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## A NOVEL AND ECONOMIC APPROACH TO CAN (LAN) PRILL TOWER PLUME ABATEMENT UTILIZING LOW TEMPERATURE PRILLING

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### RESUME

*A cause du constituant calcaire/dolomie dans le CAN, des émissions de panache durant le prilling de ce produit ont été et demeurent un problème majeur. Les efforts dans le passé se sont attachés à la réduction du panache après l'opération de prilling. L'approche adoptée dans cette communication cherche à traiter le problème à sa source - c'est-à-dire réduire les émissions de fumée de nitrate d'ammonium pendant l'opération de prilling.*

*La réduction de fumée peut être réalisée par un changement de paradigme - le paradigme original étant que les engrais avec nitrate d'ammonium doivent avoir une humidité aussi réduite que possible. En utilisant un dessiccateur, le nitrate d'ammonium dans ce cas - un produit à plus forte humidité peut être prillé, ce qui favorise une température plus basse, et en conséquence de son rapport de température Arrhénius, permet une réduction corrélative de la production de fumée de nitrate d'ammonium.*



### 1. BACKGROUND

Kynoch's LAN<sup>a</sup> plant Milnerton was designed by Stamicarbon and built by Simon Carves in 1966/7. Particular features of the prilling section include the use of a relatively short, large diameter concrete tower with side discharge of cooling air (via axial fan ducts). Milled dolomitic limestone is mixed into the ammonium nitrate (AN) melt and prilled through a spinning bucket. Due to the incorporation of the limestone (making currently a 28% N product) typical prilling temperatures employed in the past were in the region of 180-185°C. It was interesting to note that the original permits obtained from the Chief Air Pollution Control Officer (CAPCO) in South Africa did not specify AN dust limits in respect of prill tower emissions.

Initially no additive was employed to counter thermal degradation but after major product complaints in the early '70s the need for a stabilising agent became rapidly apparent. This was achieved by incorporating ammonium sulphate - produced via co-neutralisation of some sulphuric acid with the nitric acid - into the product as well as with the installation of a deep vacuum evaporation system which resulted in the formation of a hard, low moisture product with excellent resistance to temperature cycling. As such this product soon gained a reputation as a top quality LAN in South Africa.

From the date of plant commissioning the problem of the highly visible and persistent AN fume generated during the prilling of LAN was identified as a source of concern (see Figure 1) - even given the plant's remote location in those days. Plant management performed pilot plant testwork using a variety of processes to both reduce the amount of fume after prilling as well as minimise fume generation. Tests included:

- wet scrubbing
- diffusion scrubbing (mist eliminators)
- venturi scrubbing
- electrostatic precipitation
- shroud collection
- melt cooling (via heat exchange just prior to prilling)

Although much was learnt during these trials little success was achieved in respect of fume abatement, other than proving to the respective authorities that attention was being paid to this « unsightly » problem. Concentrations of AN fume at 100-120 mg/mm<sup>3</sup> (measured anisokinetically) were considered as typical but the associated light-scattering haze gave the impression that concentrations were far higher - especially

<sup>a</sup> Note LAN is limestone ammonium nitrate, which is also known internationally as calcium ammonium nitrate, i.e. CAN. The terms LAN and CAN are used interchangeably throughout this document.

under certain weather conditions and at night. Note that loss of AN by this means was approximately 1.2 kg/t product.

As no economic solution to this problem was evident at the time and due to the somewhat laager mentality of the South African Chemical Industry during the '70s and '80s complaints about this plume were basically ignored or explained away as a non-hazardous nuisance - although CAPCO did advise management that no permit would be issued for a new prilling tower unless it complied with specified emission levels. With the ever encroaching residential areas and political change occurring in South Africa external pressure to do something about the prill tower pollution began to mount in the early '90s. This pressure was foreseen by factory management and a drive commenced during the latter half of the '80s to develop a market for AN based liquid fertilizers. Although significant progress was made in switching solids to liquids it soon became apparent that this was not going to be a total solution to the problem.



**Figure 1:** Kynoch Milnerton Prill Tower Plume (High temp) as observed from a distance of 2½ km

In early 1993 CAPCO, who was coming under considerable public pressure, instructed Kynoch management at Milnerton to furnish him, on a six-monthly basis, with improvement plans regarding prill tower pollution abatement and progress measured against these plans. Given the age of the plant and the financial constraints of the South African fertilizer industry necessity, once again, became the mother of invention. This paper describes, in broad outline, the steps taken to reduce prill plume visibility to acceptable levels and their impact on product quality and economics.

