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FISONS HEMIHYDRATE PROCESS - A DECADE OF ENERGY SAVING

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SUMMARY

This paper reviews the changes in the cost structure of phosphoric acid production over the last ten years with respect to prices of raw materials and utilities. Data is presented from Windmill Holland BV where hemihydrate and dihydrate process plants operate side by side.

The data shows that operating costs to produce P_2O_5 as phosphoric acid have risen by a factor of 3.5 between 1971 and 1981. Both raw materials and utility prices have risen in parallel, by factors of 3.6 and 3.2 respectively. Closer analysis of the contribution of individual items highlights the influence of energy. The cost of steam has risen by a factor of 12 and of electricity by a factor of 4 in this ten year period.

Over 80% of the phosphoric acid operating cost is contributed by the raw materials, and when the process performance is optimised to reduce this cost it is necessary to look elsewhere in the plant to improve cost effectiveness. Therefore energy usage, particularly steam, becomes an increasingly important item for attention.

The paper demonstrates how the hemihydrate process from Fisons Fertilizers has maximised the benefits of energy saving since the start of the first commercial plant in 1970.

Cost savings of US $31 per tonne P_2O_5 produced can be achieved when using the hemihydrate process compared to the dihydrate process. This is equivalent to a saving of almost 7% in operating cost.

The developments which have led to the hemidihydrate process give rise to improved P_2O_5 recovery efficiency whilst maintaining the same energy saving. A saving in operating cost of 11% compared to a dihydrate plant can thus be achieved.

INTRODUCTION

At Windmill Holland BV in Vlaardingen the first hemihydrate process plant from Fisons Fertilizers began operation in 1970. Windmill already operated a dihydrate plant on the same site. The two main reasons for installing a hemihydrate plant rather than another conventional dihydrate plant, were:

- the capital cost of the hemihydrate plant was significantly lower than that of a dihydrate plant
- the hemihydrate plant could produce 50% P_2O_5 acid directly from the filter without the need to generate steam for a P_2O_5 concentration plant.

In addition, the utilities costs when producing 50% P_2O_5 acid in the hemihydrate plant were lower than those of the dihydrate plant for a similar duty. The main saving was in energy costs, because of the consumptions of steam and electricity. Since 1971 the dramatic increases in the price of raw materials and energy have influenced the production costs of phosphoric acid. A close examination of the effect of these price increases on the production costs of phosphoric acid shows that the proportion of the total production costs contributed by energy has risen at a higher rate than any other item.

This paper reviews the increasing importance of energy savings on phosphoric acid production costs, comparing achieved performance of the hemihydrate process and the conventional dihydrate process.

The development of the hemidihydrate process and the extra cost savings due to improved P_2O_5 recovery are examined.

A broader view of energy saving with respect to electricity cogeneration and reduced rock grinding requirement is portrayed.

1. PROCESS DESCRIPTIONS

The overall chemical reaction for the hemihydrate process may be expressed as:

$$Ca_{10}(PO_4)_6F_2.CaCO_3 + 11H_2SO_4 + 5\tfrac{1}{2}\ H_2O$$

$$\longrightarrow\ 6H_3PO_4 + 11CaSO_4.\tfrac{1}{2}H_2O + 2HF + CO_2 + H_2O$$

This represents complete release of the P_2O_5 content in the rock feed as H_3PO_4. It is the aim of all commercial processes to get as near to this ideal state as possible. As is well known, some of the P_2O_5 can leave the system as unreacted rock, this being generally very small; and as lattice P_2O_5 which has co-precipitated in the calcium sulphate crystal in the form of HPO_4 ions. Additional physical losses also occur during filtration when acid (P_2O_5) is left in the cake as a result of inefficient cake washing. Mechanical losses resulting from poor drainage, pump leaks, line failures, etc., are P_2O_5 losses which are often ignored, mainly because they are difficult to measure and result from inadequate housekeeping and maintenance, rather than from faults in the basic process.

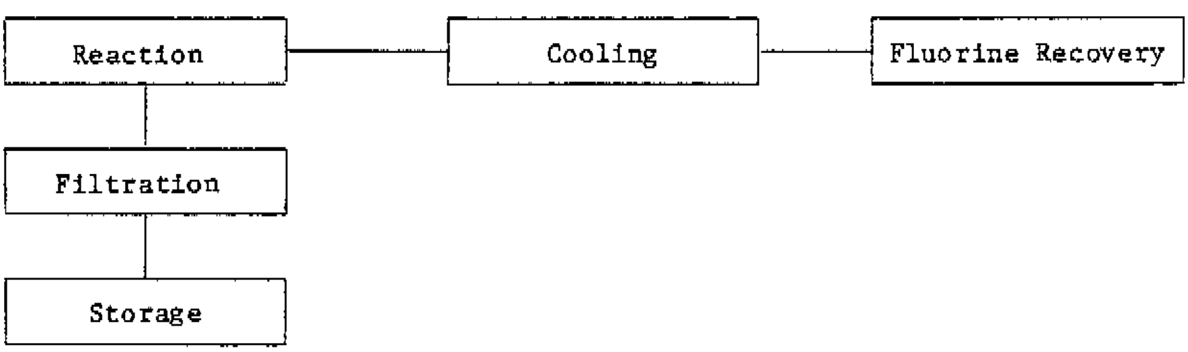
The resemblance of the hemihydrate process to the reaction and filtration section of the dihydrate process is immediately obvious by reference to the simplified flow sheets, Figures 1 and 2. There are, however, two important differences from the general requirements of most other phosphoric acid processes.

(a) The process normally requires only a coarse ground rock, 100% passing through 10 mesh (approximately 1.7 mm). Grinding costs are therefore reduced.

(b) The acid strength is up to 50% P_2O_5 ex filter and requires no further treatment. Intermediate storage, concentration and clarification equipment are not needed.

HEMIHYDRATE PROCESS (1), (2), (3)

