International Fertilizer Industry Association

ISMA* Technical Conference

Orlando, Florida, USA
23-27 October 1978

**In 1982, the name of the International Superphosphate Manufacturers' Associations (ISMA) was changed to International Fertilizer Industry Association (IFA).*

International Fertilizer Industry Association - Secretariat: 28 rue Marbeuf - 75008 Paris - France
Tel. +33 1 53 93 05 00 - Fax +33 1 53 93 05 45/47 - ifa@fertilizer.org - www.fertilizer.org

THE USE OF MAP IN LARGE-CAPACITY GRANULATION PLANTS

R.F. BARUT HEURTEY INDUSTRIES

I. KOTLAREVSKY GARDINIER (FRANCE)

1. INTRODUCTION

The slurry process is currently the most widely used process for the manufacture of high grade NPK and NP granular fertilizers. At its present state of development it has good features but it also has the disadvantage of requiring high recycle ratios, especially for DAP, and this results in high investment costs.

Efforts at improvement made via a number of processes aim mainly at reducing this recycle ratio, and hence the investment costs for a given capacity, or allow higher capacities to be achieved with a single production stream, made up of plant of traditional size.

The GARDINIER Company has directed its efforts towards obtaining such results by using powdered MAP manufactured by its own process as intermediate to replace the slurry.

This article analyses what can be expected from the use of GARDINIER MAP in large-capacity granulation plants, in the light of the experience that this Company has already acquired in this field, with two products which are considered as typical examples:

- 17.17.17
- 16.48.0 and 18.46.0 DAP

2. DESCRIPTION OF THE GARDINIER PROCESS FOR THE PRODUCTION OF MAP

The main characteristic of the MAP obtained by the GARDINIER process is a micro-crystalline texture with excellent granulation properties. This MAP can be used either directly on leaving the tower with a moisture content of 5 to 6% or after storage (the moisture content and the temperature must be controlled to avoid caking problems).

The process to obtain the MAP is very simple and requires only low investment.

The very low inertia of the plant allows almost immediate shut-down and start-up. Thus, the intermediate store can be eliminated and the MAP plant can be operated to suit the granulation rate.

The MAP production process as it appears on the flow chart consists of one (or more) reactors (called guns) whose role is to fully mix the phosphoric acid and the gaseous ammonia under a pressure of a few atmospheres.

The guns are installed in the upper section of a tower. The MAP which is formed by reacting the ammonia with the acid is sprayed at the exit from the gun at a temperature which causes the water carried by the phosphoric acid to evaporate. At the bottom of the tower the product is collected in the form of a powder of which 60 to 80% of the particles are less than a millimetre in diameter.

The product thus obtained can be sent into the granulation plant.

The integration of an MAP plant into a traditional circuit gives flowchart No. 1.

The main advantage of this process is that the product leaving the granulator contains very little moisture, which explains:

- the low recycle ratio
- the low consumption of fuel oil for drying
- the product at the bottom of the tower has the following characteristics:

MAP	powder)	according to the
N	9.5 to 11.5)	phosphoric acid used
P_2O_5	50 to 54.5)	
Moisture	3 to 6%)	

Particle size analysis: 100% between 0.1 and 1.5 mm.

- the plant operates continuously and requires only 2 hours' shut-down a week if the acid is clean (2 hours a day if the acid is very dirty).
- the flexibility of the installation allows production to be varied between 85 and 115% of nominal capacity.

3. PRODUCTION EXPERIENCE WITH 17.17.17

Two French plants of the GARDINIER group have for several years been manufacturing ternary compound fertilizers, in particular 17.17.17, from MAP.

At GARDILOIRE (near ST-NAZAIRE - France)

With a granulation circuit of 150 t/hr, regular production of 1700 t/day and peaks of 2000 t/day are obtained, representing a recycle ratio of less than 1.2 to 1.

