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COMPACTION REVAMP AND EXPANSION EXPERIENCE AND PERFORMANCE [1]

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SUMMARY

The market demand for granular compacted potash is increasingly important for the producers to offer premium coarse and granular products. Further, the market demand is towards tighter specification (narrow product size distribution), this, in return has negative impact on the compaction circuit yield. These trends are occurring and will continue. This enforces the Arab Potash Company management to think thoroughly on the need for revamping its old compaction plant and the need for installing additional compaction capacity.

The following pages highlight the modifications of old compactors, the performance of old and new compactors and the experience gained through operating a compaction plant for more than ten years. This paper also covers APC current and future projects in granular potash production and expansion, projects for greater respect of the environment, and the quality approach to customer satisfaction.

RESUME

La demande du marché en potasse granulée compactée est de plus en plus importante pour les producteurs qui veulent offrir un produit de qualité comme les produits bruts et granulés. Par ailleurs, la demande du marché s'oriente vers une spécification plus étroite (répartition granulométrique plus serrée), ceci, en contrepartie a un impact négatif sur le rendement du circuit de compactage. Ces tendances se manifestent et se poursuivront. Ceci a incité la direction de Arab Potash Company à réfléchir sur la nécessité de moderniser le vieil atelier de compactage et d'installer une capacité supplémentaire.

Les pages suivantes insistent sur les modifications de vieux compacteurs, la performance des anciens et des nouveaux compacteurs et l'expérience acquise dans le fonctionnement d'une unité de compactage pendant plus de 10 ans. Cet exposé examine aussi les projets actuels et futurs d'APC dans la production de potasse granulée et les projets d'expansion en vue d'un meilleur respect de l'environnement et l'approche qualité pour satisfaire le client.

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THE ARAB POTASH COMPANY

The Arab Potash Company is 56% owned by the Government of Jordan and the plants are located at the south end of the Dead Sea, at 110 Km south of Amman. The Company utilizes two of Jordan's most abundant resources: solar energy and the mineral rich brine of the Dead Sea.

The cost of the existing facilities including substantial infrastructure is nearly 650 million USD. The initial plant was built to a capacity of 1.2 MMTPY of product. This was expanded in the mid eighties to handle 1.4 MMTPY and key modifications were undertaken with the solar system to enhance the production of the ore accordingly. A second plant based on more advanced technology and of a capacity of 0.4 MMTPY was built in 1993 and this brought the total production capacity to 1.8 MMTPY.

THE NEED FOR GRANULAR POTASH

Modern farming has become highly mechanized and relies on pre-mixed, specially formulated fertilizers for optimal results. Fertilizer technology has changed drastically during the last 10 years. The high cost of fertilizer is unacceptable today because of price attributable to transport, storage, and packing. The highly concentrated fertilizers in the earlier form are finely powdered materials, mixing such fine materials is susceptible to degradation and caking during storage and handling. Also when applied to the soil, considerable amounts are lost as dust or washed away from the crop by rainwater.

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[1] *Compaction, réhabilitation et expansion - Expérience et performance*

To overcome the above-mentioned problems and to comply with market demand, two different technologies have been developed in recent years: granular and liquid mix fertilizer. Solid granulated mixed fertilizers continue to dominate the market. The granular fertilizer with appropriate particle size distribution and free flowing characteristics and high chemical purity can be distributed uniformly over a wide range by rotating disc spreader, and they do mix with other fertilizer of the same particle size distribution, with no segregation. Additionally, the particle size must be strong enough to withstand physical damage, which would produce fines during transport, storage, packing and use i.e. degradation to be minimum.

THE COMPACTION PROCESS

The compaction process is basically a dry granulation process. Fine particles of fertilizer material are subjected to a sufficiently high pressure to squeeze them together and bring their surfaces close enough for short-range intermolecular and electrostatic forces to cause cohesion.