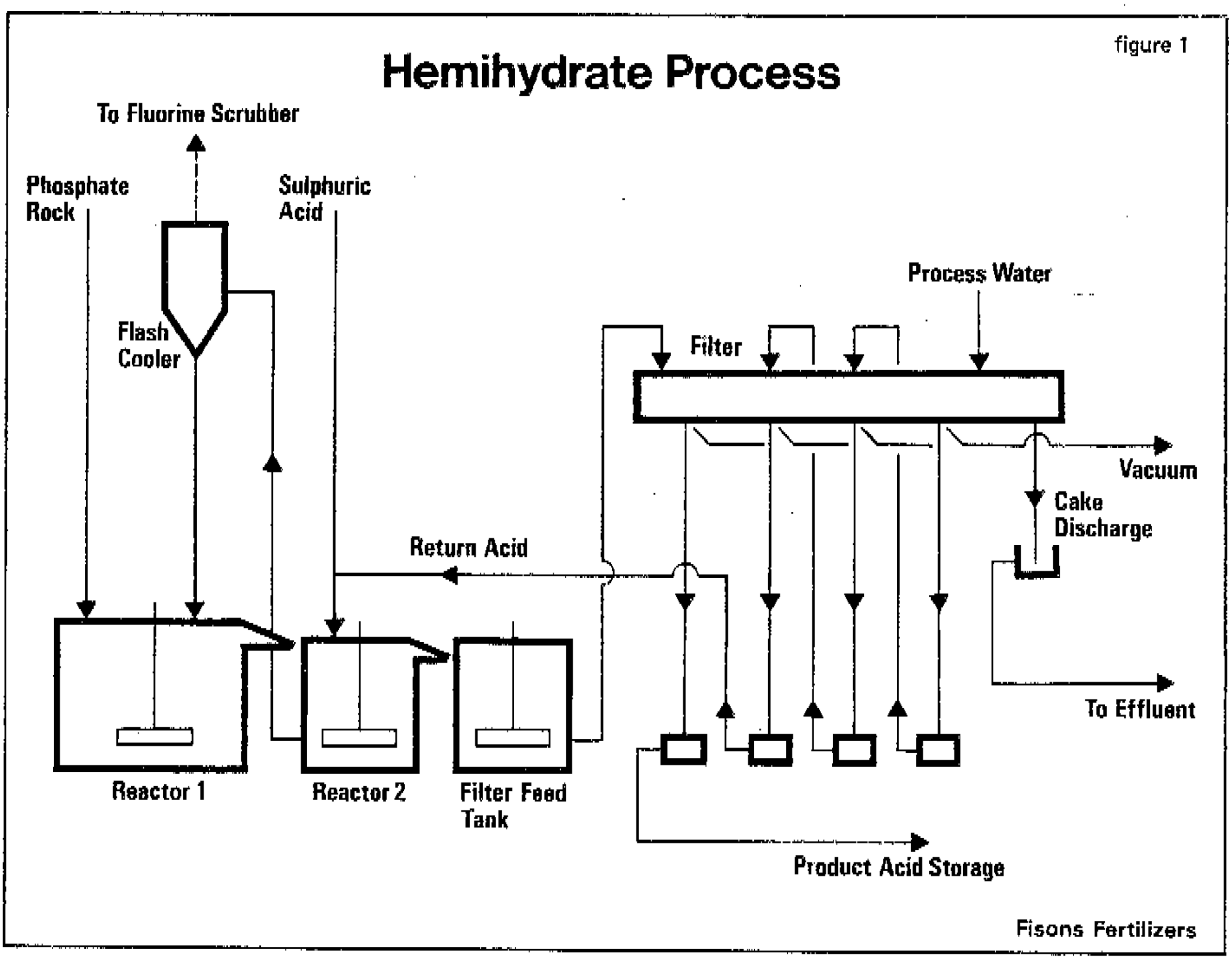
The unit operations are:



The reaction system consists of three agitated vessels or compartments, with the approximate volumetric ratio of 2:1:1. Phosphate rock is fed to reactor 1, sulphuric acid and dilute phosphoric acid ("return acid" from the filter) are fed to reactor 2. Slurry from reactor 2 is recycled to reactor 1, thus exposing the phosphate rock to sulphate ions under controlled conditions to promote the reaction. Reactor 3 is a filter feed tank, the vessel allows further time for the slurry to mature before filtration, and acid supersaturation is reduced.

The reaction is exothermic and it is necessary to remove heat in order to maintain the slurry temperature between 98-100°C. Cooling at Windmill is performed by a flash cooler. Fluorine recovery or removal can be achieved by a unit installed at the exit of the flash cooler, though at present this is not installed at Windmill.

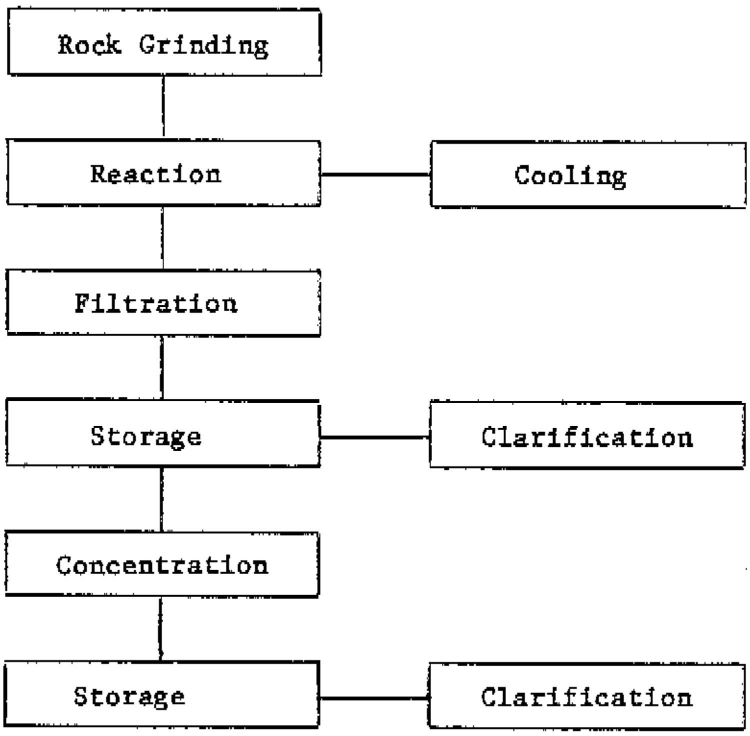
The product acid and hemihydrate are separated by a horizontal vacuum filter, with two or three counter current wash stages. Product acid from the filter passes directly to storage, it does not require clarification or solids removal.



DIHYDRATE PROCESS

In order to demonstrate the similarities to and differences from the hemihydrate process, details of a conventional dihydrate process are given below.

The unit operations are:



The reaction section consists of four agitated compartments usually contained in a single vessel which is internally divided. Phosphate rock is fed to reactor 1, sulphuric acid and dilute phosphoric acid ("return acid" from the filter) are fed to reactor 3. Slurry from reactor 3 is recycled to reactor 1. Most of the reaction takes place in reactor 1 and is completed in reactor 2. Reactor 4 is a filter feed tank where the slurry matures before being pumped to the filter. Heat is removed from the reaction slurry to control the temperature between 78-80°C.