The solid MAP and potash are fed into the granulator with the recycled product and the granule bed is sprayed with additional phosphoric acid from the gas scrubbers using a distribution manifold. The nitrate required for the formulation is added in the form of a concentrated solution, (which practically eliminates steam consumption). Finally, a series of injectors distributes the gaseous ammonia under the granule bed. On leaving the granulator the product is dried, screened and recycled, and the commercial product is sent to storage after cooling and coating.

At SOCADOUR (near BAYONNE - France)

With a very similar flowchart 1500 t/day is produced using a granulation circuit of 130 t/hr. The recycle ratio is comparable to that at GARDILOIRE although, for reasons of procurement, the nitrate is fed in as a solid.

In both cases the utilities consumptions are :

Fuel oil	8 to 9 kg per tonne of fertilizer produced
Electricity	25 kWh per tonne of fertilizer produced

LP steam — 10 kg per tonne of fertilizer produced if the nitrate is fed in as a liquid,

70 kg per tonne of fertilizer produced if the nitrate is fed in as a solid

PRODUCT QUALITY

- analysis: 17.17.17 (100% water and citrate soluble P_2O_5)
- moisture content: less than 0.3%
- particle size analysis: 100% between 1.6 and 4 mm (10 and 15 Mesh)
- granule hardness greater than 5 kg (11 lb) by the granule crushing method

UTILISATION

310 days a year (7440 hours)

30 days of planned maintenance

25 days (12 hours a week) of weekly maintenance and cleaning

FLEXIBILITY

Change of formulation in 6 hours

Production can be varied between 75 and 125% of nominal capacity

Start-up/into full operation: 4 hours

Shut-down/emptying circuits: 2 hours

4. PROSPECTS OPENED UP BY THIS EXPERIENCE

a) Search for maximum capacity

If one believes, as we do, that it is not advisable to go much beyond 300t/hr in the scaling of a recycle circuit, the GARDINIER process allows the design of single stream plants to produce 3000t/day, that is, 1,000,000 t/yr, of 17.17.17.

With the slurry process (recycle ratio $\frac{3+1}{1}$) two parallel streams of 1500 t/day, each comprising a 250 t/hr recycle circuit would be needed.

Comparative Investments

Two streams of 1500 t/day using the slurry process, with 250 t/hr recycle circuit = $54m

One stream of 3000t/day using the GARDINIER process with MAP production and 300 t/hr recycle circuit = $42m

Comparison of capacities for the same recycle circuit

For recycle circuits of equal size (250 t/hr being a reasonably high figure), the capacity increases from 1500 t/day using the slurry process, to 2400 t/day using the GARDINIER process.

The investment is roughly the same, the slurry process reactor and its ancillaries being replaced by the MAP production plant.

Price of a reactor with scrubbers and pumps: $0.5m approx.

Price of a 30 t/hr MAP plant: $0.8m approx.

c) Maximum use of an existing plant

Finally, the use of the GARDINIER process allows an increase in the capacity of the existing plants by installing a production plant for MAP which can be used direct without any storage, at 6% moisture content. The potential capacity increases from 1 to 1.8.

Of course, the plants downstream of the circuit must be adapted to the new capacity where required, but this is always possible at small cost, which is not the case for the recycle circuit.

5. COMPARISON OF COSTS of 17.17.17 fertilizer

Capacity 3000 t/day (1 million t/yr) — 1 line using GARDINIER process; 2 lines using slurry process

1. Cost of production: in US dollars per tonne

	Slurry process	GARDINIER process
Total investment $	54×10^6	42×10^6
Variable cost per tonne	113.30	114.20
Fixed cost per tonne (including maintenance)	10.80	8.40
Depreciation & profits (17% of the investment)	9.18	7.14
TOTAL COST	133.28	129.74

The saving by the GARDINIER process amounts to 12 million dollars on the capital investment and 3.5 million dollars a year on operating costs.

Variable costs: for one tonne of fertilizer in US dollars.

