VP	Inversion of the cloth
Product Quality	Dilution	P	G	VP	S	S	Short time for filtrates to flow-Long draining time
	Clarity of filtrate	P	G	G	G	G	Possibility of a presector

IV. HOW THE UCEGO° FILTER APPROACHED PHOSPHORIC ACID FILTRATION PROBLEMS

A. HIGH PRODUCTIVITY

High productivity depends on a number of things:

CAKE THICKNESS - As noted earlier, the productivity of a given filter is inversely proportional to the thickness of the cake, or what amounts to the same thing, proportional to the square root of the speed.

It is necessary, therefore, that the filter should travel as fast as possible but also that the speed may be adjusted to the required production capacity. The maximum speed, however, is generally ruled to the following limitations:

MECHANICAL

Different filters are limited mechanically in various ways but, as an example, tilting pan filters are limited in peripheral speed in order to avoid shock and vibration. Belt filters are limited in the mechanical strength of the belt, etc. The rotating table was chosen here as it was not subject to those limitations.

Mechanical concept eliminated various moving components thus reducing failures and down-time to a minimum.

REPORT TIME

In order to insure good extraction efficiency and avoid mixing of the grades of filtrate, it is imperative that the liquor has a certain amount of time to reach the outlet branch after leaving the cake. It is also imperative to avoid mixing wash water with the first filtrate, causing dilution.

TO SURMOUNT THE DIFFICULTIES UCEGO° has:

- INCREASED THE NUMBER OF FILTER PANS - 30 on small filters, 36 on larger models which gives better filtrate separation at all speeds.

- INCREASED LIQUOR OUTLETS FROM EACH PAN - 2 vertical outlets on small pans, 3 vertical outlets on larger pans which gives the shortest possible flow path for filtrates.

- PUT STEEP SLOPES ON THE PAN BOTTOMS AND CONNECTING PIPES increasing the velocity of the filtrates (10° on pan bottoms and 17° on pipes).

- REDUCED THE EXTERNAL DIAMETER OF THE TABLE by using more of the surface at the center.

It can be seen that when all these factors were added together, the UCEGO° filter could rotate faster than other filters without any mechanical risk, danger of dilution, or mixing of filtrates. In fact, for the same filter area, the filter proved it could actually rotate twice as fast as other filters in its class. In other words, if a middle size filter was generally limited to one revolution every 3 minutes and the UCEGO° could make one rotation every 1½ minutes, it could exhibit productivity equal to the square root of two times the slower filter capacity, or, approximately 40% more.

B. HIGH EXTRACTION EFFICIENCY

EXTRACTION EFFICIENCY DEPENDS ON A NUMBER OF FACTORS ALSO. AMONG THESE ARE:

Even distribution of the slurry to maintain a level cake of constant thickness.

- This was accomplished by arranging the shape of the slurry distribution box to provide a flow of slurry which is uniform at all points across the surface. Also, the slurry was let on to the surface via a rubber apron and not allowed to "free fall".

- Also, a factor was the continuous flat filter surface which eliminated the "wave effect" incurred from slurry pouring over the sides of pans and the "edge effect" of cake coming away from pan sides giving access to "fugitive air" or preferential passages for filtrates and wash water.

Good separation of the various filtrates to maintain quality.

- The first step in separation is promoted by the numerous filter cells under the filter cloth.

- This is only the first step however, and the filter must be capable of rapid adjustment to suit the quality of the slurry. Adjustment of the filter dams is easily accomplished by geared hand wheels on each dam.

In order to have a good extraction, efficiently, it is necessary to extract the gypsum and wash the cloths carefully. For this reason, the fixed rim of the typical table filter was replaced by a continuous rubber belt which is drawn away from the table edge in the gypsum removal zone.(3)

The gypsum extraction screw moves 80% to 90% of the dry cake into the gypsum hopper for disposal. Following, the small amount of gypsum remaining on the table is washed from the table with a flight of tangential sprays and a second flight of sprays which are perpendicular to the surface.

The first flight of sprays drive the gypsum over the edge of the table and the second flight of sprayers pass water through the cloths, cleaning the cloths, pans and collection tubes. It is possible, therefore, to not only remove all the gypsum but to wash the cloths and pans with generous amounts of water. With this method, the cloths and pans are repeatedly washed with water which reduces cloth blinding and removes build-up in the system.

A filter must be capable of extensive changes as demanded by various phosphate rock. It must be easy, therefore, to adjust the size of the various sectors separating liquors in the vacuum box. For this, the moving part of the vacuum box can be raised in a few minutes, without dismantling, giving access to the movable partitions which can be easily adjusted.

C. LOW ACID DILUTION

1. Since phosphoric acid plants are generally followed by concentration units, it is essential that the filtrate not be diluted on the filter, which would increase the cost of concentration.