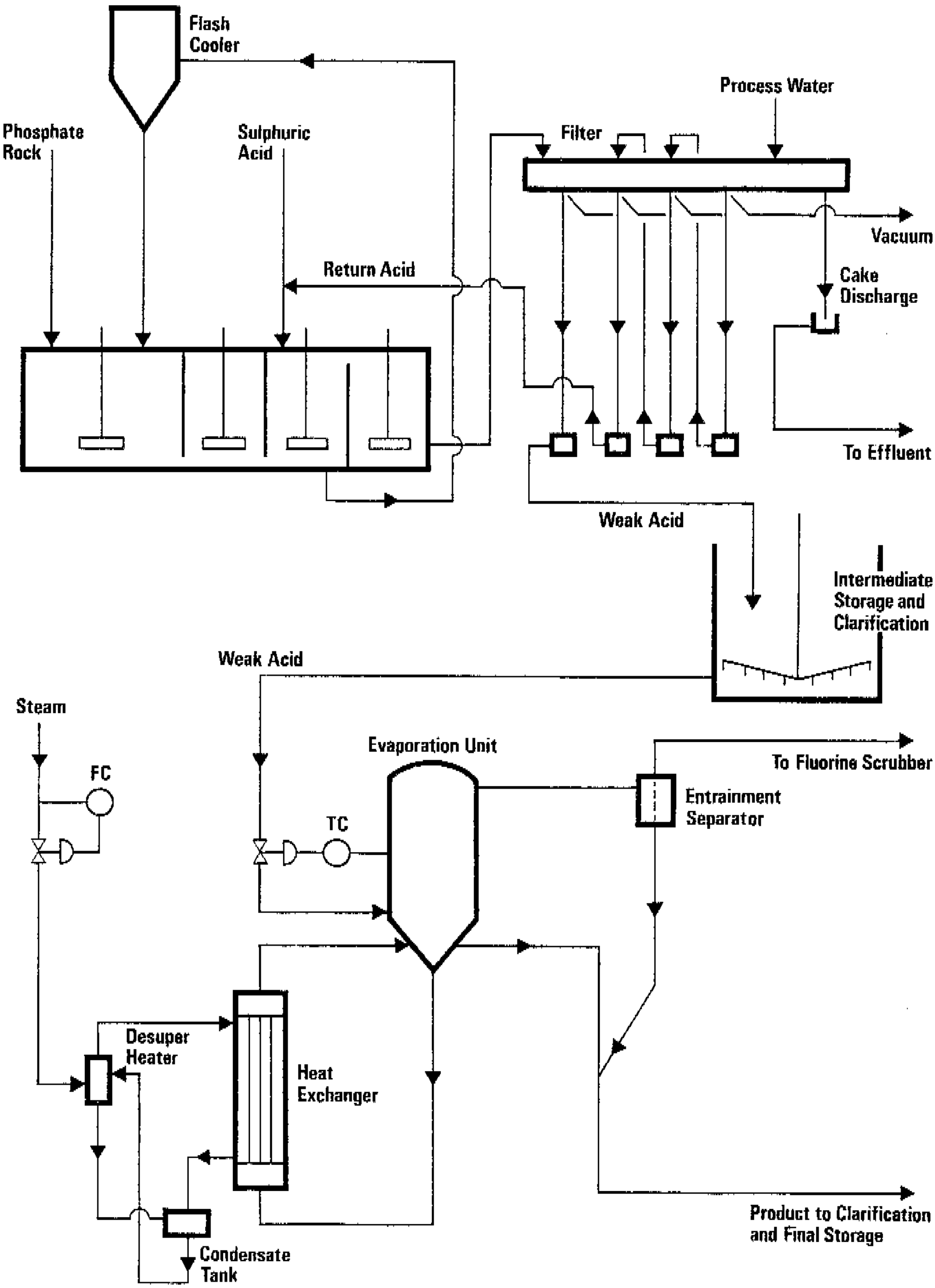
In full-scale commercial plants the reactor acid is separated from the dihydrate by a horizontal vacuum filter with a three stage counter current wash system.

It is necessary to concentrate the dihydrate filter acid before it can be used in most fertilizer processes. The concentration process involves acid circulation and heating, acid boiling and removal of the entrained acid from the released vapours, vapour condensation and vacuum control. Fluorine recovery or removal takes place from the vapours of the concentration unit.

In most cases dihydrate acid requires clarification and solids removal prior to downstream usage. This is normally achieved by settling, centrifuging, flocculation, etc.

figure 2

Dihydrate Process



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2. PHOSPHORIC ACID PRODUCTION COSTS: COMPARISON OF 1971 AND 1981

Over the past ten years technical innovation and technological progress have led to changes in production, operating and maintenance techniques in the manufacture of phosphoric acid. However it is important to recognise that the driving force behind these changes has been the need to reduce production costs and increase profitability, and this has not been easy in a period which has seen dramatic increases in raw material and utility prices.

In order to maximise the benefits of the technical and technological improvements now available it is useful to evaluate the changes in the cost structure of phosphoric acid production since the early 1970's. To ensure a realistic evaluation, data are given for actual raw material and utility consumptions including the often "hidden" elements which are not covered in theoretical assessments.

All consumptions are based on data from Windmill Holland BV from plant performances in 1981. These consumption figures have also been related to 1971 prices to show the change in the proportion of cost contribution of each item during the ten year period.

The prices used for phosphate rock and sulphuric acid are world market prices, the utilities are at typical Dutch prices except for maintenance and chemicals which are actual costs.

Tables 1-4 provide consumption and cost information per tonne P_2O_5 produced as 50% P_2O_5 acid in 1981 and 1971 via the dihydrate route and the hemihydrate route.

The Windmill operation gives an unusual opportunity to compare processes as they operate hemihydrate and dihydrate plants both of approximately 100,000 tpa P_2O_5 capacity, (4).

Examples are given for two phosphates: Togo 78 BPL and Florida 72 BPL.

Table 1. Cost of Phosphoric Acid from a Dihydrate Plant
Phosphate: Togo (35.7% P_2O_5, 48.7% CaO)
Acid ex filter: 27.5% P_2O_5, concentrated to 50% P_2O_5

Item	Unit	Consumption unit per tonne P_2O_5 produced	Cost, US$ per tonne P_2O_5 produced	
			1971 prices	1981 prices
Phosphate rock	tonne	2.964	50.39	219.34
H_2SO_4 (100%)	tonne	2.638	52.76	145.09
Steam	tonne	2.5	2.62	31.89
Electricity	kWh	160	2.47	9.92
Process water	m^3	6.7	1.31	4.42
Cooling water	m^3	70	-	-
Labour	man-hours	0.38	2.88	4.80
Chemicals	US$	-	-	-
Maintenance	US$		9.86	13.48
Total			122.29	428.94

Table 2. Cost of Phosphoric Acid from a Hemihydrate Plant
Phosphate: Togo (35.7% P_2O_5, 48.7% CaO)
Acid ex filter: 50% P_2O_5

Item	Unit	Consumption unit per tonne P_2O_5 produced	Cost, US$ per tonne P_2O_5 produced	
			1971 prices	1981 prices
Phosphate rock	tonne	3.061	52.04	226.51
H_2SO_4 (100%)	tonne	2.602	52.04	143.11
Steam	tonne	0.17	0.18	2.17
Electricity	kWh	110	1.7	6.82
Process water	m^3	3.2	0.63	2.11
Cooling water	m^3	40	-	-
Labour	man-hours	0.3	2.26	3.76
Chemicals	US$	-	5.16	4.6
Maintenance	US$	-	4.84	10.85
Total			118.85	399.93

Table 3. Cost of Phosphoric Acid from a Dihydrate Plant
Phosphate: Florida (32.8% P_2O_5, 48.1% CaO)
Acid ex filter: 27.5% P_2O_5, concentrated to 50% P_2O_5