	Unit Price	Slurry Quantities	GARDINIER Quantities	Slurry Partial Costs	GARDINIER Partial Costs
NH_3	125 $T	0.077	0.058	9.625	7.250
P_2O_5	248 $T	0.174	0.174	43.152	43.152
NH_4NO_3	105 $T	0.321	0.365	33.705	38.325
KCl	80 $	0.285	0.285	22.8	22.8
kWh	0.03 $	40	25	1.2	0.750
Process water	0.2 $	0.015	0.15	0.003	0.03
Fuel oil	90 $	0.019	0.009	1.710	0.810
LP steam	10 $	0.045	0.070	0.450	0.70
Labour	8 $	---	---	---	0.380
3 men/shift					
5 men/shift				0.640	
		TOTAL		113.285	114.197

The raw materials constitute 98% of the variable costs which are essentially a function of their purchase price.

6. DAP PRODUCTION TRIALS

There is no industrial production of DAP in France but in August 1977 in the 17.17.17 plant at MONTOIR a very valuable trial was carried out during which 18.46.0 DAP of very high quality was manufactured using GARDINIER process MAP at the rate of 55% of the P_2O_5 load with a recycle ratio of 3 + 1.

Preparations for the trial consisted of making a few minor modifications in the manifolds distributing the phosphoric acid, water and ammonia to the granulator and to the height of the weir.

Production was limited to 17 t/hr by the capacity of the ammonia evaporator.

Nevertheless, by improving the different injections in the granulator and by studying the operating parameters, the recycle ratio can be lowered to 2 + 1.

PRODUCT QUALITY

- analysis: 18.46.0 (100% water and citrate soluble P_2O_5)
- pH: 7.6 approx.
- moisture content: less than 2%
- particle size analysis: 80% larger than 2.5 mm (+ 8 Mesh)
  98% larger than 2 mm (+ 9 Mesh)
- granule hardness: 7 to 8 kg by crushing method

UTILISATION

310 days a year (7440 hours)

30 days of planned maintenance

25 days (12 hours a week) of weekly maintenance and cleaning

FLEXIBILITY

Change of formulation in 6 hours

Production can be varied between 75 and 125% of the nominal capacity

Start-up/into full operation: 4 hours

Shut-down/emptying circuits: 2 hours

7. PROSPECTS OPENED UP BY THIS TRIAL

1. The industrially proven recycle ratio of 3 + 1 compares with that of 5 + 1 minimum in the slurry process, that is a DAP plant built to have a recycle circuit of 166 t/hr will have a capacity of 660 t/day with the slurry process and 1000 t/day with the MAP process.

   The effect on investment is great:

   - a traditional slurry process DAP plant of 600 t/day costs, in current economic conditions: $15m approx.

   - a GARDINIER DAP plant of 1050 t/day would cost:
     $15m + the cost of 25 t/hr MAP - Reactor and auxiliaries = $15.5m.

   To be compared with the price of a traditional 1000 t/day plant which is $18m at least.

   This represents a realistic saving of around $2.5m or 16 to 17% of the investment cost.

2. As in the case of 17.17.17, much greater capacities on a single stream can be envisaged.

A slurry DAP plant is limited to the traditional size of 1000 t/day by the granulation circuit which is then 290 to 320 t/hr.

With the use of MAP a single stream capacity of 1700 t/day can be envisaged without any risk of problems due to the equipment being oversized.

3. There is the possibility, as in the case of the 17.17.17, of increasing the capacity of existing plants by around 45% at low investment cost.

8. COMPARISON OF COSTS: 16.48.0

Capacity: 1000 t/day

1. Production costs: in US dollars per tonne

	Slurry process	GARDINIER process
Investment $	18×10^6	15.5×10^6
Variable cost/tonne	150.01	149.42
Fixed cost/tonne (including maintenance)	10.90	9.39
Depreciation & profits (17% of the investment)	9.41	8.10
TOTAL COST	170.32	166.91

The saving by the GARDINIER process amounts to 2.5 million dollars on the investment and more than 1 million dollars a year on the operating costs.

