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EXPANSION AT JORF LASFAR - A NEW 1000 MTPD P_2O_5 UNIT[1]

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SUMMARY

The fertiliser complex, Maroc Phosphore III & IV that enables the OCP to produce 1.4 Mio tonnes of P_2O_5/year in the form of phosphoric acid consist of production units of DAP and TSP, sulphuric acid from liquid sulphur, a power station and offsites utilities.

Expansion projects include the revamping of existing plants, a new unit of phosphoric acid purification plant operated by EMAPHOS, a joint venture between OCP (40%), Prayon-Rupel S.A. (40%) and Chemische Fabrik Budenheim (20%) and also a new phosphoric acid unit to produce 330,000 mtpa P_2O_5 of 54% P_2O_5 acid in joint venture (50% - 50%) between Group OCP and group BIRLA – CFCL (India).

RESUME

Le complexe industriel Maroc Phosphore III et IV permet à l'OCP de produire annuellement 1.4 Mio tonnes de P_2O_5 sous forme d'acide phosphorique et comporte : des unités de production d'engrais DAP et TSP, d'acide sulfurique au départ de soufre liquide, une centrale électrique et les utilités annexes.

Les projets d'expansion comportent le revamping d'usines existantes, une nouvelle unité de purification de l'acide phosphorique exploitée par EMAPHOS une "joint venture" entre OCP (40%), Prayon-Rupel S.A. (40%) et Chemische Fabrik Budenheim (20%), ainsi qu'une unité d'acide phosphorique d'une capacité de 330.000 t P_2O_5/an construite par IMACID une association entre le groupe OCP et BIRLA (Inde).

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A. The Existing Plants – Maroc Phosphore III & IV

The fertiliser complex, Maroc Phosphore III & IV, was started in 1986 and this enabled the OCP Group to double its solubilisation capacity. It is situated 100 km southwest of Casablanca and 150 km from the Khouribga phosphate mines.

The annual production figures are of the order of 1.4 Mio tonnes of P_2O_5 in the form of phosphoric acid requiring as raw materials about:

- 5 Mio tonnes of phosphate from the Khouribga mine
- 1.4 Mio tonnes of imported liquid sulphur

About two thirds of this production can be transformed at the site into DAP and TSP, that is to say the equivalent of 1.7 Mio tonnes of DAP.

The electrical energy requirements of the complex are served by a Co-generation unit of 111 MW of which about 30 MW is fed into the National Grid.

The chemical complex of Jorf Lasfar consists of the following units described below. The processes and capacities of each unit are set out in Table 1, and the interconnection between the units is shown in Figure 1.

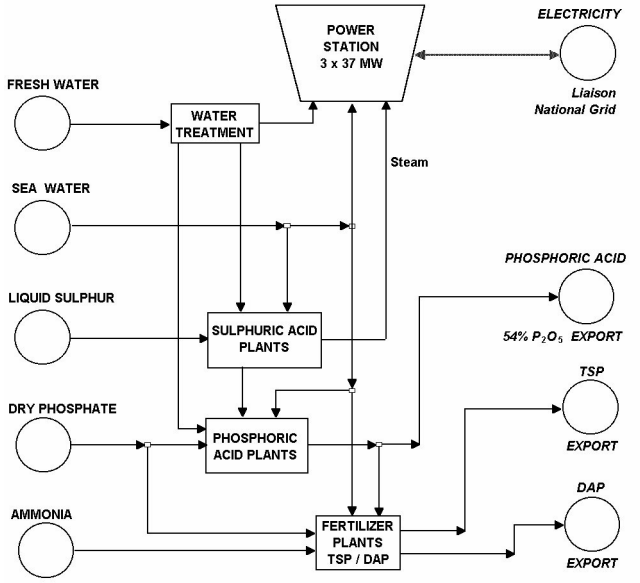
[1] *Expansion à Jorf Lasfar - une unité nouvelle de 1000 t P_2O_5/jour*