Item	Unit	Consumption unit per tonne P_2O_5 produced	Cost, US$ per tonne P_2O_5 produced	
			1971 prices	1981 prices
Phosphate rock	tonne	3.261	48.92	228.27
H_2SO_4 (100%)	tonne	2.804	56.08	154.22
Steam	tonne	2.5	2.62	31.89
Electricity	kWh	170	2.62	10.54
Process water	m^3	6.7	1.31	4.42
Cooling water	m^3	70	-	-
Labour	man-hour	0.42	3.2	5.33
Chemicals	US$	-	0.46	0.93
Maintenance	US$	-	10.94	14.96
Total			126.15	450.56

Table 4. Cost of Phosphoric Acid from a Hemihydrate Plant
Phosphate: Florida (32.8% P_2O_5, 48.1% CaO)
Acid ex filter: 50% P_2O_5

Item	Unit	Consumption unit per tonne P_2O_5 produced	Cost, US$ per tonne P_2O_5 produced	
			1971 prices	1981 prices
Phosphate rock	tonne	3.369	50.54	235.83
H_2SO_4 (100%)	tonne	2.762	55.24	151.91
Steam	tonne	0.17	0.18	2.17
Electricity	kWh	125	1.93	7.75
Process water	m^3	3.2	0.63	2.11
Cooling water	m^3	40	-	-
Labour	man-hour	0.34	2.56	4.26
Chemicals	US$	-	6.09	6.46
Maintenance	US$	-	5.48	12.3
Total			122.65	422.79

Cost increases for the important items have been extracted from the tables and are shown pictorially in Figure 3. The data indicates that the steam cost in phosphoric acid production has increased by a factor of 12 over the past ten years for both processes.

In the dihydrate process the combined energy cost has risen by a factor of 8 compared to an increase in total operating costs of 3.5.

For the hemihydrate process the total energy cost has increased by a factor of 4.7 between 1971 and 1981 compared to a factor of 12 for the increase in steam cost and a factor of 3.4 for the increase in total operating cost.

The increase in steam cost relative to the increase in total operating costs means that the contribution of steam and energy in general to the cost of manufacture of phosphoric acid has grown in significance. This can be seen clearly by comparing Figures 4 and 5.

In a dihydrate process the proportion of the operating cost attributed to steam has increased from 2% to 7% in the last ten years, whereas in the hemihydrate process the increase has been from 0.15% to 0.5%. Similarly the total energy cost in a dihydrate plant has increased from 4% to 9% over the same period compared to a rise from 1.6% to 2.3% of the operating cost of a hemihydrate plant.

Consequently a review of the raw material and utility consumptions shows that there is now a substantial saving to be made in operating cost by reducing the steam consumption required in the concentration of wet process acid from 28% to 50% P_2O_5. Such a saving which amounts to over 6% of operating cost can mean the difference between profit and loss.