Variable costs: in US dollars per tonne

	Unit Price	Slurry Quantities	GARDINIER Quantities	Slurry Partial Costs	GARDINIER Partial Costs
NH_3	125 $/t	0.200	0.200	25.00	25.00
P_2O_5 (54%)	248 $/t	0.487	0.487	120.77	120.77
kWh	0.03 $	45	37	1.35	1.11
Fuel oil	90 $	0.015	0.010	1.35	1.00
LP steam	10 $	0.09	0.09	0.9	0.9
Process water	0.2 $	0.35	0.35	0.07	0.07
Labour	8 $/hr			0.57	0.57
		TOTAL		150.01	149.42

The raw materials make up 97% of the variable costs which are essentially a function of their purchase price.

CONCLUSIONS

The GARDINIER granulation process using powder MAP brings a certain number of advantages to the so-called "dry process" of granulation over the "slurry" process. These advantages are the following:

FLEXIBILITY

Start-up, changes in operating conditions and shut-downs are extremely fast

VERSATILITY

Changes in formulations are possible over a very wide range since the following can be produced in the same plant:

NP fertilizers

NPK fertilizers

and, without MAP:

straight P fertilizers

PK fertilizers

Changes in raw materials are easily accepted which allows the best advantage to be gained from the market situation.

SAVINGS ON INVESTMENT

Between 15 and 30% depending on the capacity and the product.

ENERGY SAVINGS

Steam composition is minimised (practically nil if liquid nitrate is available fon the production of 17.17.17).

Consumption of fuel oil for drying is half that for the slurry process, since the product leaving the granulator contains less moisture.

Consumption of electric power is small since only one drier is needed.

In the current state of the market, it is very important to have the advantage of a versatile plant for which the investment is low.

BIBLIOGRAPHY

I. KOTLAREVSKY and J. CARIOU

Use of solid P_2O_5 intermediates in granulation.

International Conference London Nov. 1977

I.S.E. MARTIN and F.J. HARRIS

Granulation with solid MAP intermediates.

International Conference London Nov. 1977

J.A. BROWNLIE

A new form of ammonium phosphate for incorporation in high analysis granular NPK fertilizers