## 2. AN CHEMISTRY AND FUME REDUCTION

An appreciable vapour pressure of ammonia and nitric acid exists above molten AN as a result of the dissociation reaction:



In the process of prilling AN these dissociation products recombine upon being exhausted into the cooler ambient air surrounding the tower. This results in the formation of sub-micron particles of solid AN which account for the well known, highly visible and persistent blue/white haze associated with AN prilling towers - particularly those of earlier vintage.

Carter and Roberts<sup>(2)</sup> indicate the evolution of AN fume to be dependent principally on three variables:

melt pH  
air velocity over surface of the melt  
melt temperature

The implications of the dependency of AN plume on these three variables are discussed in the context of operation of the Kynoch Milnerton prilling tower. This is done with a view to minimising fume generation during the prilling operation. After this comments are made on techniques employed to clean up the cooling air from prilling towers after fume has been formed, i.e. treating the symptoms and not the cause.

## 2.1 Melt pH

Increasing melt pH, although resulting in higher ammonia losses, reduces the amount of AN fume generated. A short spell of tests were conducted on the tower during 1993 to establish whether elevated melt pH would reduce plume visibility. Although emission measurements indicated some approximate 12-14% reduction<sup>b</sup> in overall fume and dust generation by increasing pH to just above 6 the visual impact of this was not particularly discernible - especially as far as a member of the public would have been concerned.

Due to the apparent minor impact of elevating pH and its concomitant increase in ammonia loss this avenue was not pursued any further as a potential solution to the fume visibility problem. It is, however, accepted that an optimum pH (in the region of 6,5) exists with respect to overall minimisation of the loss of nitrogen upon prilling.

## 2.2 Air velocity over the surface of the melt

A decrease in air flow over the hot surface of the AN droplets reduces the loss of AN by simply lowering its mass transfer rate. As the Stamicarbon designed tower already incorporates a very low air velocity up the tower (approximately  $0,6 \text{ ms}^{-1}$ ) it was felt there was little scope to use this mechanism to achieve any major reduction in fume. In addition the prill tower at Milnerton is short (31 m drop) and thus prill exit temperature is already a limitation.

A further point should be made here in respect of tower top design. Carter and Roberts<sup>(2)</sup> reported on wind tunnel tests to model and compare plume dispersion of the two common air discharge arrangements, namely:

- (1) vertical fan discharge (normally at fairly high velocity)
- (2) discharge at side of tower.

They indicated, from this testwork, that vertical discharge results in the plume remaining well clear of ground level and it is readily diffused even unfavourable wind directions. With side discharge the plume has a tendency to be drawn down into the lee of the tower increasing ground level concentrations. The second method of discharge is employed at Milnerton and the phenomenon reported above is often experienced (refer photograph in Figure 1) which obviously exacerbates the problem. At this stage, however, no attempt has been made to change the air discharge configuration as effort has been concentrated on minimisation of fume generation (see below).

## 2.3 Melt temperature

The dissociation of AN reaction has a very strong temperature dependency. An approximation of AN vapour pressure over hot AN melt/solution is given by the following relationship<sup>c</sup>:

$$\ln P = 8,78 \ln T - 44,7$$

where: P = AN vapour pressure in mm Hg  
T = temperature of AN melt, °C (range 100-220°C).

<sup>b</sup> It should be noted that the geometry of the emission ducts of the Kynoch Milnerton tower does not permit isokinetic sampling of dust/fume loading in the exhaust cooling air. The reduction quoted was therefore determined anisokinetically and should be treated only as an approximation.

<sup>c</sup> As derived from a graph presented by Carter and Roberts<sup>(2)</sup>

A reduction in prilling temperature from, say, 185°C to 155°C should therefore give a theoretical reduction of AN fume generation of 79% ( $P_{185} = 3,11$  mm Hg;  $P_{155} = 0,66$  mm Hg). There would, therefore, appear to be considerable scope for utilising this property of AN to achieve discernible reductions in fume. This is supported by very small amount of AN fume generated by plants making porous prilled ammonium nitrate at typically 140°C. Given the paradigm, however, that most AN/CAN fertilizers must have as low a moisture as possible ( $< 0,2\%$  H<sub>2</sub>O)<sup>(5)</sup> to ensure thermal stability against temperature cycling and to prevent caking this once again limits possibilities in this regard.

In the particular case of the Kynoch Milnerton plant ammonium sulphate was traditionally used as a stabilising agent. This, combined with the fact that limestone was mixed in prior to prilling, led to melt temperatures in the region of 185° being employed - especially to ensure low moistures were maintained. As mentioned above some attempts were made at melt cooling just prior to prilling by mechanical means utilising a cooling-coil. Although some rather ingenious designs were incorporated into this coil to prevent the AN from solidifying prematurely, its operation was problematic and it was never commissioned satisfactorily. Its scope for fume reduction was, in any event, limited as it was never anticipated operating below an exit temperature of 175°C.