figure 3

Phosphoric Acid Production: Cost of Raw Materials and Utilities 1971 and 1981

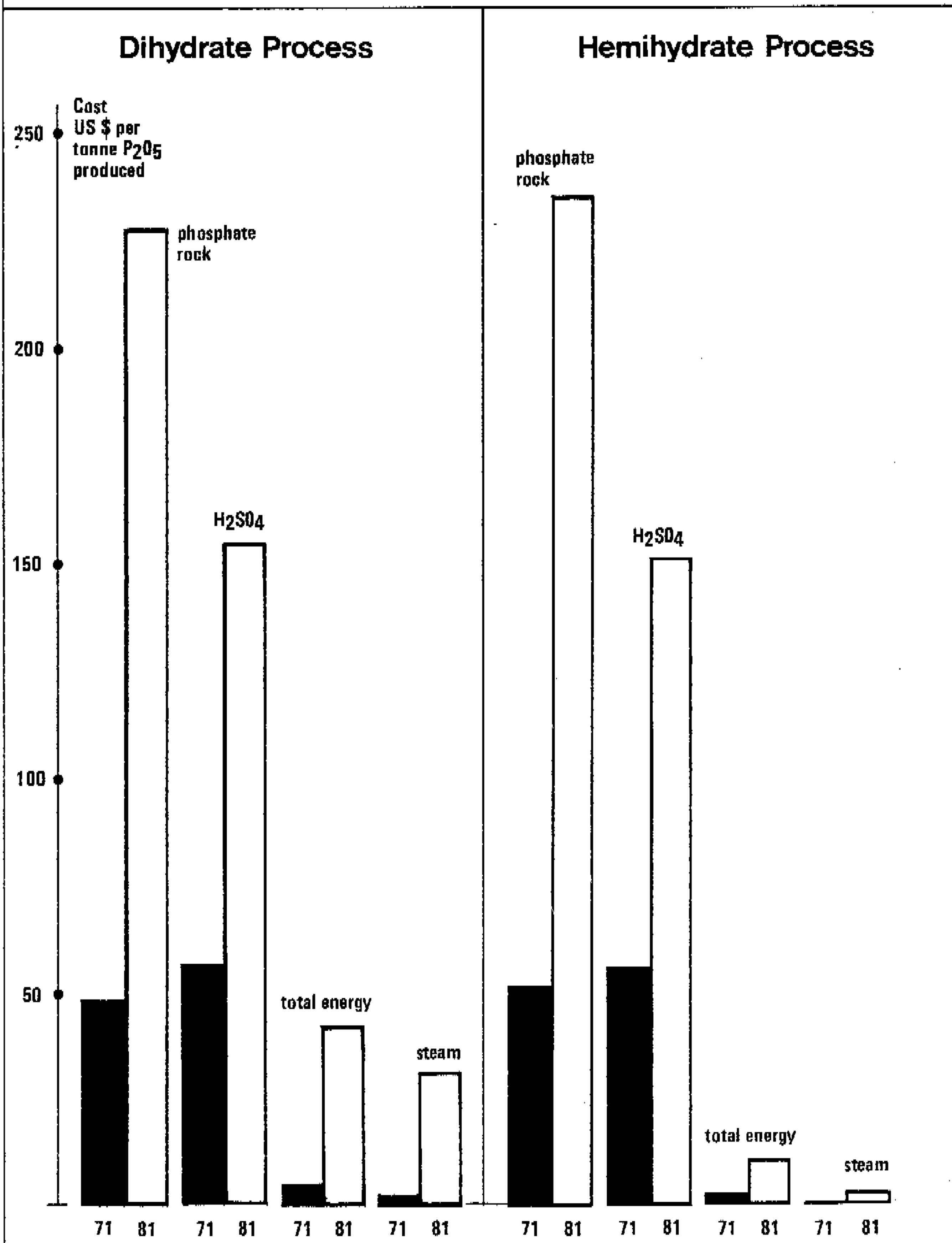

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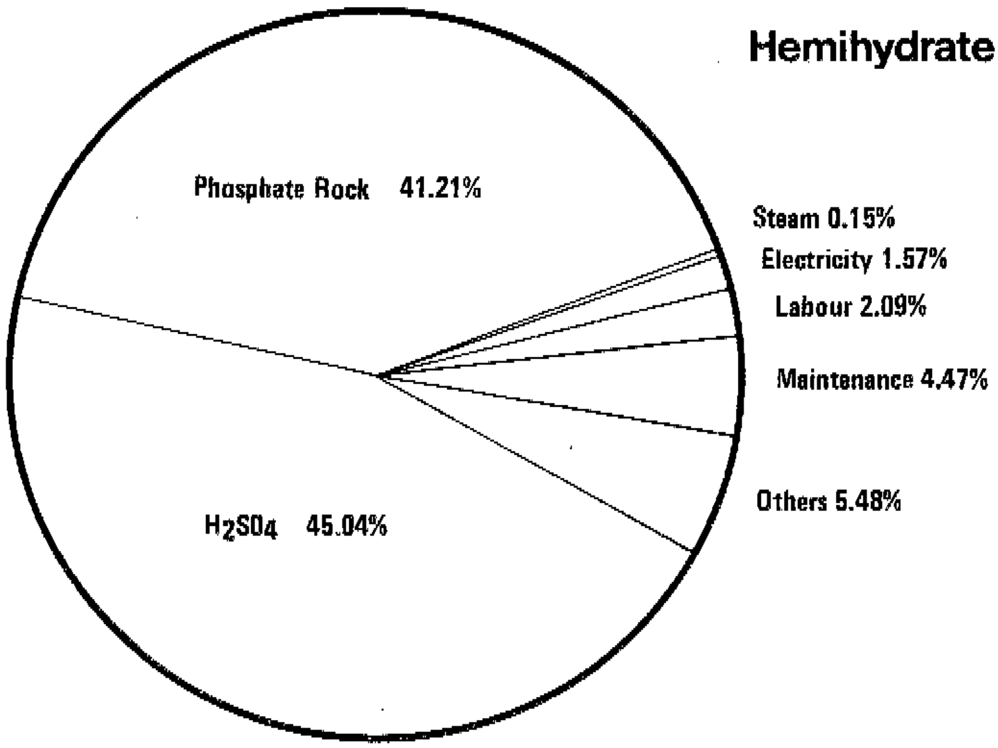
figure 4