63rd National Meeting AIChE Feb. 1968

J.L. SCHWOB and C. BLOCH

Les grandes unités de production d'acides minéraux et d'engrais

B.I. HEURTEY No. 59

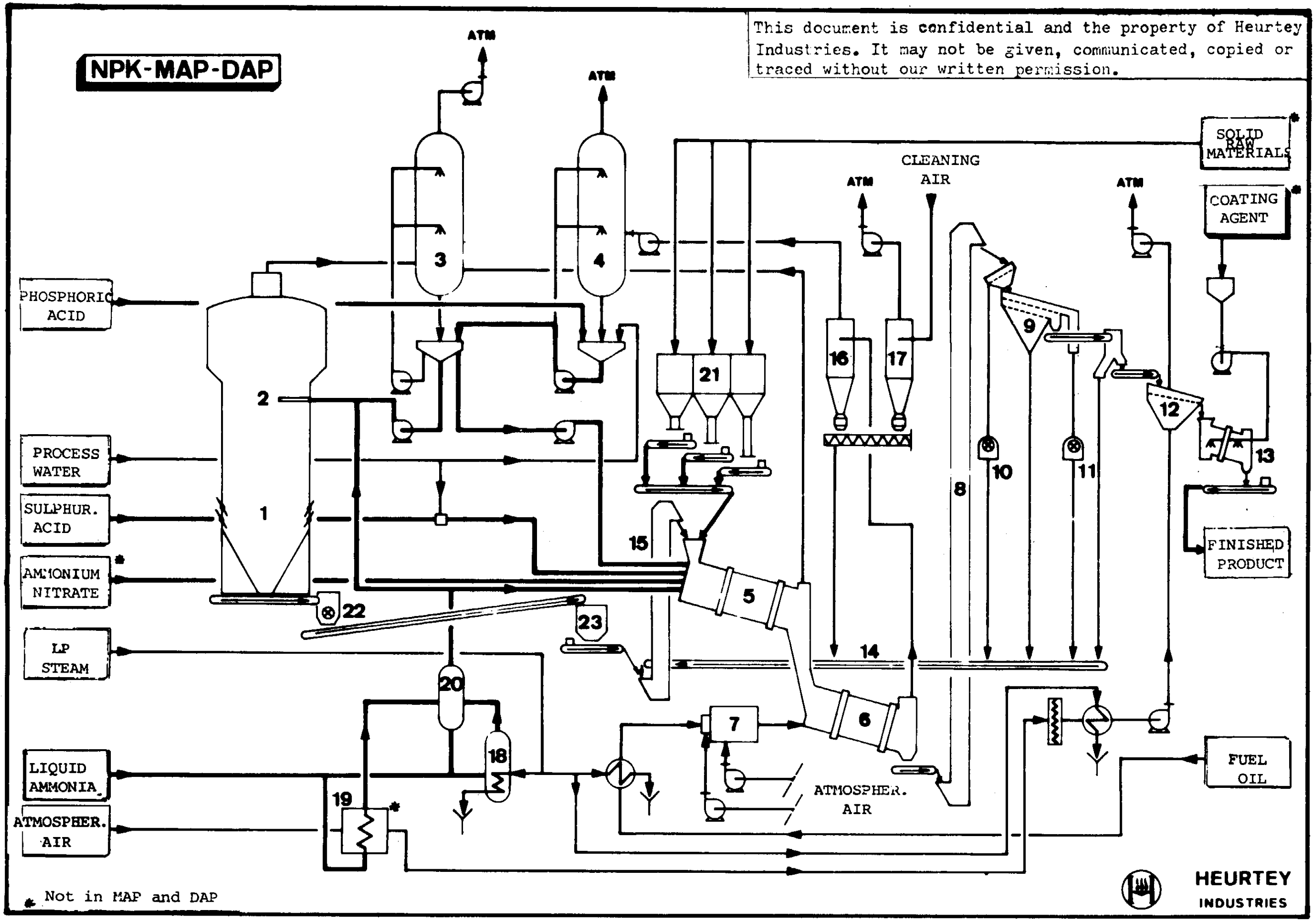
MAP DAP NPK

HEURTEY INDUSTRIES/GARDINIER PROCESS

KEY

1. MAP tower

2. MAP reactors



NPK-MAP-DAP
This document is confidential and the property of Heurtey Industries. It may not be given, communicated, copied or traced without our written permission.
ATM
ATM
ATM
ATM
CLEANING AIR
SOLID RAW MATERIALS
COATING AGENT
PHOSPHORIC ACID
PROCESS WATER
SULPHUR. ACID
AMMONIUM NITRATE
LP STEAM
LIQUID AMMONIA
ATMOSPHER. AIR
ATMOSPHER. AIR
FINISHED PRODUCT
FUEL OIL
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
* Not in MAP and DAP
HEURTEY INDUSTRIES

3. Granulator and MAP tower gas scrubber
4. Drier gas scrubber
5. Granulator
6. Drier
7. Combustion chamber
8. Main elevator
9. Screens
10. Crusher (for very large particles)
11. Crusher
12. Fluidised bed cooler
+13. Recycle coater
14. Recycle conveyor
15. Recycle elevator
16. Drier gas cyclone
17. Cyclone (of dust control filter)

18. Ammonia evaporator
+19. Ammonia evaporator/air cooler
20. Ammonia separator
+21. Solid raw materials hoppers
22. MAP lump breaker
23. MAP buffer hopper

\+ Do not exist in MAP or DAP production.