The roller press comprises a feed unit and two parallel synchronous rollers rotating on horizontal axes and separated by a small but precisely determined gap. The axis of one of the rollers is fixed, while the axis of the second roller can move towards or away from that of the fixed-axis roller. It is pushed towards the fixed roller to provide a constant compacting pressure by means of two or four hydraulic jacks.

To ensure uniformity in the product it is most important that the feed system should maintain an absolutely steady flow of material to the compaction rollers. Its design is therefore critical. The design of the intermediate parts between the various systems and the nip of the rollers is very important and each manufacturer has its own design.

The material passes out of the nip of the rollers in the form of a laminar sheet, which breaks into flakes under its own weight. To make a granular fertilizer it is broken up into smaller fragments in a flake breaker installed directly downstream of the compactor. Particles in the desired size range are screened and removed as a product, while oversize is returned to the crusher and undersize to the compactor.

The compaction plant at APC is designed to produce granular MOP grade. Various process equipment such as compactors, crushers, flake breakers, vibrating screens and handling and conveying equipment are used to accomplish this.

The compaction process starts at the compaction feed bin where fine or standard potash can be fed into the bin at any ratio.

This feed is then run via the compaction elevator and the compaction feed surge bin into two compactors. The discharged product is then broken into sheets utilizing two flake breakers and then the material is conveyed to the screening section of the compaction circuit.

Two types of screens are found in this area, the first of these are two-hammer screens double deck type. The broken flake is fed into these screens with the oversized particles being sent to Cagepactor crushers for further crushing and recycled back as feed to the hammer screen again.

The undersize product is advanced to four vibrating screens where the screen oversize is the granular product and the screen undersize is recycled back to the compaction circuit as feed materials to the compactors.

THE COMPACTOR PERFORMANCE

The compaction circuit was originally designed to produce 700 TPD granular product. The -6 +14 mesh to be of 85% accumulative weight. However, due to customers demands for -5 +12 mesh specifications to be (95%) accumulative weight minimum, the deviation from the design specifications has reduced the production rate of granular considerably and probably contributed to mechanical failures with this increased recycle rate to the compaction feed.

The compaction plant was commissioned and operated for a short period of time during 1983 to produce granular products on trial basis, many problems were faced due to frequent overloads on screw conveyors, motors and bucket elevator. At that time no marketing opportunities were apparent for granular product, so the compaction plant remained idle. Many equipment from this circuit were used in the fine and standard production system due to the late delivery of spare parts for replacements, and these equipment were made necessary in the screening plant.

During the last quarter of 1985 the compaction plant has been once again re-commissioned after being idle for a period of almost 2 years.

During 1985, APC produced 4552 tons of granular product. As the market demand for granular product increases, the production of granular has increased substantially.

The present compactors production daily average is running at 300-350 TPD granular product, the reduced production is mainly due to change in screen meshes into a bigger opening to guarantee the quality of granular products.

SPECIFICATION OF EXISTING APC COMPACTORS

Both compactors are made by Koppern of Germany. These compactors are of type 72/7.5 - 4A 600 DG2S, rolling press ring dia is (750 mm) and the working width of the press is (600 mm) and the supplied press power is (404 KW) of 700 Tons per day for both units.

The gearbox is manufactured by Thyssen also of Germany, the input speed is 1204 rpm and the output is 21.5 rpm.

The compactor roller press rpm is 21.5 and the working pressure is 230 bar. The minimum gap between the rollers is 4mm and the maximum gap is 10 mm.

The force feeder screw is running at speed ranges between 27-81 rpm.

COMPACTION PROBLEMS

A. Old Compactor Mechanical Problems

The problems encountered were mainly due to the followings:

A.1. Failure on pinion gears
A.2. Failure on compactor press
A.3. Gear box damages and high GB oil temperature
A.4. Cracks in the gear casing
A.5. Problems with hydraulic and lubrication system
A.6. Screw feeder problems

This caused frequent stoppage of compactor for a longer period than expected, and a reduction of granular production.

Therefore, a modification scheme to revamp existing compactors was decided. A complete revamp project was carried out and commissioned in October 1994.

