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SAFCO'S EXPERIENCE WITH FLUIDIZED BED UREA GRANULATION PROCESS

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RESUME

Le but de ce bref exposé est de présenter un aperçu de l'expérience de SAFCO avec une unité de granulation qui sera présentée.

Le Complexe SAFCO Jubail de production d'ammoniac et d'urée situé dans la ville industrielle d'Al-Jubail, Royaume d'Arabie Saoudite, comporte une unité d'ammoniac TOPSOE (1500 t/j) et une unité d'urée STAMICARBON (1800 t/j) avec une unité de granulation HYDRO AGRI pour produire de l'urée granulée de taille normale 2-4 mm et de grande taille 4-8 mm par le procédé de fluidisation. Les installations de granulation d'urée seront décrites en détail.

La production d'urée granulée de SAFCO a commencé le 2 juin 1993 et un total de 292.291 t ont été produites jusqu'au 31 décembre 1993. Le fonctionnement stable de l'unité de granulation est attribué à de nombreux facteurs parmi lesquels la formation du personnel et le bon réglage des paramètres de l'unité de granulation. Ceux-ci seront présentés en détail.

Pendant la période de réception, plusieurs problèmes de conception sont apparus et des modifications appropriées ont été apportées. Elles seront présentées en détail.

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INTRODUCTION

Saudi Arabian Fertilizer Company (SAFCO) operates two urea complexes in Saudi Arabia. SAFCO's Dammam plant was commissioned in 1969 and is designed to produce 330,000 tons/year of *prilled urea*. SAFCO's other plant in Jubail has gone into commercial production recently in March 1994 and is designed for 600,000 tons/year of *granular urea*. The new plant is designed on Stamicarbon's urea process with Hydro Agri's fluidized bed granulation process.

The granular urea product from SAFCO's new plant is generally better than prilled urea in terms of quality and handling. Moreover, the caking problems usually associated with prilled product is overcome to a large extent. The following table shows comparative advantages of using granular urea:

TABLE 1

ITEM N°	DESCRIPTION OF PROBLEM	PRILLED UREA	GRANULAR UREA
1.	Caking	Strong tendency	Minimum
2.	Product losses	Up to 5%	Minimum
3.	Crush strength	Low	High
4.	Shatter resistance to piling	Poor	High
5.	Environmental pollution	High	Minimum

This paper describes SAFCO'S experience with fluidized bed urea granulation process. Initial teething problems have been overcome to a large extent and overall experience to date with the granulated urea production is satisfactory.

Process Description

Please refer to the outline of the process as shown in **Attachment 1**.

The granulator basically consists of a perforated plate, lower and upper casing and feed solution injection headers.

The fluidisation air is supplied by centrifugal fan which is equipped with heaters for adjusting the air temperature. The fluidisation air is distributed by the perforated plate which also acts as a grid to support urea granules when it is at rest.

The urea melt feed is basically a 95% urea solution containing an anti-caking agent. This is sprayed upwards by atomisation onto granular seed material held in fluidised suspension.

Low pressure atomisation air supplied by centrifugal fan equipped with heaters is preheated to slightly above the solution crystallization temperature, to avoid choking of urea spray nozzles and is fed to the urea solution injection system.

The seed material for granulation is introduced into the first fluidized bed chamber and progressively grows by accretion. The accretion mechanism differs from those encountered in other granulation process, namely agglomeration and layering in that the final particle builds up its size from one seed and not from several ones (agglomeration) and also its growth is continuous .

The biuret formation in the granulator is nil and altogether the granulation unit contributes for only (approximately) 0.03% biuret increase.

The urea granules traverse laterally across the three chambers equipped with spray nozzles and further three cooling chambers before being extracted by vibrating extractors. On-size urea is first sent to fluid bed cooler at 95°C. The oversize urea granules are sent to recycle tank for dissolution and return to urea solution plant.

The atomisation and fluidisation air containing 3.5% of the total urea production as dust is extracted from granulator top and urea dust is recovered in the granulator wet scrubber equipped with an exhaust fan. The average dust particle size is 3 micro meters.

The concentration of the urea solution in the wet granulator scrubber is 30% wt. The scrubber drains into granulator scrubber tank. Recovered urea solution is pumped to recycle tank where the concentration varies between 40-60% and steam ejector is provided for agitation purposes.

The fluid bed cooler consists of casing equipped with perforated plate for distribution of the fluidisation air.

Fluidisation air is supplied by centrifugal fan equipped with heater in case of damp air. Here the temperature of the urea granules is decreased to 70°C. Then urea granules are transported by bucket elevator to screen feeder for size classification. Oversize product is sent to the crusher and later joins with the undersize granules as seed feed material for the granulator. The ratio of oversize plus undersize to on size is 0.5.

