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JORDANIAN PHOSPHORIC PROCESS

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Introduction

The need to elevate our phosphoric acid production to a more stable and continuous productive condition, has prompted JPMC to develop a new dihydrate process and build a new attack unit to run in parallel with existing reaction unit in such an arrangement which enables the main attack section to run in conditions favorable to the design figures in terms of capacity and product quality and to utilize the extra filtration and grinding capacities in the other sections of the existing phosphoric acid plant as demands for P_2O_5 have been rising locally and abroad.

It is worthy to note that this project has been designed, built and commissioned by local capabilities

MAIN FEATURES OF ATTACK UNIT

The new Jordanian dihydrate process (JPP) which has been developed by JPMC personnel is distinguished by RAW MATERIAL FEEDING METHOD , SLURRY COOLING AND SLURRY CIRCULATION .

RAW MATERIAL FEEDING METHOD:

The three feeding materials, rock, sulfuric acid and recycle acid are fed directly to the reactor in such a way that will achieve complete reaction between the rock and sulfuric acid.

The large reaction volume which is 2 m^3 per ton of P_2O_5 production per day, and the high sulfuric acid level at the phosphate rock feed, increase the reaction efficiency by reducing both attack and lattice P_2O_5 losses (unreacted - 0.145 %w,co-crystallized-0.621%w). This arrangement is the most suitable for Jordanian rock due to its high reactivity when used as fine and dry phosphate with the following tyler screen mesh analysis .

TYLER SCREEN	PASSING
MESH NO.4	
20(32)	100
48	97.8
100	92.8
200	77.4
270	46.6

SLURRY COOLING:

The JPP unique reactor slurry cooling system relies on a specially designed spiral jet spraying nozzles carefully distributed on the direction of air draught into reactor and gases outlet hood. These sprayers are fed with circulated slurry from the digester at rate of 300 m^3/hr per unit, creating a hollow cone spray with 120^o angle. The sweeping air above the normal operating slurry level cools circulated and sprayed slurry, these spiral spraying nozzles can be characterized as the following:

1. The spiral nozzles are not subject to F attack because the air draught sweeps away all evolved reactor gases to the scrubbing system, consequently DIN 1:4539 has been selected as spray jet nozzles material which provides excellent resistance to corrosion and erosion with good cost optimization.

2. Highly efficient spraying nozzles with almost clogging-free equipment, easy to clean if any clogging occurs.

3. Low operating cost with respect to maintenance and power consumption.

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The concept of Jordanian phosphoric acid process cooling system is unprecedented. It combines efficiency and simplicity for process cooling methodology. The basic component of this system is a spiral jet nozzle with flange. It is made of material DIN 1:4539 SS. This spiral jet is the largest nozzle of its type, designed, developed and built by a spraying systems company from the U.S.A.

There were several problems encountered during nozzle's development ,one of these problems which had to be solved, was designing the nozzle's physical size to obtain the flow rate required.

The successful nozzle's design was achieved after tedious efforts where several design prototype models had to be tried in several laboratories of the Spray System Company. Once the required flow rate was achieved, the spray angle had to be developed. Also, the same procedure and tedious efforts were followed to come-up finally with required 120^o angle.

The application of the spiral jet nozzles in the new attack unit has proved the success of the nozzle's design, larger nozzle produces less small droplets.

SLURRY CIRCULATION:

The high circulation rate from digester to reactor through spiral sprayers has proved to be a real advantage process-wise as shown by viewed crystals which have been favorable to filtration (mainly cluster and rhombic crystals with good growth). By trials and during the semi-industrial tests, it has been determined that the optimum slurry/ rock ratio was 90:1. This ratio optimizes the main three elements, slurry cooling, slurry consistency and power consumption.

PROCESS DESCRIPTION

The Jordanian Phosphoric Process (JPP) is a process using one reactor, digester and filter feed tank in sequence (Figure 1).

The reactor is a cylindrical baffled concrete tank containing no internal compartments. Agitation and circulation within the reactor are provided using a centrally located agitator, which ensures that the entire slurry content passes through it. This reactor is rubber lined, protected by brick lining. Underneath the agitator, an anti-wearing DIN 1:4539 plate is fixed.