The modifications of the old compactors has been carried out in order to achieve the followings:

- To improve operation of the compaction area.
- To increase the output.
- To improve hardness values of the product.
- To increase the machines reliability and availability.

These transformations, associated with mechanical improvements (bearings, cooling and lubrication system, etc.), resulted in a better availability of the unit. The quality of the product, however, especially the hardness, evaluated by abrasion tests, does not changed positively as planned for.

The old and modified compactor data are shown in the following tables (Table 1 and Table 2).

Table 1 - Modified Compaction Process

Capacity	700 MTPD (using two compactors)					
Feed size Distribution % Wt. Acc.	**1.18 mm** 10-15	**0.60 mm** 35-45	**0.30 mm** 60-70	**0.15 mm** 80-85		
Feed Rate	54 T/Hr.					
Feed Temperature	110 - 120 Deg. C.					
Feed Bulk Density	1.10 g/cm					
Feed Moisture content	0.20 %					
Compactor Size	Roller press dia. = 750 mm Roller press working width = 600 mm					
Product Size % Wt. Acc.	**4.75 mm** 2.1	**4.00 mm** 10.7	**3.36 mm** 30.4	**2.36mm** 74.6	**1.70mm** 97.7	**1.4mm** 99.2
Crushing Equipment	One Cagepactor per compactor One Flake Breaker per compactor					

Table 2 - Compactor Modifications

Item No.	Description	Old	New
1.	Force feeder	Triple feed screw with hydraulic drive	Two fold feeder driven by two motors, 22 KW each with frequency converter
2.	Compactor roll working width	750 mm	600 mm
3.	Compactor roller speed	15.6 RPM	21.5 RPM via v-belt pulleys.
4.	Pressing force	49 KN /cm	60 KN /cm
5.	Main drive motor	350 KW	400 KW
6.	Main bearing block		4 new bearing (new design) and accessories.
7.	Bearing life	14,300 Hrs	12,000 Hrs, or 18 months from shipments
8.	Hydraulic control system		modified
9.	Lubrication system		New grease lubrication system
10.	Compactor throughput	47.3 TPH	45 TPH at 21.5 RPM

B. The New Compactors

The current situation of the compaction units is satisfactory; but APC thinking is toward enhancing the quality of its product by implementing the following modifications:

B.1. Changing the crusher type to hammer mill crusher.
B.2. Installing a screen directly before granular shipment.
B.3. Improving the dust removal system of the compaction plant.
B.4. Using a dust suppressing system.

QUALITY CONTROL OF APC GRANULAR MOP

Physical quality is an important criterion used by a farmer-consumer in selecting a particular fertilizer. The acceptability of a fertilizer material in the marketplace depends not only on its nutrient content but also on its physical quality. Although the available nutrient content and its effect on crop response is the ultimate reason for the use of fertilizers, physical quality is often the reason for selecting one fertilizer over another.

The farmer-consumer cannot detect whether the guaranteed nutrient content is really present in a fertilizer. However, federal or state laws, thereby giving some protection to the farmer-consumer normally regulate the nutrient content. In contrast, there are no laws regulating the physical quality of fertilizer, but the farmer-consumer certainly evaluates the physical condition of the fertilizer. Simply by observation, he can see that a fertilizer is caked or free flowing, dusty or dust free, wet and sticky, or dry.

The physical form of a fertilizer product and its ability to resist deterioration is important with respect to processing, handling, transport, storage, field application, and agronomic response. Obviously, some of the problems associated with each of the above stages are decreased if a fertilizer has good physical properties. For example, reducing fertilizer losses can decrease the production cost. Fertilizer losses can be decreased by increasing the strength of a product or by more efficient sizing during the screening operation, thereby reducing the amount of dust loss. Another benefit of these actions would be fewer complaints among operators and laborers about unsatisfactory working conditions due to excessive dustiness thereby creating a more productive and quality-conscious employee.

The most frequently encountered problems resulting from deficiencies in physical properties are caking (agglomeration or lump formation), dustiness, poor flowability, excessive hygroscopicity (moisture absorption characteristics), and segregation (non uniformity of composition throughout a fertilizer lot).