Table 1 - Fertilizer Complex Maroc Phosphore III & IV

Principal Installations

SECTION	UNITS	CAPACITY	PROCESS USED
Sulphuric Acid	6	2,300 mtpd MH/stream	Monsanto (USA) double absorption
Phosphoric Acid	8	500 mtpd P_2O_5/stream	Rhône Poulenc (F)
Phosphoric Acid Concentration	16	300 mtpd P_2O_5/stream	Rhône Poulenc (F)
Fertilizer Granulation Plants	4	1,400 mtpd/stream	AZF-Chimie (F)
Power Station (Turbo-alternators)	3	37 MWh/Group	GEC-Alsthom (F)
Water treatment	3	2,000 m^3/h/total	Mannesman (D)
Sulphur melting - Filtration (Sulphur melting)	8	1,000 mtpd/stream	Mitsui (J)

Figure 1 – Block diagram of Maroc Phosphore III & IV



A.1 SULPHURIC ACID

This section consists of 6 sulphuric acid units each capable of producing 2,300 mtpd monohydrate, using the double absorption process of MONSANTO which ensures a high conversion rate and gives maximum protection to the environment.

A.2 OFFSITES

The offsite facilities consist of:

- One power station with 3 turbo-alternators of 37 MW each
- One water treatment unit for 2,000 m^3/h
- One sea water pumping station of 60,000 m^3/h
- One compressed air unit for process and instrumentation needs

A.3 PHOSPHORIC ACID

This section consists of:

- 8 phosphoric acid plants, each of 500 mtpd P_2O_5
- 16 lines of concentration each for 300 mtpd P_2O_5
- associated storage and clarification tanks

These units were designed according to the Rhône-Poulenc single tank dihydrate process and are fitted with air cooling and a two-stage gas scrubbing system

A.4 FERTILIZER PLANTS

This section consists of 4 Fertiliser granulation plants designed for the production of DAP but also capable of producing GTSP, the production capacities being:

- Producing DAP : 1,400 mtpd
- Producing GTSP : 1,100 mtpd

The process used was supplied by AZF-Chimie and uses double pipe reactor technology for the production of DAP and agitated dissolution tanks for GTSP.

A.5 STORAGE AND PORT

The port and storage areas consist of:

- Storage buildings for solids; phosphate, sulphur and fertilisers
- Storage tanks for liquids; liquid sulphur, ammonia and phosphoric acid
- Units for the melting and filtration of sulphur
- Station of filtration and pumping of sea water
- Bagging units for fertiliser destined for exportation in sacks
- Installations equipped for:
  - ↘ Discharging
    - Sulphur with two grabs
    - Ammonia via two unloading arms
- Installations equipped for:
  - ↗ Loading
    - Phosphate or bulk fertilisers with two grabs
    - Phosphoric acid via two loading arms

A.6 SUMMARY

This concludes the description of the Maroc Phosphore III and IV complex which you will all be visiting today. Recently one additional unit has been built. This unit started up early in 1998 to produce technical and food grade phosphoric acid from a Merchant Grade Acid feedstock. This unit is operated by EMAPHOS a joint venture between OCP (40%), Prayon-Rupel S.A. (40%) and Chemische Fabrik Budenheim (20%) and uses Prayon-Rupel Technologies solvent extraction process.

B. <u>The Major Expansion at Jorf – The IMACID Project</u>

The Group OCP (Morocco) and the group BIRLA – CFCL (India) have decided to build in joint venture (50% - 50%) a new phosphoric acid unit to produce 330,000 mtpa P_2O_5 of 54% P_2O_5 acid at Jorf Lasfar, Morocco. General details of the investment are set out in Table 2. BIRLA is a private sector Indian group having subsidiaries not only in the fertiliser field but also in the various other fields such as the media, sugar, cement, engineering, education, textiles, tea, coffee, etc.

The subsidiaries of the BIRLA in the chemical and fertiliser field are ZUARI (Zuari Agro Chemicals Limited) and CFCL (Chambal Fertiliser & Chemicals Limited) who both produce urea, DAP and NPK.

The joint venture company was baptised IMACID.

Table 2 – General Details of the IMACID project
IMACID

INDO MAROC PHOSPHORE, s.a.