Phosphoric Acid Operating Costs in 1971

Florida phosphate 72 BPL

Hemihydrate Process



Dihydrate Process

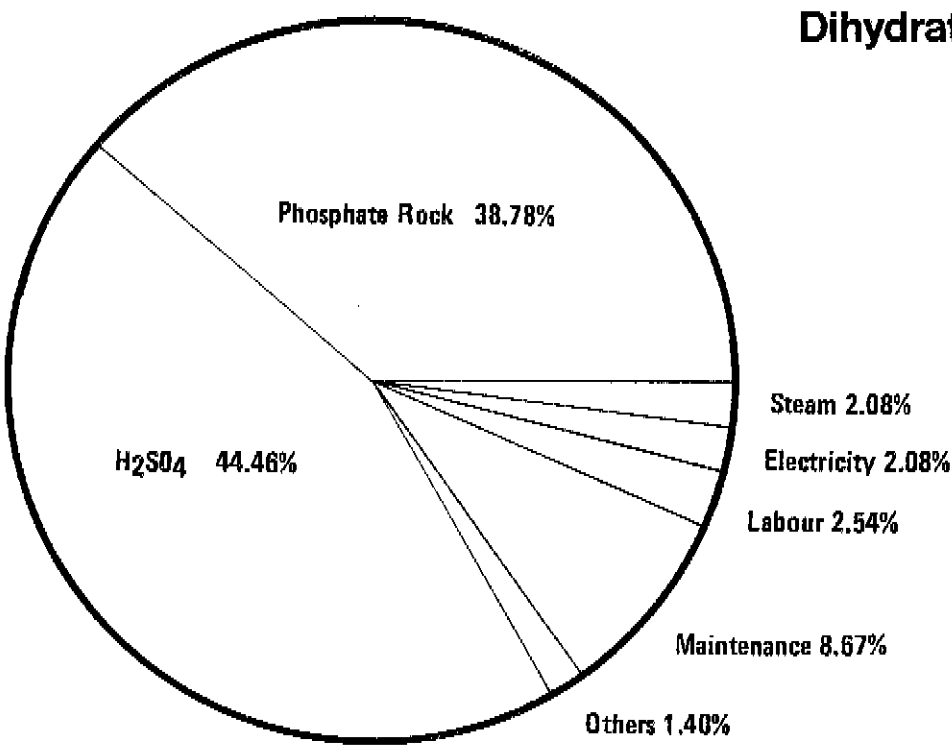


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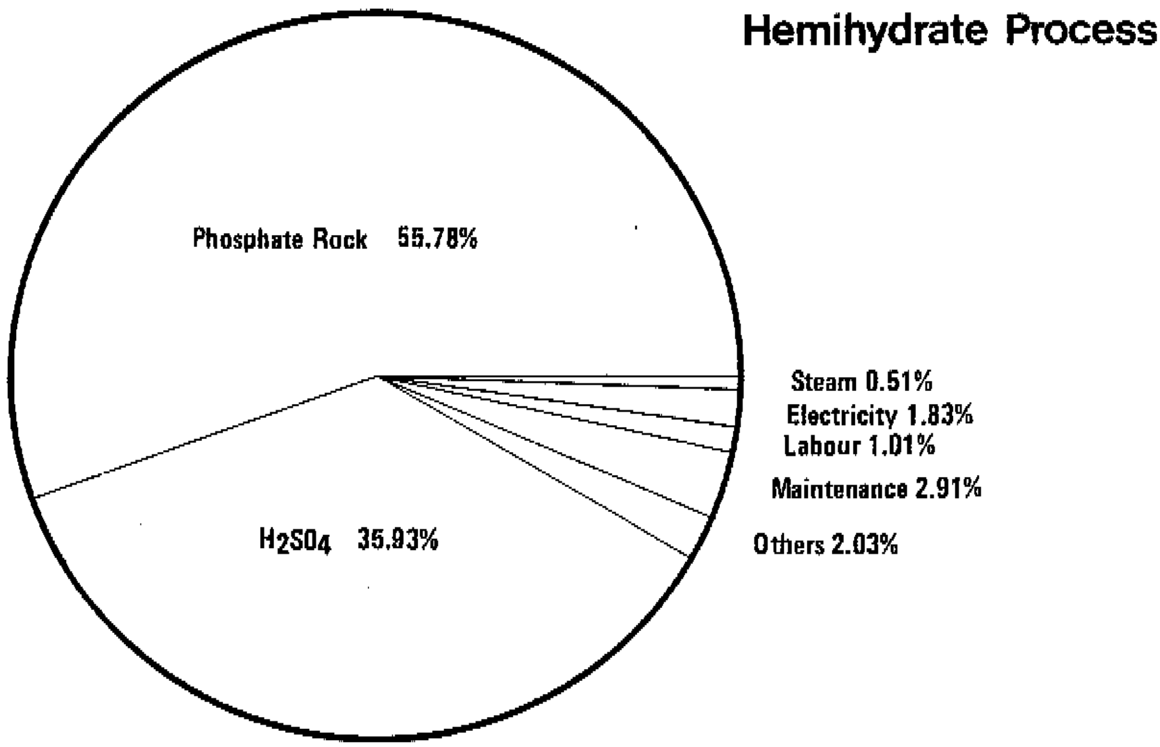
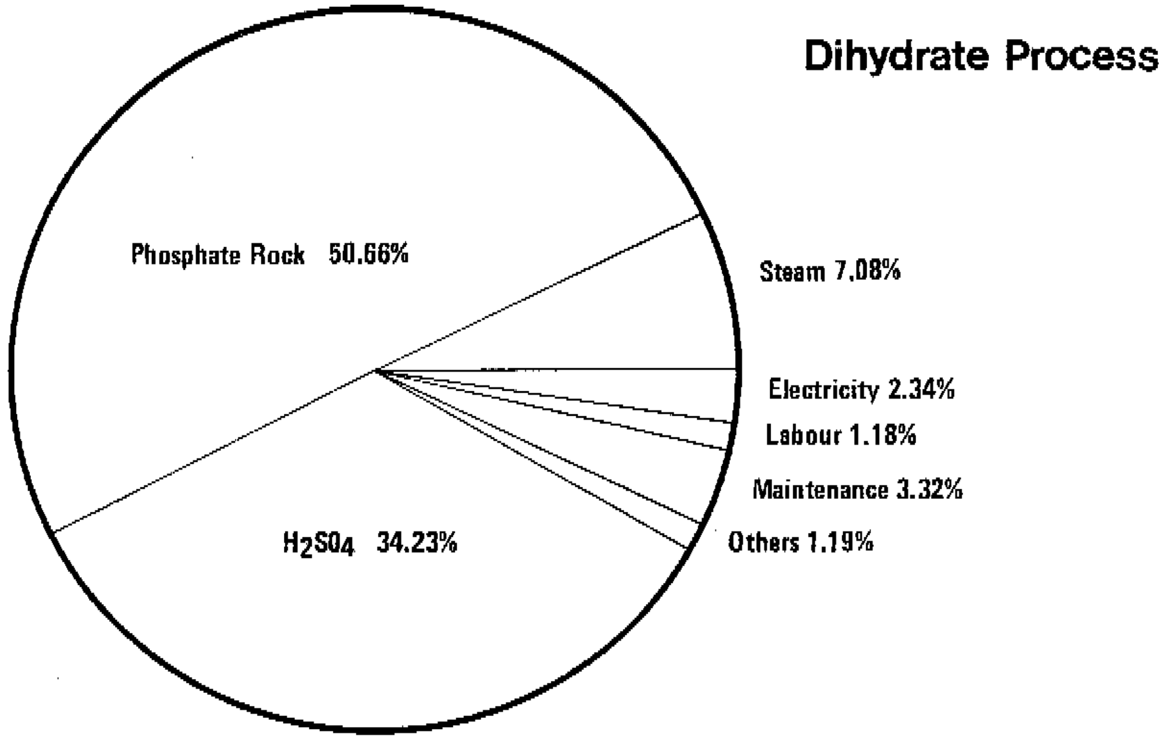
figure 5

Phosphoric Acid Operating Costs in 1981

Florida phosphate 72 BPL





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A further development at Windmill which has been successful in minimising total operating cost has been the optimising of product acid strength and plant capacity. This has been made possible because Windmill now requires mainly 42% P_2O_5 acid for its downstream processes. The production of 42% P_2O_5 acid ex filter has resulted in increased filtration rate and enhanced P_2O_5 recovery efficiency. The plant output has been increased by over 20% hence the cost per unit P_2O_5 produced has been reduced. Any remaining 42% P_2O_5 acid not used in downstream processes is concentrated to 50% P_2O_5 acid in a conventional concentration unit.

A breakdown of operating costs for this case is given in Tables 5 and 6 for Togo and Florida phosphates. For the sake of completeness comparative data is provided for 1971 and 1981.

The data indicates a small but significant reduction in costs due to savings in phosphate rock and sulphuric acid consumptions, more than compensating for the added steam costs when concentrating from 42% to 50% P_2O_5.

The cost saving is over US $3 per tonne P_2O_5 produced. Thus with the current profit margins the saving of US $300,000 per year on the production of 100,000 tP_2O_5 is important.

Table 5. Cost of Phosphoric Acid from a Hemihydrate Plant
Phosphate: Togo (35.7% P_2O_5, 48.7% CaO)
Acid ex filter: 42% P_2O_5, concentrated to 50% P_2O_5.

Item	Unit	Consumption unit per tonne P_2O_5 produced	Cost, US$ per tonne P_2O_5 produced	
			1971 prices	1981 prices
Phosphate rock	tonne	2.986	50.76	220.96
H_2SO_4 (100%)	tonne	2.538	50.76	139.59
Steam	tonne	0.75	0.79	9.57
Electricity	kWh	110	1.7	6.82
Process water	m^3	3.5	0.7	2.31
Cooling water	m^3	55	-	-
Labour	man-hours	0.25	1.92	3.2
Chemicals	US$	-	5.16	4.6
Maintenance	US$	-	4.11	9.22
Total			115.9	396.27

Table 6. Cost of Phosphoric Acid from a Hemihydrate Plant
Phosphate: Florida (32.8% P_2O_5, 48.1% CaO)
Acid ex filter: 42% P_2O_5, concentrated to 50% P_2O_5

Item	Unit	Consumption unit per tonne P_2O_5 produced	Cost, US$ per tonne P_2O_5 produced	
			1971 prices	1981 prices
Phosphate rock	tonne	3.285	49.28	229.95
H_2SO_4 (100%)	tonne	2.694	53.88	148.17
Steam	tonne	0.75	0.79	9.57
Electricity	kWh	120	1.85	7.44
Process water	m^3	3.5	0.69	2.31
Cooling water	m^3	55	-	-
Labour	man-hours	0.28	2.13	3.56
Chemicals	US$	-	6.82	8.31
Maintenance	US$	-	4.57	10.25
Total			120.01	419.56

3. PHOSPHATE ROCK GRINDING

It has been seen that electricity consumption is lower for a hemihydrate process than for a dihydrate process of similar capacity. Additional savings can be made in rock grinding.

The typical phosphate rock size specification required for the hemihydrate and dihydrate processes is:

Table 7

British Standard Sieve Size (Mesh)	Aperture (Microns)	% Through	
		Hemihydrate process	Dihydrate process
10	1700	100	-
30	500	75	100
60	250	25	95
100	150	-	60
200	75	-	30

When these requirements are compared with the particle size distribution of some phosphates (see Table 8) as supplied to consumers it can be seen that it is not necessary to grind the phosphate prior to feeding to a hemihydrate process plant, although it requires grinding for the dihydrate process.

Table 8

Typical particle size distribution of phosphates as received by consumer.

British Standard Sieve Size (Mesh)	Aperture Microns	Florida 72 BPL % Through	Khouribga Morocco 72 BPL % Through
18	850	96	91
30	500	87	87
60	250	50	65
100	150	12	22

The use of wet rock grinding is growing in importance and energy consumption is of the order 18 kWh per tonne rock when grinding a typical Florida concentrate for a dihydrate plant as defined above. At an electricity cost of US $0.05 per kWh this amounts to US $0.9 per tonne rock or US $2.9 per tonne P_2O_5 produced.