Rock is fed into the zone of high turbulence near the central agitator at a point remote from the gas extraction hood. Also sulfuric acid is fed through a mixer which also receives P_2O_5 recycle acid flow and mixes with sulfuric acid feed in such a way that the mixing occur at the outlet of the acid mixer and poured at a zone of high turbulence to ensure good mixing of these vital feeds and an effective distribution throughout reactor slurry content achieves a complete reactants attack .A baffle is fixed at the inlet of the gas extraction hood to reduce slurry and fine rock carry over to the scrubbing system.

Eight air openings are distributed throughout reactor roof beside four openings with specially designed slurry nozzles which spray circulated slurry from digester at a rate of 1200 m^3/hr from digester by two pumps (Figure 2). Air is drawn by fixed speed scrubbing fan through the air openings, air flow rate is regulated by controlling scrubbing fan suction flow regulator damper, air –swept cooling take place to remove heat generated by reaction and sulfuric acid dilution. Effluent gases leaving reactor are drawn to an efficient scrubber before being discharged to the secondary scrubber into the atmosphere with 10 mg F^- per one ton of P_2O_5 produced or less, thus respecting tight environmental limits. Defoamer agent dosing is arranged to reactor, digester and filter feed tank.

NEW PROCESS ADVANTAGES

JPP main advantages, based on industrial basis results obtained during performance test period and four months operation, are the following:

- Highly efficient unique cooling system which proved to be consistent with expectation: low power consumption, low maintenance cost and durable system.
- Slurry circulation ratio to rock (90: 1) has optimized three important parameters, slurry cooling, homogenized slurry and lower power consumption.

- High P_2O_5 recovery efficiency which has reached 96.8% during three days performance test period at 113,8% of the design load.
- Process is very simple.
- Minimum number of equipment items.

APPLICATION OF JPP

A new pilot attack unit has been built with a capacity of 150 tonnes P_2O_5/day, implementing the Jordanian Phosphoric Process, and incorporated with 1310 tonnes P_2O_5/day existing unit.

The tying between the new attack unit and existing plant has been done in a way to take advantage of extra load capacities of the existing phosphoric acid plant section: grinding sections, sulfuric acid feed and filtration section. Also the operation was set-up in a homogeneous link in such a way that will not cause any breaching of the plant's interlock.

Feeding streams are linked with exiting streams as in the following:

- Ground rock feeding is tied with plant's recycle chain conveyor. The phosphate is conveyed to mass flow meter by a screw conveyor. This system is well sealed to minimize spillages. The weighed rock is delivered by well designed conveyor to the reactor.
- Recycle phosphoric acid feed is linked with the main recycle acid header, the quantity of this acid is controlled by a flow control valve (FCV).
- Sulfuric acid feeding is linked with the main sulfuric acid header in a point, which is, located up-stream the battery limit of the existing plant. An effective pressure reduction and control valve is installed on the new unit sulfuric acid 4 inch header (PCV) to control the downstream pressure as low as possible. The quantity of sulfuric acid fed to reactor is controlled by flow control valve (FCV).

The erection of the new attack pilot unit was completed by the end of February 1999 (Figure 3). Commissioning activities commenced in February 1999 followed by successful test run which was carried out at 113% of the design load. An extensive inspection was carried out for main equipment (agitator, spray nozzles and pumps) and vessels (brick and rubber lining), and no significant corrosion or erosion effects were observed.

The new attack pilot unit has been built without filter feed tank as originally described in the process. This situation has resulted some drawbacks.

Slurry liquid high turbulence in the digester, caused by high circulation rate, hindered the performance of the product slurry vertical pump, which caused some difficulties regarding slurry level control. An overflow funnel installed on the digester at level 5.20 m with horizontal pump. This arrangement has significantly improved the operation of the new attack unit by allowing better level control in the digester.

The technical data are shown in Appendix I.