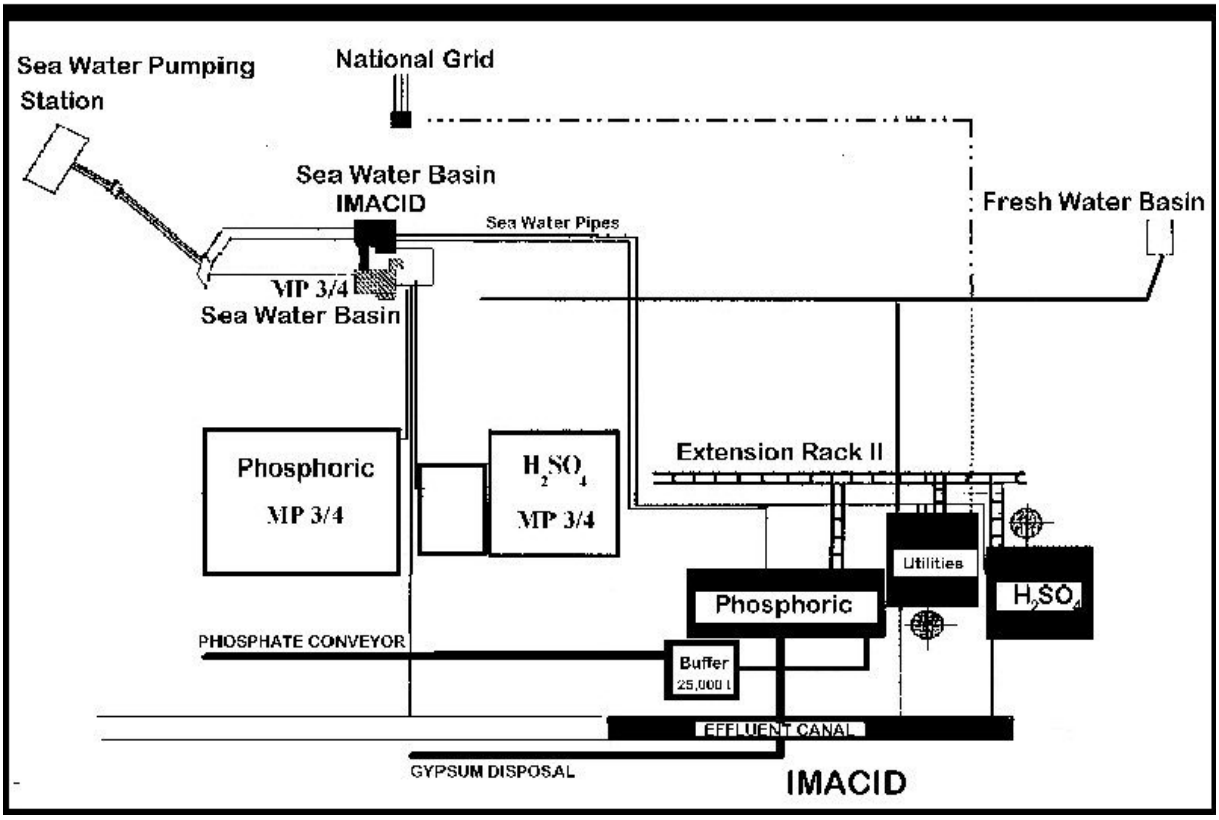
PARTNERS	
OCP (MOROCCO) : 50%	**BIRLA (INDIA) : 50 %**

PROJECT	
330,000 mtpa P_2O_5 of phosphoric acid in Jorf Lasfar	
Schedule	: 30 months
Permanent jobs	: 250

TECHNICAL CHARACTERISTICS	
The IMACID project includes :	
Sulphuric acid plant	: 3,300 mtpd MH
Phosphoric acid plant	: 1,000 mtpd P_2O_5
Turbo-Alternator Group	: 27 MWh
Water treatment unit	: 2 x 100 m^3/h
Compressed air unit	: 2 x 1,500 Nm^3/h
Sea water supply	: 15,000 m^3/h
Process	
Sulphuric Acid	: Monsanto - double absorption
Phosphoric Acid	: Prayon Mark 4
Expected start-up date	: 1st. half of 1,999

This complex will be an integrated unit situated close to existing sulphuric acid plants of Maroc Phosphore III & IV, see Figure 2.