The on-size product is sent to a final fluid bed cooler for cooling with chilled air. Dry fluidisation air is supplied by centrifugal fan equipped with a chiller using refrigerant ammonia. The condensed water is knocked out by plate separator and temperature of dry air is adjusted by steam coil heater. The product granular urea leaving final bed cooler is about 50°C. There is provision for bypassing the second bed cooler for maintenance purposes.

The dust laden exhaust air from cooler top and final cooler top are sent to cooler scrubber where it is scrubbed with weak (6% wt.) urea solution. This air contains coarse dust particles of size around 20 micro meters. This is a wet scrubber similar to the granulator scrubber. The cooler scrubber is equipped with an exhaust fan. The cooler scrubber drains to cooler scrubber recycle tank and the weak urea solution is pumped to granulator scrubber tank.

The exhaust air from the granulation stack contains urea dust (about 25 ppm/Nm^3) and ammonia gas about (90 ppm per Nm^3). The exhaust air flow rate is about 48,0000 Nm^3/hr) and the cumulative daily emissions are 290 kg of urea dust and 1050 kg of ammonia.

The total power consumption for the granulation unit is 44 to 46 kW per ton urea excluding lighting for granulation unit.

A start-up bin has been provided for the initial filling of the granulator and at each start-up. **Table 2** shows an over-all material balance on the granulation unit for the urea feed melt.

<u>TABLE 2</u>

		Input	Output
Flow rate	kg/hr	81,382	75,000
Urea	%	94.97	98.61
Urea Formaldehyde	%	0.43	0.45
Biuret	%	0.70	0.73
Moisture	%	3.82	0.2
Ammonia (Free)	%	0.08	0.01
Urea Size 2 mm-4mm	%		90

<u>Training</u>

Prior to start of commissioning the operations and maintenance teams were given class room tuition by qualified instructors dispatched by the process licenser. Further on-the-job training was imparted by their commissioning team. This has helped the operations staff, most of who were relatively inexperienced with this technology, quickly master the plant operations. This is reflected in the production statistics where the service factor is 99% and capacity factor 101%.

<u>Operations</u>

The first granular urea production was made on 24 May '93 and the first continuous granular urea production was made on 7 June '93. The granulator has some process conditions affecting its performance.

The bulk of the urea granules remains in the fluidized state but even so the build-up of urea solid has been observed around the granulator walls, roof and in the exhaust air line from the top of the granulator.

After continuous operation of the granulator at 100% capacity for about 3 to 4 weeks lumps of urea can be seen along with the granules. The percentage of on-size urea granules decrease and when it reaches 90% the granulation unit is shut down for routine washing. The washing does takes about 6 hours and for this duration the urea plant can be kept operational but at 70% capacity.

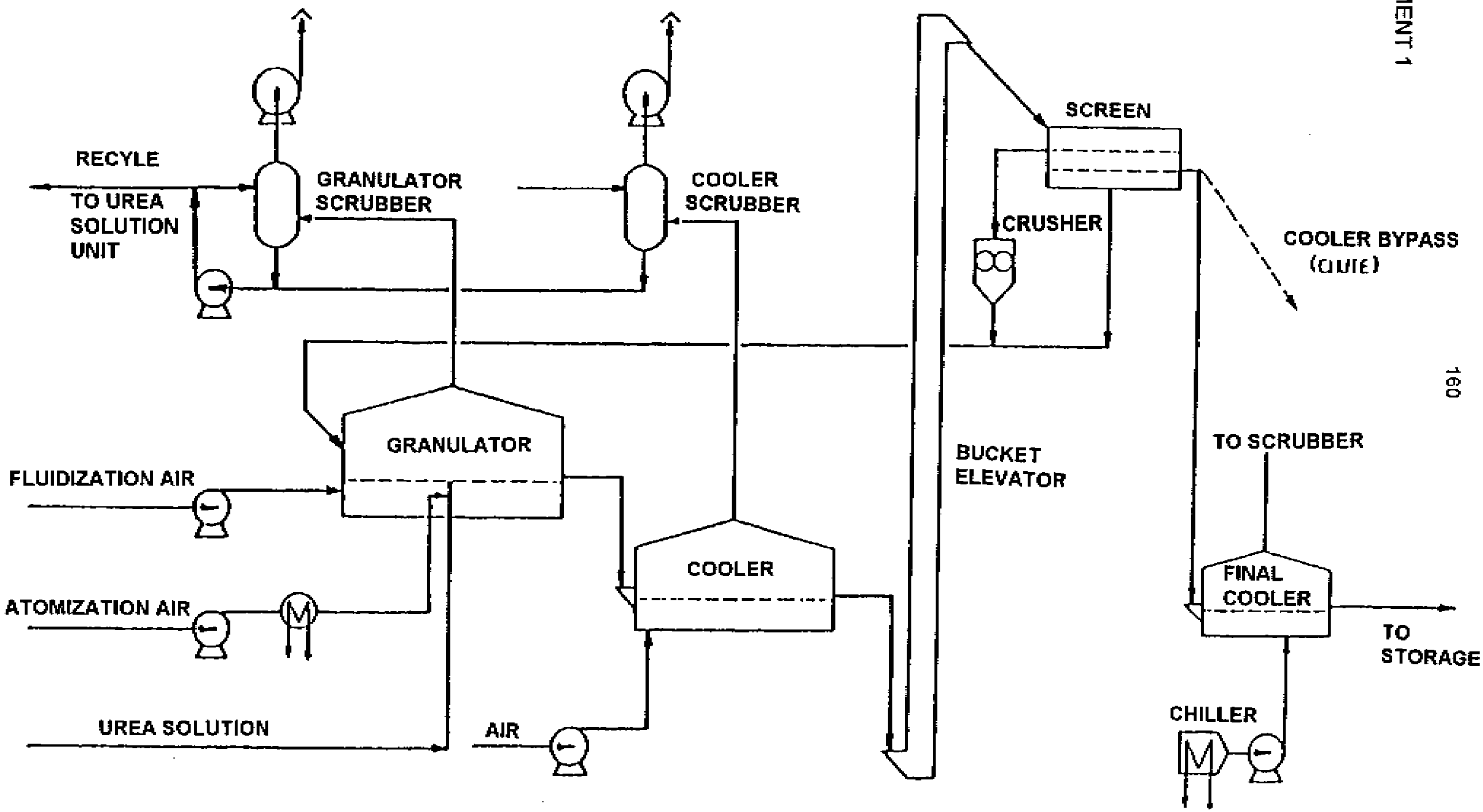
The quantity of fluidisation air to the granulator has to be maintained at about 10% more than design to ensure adequate fluidisation. However the load on the fluidisation motor increases and becomes limiting.