Even greater savings can be expected with dry grinding.

4. ELECTRICITY COGENERATION

Most phosphoric acid producers also manufacture sulphuric acid and are therefore able to benefit from the steam produced as a by-product from the sulphuric acid process. When the phosphoric acid is manufactured by the conventional dihydrate process route, it is common practice for this by-product steam to be used in the evaporation stage. This operation does not normally consume all the by-product steam, the remainder can be used for electricity cogeneration.

The use of a hemihydrate process plant to produce phosphoric acid will allow the operating company to maximise electricity cogeneration because of its minimal steam requirement. The rising energy costs of today's industry makes the improved cost credit from electricity cogeneration an increasingly important factor.

The value of enhanced electricity cogeneration can be seen by comparing the steam availability arising from a dihydrate process plant and a hemihydrate process plant each associated with a sulphur burning sulphuric acid plant.

A sulphuric acid plant will typically generate 1.1 tonne steam per tonne sulphuric acid, at 38 bar and 400°C. With a dihydrate plant 1.4 bar steam is required for concentration and it is normal practice to use a back pressure turbo alternator for electricity cogeneration whilst providing this steam for P_2O_5 concentration. In a hemihydrate plant there is minimal steam usage therefore a condensing turbo alternator set can be used for electricity cogeneration. The relative outputs are given in Table 9.

Table 9. Electricity generation by back pressure and condensing turbo alternators:

Phosphoric acid production	Type of phosphoric acid plant	Sulphuric acid production	Type of turbo alternator	Output
500 tpd P_2O_5	Dihydrate	1,350 tpd H_2SO_4	Back pressure	7,500 kW
500 tpd P_2O_5	Hemihydrate	1,350 tpd H_2SO_4	Condensing	13,000 kW
1000 tpd P_2O_5	Dihydrate	2,700 tpd H_2SO_4	Back pressure	15,600 kW
1000 tpd P_2O_5	Hemihydrate	2,700 tpd H_2SO_4	Condensing	26,000 kW

The cost credit benefit assuming that electricity costs are US$0.05 per kWh is given in Table 10.

Table 10. Electricity cost credit associated with Dihydrate and Hemihydrate Process Plants

Phosphoric acid production	Type of phosphoric acid plant	Electricity Cogeneration per day	Cost Credit	
			US$ per day	US$ per tpd P_2O_5
500 tpd P_2O_5	Dihydrate	180,000 kWh	9,000	18.0
500 tpd P_2O_5	Hemihydrate	312,000 kWh	15,600	31.2
1000 tpd P_2O_5	Dihydrate	374,400 kWh	18,720	18.72
1000 tpd P_2O_5	Hemihydrate	624,000 kWh	31,200	31.2

5. PROCESS DEVELOPMENTS

Since the first commercial scale hemihydrate process plant from Fisons Fertilizers was built at Windmill Holland BV in 1970 there have been a number of developments which have improved the process performance and subsequently reduced operating costs. Although it is not possible to detail all of these in this paper, it is worthwhile highlighting a number of them which directly affect energy costs.

(a) Agitator power consumption: There has been a small but significant reduction in agitator power consumption following an optimisation of the reactor agitation system.

(b) Reaction volume: Following extensive pilot plant investigations and commercial scale developments by Windmill Holland BV, the reaction volume has been reduced by as much as 50% for some phosphates without impairing the process performance. Since it is related to reaction volume this has led to a substantial reduction in the agitator power consumption.

(c) Plant utilisation: Improved maintenance procedures and use of appropriate materials of construction have increased the number of operating days per year and thus reduced fixed operating costs per unit P_2O_5 produced.

(d) P_2O_5 recovery efficiency: The development of the hemidihydrate process by Fisons Fertilizers has increased the P_2O_5 recovery efficiency to over 98%. More details are given in Section 6.

6. HEMIDIHYDRATE PROCESS (5), (6), (7)

The main loss that occurs in phosphoric acid production is P_2O_5 co-precipitated in the calcium sulphate which is discharged. In the HDH process this loss is minimised by adding a second stage in which almost all of the lattice P_2O_5 is recovered.

Unit operations are as follows:-

HH REACTION	COOLING	FLUORINE RECOVERY
HH FILTRATION	STORAGE	
HH to DH TRANSFORMATION		
DH FILTRATION		

HH Reaction and HH Filtration

The hemihydrate reaction stage is the same as for the single stage process.

HH Transformation and DH filtration

The hemihydrate cake is discharged from the first stage filter into an agitated transformation tank. In this tank the residence time, solids content and chemical composition are controlled to ensure complete transformation of hemihydrate to dihydrate and to allow sufficient time for the dihydrate crystals to grow. The lattice P_2O_5 co-precipitated during the initial acidulation stage is released into the liquid phase.

The dihydrate slurry is then filtered and the filtrate containing the released P_2O_5 is returned to the hemihydrate reaction stage as the last wash on the hemihydrate filter. The dihydrate cake is washed on the second stage filter with process water before being discharged.

A simple flow sheet is given in Figure 6.