Figure 2 – General layout of IMACID

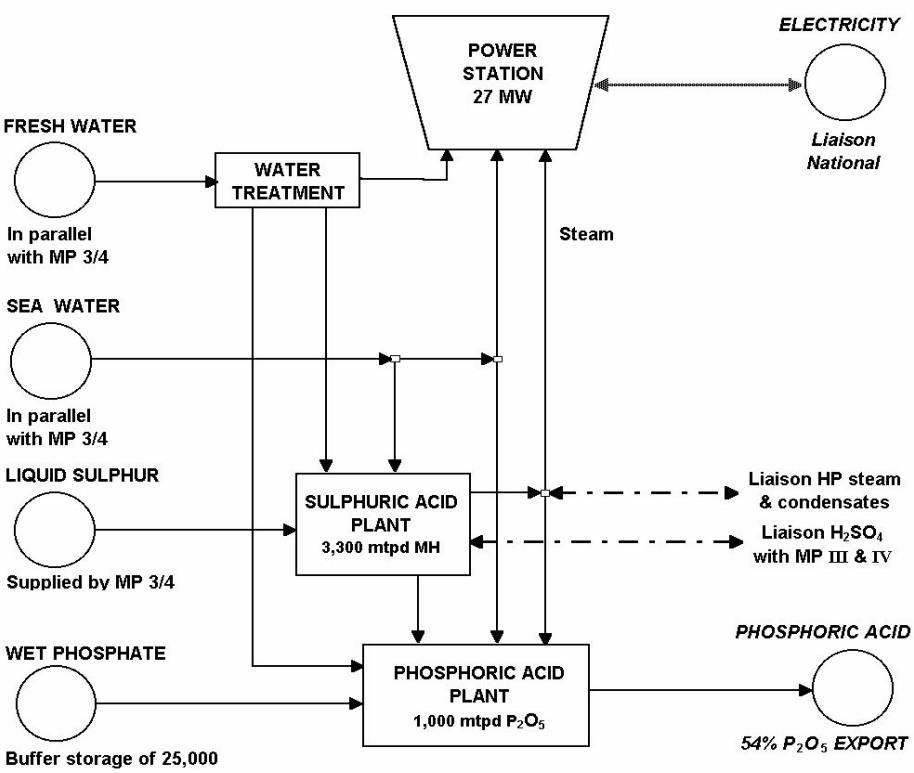


In effect this site was chosen profiting from the foresight of the planning of Maroc Phosphore III & IV as the original design of the site was developed with consideration for the extension of production capacity in the future. With this feature this project is able to benefit from many of the facilities already existing on the Maroc Phosphore III & IV site; the Port, the railway lines, access roads, storage, electrical distribution, effluent collection and treatment, sea water and fresh water supply, workshops, etc.

The whole needs for process cooling water are supplied from the existing sea water pumping system of Maroc Phosphore III and IV which delivers water at 22°C max.

The principal units forming the IMACID project are shown on the block diagram Figure 3. This also shows the principal interconnections between IMACID and Maroc Phosphore III & IV.

Figure 3 – Block diagram of IMACID



Of the 54% P_2O_5 Merchant Grade (MGA) phosphoric acid produced by IMACID about two thirds will be exported to supply the fertiliser units of the Indian partner CFCL.

The project has been conceived using the most advanced technology and equipment for each of the units and all the units will be controlled and linked using Digital Control Systems – (DCS).

IMACID partners chose to minimise the turn-key contracts in order to maximise the participation of local companies with real know-how transfer and employment consolidation.

B.1 SULPHURIC ACID

The capacity of this unit is 3,300 mtpd Monohydrate and is based on the MONSANTO double absorption process. The basic engineering being supplied by the American company MONSANTO and the detailed engineering by the French company SOFRECID -KVAERNER PROCESS.

The purchasing of equipment and procurement is being effected by IMACID.

The expected conversion rate of sulphur is >99.7%. The sulphuric acid is produced at a strength of 98.5% by the burning of liquid sulphur and is supplied to the phosphoric acid plant for the solubilisation of the phosphate.

In order to optimise the recovery and protect the environment, on line analysers are provided on the stack. pH-meters are also supplied on the cooling water outlet.