Nevertheless this strong dependency of AN fume concentration on melt temperature was later utilised, together with a paradigm shift (see below), to significantly reduce AN fume generation at Milnerton.

#### **2.4 Mechanical collection/minimisation of AN fume (and dust)**

Some brief comments are made under this heading with regard to various means employed within the industry to clean up prill tower cooling air after the fume has been generated. Reasons for why these have not been employed at Milnerton are given. Best Available Techniques for pollution prevention and control in the European Fertilizer Industry (BAT emission levels) as proposed by European Fertilizers Manufacturers' Association (EFMA)<sup>(3)</sup> are also discussed.

##### **2.4.1 Irrigated candle filters**

Although these have been developed<sup>(3)</sup> (and work well) for AN prilling they have not been employed for effluent abatement on CAN plants because of rapid fouling of the filter surface by insoluble calcium and magnesium carbonates. Tests at Milnerton during the '70s confirmed this. These units are also costly (\$4-5 million) when designed into new plants and even more so when retrofitted into existing plants.

##### **2.4.2 Less efficient filters (e.g. bag filters)**

Although more operable than the irrigated candles the efficiency of these units is simply not acceptable - especially considering the high cost still associated with such units.

##### **2.4.3 Electrostatic precipitation (ESP)**

Testwork using ESP was performed during the '70s at Milnerton with a degree of success. The perhaps questionable practice of using ESP in an AN dust environment as well as its relatively high capital cost, however, ruled out this option.

##### **2.4.4 Wet scrubbers**

These systems (even including high efficiency venturi scrubbers) simply did not have the capability/efficiency to deal with sub-micron particles (i.e. prill tower fume).

##### **2.4.5 Prill Tower Shrouds**

The use of a bell-shaped shroud around the spray head in the upper part of the tower facilitates selective collection of fume-laden air which typically represents only 25%<sup>(1)</sup> of total air flow. This is normally used in conjunction with scrubbing and irrigated candles as it helps to considerably reduce the size of equipment required to deal with the air flow. This system has been employed on a large number of AN prilling towers but not on CAN plants - due to problems outlined above and the cost of retrofitting such a system.

### 2.4.6 Total air recycle prilling towers

Although this principle is now being commercialised (on porous prilled AN), in combination with scrubbing and cooling of the recycled air, the economic viability of retrofitting such a system to an existing CAN plant is remote.

### 2.4.7 Granulation (e.g. pan granulation)

One way of reducing tower throughput (and thus fume generated) is to fatten the prills by granulation - by splitting the AN feed between prilling and granulation. Testwork has been performed at Milnerton utilising a pan granulator. Although results of this work appear promising there still remains, with high temperature prilling, a very noticeable plume.

Apart from the excess capital costs (and in most cases non-suitability) of installing the above mechanical systems there are considerable operating costs in terms of power requirements for running the large fans associated with most of these units. As the BAT booklet<sup>(3)</sup> points out the « overall environmental impact » should be considered in relation to CO<sub>2</sub> emissions from fossil fuel power plants. In any event, the approach recently employed by Kynoch Milnerton is to cure the problem (i.e. prevent fume formation in the first place) rather than treat its symptoms. Note the value of ammonium nitrate recovered by these various mechanical collection methods normally only pays for the operating costs of such units and does not amortise the capital required.

Note that the BAT emission levels proposed<sup>(3)</sup> do not specify recommendations for existing CAN plants. Jenssen<sup>(4)</sup> in a recent update of this bulletin, however, suggests concentrations of 50 mg/Nm for existing plants with a total emission of 0,5 kg/t of product.

## 3. PARADIGM SHIFT

As reported above a paradigm existed that CAN fertilizer should have as low a moisture as possible. A system was even retrofitted to the Milnerton plant in the '70s which facilitated moisture contents as low as 0,08-0,10%. The reason for this approach (see References 5 and 6) was that most stabilising additives employed in AN (e.g. ammonium sulphate (on its own or with DAP), aluminium sulphate and bentonite) require low moisture to prevent loss of stability due to temperature cycling and caking formation.