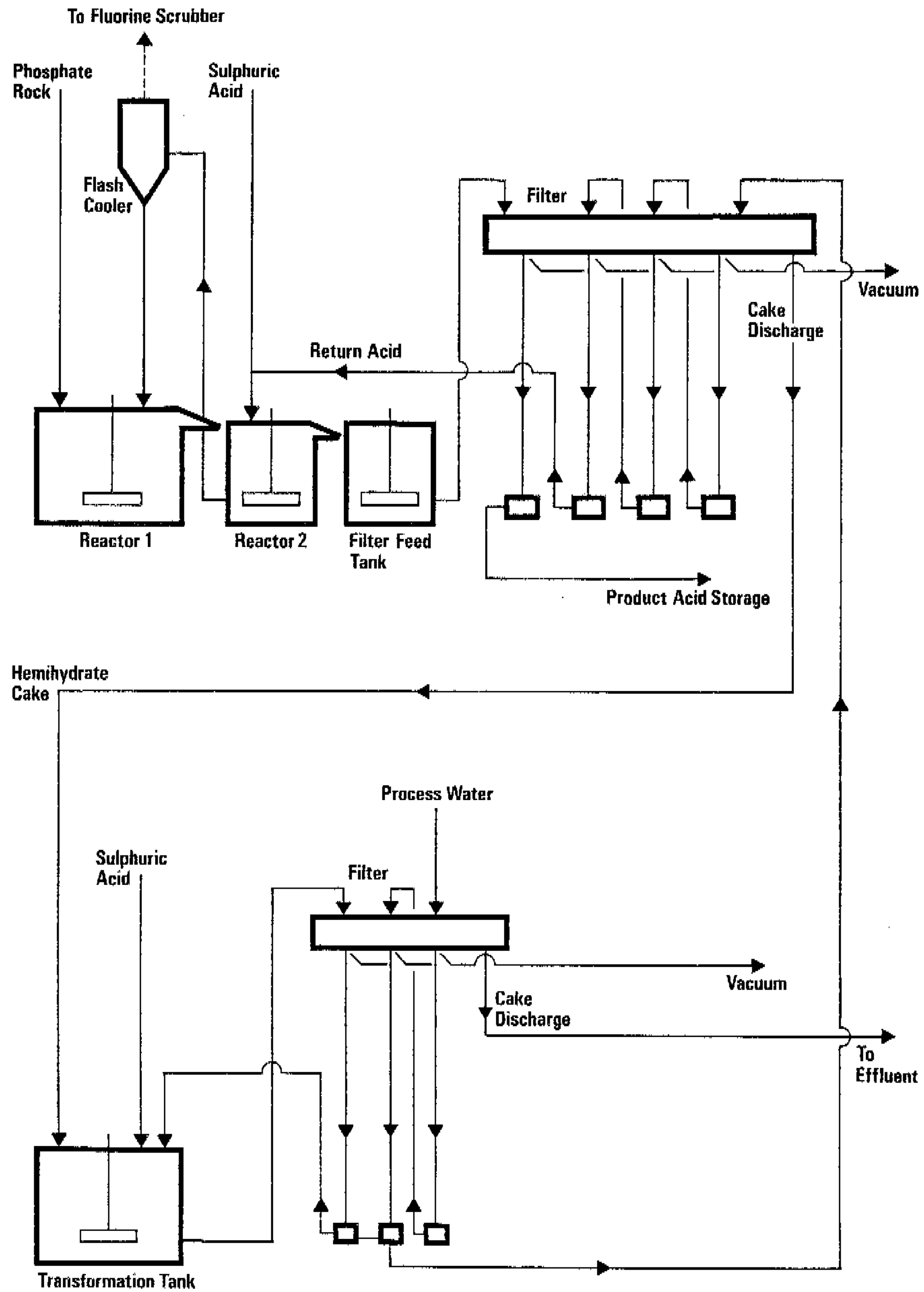
A significant increase in P_2O_5 recovery efficiency is achieved by incorporating these two unit operations. This in turn reduces the phosphate rock and sulphuric acid consumptions per unit P_2O_5 produced whilst maintaining the benefit of energy savings inherent in hemihydrate technology. This is translated into cost savings as shown in the following table:

Table 11. Cost of Phosphoric Acid from a Hemidihydrate Plant
Phosphate: Florida (32.8% P_2O_5, 48.1% CaO)
Acid ex filter: 50% P_2O_5

Item	Unit	Consumption unit per tonne P_2O_5 produced	Cost, US$ per tonne P_2O_5 produced 1981 prices
Phosphate rock	tonne	3.11	217.7
H_2SO_4 (100%)	tonne	2.60	143
Steam	tonne	0.17	2.17
Electricity	kWh	135	8.37
Process water	m^3	6.0	3.96
Cooling water	m^3	50	-
Labour	man-hour	0.42	5.33
Chemicals	US$	-	6.5
Maintenance	US$	-	13.5
Total			400.53

figure 6

Hemidihydrate Process



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Using 1981 data it is possible to compare the operating costs to produce 50% P_2O_5 acid via the following routes:

(a) dihydrate process - 28% P_2O_5 ex filter, concentration to 50% P_2O_5

(b) hemihydrate process - 50% P_2O_5 ex filter

(c) hemihydrate process - 42% P_2O_5 ex filter, concentration to 50% P_2O_5

(d) hemidihydrate process - 50% P_2O_5 ex filter

Table 13. Cost of Phosphoric Acid from various dihydrate and hemihydrate process routes.
Phosphate: Florida (32.8% P_2O_5, 48.1% CaO).
1981 prices. To produce 50% P_2O_5 acid.

Item	Cost, US$ per tonne P_2O_5 produced			
	Dihydrate (a)	Hemihydrate (b)	Hemihydrate (c)	Hemidihydrate (d)
Phosphate rock	228.27	235.83	229.95	217.7
H_2SO_4 (100%)	154.22	151.91	148.17	143.0
Steam	31.89	2.17	9.57	2.17
Electricity	10.54	7.75	7.44	8.37
Process Water	4.42	2.11	2.31	3.96
Cooling Water	-	-	-	-
Labour	5.33	4.26	3.56	5.33
Chemicals	0.93	6.46	8.31	6.5
Maintenance	14.96	12.3	10.25	13.4
Total	450.56	422.79	419.56	400.53

7. CONCLUSIONS

Because of the variation in the rate of increase in raw materials and utilities prices over the past ten years, the contribution to operating cost from steam consumption has taken on a greater importance.

Ten years of commercial operation of hemihydrate plant have proved that over 6% of the operating cost can be saved by avoiding the need for concentration of 28% to 50% P_2O_5 acid with its required steam consumption. This can be achieved by eliminating the steam generation or if steam is available as by-product it can be used in electricity cogeneration.

During this period there have been developments in the process by Fisons Fertilizers which have reduced consumption and costs. Particularly this has led to the hemidihydrate process which is now used in four commercial plants in various parts of the world. A saving of over 11% in operating cost can be achieved with the hemidihydrate process compared to the dihydrate route.

Further electricity savings of up to 18 kWh per tonne rock can be achieved by avoiding the need to grind the phosphate prior to feeding it to a hemihydrate plant.

REFERENCES

Paper	Author(s)	Presented to
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(6) Fisons HDH Phosphoric Acid Process, Operating Experience with a 160 tpd Plant	V. Lasovic et al	ISMA, The Hague - September 1976
(7) Full-scale Application of the HDH Phosphoric Acid Process	H.J. Koenig E.W. Schwehr	The American Institute of Chemical Engineers, Philadelphia - June 1978

TA/82/17 Fisons hemihydrate process - A decade of energy saving, by B.T. Crozier, Norsk Hydro Fertilizers, United Kingdom

DISCUSSION : (Rapporteur Mr. A. Constantinidis, SICNG, Greece)

Q - Mr. F. THIRION, Société Chimique Prayon-Rupel, Belgium

In the new Fisons process (high P_2O_5 content) can you give us for each existing unit:

1. The type(s) of phosphate rock processed (mixed or not, please indicate)
2. The production capacity t P_2O_5/24 h
3. The P_2O_5 content of the acid produced
4. The actual operation efficiency
5. The P_2O_5 efficiency of the reaction/filtration unit.

A - Types of phosphate processed:

73% BPL Khouribga
72% BPL Khouribga
72% BPL Jordan
73% BPL Calcined Morocco
69% BPL Morocco
68% BPL Florida
68% BPL Queensland/68% BPL Florida/Nauru mixture.

A -

Operating Company	Plant capacity tpd P_2O_5	Product Acid Stength % P_2O_5	Typical P_2O_5 efficiency R & F unit
Trepca, Yugoslavia	160	50	98%
A&W, UK	500	45	98%
CSBP, Australia	600	48	97.6%
Pivot, Australia	150	48	97.6%

A - The overall operation efficiency of each plant depends on several factors including rock source and housekeeping. For the above plants it is generally between 97-98%.