The unit also produces 120 mtph of HP steam (60 bar @ 500°C) and 55 mtph of MP steam (9 bar). This steam results from the recovery of the heat of combustion of sulphur which is extremely exothermic.

This steam will be fed to the Power Station serving the following functions:

- Co-generate electric power for the complex
- Feed MP steam for the concentration of phosphoric acid

B.2 OFFSITES

B.2.a Power Station

The execution of this unit was contracted on a turnkey basis to GEC-ALSTHOM of France. This unit essentially consists of:

- A pass-out & condensing turbo-alternator of 27 MW
- A diesel auxiliary power supply at 10kW and 1200 kVA
- The steam circuits for HP, MP and LP steam
- The electrical distribution for 60 kV, 10 kV and 660V
- Other utility circuits

This unit is connected with the main HP and MP steam systems of Maroc Phosphore III & IV to supply start-up steam and improve the operating factor of all the units on the Jorf Lasfar site.

B.2.b Water Treatment Plant

The execution of this unit was also contracted on a turnkey basis to USF-FRANCE and consists principally of:

- The raw water circuit
- Two trains of silica removal each for 100 m^3/h
- Distribution systems for each type of water (drinking, fire and process)
- A station for compressed air rated at 2 x 1,500 m^3/h

B.3 PHOSPHORIC ACID

The nominal capacity of this unit is 1,000 mtpd P_2O_5 as 54% P_2O_5 Merchant Grade Acid and is based on the PRAYON Mark 4 dihydrate process. The basic & detailed engineering of the Reaction and Filtration Section being supplied by the Belgian company SNC✧LAVALIN Europe and for the Concentration and Storage Sections by SMESI the engineering subsidiary of OCP based in Casablanca.

The purchasing of equipment and procurement is being effected by IMACID.

The main differences between the units of Maroc Phosphore III & IV and IMACID projects are set out in Table 3:

Table 3 – Key features of the Maroc Phosphore III & IV and IMACID projects

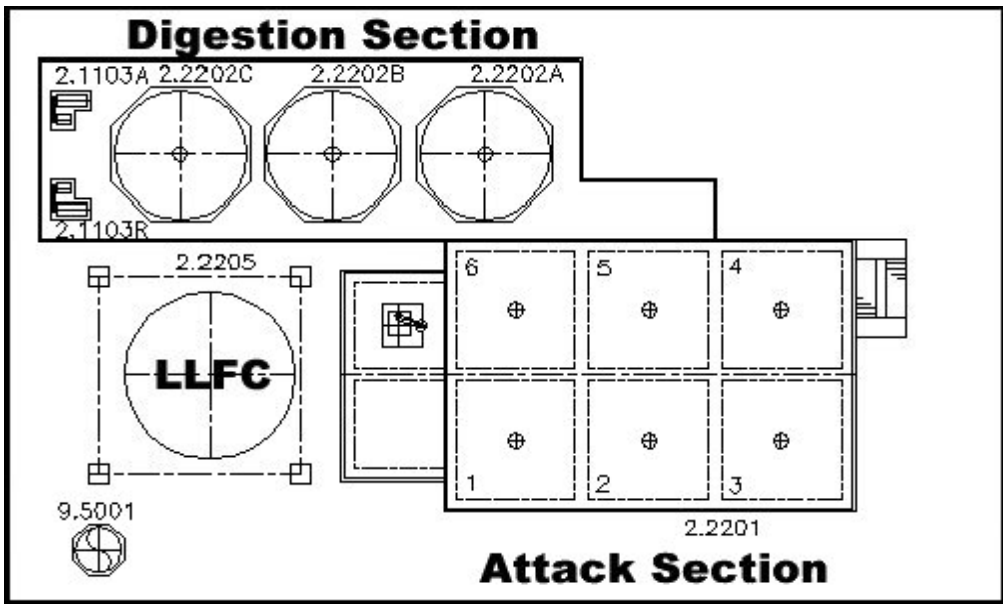
	Maroc Phosphore III and IV	**IMACID**
	Reaction	
Nominal Capacity	8 x 500 mtpd P_2O_5 / line	1000 mtpd P_2O_5
Design wash cycle	2 hours per day	8 hours per week
Phosphate	Dry Khouribga	Wet Khouribga K 09
Grinding system	Air swept ball-mill	Wet grinding
Size specification	Fine phosphate	25 > 160 m
Reactor cooling	Air cooling	Flash cooling
Type of reactor	Single tank	Multi-compartmented tank
Filter feed	Pumping vessel	Digestion section
	Filtration	
Type of filter	Table filter	Tilting pan filter
Active surface	153 m^2	220 m^2
	Concentration	
Nominal Capacity	16 x 300 mtpd P_2O_5	3 x 440 mtpd P_2O_5
Heat exchangers	Carbon Block	Graphite tubes