Van Hijfte<sup>(5)</sup>, however, showed that AN stabilised with 1,5-2,0% Mg(NO<sub>3</sub>)<sub>2</sub> may absorb up to 1% total water before stability is reduced. In the case of the Milnerton CAN plant this strong desiccant property of Mg(NO<sub>3</sub>)<sub>2</sub> was utilised to shift the paradigm of low moisture AN/CAN fertilizer. By incorporating as much as 3% Mg(NO<sub>3</sub>)<sub>2</sub> in the 28% N CAN moistures of up to 1,2% became acceptable, which in turn allowed low temperature prilling ( $\pm$  155°C). Details of progress in this regard and its implications on product quality and financial impact are described in paragraph 4 below.

## 4. IMPLEMENTATION OF LOW TEMPERATURE PRILLING AT KYNOCH, MILNERTON

### 4.1 Initial testwork and subsequent progress

Although most of the CAN fertilizer produced out of the Milnerton plant in the past utilised ammonium sulphate as stabiliser, export of sizeable quantities of AN stabilised with magnesium nitrate was commenced in the early '90s. Typically this export material contained 1,2-1,4% Mg(NO<sub>3</sub>)<sub>2</sub> and was still prilled at high temperature (175-180°C). The magnesium nitrate solution required for the production of this AN was supplied by Kynoch's liquid fertilizer plant at Milnerton. The idea of leaving more water in the AN and utilising extra magnesium nitrate to sequester this water germinated in 1994. Some relatively short test runs, ranging from a couple of hours to a few days, were then performed during 1994 in order to assess the technical feasibility of the process and the quality of the product it generated. The marked impact of low temperature prilling by this means can be seen by inspection of comparative photographs presented in Figures 2 and 3 overleaf.

Full scale commercial production of this material (referred to in-house as «MagLAN») was started in 1995 and accounted for 67% of the total prilling time employed during 1995. From January 1996 up to the end of April 1996 this figure increased to 86% although the planned figure for 1996 as a whole will drop slightly back to 82% of prilling time. Reasons for the balance of the time still being used for high temperature prilling are given in paragraph 4.4.2.