Figure 1

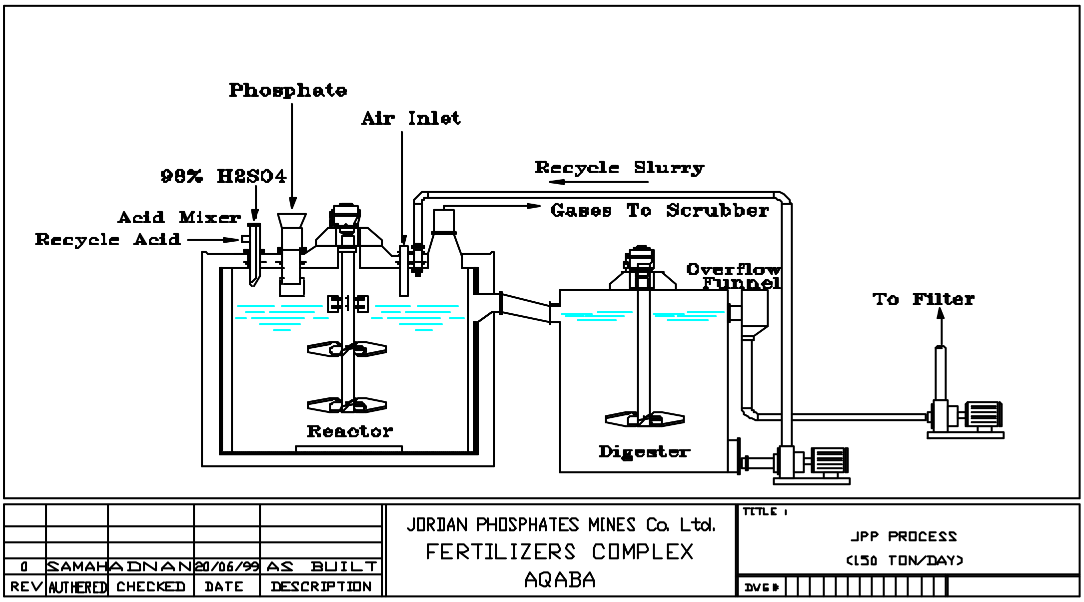


Figure 2

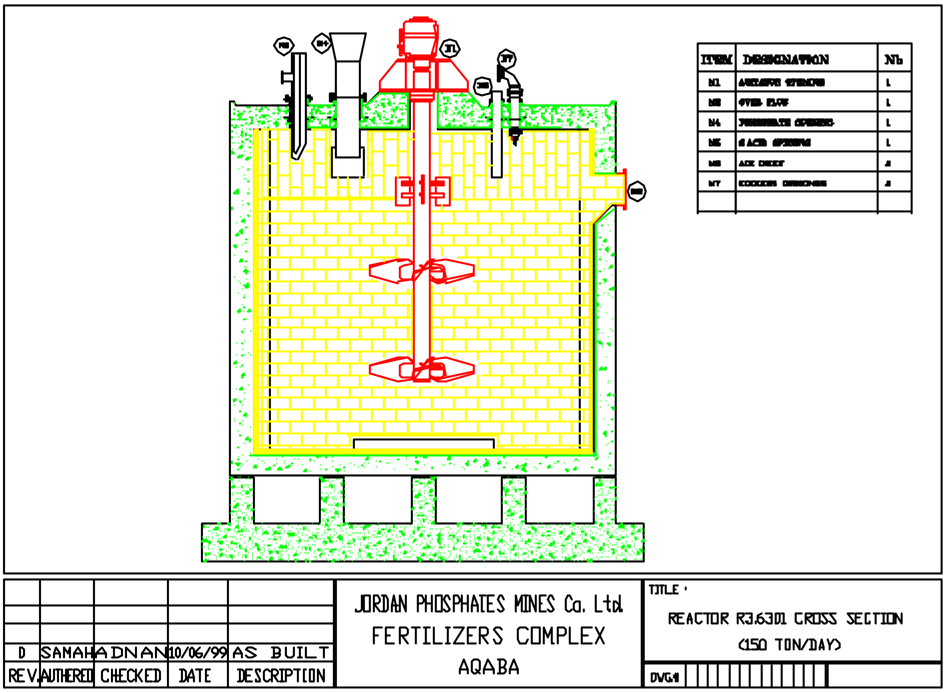
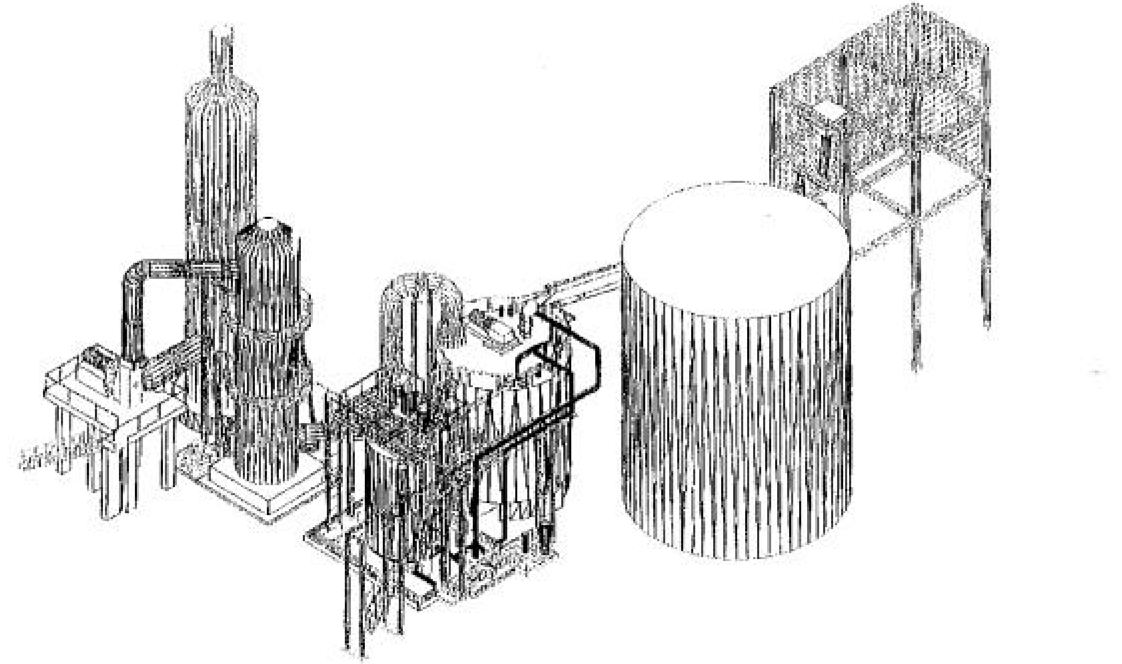


