

**Increasing P2O5 Production
By Retrofitting a Tilting Pan Filter
With a UCEGO® Filter**

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**Presented at the Annual Meeting of the
American Institute of Chemical Engineers
Central Florida Section
Clearwater, Florida**

May 29, 1999

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Today's typical phosphoric acid plant has been in operation for 15 to 30 years and is operated at instantaneous rates 120% to 200% above original design capacity. The higher instantaneous P₂O₅ production rates in these plants have been achieved through process equipment and control system improvements. Improved sulfate control has allowed plants to maintain low reaction losses while reducing the retention time in the reaction system. The available filtration area and the rate of water-soluble P₂O₅ recovery are currently limiting the instantaneous production rate of many phosphoric acid plants.

A typical phosphoric acid plant could realize a significant increase in water-soluble P₂O₅ recovery and augment its production capacity if the plant filtration area is increased. One way to increase filtration capacity is the replacement of an existing filter with a filter that has a higher active filtration area. A significant number of existing phosphoric acid plants in operation are equipped with tilting pan filters that can be replaced with higher capacity UCEGO filters in the same available building space.

There are currently 87 UCEGO filters in operation around the world. UCEGO filters produce more than 35% of the world's phosphoric acid. One of the major advantages of a UCEGO filter is that it requires less building area (m²) per square meter of active filtration area than a tilting pan filter. A UCEGO filter can be installed

in place of an existing tilting pan filter with an increase of 32% to 125% in active filtration area. The UCEGO filter requires less building area because it utilizes a cake extraction screw for removal of gypsum cake from the filter table as opposed to the flipping of pans that is required with a tilting pan type filter. The pan rotation for cake discharge, with associated twisting of flexible hoses connecting the pans to the central valve, requires a larger inner diameter of the pan filter compared to the UCEGO filter. The consequence is a lower filtration area of the tilting pan filter compared to the UCEGO filter for a given outer diameter. A comparison of tilting pan and UCEGO filter diameters and active filtration areas is shown in Figure 1.

Figure 1.

UCEGO vs. Tilting Pan Filter Comparison

Tilting Pan Filter			UCEGO Filter			Area Increase
No.	Dia. (m)	Active Area (m ²) Wet Discharge	No.	Dia. (m)	Active Area m ² Wet Discharge	Percent (%)
24B	14.6	60.4	8	12.3	88.1	46
			9	14.2	112.1	86
			10	15.4	135.7	125
24C	16.0	88.3	10	15.4	135.7	54
			11	17.1	157.6	45
			11A	18.3	185.8	110
24D	17.7	108.7	11	17.1	157.6	45
			11A	18.3	185.8	71
			12	19.4	211.1	94
30C	20.1	139.4	11A	18.3	185.8	33
			12	19.4	211.1	51
			12A	21.0	236.3	70
			13	21.3	263.9	89
30D	21.6	165.8	12	19.4	211.1	27
			12A	21.0	236.3	43
			13	21.3	263.9	59

A UCEGO filter with active area equal to a tilting pan filter will have the same washing efficiency as a tilting pan filter at a given cake thickness. However, the UCEGO filter will have a higher filtration capacity than the tilting pan filter. The gain in capacity is due to the fast draining characteristics of the filter and the ability of a

UCEGO filter to operate at higher speeds. After the filtrates are pulled through the filter cake, under vacuum, steeply sloped pans under the filter grids rapidly transfer the liquids to sloped outlet pipes. This minimizes the liquid retention in the pans. The central valve of the UCEGO filter is adequately sized with large outlet nozzles to allow unrestricted flow of filtrates to the receivers. This allows the filter to operate at high speeds with no mixing of filtrate.

The retrofit of a tilting pan filter must be evaluated on a case by case basis. The payback for a filter retrofit differs for each facility and is dependent on the plant's long term increased production objectives.

The retrofit paybacks are:

- ◆ Increased P2O5 Production
- ◆ Increased Water Soluble P2O5 Recovery
- ◆ Reduced Filter Maintenance Costs

The retrofit costs are:

- ◆ New UCEGO Filter
- ◆ Building Modifications
- ◆ Existing Process Equipment Upgrades
- ◆ Plant Downtime

Case study for retrofit options:

Consider an increased capacity to 1000 mtpd P2O5 from a plant currently producing 770mtpd P2O5 with a 24C tilting pan filter. The existing 24C filter can be replaced with either a #9 or a #10 UCEGO filter. Sizing options and expected performance for the filter retrofit are summarized in Figure 2.

Figure 2.