The phosphoric acid section of the Maroc Phosphore III & IV complex was designed according to the Rhône-Poulenc process whilst the IMACID unit uses the Prayon Mark 4 process.

A sketch of the reaction and filtration section of the IMACID plant is shown in Figure 4 and an overall layout in Figure 5.

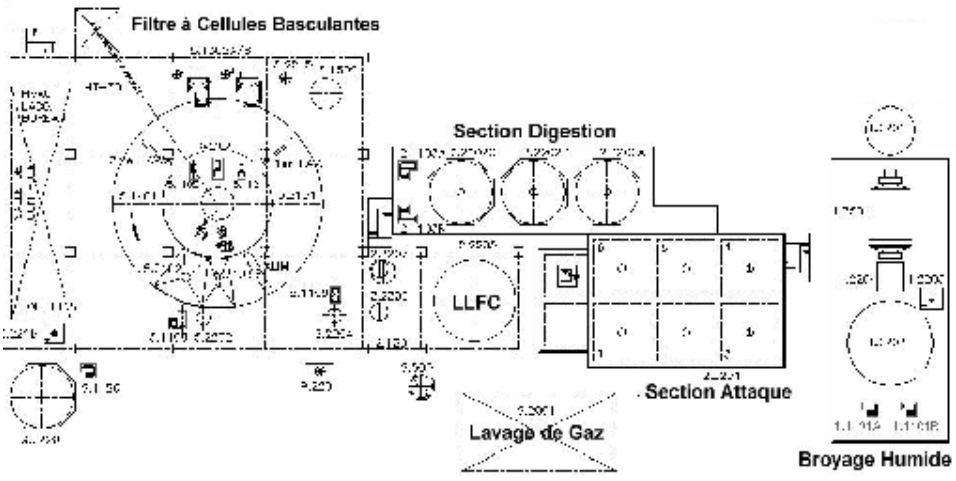
The wet rock is received across the Battery Limits and stored in the Phosphate Silo 1.2201 where it is fed to the Phosphate Mill 1.2501 where it is ground to the required fineness and stored in the Phosphate Slurry Tank 1.2202. From here the phosphate is fed at about 68% solids by the variable speed Phosphate Slurry Feed Pump 1.1102 to the N°1 compartment of the Attack Tank 2.2201. Recirculation is maintained through the Low Level Flash Cooler 2.2205 and the Attack Tank 2.2201 by the Flash Cooler Feed Pump 2.1101 which takes suction from the N°6 compartment and delivers the cooled slurry to N°1 compartment. Each compartment has a volume of 245 m^3.

Figure 4 – Overall view of the Reaction Section



The sulphuric acid is pre-mixed in mixing-tees, 2.2217A/B, with the return phosphoric acid from the filter and can be fed into either N°2 or N°3 compartment depending on the requirements. The slurry overflows from the 6^{th} compartment of the Attack Section to the first tank of the Digestion Section 2.2202A where additional H_2SO_4 may be added if desired. After passing through the three Digestion Tanks, each with a volume of 245 m^3, the slurry is pumped by a variable speed Filter Feed Pump 2.1103 to the Filtration Section. The Reaction Tanks are maintained under depression by the Scrubber Fan 9.1201, the gases being washed in the two in series Gas Scrubbers 9.2001 A/B prior to the Scrubber fan 9.1201, before being vented to atmosphere via the Stack 9.5001. The expected fluorine content of the stack gases is less than 5 mg / Nm^3.