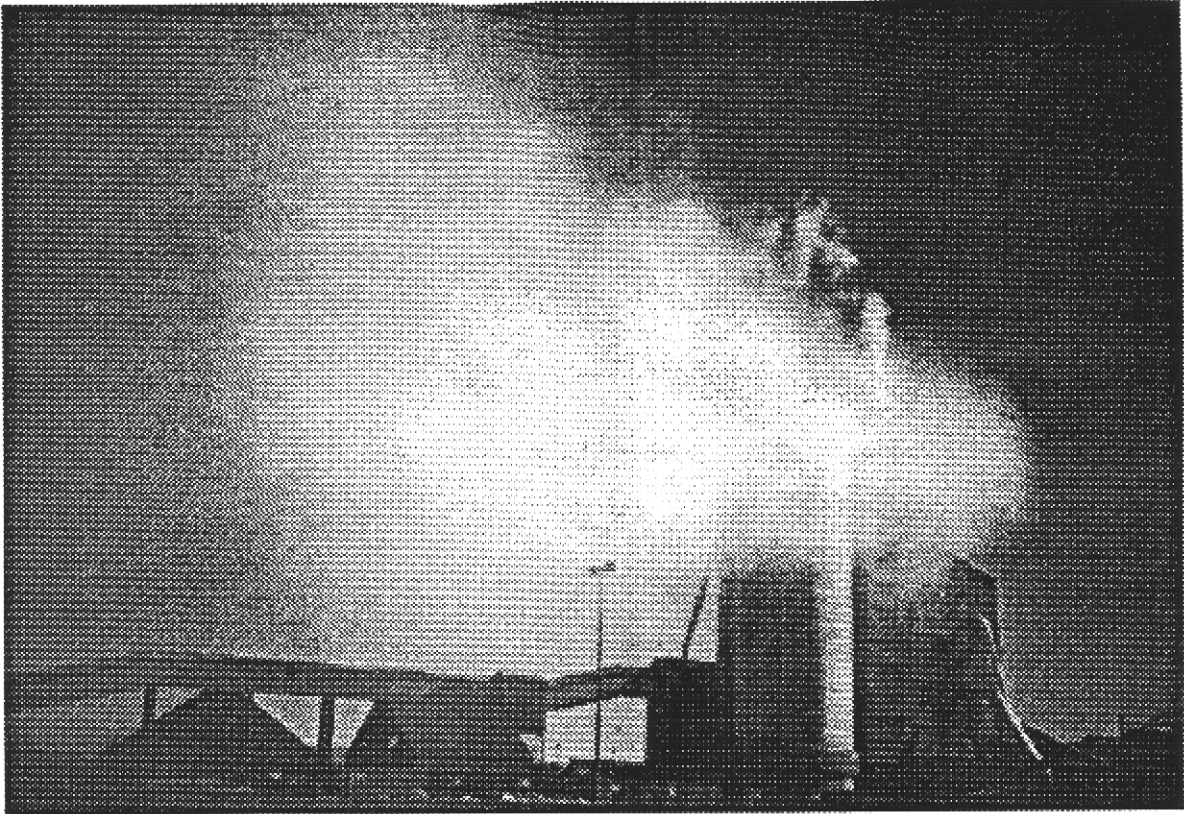


Figure 2: High Temperature Prilling at Kynoch, Milnerton

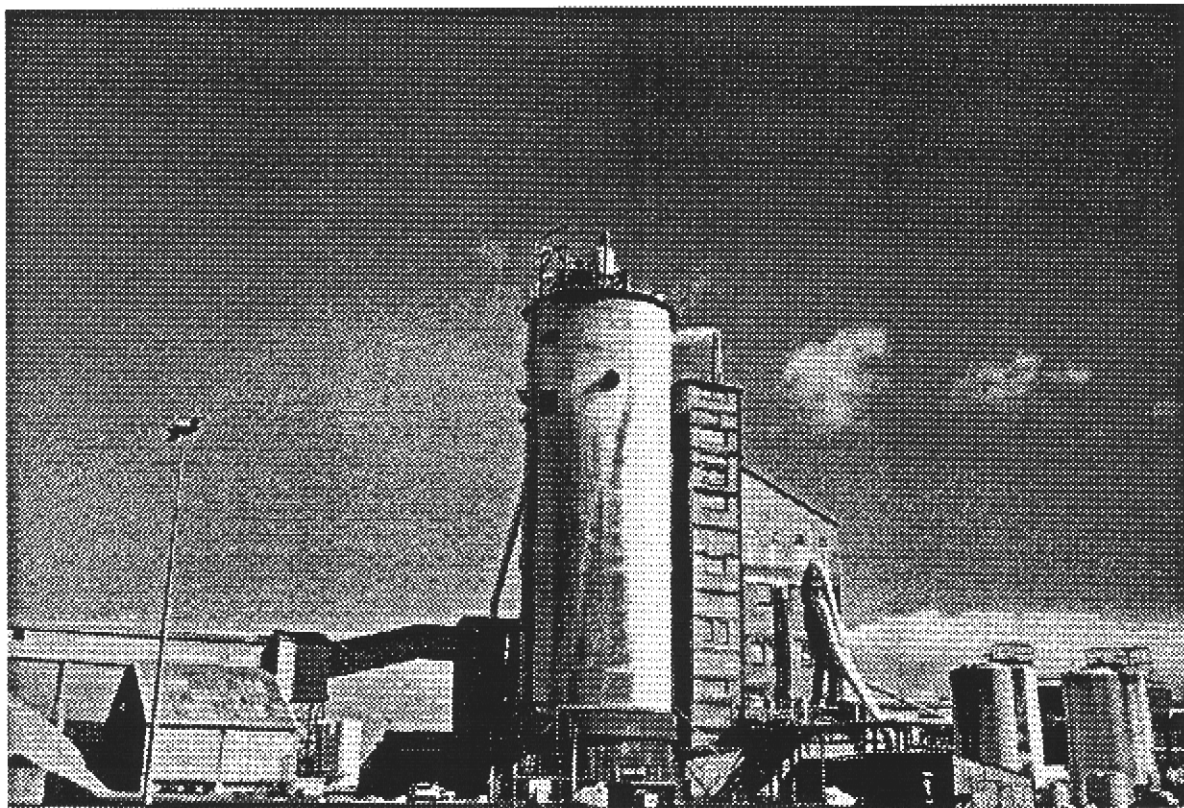


Figure 3: Low Temperature Prilling at Kynoch, Milnerton

## 4.2 Financial implications:

As the infrastructure to both manufacture and dose magnesium nitrate solution into AN solution before evaporation already existed no extra capital cost has been incurred to facilitate the low temperature prilling program. From an operating cost point of view there are higher costs associated with using more magnesium nitrate than with what can be considered normal additions of magnesium nitrate for low moisture, high temperature prilling. The extra operating cost (including overheads of liquids plant) in this respect is in the order of \$3,00/t LAN. The operating cost, however, associated with using ammonium sulphate is virtually the same as for the low temperature prilling option.

The low magnesium product is not as good a quality as that stabilised with ammonium sulphate (mainly from a hygroscopicity point of view - see below) and it would result in unacceptable fume emissions. The choice, therefore, lies between the high magnesium product with its much lower emissions or that with ammonium sulphate which has better storage qualities. Thus operating cost is basically not an issue with regard to LAN production. It should be noted, nevertheless, that work is underway to significantly reduce the current production cost of the magnesium nitrate component in the Milnerton LAN.