APC is implementing the highest international standards for controlling the quality of its granular product. In addition to the excellent chemical grade of the potash produced, through the precise control in the different process stages, APC gives the highest level of concern to satisfy its customers needs for the super physical quality of the GMOP product. The followings are some of these important physical measures that are used in maintaining the highest quality of the product.

1. PHYSICAL COMPATIBILITY IN BLENDS

Physical compatibility in blends is the ability of two or more materials (such as NPK, PK, or NK blends) to remain thoroughly mixed during handling, storage, and application. Segregation of materials in a bulk blend is normally caused by mismatched particle sizes.

Performing size analyses of the individual materials to be blended carries out determination of physical compatibility in bulk blends.

After size distributions are determined, compatibility is determined by:

(A) Comparing the cumulative PS distributions of each bulk-blend ingredient.
(B) Determining the median particle size of each bulk blend ingredient (SGN method).

2. GRANULE CRUSHING STRENGTH

It is a measure of the resistance of granules to deformation or fracture under pressure. It is of interest in estimating the handling and storage properties of the granular material and determining the pressure limits applied during bag and bulk storage.

3. ABRASION RESISTANCE

It is the resistance to the formation of dust and fines as a result of granule to granule and granule to equipment contact. It is useful in determining material losses; handling, storage, and application properties.

4. IMPACT RESISTANCE

It is an indication of the mechanical strength of the granules. Impact resistance is of interest with fan-type fertilizer spreaders, when a material is discharged from an overhead conveyor into a bulk pile, and when bags of the material are dropped during handling.

APC GRANULAR PRODUCTION AND SALES

Table 3 below shows the Arab Potash granular potash production against its total production for the years from 1990 through 1997.

Table - 3 - APC Granular Potash Production 1990 -1997

Year	Total Production (Tons)	Tons of Granular	% Granular Production
1990	1,402,652	42,862	3.06
1991	1,364,070	39,096	2.87
1992	1,211,975	53,354	4.40
1993	1,370,086	71,566	5.22
1994	1,550,259	43,395	2.80
1995	1,780,004	65,041	3.65
1996	1,765,328	81,385	4.61
1997	1,415,675	85,581	6.05

Table 4 below shows the distribution of APC sales from granular MOP for the previous year, 1997.

Table 4 - APC Granular Potash Sales in 1997

Italy	32,650 Tons
Australia	15,800 Tons
Brazil	12,500 Tons
New Zealand	11,400 Tons
Spain	3,445 Tons
Mozambique	2,500 Tons
South Africa	2,100 Tons
Reunion	1,800 Tons
Jordan	1,364 Tons
Total	**83,559 Tons**

CURRENT AND FUTURE PROJECTS

1. Revamp of Existing Compaction Plant

APC is currently carrying out a revamp program for the crushers, screens, and screw conveyors in the compaction area. This is expected to increase the production capacity sharply by decreasing the recycle ratio. It is also expected to improve the quality of the granular product.

2. Dust Suppressing System In Aqaba

APC has internally designed and implemented a project to treat the dust formed during loading and unloading of ships. The system is simply treating the granular potash during shipment with a de-dusting agent (a special type oil) at a precisely controlled ratio. The system gave very excellent results and is now working satisfactorily.

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3. Final Screening

Removal of the off-size material and dust from the granular product, which results during successive handling, is planned through the installation of a final screening unit. This will guarantee a minimum possible size degradation of the granules.

4. Post Treatment

APC has made several comprehensive studies regarding the post treatment of its granular product in order to enhance the hardness and prevent degradation of the granules. Also some consultancy work recommended a hydrothermic post-treatment to improve the granular strength of the material. APC is evaluating this matter versus production cost.

5. APC is planning to install a 120,000 TPY compaction plant at Safi to increase its production of GMOP to about 220,000 TPY. The proposed production will be marketed mainly to Australia, New Zealand and Brazil.