   Since the risk of such dilution is greater the faster the filter turns, two items were designed into the filter which helped solve the problem:

   - steep slopes in the pan bottoms and filtrate tubes to facilitate the rapid flow of liquids.
   - a "pre-sector" in the filter valve which sorts out the first fractions of filtrate which have been diluted by water from the wash cycle. These are in turn returned to the reaction section leaving only undiluted acid as product.

Through the "pre-sector", the filter also removes the first fractions of acid which are contaminated with gypsum making it possible to obtain reasonably clear filtrates. The "pre-sector" itself is not unique but, due to the speed of the liquid flow, the "pre-sector" size is held to a minimum and the need for a "cell drying" section in the filter valve is eliminated leaving more of the vacuum box area for actual production.

REFERENCES

(1) Societe Rhone-Progil, Bulletin No. 4, 1973

(2) Chemical Engineer's Handbook, Perry, 3rd Edition, P.965 (Poiseuille's Law)

(3) Volume I, Phosphoric Acid, A.J. Slack, 1968

(4) Technical Paper, E.M. Edwards, J.W. Salter, May 26, 1979.

U C E G O

Filter No.	Square Meters	Square Feet
1	8.8	94.688
2	14.7	158.17
3	23.0	247.48
4	34.0	365.84
5	40.0	430.40
6	52.0	559.52
7	63.0	677.88
8	85.0	914.60
9	109.0	1,172.84
10	132.0	1,420.32
11	153.0	1,646.28
12	205.0	2,205.80
13	256.0	2,754.56
14	307.0	3,303.32

Formula:

Multiply square meters x 10.76 to get square feet

Multiply square feet x .0929 to get square meters

Courtesy of:

F. Aoustin & Cie., France

REFERENCE LIST

START UP	COUNTRY	LOCATION COMPANY	FILTER N° & EFFECTIVE AREA	PRODUCT & PROCESS	MAIN PHOSPHATE USED	MAX.CAPACITY ACHIEVED T/D P205 or OTHER
1963	FRANCE	ROUEN - RP	1 - 8,8 m2	P205 - RP	MOROCCO 75	75
1965	FINLAND	UUSIKAUPUNKI - RIKKIHAPPO	4 - 34 m2	P205 - RP	KOLA	190
1965	FRANCE	ROUEN - RP	7 - 63 m2	P205 - RP	TOGO	700
1966	SPAIN	HUELVA - FERTIBERIA	5 - 40 m2	P205 - UCB	MOROCCO 75	210
1968	BELGIUM	OSTENDE - UCB	2 - 14,7 m2	P205 - UCB	MOROCCO 75	75
1968	ITALY	PORTO MARGHERA MONTEDISON	2 - 14,7 m2	P205 - RP	MOROCCO 75	110
1968	LEBANON	SELAATA - LCC	5 - 40 m2	P205 - RP	JORDAN	290
1968	ROUMANIA	TURNU - MAGURELE	5 - 40 m2	P205 - UCB	KOLA	200
1968	SENEGAL	DAKAR - SIES	1 - 8,8 m2	P205 - RP	TAIBA	85
1968	URSS	KEDAINIAI - TECHMASHIMPORT	5 - 40 m2	P205 - UCB	KOLA	170
1968	YUGOSLAVIA	PRAHOVO - BOR	7 - 63 m2	P205 - RP	JORDAN	440
1970	BELGIUM	ANVERS - RUPEL	6 - 52 m2	P205 - NISSAN	MOROCCO 75	300
1970	FRANCE	OTTMARSHEIM - PEC RHIN	6 - 52 m2	P205 NISSAN	MOROCCO 75	170
1970	FRANCE	GARDANE - PECHINEY	3 - 23 m2	Al 203		5000
1971	ROUMANIA	NOVODARI	5 - 40 m2 (2)	P205 - UCB	KOLA	2 x 200
1972	ALGERIA	ANNABA - SONATRACH	11 - 153 m2	P205 - RP	DJEBEL ONK	700
1972	FRANCE	SALINDRES PECHINEY	1 - 8,8 m2	Al 203		75
1972	FRANCE	MULHOUSE - MDPA	3 - 23 m2 (2)	NaCl + KCl .		2 x 5000
1977	INDIA	UDAIPUR HINDUSTAN ZINC	2 - 14,7 m2	P205 - RP	MATON	87
1972	ROUMANIA	VALEA-CALUGAREASCA	5 - 40 m2	P205 - UCB	KOLA	200
1972	TUNISIA	GABES - ICM I GABES - ICM I	2 - 14,7 m2 10 - 132 m2	Clarification P205	GAFSA	400 450
1973	TURKEY	SAMSUN	9 - 109 m2	P205 - SIAPE	GAFSÀ	340
1972	TANZANIA	TANGA TFC	2 - 14,7 m2	P205 - RP	JORDAN	75
1974	FRANCE	ROUEN - RP	5 - 40 m2	CLARIFICATION	TOGO	800