Figure 5 – Typical plot plan of the Reaction and Filtration Sections

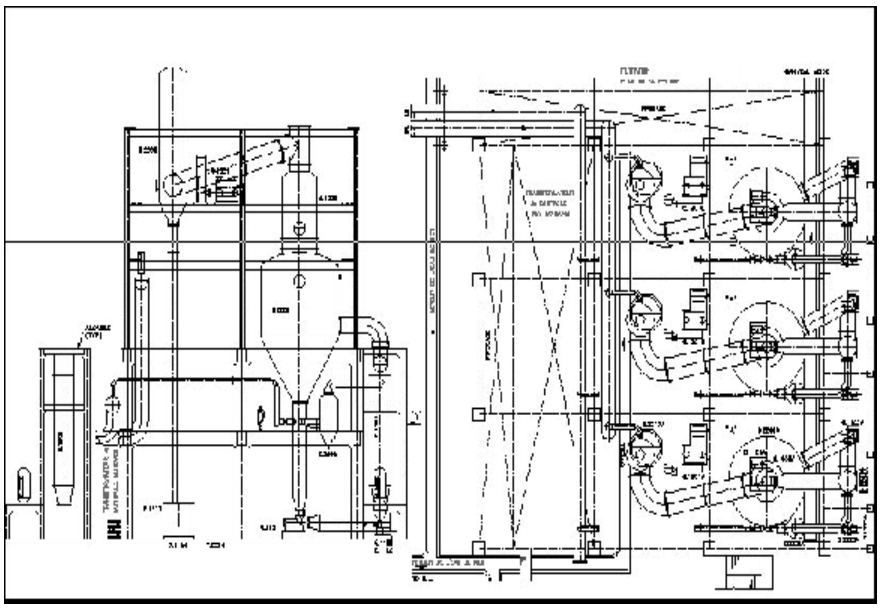


The Filtration Section consists of one wet-discharge two-wash BIRD-Prayon tilting-pan filter with 30 pans and an active surface of 220 m^2. The filter is fitted with the latest design of *"Fast-drain"* pans and has a cloth wash recovery chute and a gypsum discharge chute. It is also fitted with the latest cloth fixing mechanism that allows the changing time of one cloth to be reduced to less than 10 minutes. The product acid is pumped to the Weak Acid Storage Section by the Weak Acid Pump 5.1101. The Return Acid Pump 5.1102 delivers the wash liquor to the Mixing-Tees 2.2217A/B in the Reaction Section.

The Weak Acid Storage Section consists of one dispersion tank 3.2220 of 1940 m^3 one Weak Acid Decanter 3.2221 of 21 m diameter and one Weak Acid Storage Tank 3.2222 of 3350 m^3. The three Evaporators are fed with individual Evaporator Feed Pumps 3.1104A/B/C. Sludge from the Decanter is fed back to the Reaction Section.

The plot plan and the elevation drawings of a Concentration Section are shown in Figure 6.

Figure 6 – Concentration Section
(Typical plan and elevation drawings)



The Concentration Section consists of three units in parallel each with a design capacity of 474 mtpd P_2O_5 when evaporating from 29% to 54% P_2O_5. Each unit is fitted with a Flash Chamber 6.2201 and an axial flow Recirculation Pump 6.1101 of 7,000 m^3/h to maintain the dT below 3°C. Low pressure steam is fed after desuperheating to a 725 m^2 graphite tube Heat Exchanger 6.1901 and condensate is recovered and checked for quality before being recycled to the steam generation system by the Condensate Pump 6.1155. Vapours from the Flash Chamber 6.2201 pass through a proprietary PRAYSEP high efficiency Separator 6.2205 before being condensed with Sea Water.