Thus, as long as the lower level emissions of « MagLAN » are deemed acceptable, from an overall cost assessment (including amortisation of capital) this route is considered much more economic than the mechanical fume reduction methods discussed above.

## 4.3 Product quality

Refer Table 1 which gives results of comparative tests on « MagLAN », LAN+S, Chemically Pure Ammonium Nitrate (CPAN) and « FlowAN » (ammonium nitrate stabilised with magnesium nitrate).

TABLE 1 - RESULTS OF COMPARATIVE TESTS ON AN / CAN PRODUCTS FROM KYNOCH MILNERTON LAN PLANT				
Sample	% m/m Mg	% m/m H <sub>2</sub> O	Average Prill Hardness (kg)	Hygroscopicity <sup>d</sup> (% m/m)
Normal « MagLAN » (28% N)	0.51	1.00	3.41	9.75
Low moisture « MagLAN » (28% N)	0.49	0.42	2.80	9.47
Low Mg, low moisture « MagLAN » (28% N)	0.21	0.26	2.78	5.16
Low Mg, high moisture « MagLAN » (28% N)	0.19	1.20	3.18	4.55
LAN + S (27% N; 1.8% S)	-	0.15	2.91	2.78
CPAN (Chem pure AN, 34% N)	-	0.17	0.27	2.69
FLOWAN (AN with MgNitr., 34% N)	0.43	0.90	1.19	8.05

The main product quality issues surrounding magnesium nitrate stabilised CAN are its hygroscopicity and caking properties. These are discussed in detail by both Carter and Roberts<sup>(2)</sup> and van Hijfte<sup>(5)</sup>.

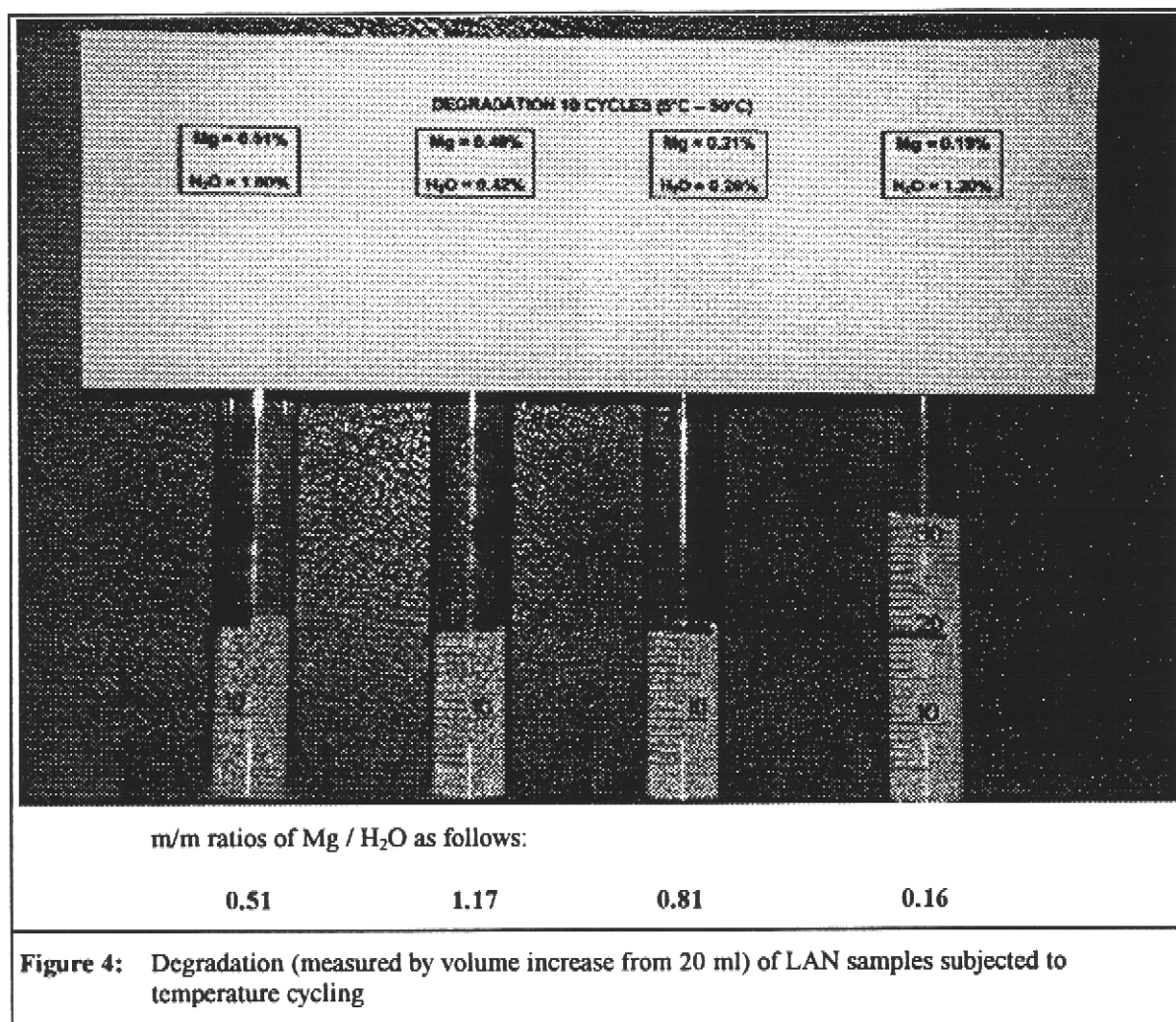
As Roberts<sup>(2)</sup> points out it is important to keep the moisture content sufficiently below the point where the magnesium nitrate product becomes completely hydrated, whereafter it allows chemically unbound water to affect the properties of the AN. This is clearly evident from the photograph presented in Figure 4 showing