Modifications

After the mechanical completion of the granulation unit to-date, a number of problems have arisen and the appropiate counter-measure is already implemented or is near implementation. Table 3 depicts the details.

TABLE 3

MODIFICATION		
Item #	**Trouble Description**	**Rectification**
1.	Mechanical failure of cooler scrubber exhaust fan. Its suction guide vanes piece came into vane of blower. Inboard bearing housing pedestal broken.	- All 24 vanes of suction guide vanes were mechanically re-enforced to prevent entry into fan casing. - Fan inboard bearing housing pedestal replaced. - Additional support for pipe pivot.
2.	Granulator scrubber exhaust fan suction guide vanes almost completely detached.	All suction guide vanes mechanically re-enforced in similar manner as in item 1.
3.	Frequent plugging of vibrating screens.	On line replacement of vibrating screen.
4.	Frequent plugging of granulator spray nozzles.	- Provision of seal between atomization air and urea solution nozzles in spray nozzles. - Reduction in pressure of urea solution feed to granulator. - Ensure adequate urea concentration in the feed by lab analysis.
5.	Screen feeder motors fell down causing curtailment in granulation load.	Bracket provided with better strength bolts to hold down motor.
6.	Recycle solution tank 2T603 inadequate size to collect granulator floor washing.	Recycle solution tank capacity extended and steam ejector also provided.
7.	Screen feeder of inadequate capacity.	1) Vibration motor higher vibration adjustment of counter weight. 2) Provided declined slope on feeder casing of 5 degree to increase velocity.
8.	Inspection access not available for granulator fluidisation air heater.	Provision of manways doors.
9.	Feed urea recycle line to granulator frequently blocked/choked.	Inspection doors and access provided for hand cleaning.
10.	Anti-caking additive pump had excess flow.	Pressure regulator provided on pump discharge.
11.	No direct measurement of anti-caking additive flow to granulation.	Independent flow meter provided with remote indication in DCS in central control room.
12.	Deposit buildup on granulator scrubber and cooler scrubber demisters.	. Provision of DP manometer gauge. . Fabrication of chemical cleaning system complete with tank and pump.
13.	Steam condensate line hammering.	Provision of separate line for hot and cold steam condensate.
14.	The chiller for the final cooler stops when refrigeration compressor in ammonia unit is shut down causing hot urea granule sent to urea storage to cake.	Provision of dedicated packaged ammonia refrigeration compressor for the chiller in the second cooler.
15.	Inadequate ventilation in the granulation building.	Windows provided in the granulation building.
16.	Free ammonia content in urea product was about 85 ppm.	Reduction in pressure of steam from 2.5 kg/cm to 1.8 kg/cm^2G in urea melt line steam jacket has helped to reduce the free ammonia in urea product from 85 ppm to about 70 ppm.
17.	Caking of urea in start-up bin.	The slope of the outlet line from start up bin was increased. Filing and emptying of the start up bin more frequently. Introduction of relatively colder urea in the start up bin.



GRANULATION PROCESS: COOLING IN 2 SEPARATE COOLERS