Figure 3



					JORDAN PHOSPHATES MINES Co. Ltd. FERTILIZERS COMPLEX AQABA	TITLE : NEW PHOSPHORIC ACID ATTACK PROJECT (150 TON/DAY)
0	Eng. SAMAH DAOUD	ADNAN	10/03/99			
REV	DRAWN BY	CHECKED	DATE	DESCR		DWG#

Appendix 1 - TECHNICAL DATA

REACTION	
Total volume (m^3)	312
Specific volume (m3/ton P_2O_5 product/day	2
Residence time (hr)	5.10
REACTOR	
Type and specification	Concrete and cylindrical with baffles
Diameter (m)	7.0
Height (m)	7.43
DIGESTER	
Type and specification Diameter (m) Height (m)	Cylindrical and rubber lined carbon steel 5.0 7.0
AGITATION	
REACTOR AGITATOR	
Type	central agitator, 1 radial turbine, 2 propellers and 4-blades
Total flow rate (m^3/hr)	46700
Cross velocity (m/s)	2.1
Up ward velocity (m/s)	0.254
Renewal ratio time (1/hr)	220
Absorbed power (Kw)	120
Specification power (Km/m^3)	0.566
SLURRY	
Circulation flow (m^3/hr)	1200
Rate / reaction volume	3.8
Rate / slurry product	20
Rate / rock feed (T/T)	93
Absorbed power (kw)	71
COOLING SYSTEM	
Type of cooling	Surface cooling through slurry spray
Reactor service area (m^2)	38.5
Digester service area (m^2)	19.6
Total gases flow to scrubbing fan (m^3/hr)	60000
Gases flow through reactor (m^3/hr)	54368
Gases flow through digester (m^3/hr)	5632
Gases velocity in reactor (m/s)	0.39
Gases velocity in digester (m/s)	0.08
Pressure in reactor (mbar abs.)	980
Specific flow (m^3 / m^2 area/hr)	1412
Air inlet temperature (°C) max/min	45/24
Gases outlet temperature (°C)	65
Dry bulb temperature (°C)	45
Wet bulb temperature (°C)	29
Heat load (Kcal)	7.85*10°
Heat load removed by each nozzle (Kcal/hr)	$1.06*10^6$
Heat transfer rate (Kcal/m^2/hr)	$110*10^3$
Absorbed power for circulation (kw)	71
Absorbed power for scrubbing fan (Kw)	130
Specific power (Kw/Kcal)	$4.7*10^5$