<sup>d</sup> Hygroscopicity is measured by exposing 5 g of sample to an atmosphere with 90% relative humidity at room temperature (23°C) for 24 hours.



the results of subjecting products with differing Mg:H<sub>2</sub>O ratios to temperature cycling. The product with an unacceptably low Mg:H<sub>2</sub>O ratio is clearly evident.

Hygroscopicity (and therefore caking together with suitability for bulk blending) remained a concern during the commercialisation phase of this high magnesium product. van Hijfte<sup>(5)</sup> indicates that whilst most commercial CANs have a critical relative humidity (CRH) ranging from 30-50%, products stabilised with magnesium nitrate have a CRH < 10%. This increased hygroscopicity is confirmed in Table 1. It is interesting to note, from Table 1, a point made by Roberts<sup>(2)</sup> that moisture absorption rate of AN drops after reaching point of saturation of the magnesium nitrate dessicant is confirmed by the hygroscopicity measured for the low Mg, high moisture CAN sample.



Van Hijfte's<sup>(5)</sup> experience, however, is that bulk quantities of fertilizer in a heap behave quite differently to individual particles. He goes on further to demonstrate that AN fertilizers stabilised with magnesium nitrate exhibit only a slightly higher moisture uptake rate ( $\pm 15\%$ ) when stored in bulk compared to other commercial CAN and AN products. To date experience with the Milnerton « MagLAN » appears to support van Hijfte's findings. Bulk handling of the product (one non-airconditioned store has had up to 30 000t of this bulk material) has been very similar to the old ammonium sulphate stabilised product. There has been a very slight tendency to formation of small lumps but this so far has been insignificant (probably < 0,5%) and is ascribed to transfer of material in wet rail trucks.

Bulk blending with the « MagLAN » has been successful thus far, although 1996 represents the first season it has been performed on full scale. No problems have been reported from the bulk blending plant but the ultimate proof remains with its application. At the time of writing this paper no complaints have been reported from customers who are half-way through the main season.

It is interesting to see, from Table 1, the effect limestone incorporation has in increasing hardness. The « MagLAN », in fact, has an average hardness greater than that of the 27,0% N LAN with sulphur (as ammonium sulphate) product.

Inspection of the photograph in Figure 4 shows that resistance of the « MagLAN » to temperature cycling is good provided the moisture levels of the product have not totally saturated the magnesium nitrate component.

The « MagLAN » does have other advantages over LAN with sulphur (as ammonium sulphate) in that it has approximately 15% higher bulk density and also appears to generate less dust on handling - especially when bagging the product, thus heat sealing of the bags tends to be less of a problem handling « MagLAN » than LAN with high quantities of ammonium sulphate as stabiliser.

Finally it should be noted that an amine-oil coating is still being applied to the « MagLAN » - as traditionally was the case with the ammonium sulphate stabilised LAN. It is actually debatable whether or not a coating is actually required on CAN containing such a strong desiccant as magnesium nitrate. Some thought has been given to improvement of the water proofing of the prills by coating and testwork in this regard is planned. The effectiveness of the current coating must still be established in order to determine whether it is in fact necessary.