		<u>Retrofit Options and Expected Performance</u>			
		Existing 24C Tilting Pan Filter	UCEGO #9 Filter	UCEGO #10 Filter	UCEGO #10 Filter
Daily capacity	Mtpd	770	1000	1000	1240
Operating days	Dpy	330	330	330	330
Active area	m ²	88.3	112.1	135.7	135.7
Total area	m ²	111.5	132.9	160.8	160.8
Filter diameter	m	16.0	14.2	15.4	15.4
Industrial filtration rate	mtpd P2O5/m ²	8.7	8.9	7.4	9.1
Wet gypsum	mtpd	5500	7143	7143	8858
	m ³ /d	4400	5714	5714	7087
Cake thickness	mm	65.7	64.3	77.8	62.7
Filter speed	min/rev	2.40	2.15	3.15	2.05
Cycle time	min	1.90	1.82	2.66	1.73
Annual production	mtpy	254100	330000	330000	409175

Basis:

Dry Gypsum Production Ratio: 5 mton dry gypsum/mton P2O5 Produced
 Wet Gypsum Cake free H2O: 30%
 Wet Gypsum Cake Density: 1.15 mton/m³

A #9 UCEGO filter can be installed in place of an existing 24C tilting pan filter and would adequately handle 1000 mtpd P2O5 production. A #10 filter installed in place of the same 24C filter and operating at 1000 mtpd P2O5 capacity would have cycle time increase by 40%. The same #10 UCEGO filter would also be capable of operating at up to 1240 mtpd P2O5 while running at design speed of rotation.

Operating and Maintenance Costs

Historical operating and maintenance costs for a UCEGO filter are summarized below:

Cost per mton of P2O5 produced

Parts, Material and Labor	\$0.31
Filter Cloth Materials	\$0.08
TOTAL:	\$0.39

Retrofit Costs

Feasibility studies for the retrofit of existing tilting pan filter installations show that an existing filter building can be modified for the installation of a UCEGO filter with larger surface area than the original tilting pan filter. The modifications include the addition of filter roller supports and access platforms around the circumference of

the filter. The overall modifications required to an existing building are minor compared to the erection of a new filter building. A summary of estimated costs for a filter retrofit is shown below.

<u>Engineering and Installation</u>	<u>Estimated Cost</u>
Demolition of Existing Filter	\$ 80,000
Filter Building Modifications	\$220,000
New Filter Installation	\$300,000
Engineering and Contingency	<u>\$250,000</u>
TOTAL	\$850,000

Equipment

New UCEGO #9 Filter (317L SS)	\$2.6 MM
New UCEGO #10 Filter (317L SS)	\$3.0 MM

The time required for demolition of an existing tilting pan filter, modifications to the filter building and erection of a new UCEGO filter is estimated to be 5 to 6 weeks on a 24 hr/day basis.

Retrofit Feasibility

As with any major plant upgrade, the replacement of an existing filter must be carefully evaluated. A project of this magnitude will have a good return on investment provided that the filtration system is the bottleneck and that upstream and downstream process units have sufficient capacity to process increased P2O5 production. During the project development phase, a process review of reaction systems, concentration units, acid storage and clarification systems should be conducted to evaluate other potential process bottlenecks. The process review should also evaluate de-bottlenecking of existing filtration equipment such as filter pumps, gypsum slurry system, cloth wash system, vacuum systems, fume collection systems, etc. Most tilting pan filters are

equipped with dual vacuum systems. These systems can normally be operated in parallel to satisfy the vacuum requirements of a UCEGO filter. Due to similarities in central valve configuration, tilting pan filtrate systems can be adapted for use with a UCEGO filter.

A filter retrofit project should strongly be considered in a facility that is equipped with a high maintenance tilting pan filter.

The retrofit of new filter into an existing filter building will provide excellent returns depending on reaction system excess capacity, the number of phosphoric acid filtration trains and operating flexibility of the facility. A retrofit project would be ideally suited for a facility that contains multiple phosphoric acid production units. Back to back turnarounds could be planned for parallel reaction systems in order to allow a single filtration system to be out of service while the retrofit is completed. The payback for the installation of a UCEGO filter into an existing filter building is especially attractive when compared to the cost of a new filter installation with ancillary equipment, utilities and filter building.

The cost of a typical new filtration installation is \$12-14MM compared to an estimated cost of only \$5-6MM for a filter retrofit project. Assuming a net profit of \$50/mt of produced P₂O₅, the payback time is 6 to 12 months depending on the size of the installed UCEGO filter.

In terms of experience, two plants were retrofitted with a UCEGO filter:

- SICNG Thessaloniki (Greece) in 1982
- KEMIRA Siilinjarvi (Finland) in 1991

SICNG**KEMIRA**

	BEFORE	AFTER	BEFORE	AFTER
Capacity (tP2O5/day)	250	360	400	750
Filter	Tilting Pan 2x 18m²	UCEGO #7 65.1m²	Tilting Pan 110m²	UCEGO #11A 185.8m²
Remarks		UCEGO filter installed at the place of one tilting pan filter. The second filter was discarded		Stoppage 8 weeks

Authors:

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