REFERENCE LIST

START UP	COUNTRY	LOCATION COMPANY	FILTER N° & effective area	PRODUCT & PROCESS	MAIN PHOS-PHATE USED	Max. Capacity achieved T/D P205 or other
1974	FRANCE	ROUEN - RP	11 - 153 m2	P205 RP	TOGO	1000
1974	LEBANON	SELAATA - LCC	5 - 40 m2	P205 - RP	JORDAN	290
1974	PORTUGAL	LISBON - CUF	4 - 32 m2	P205 - CUF	MORROCO	200
1974	TUNISIA	GABES - ICM I I	10 - 132 m2	P205 - SIAPE	GAFSA	450
1974	TURKEY	YARIMCA - GUBRE	6 - 52 m2	P205 - RP	JORDAN	230
1975	BRASIL	SANTOS- COPEBRAS	7 - 63 m2	P205 - NISSAN	FLORIDA	300
1975	MOROCCO	SAFI - MAROC PHOSPHORE I	10 - 132 m2 (3)	P205 - NISSAN	YOUSSOUFIA	3 x 500
1975	MOROCCO	SAFI - MAROC CHIMIE	10 - 132 m2	P205 - RP	YOUSSOUFIA	500
1975	TURKEY	ISKENDERUN-GUBRE	6 - 52 m2	P205 - RP	JORDAN	230
1976	BRASIL	IMBITUBA - ICC	7 - 63 m2	P205 - RP	FLORIDA	360
1976	FRANCE	ROCHES DE CONDRIEU RP	10 - 132 m2	P205-RP	MOROCCO	400
1976	TAIWAN	KAOHSIUNG CHINA PHOS.CORP.	4 - 34 m2	P205 -JAPAN	FLORIDA	120
1976	YUGOSLAVIA	TITO VELES - ZLETOVO	5 - 40 m2	P205-FISONS	MOROCCO 75	170
1977	YUGOSLAVIA	BOR-PRAHOVO	9-109 m2	P205 - RP	MOROCCO 75	600
1979	BRASIL	ARAXA	3 - 23 m2	PHOSPHATE		2000
1979	BRASIL	VALEFERTIL	9 - 109 m2 (2)	P205 - RP		2 x 500
1979	U.S.A	OXY FLORIDE	7 - 63 m2	P205 - hemi		440
1980	URSS		9 - 109 m2	P205 - RP		500
1979	MOROCCO	SAFI MAROC PHOSPHORE II	11 - 153 m2 (3)	P205 - NISSAN	MOROCCO	3 x 700
1979	U.S.A	OXY FLORIDE	12 - 205 m2	P205	Florida	
1979	BRASIL	CARAIBA METAIS	9 - 109 m2	P205		
1980	YUGOSLAVIA	INA KUTINA	12 - 205 m2	P205 - FISONS		
1980	JORDAN	J.F.I	12 - 205 m2	P205 - RP	JORDAN	
1980	MOROCCO	SAFI MAROC PHOSPHORE I	11 - 153 m2	P205 - NISSAN	MOROCCO	
1980	U.S.A	SOUTH PIERCE AGRICO	10 - 134 m2	P205	FLORIDA	

REFERENCE LIST

START UP	COUNTRY	LOCATION COMPANY	FILTER N° & Effective area	PRODUCT & PROCESS	MAIN PHOSPHATE USED	Max.Capacity achieved T/D P205 or other
1980	TURKEY	ISKUR	9 - 109 m2	P205 -NISSAN	MOROCCO 75	440
1981	MEXICO	MICHOACAN FERTIMEX	10 - 134 m2 (2)	P205	FLORIDA	
1981	MEXICO	MINATITLAND FERTIMEX	3 - 23 m2	P205		
1981	GREECE	THESSALONIQUE SICNG	7 - 63 m2	P205		
1982	U.S.A	FORT MEADE USS AGRI-CHEMICALS	9 - 109 m2(2)	P205	Fla.	
1982	U.S.A.	Farmland	7 - 63m2	P205	Fla.	
1981	U.S.A.	Agrico	10-134 m2	P205	Fla.	

WE CONSIDER IT AN HONOR TO HAVE HAD THIS OPPORTUNITY TO PRESENT THIS BRIEF DOSSIER OF THE UCEGO° FILTER.

OUR GOAL IS TO LEAVE YOU WITH AN UNDERSTANDING OF THE VARIOUS REASONS FOR THE INVENTION OF THE UCEGO° FILTER, ITS CAPABILITIES AND ITS PERFORMANCE AS A FUNCTIONAL MEMBER OF OUR PHOSPHATE-PRODUCING FAMILY.

CREDITS

RHONE-POULENC	TECHNICAL DATA
F. AOUSTIN & CIE.	TECHNICAL DATA
AOUSTIN-MURRAY INC.	U.S. REPRESENTATIVES
DAVID COOPER	PHOTOGRAPHY
RON RODKEY	ILLUSTRATIONS
CHARLES BERBERAT	INTERPRETATION & PUBLICATION
CLAUDETTE WHISENANT	INTERPRETATION & PUBLICATION

-NOTES-