#### 4.4 AN fume/dust level measurements and problems associated with the low temperature prilling program:

##### 4.4.1 Fume/dust loading measurements and their interpretation

As indicated above all measurements of particulate AN concentration in the exhaust ducts of the tower have been performed anisokinetically (and thus their accuracy should be treated with reserve). Typically differences that have been measured between high and low temperature prilling are as follows:

High temperature prilling ( $\pm 185^{\circ}\text{C}$ ):  $\pm 120 \text{ mg/Nm}^3$   
 Low temperature prilling ( $\pm 155^{\circ}\text{C}$ ):  $\pm 60 \text{ mg/Nm}^3$

Although, to date, no limestone analysis has been performed on dust collected from low temperature prilling average concentrations measured in the past on dust collected from high temperature prilling indicated a  $\pm 7\%$  limestone content (compared to 20% limestone in the LAN product). The split between dust and fume during high temperature prilling is then calculated as follows:

Dust component =  $\pm 42 \text{ mg/Nm}^3$  LAN  
 Fume component =  $\pm 78 \text{ mg/Nm}^3$  AN

If a rather gross assumption is made that the quantity of dust - from microprill carryover as opposed to fume - has remained more or less constant the fume concentration with low temperature prilling =  $\pm 60 - 42 = \pm 18 \text{ mg/Nm}^3$ , i.e. a reduction in fume concentration of  $\pm 77\%$ . This compares favourably with the predicted fume concentration reductions calculated above in paragraph 2.3.

At  $60 \text{ mg/Nm}^3$  (note latest BAT emission levels recommended are  $50 \text{ mg/Nm}^3$ ) the overall dust/fume discharge amounts to  $0,75 \text{ kg/t}$  product (compared to latest BAT recommended figure of  $0,5 \text{ kg/t}$  product). These figures represent significant improvements against  $120 \text{ mg/Nm}^3$  and  $1,2 \text{ kg/t}$  (see paragraph 1. above) for high temperature prilling. They are, however, still in excess of the latest recommended BAT levels and the reason for this is the dust concentration as opposed to that of fume. This would also explain why the fume visibility has improved by far more than would be explained by the drop in the total AN concentration in the exhaust air - since the fume is highly visible whereas the dust is not.

This state of affairs therefore presents another problem, namely: how to reduce the dust (and not the fume) concentrations? Public complaints, however, are linked to visibility problems and as this aspect has improved markedly some time should be available to address the problem of dust reduction.

##### 4.4.2 Problems with incorporation of sulphur into LAN

As sulphur appears to be more and more important agronomically there is a certain demand for it to be incorporated with the LAN produced at Milnerton. Thus a 27,0% N + 1,8% S product is still currently prilled, at high temperature, to satisfy some of the market requirements. This explains, together with some chemically pure AN production, why some small percentage ( $\pm 18\%$ ) of prilling time has still been allocated

to high temperature prilling. A solution to this particular problem is still being investigated and could include bulk blending with a suitable granular ammonium sulphate product.

Note that attempts to blend magnesium nitrate in together with the ammonium sulphate stabiliser have been unsuccessful in that the resultant product had absolutely no resistance to temperature cycling. In essence attempts to do this are tantamount to dosing the product with magnesium sulphate.

## 5. ALTERNATIVE ROUTES TO AN FUME/DUST REDUCTION AT KYNOCH, MILNERTON

These include (as mentioned above) changing to liquid fertilizers and pan granulation/prill fattening.

### 5.1 Liquid fertilizers

An on-going program is in place to shift as much of the market to liquid fertilizers as possible. Apart from the overall reduction in prill tower pollution there are also sound economic reasons for such a shift.

### 5.2 Pan granulation/prill fattening

Work on prill fattening by feeding prilled AN to a pan granulator is continuing. This is principally to improve the bulk blendability of Milnerton LAN but, used in conjunction with « MagLAN » production, will help to even further reduce AN fume/dust emissions.

## 6. CONCLUSION

The visibility impact of the Milnerton prill tower plume has been significantly reduced by the use of low temperature prilling. This has been facilitated by prilling a high moisture product utilising higher levels, than normal, of magnesium nitrate (as stabiliser) to sequester the extra water.

The overall cost implications of this change, in the context of the existing operating parameters, has been negligible. The quality of product thus generated has been acceptable - providing certain precautions are taken.

Problems concerning incorporation of sulphur into the LAN product must still be addressed. Other steps in conjunction with low temperature prilling, including change to liquid fertilizers and prill fattening via pan granulation, are being developed to further reduce overall emissions from the prill tower at Milnerton.

## 7. ACKNOWLEDGEMENTS

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