The vacuum is maintained with a liquid ring Vacuum Pump 6.1301. Strong acid at 54% P_2O_5 is pumped by the auto-regulating Product Pump 6.1102 to the Strong Acid Storage Section. The maturing of the 54% P_2O_5 acid ex-concentration and the production of Merchant Grade Acid is effected in the Strong Acid Storage Section. Directly from the evaporator the acid is fed to an Ageing Tank 8.2220 with a volume of 1940 m^3 and on to a Decanter 8.2221 of 34 metre diameter and a volume of 6355 m^3. The overflow from the decanter passes through a Pump Tank 8.2222 to a Strong Acid Storage Tank 8.2224 with a volume of 5000 m^3. As pointed out earlier the IMACID project relies on the existing final storage and port facilities for the shipping of the production to the Chambal Fertiliser factory and the other clients. All acidic effluents (leakage, periodical production section wash water, etc.) are collected into a specific tank in order to be regularly recycled in the process to the attack section by the pump 9.1120.

C. Other Expansions

C.1 AT THE JORF SITE

C.1.a Revamping of Maroc Phosphore III and IV

As mentioned earlier the MP III & IV industrial complex has 8 phosphoric acid production lines of 500 t P_2O_5 each (Rhône Poulenc process) i.e. 4000 t P_2O_5 total. The revamping of these units is an important part of OCP's policy to increase its phosphate solubilisation capacity. This is how that OCP has used its know-how and resources to realise in the short term an increase in overall capacity of 15 %.

- **Phosphoric Acid Plant**

Two units have already been boosted and started with success demonstrating the expected performances. The basic and detailed engineering procurement and erection being effected by OCP's own forces. The main technical modifications are

- increase the grinding capacity
- additional digester and a flash-cooler.

Other concentration lines are erected to concentrate the additional acid produce by the reaction section.

- **Sulphuric Acid Plant**

To supply the phosphoric acid capacity increase sulphuric acid units are also revamped. The basic engineering for the expansion of the existing sulphuric acid plants was developed by MONSANTO, implementation is presently effected by Maroc Phosphore's own means.

C.1.b EMAPHOS

As mentioned earlier in the presentation EMAPHOS (Euro Maroc Phosphore), a joint venture company (OCP 40%, PRAYON 40% and BUDENHEIM 20%), has constructed a plant to produce technical and food grade phosphoric acid from fertiliser grade acid on the Jorf Lasfar site of Maroc Phosphore. The slated production capacity was 130,000 mtpa P_2O_5. Construction of this unit was completed towards the end of 1997 and after water testing chemicals were introduced in January 1998. The plant suffered a 3 week shutdown in March to replace some graphite parts that were not up to specification but during the whole of the month of May the plant showed its capabilities to produce the quality and quantity of acid envisaged in the Contract. The majority of the acid will be shipped by sea tanker for use at the plant of Budenheim in Germany the rest being sold on the world market.

C.1.c STPP

At present marketing studies are reaching their final stages with respect to the building of a STTP unit at the Jorf Lasfar site in joint venture with PRAYON. The project envisages a design for initial production of 50,000 mtpa but with concepts to easily enable later expansion to 100,000 mtpa. The feedstock considered for this unit would be purified acid from EMAPHOS.

C.2 AT THE SAFI SITE

C.2.a Sulphuric Acid

An additional 2,300 mtpd monohydrate sulphuric acid plant is being built to make up the deficit of sulphuric acid and allow an increase in production of phosphoric acid. The engineering for this unit has been contracted to KREBS of France.

C.2.b Phosphoric Acid

There are twelve phosphoric acid plants at the Safi site, and progressively steps are being taken to get the most out of these existing investments.

- Maroc Chimie I

The first two lines of Maroc Chimie I are being rehabilitated by OCP using process consultancy from PRAYON. The aim is to increase their on line factor and reduce maintenance costs. The Reaction Sections of these two lines will be twinned and fitted with a low level flash cooler and a high efficiency gas scrubber reducing fluoride emissions to the atmosphere, the original units had air cooling. The revised unit will have a nominal capacity of 360 mtpd P_2O_5 and the two existing 40 m^2 tilting-pan filters will be modernised according to the latest BIRD-Prayon design which will enable a higher rotational speed and an increase in area to 48.6 m^2 .

- Maroc Phosphore I – 4^{th} Train

This unit is a Rhône-Poulenc single tank design and the existing 153 m^2 UCEGO filter will be replaced by a “state-of-the-art” BIRD-Prayon filter with 190 m^2 of active surface. After this the reaction section will be studied to maximise production on the new filter.