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PROBLEMS IN FERTILIZER BAGGING

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Although this paper is based on conditions as experienced in the Fertilizer Industry of the Republic of South Africa over the last decade, there must however be considerable grounds of mutual interest, and it is hoped that some of the solutions to the problems observed may be of value elsewhere.

Whilst by no means claiming to have solved all problems, we have reached a relatively trouble-free period during the last year or two, which is a considerable improvement when compared to the way things were only a few years ago.

A brief summary of prevailing agricultural and handling conditions follows, for those not familiar with our conditions.

Agriculturally, South Africa is a poor country with much of its land desert or semi-desert, yet it accounts for more than 20% of the output of the entire African continent.

Agricultural activities are thus of necessity concentrated in the most suitable areas for particular crops, mainly maize, wheat, potatoes, legumes, fruit and vines, and these are presently served by fertilizer factories situated in three main centres, which requires transport over distances, often of more than four to five hundred miles, mostly by rail. By most standards, our rail gauge of 3' 6" is narrow, the tracks are winding, and the long journeys, often taking as long as two weeks, are apt to inflict much damage to the loads if they are not properly packed or protected. Truck loading and off-loading are normally performed manually by labourers whose proficiency varies considerably. An untrained gang is often the cause of damage when very rough handling can and does occur.

Presently, fertilizer is almost totally packed in polyethylene bags. The fertilizer consists mainly of mixtures compounded from ammonium nitrate, urea, single or triple superphosphate, ammonium phosphate and potassium usually in the chloride form, although straight components are also used.

Since seasonal rains and planting times determine when the fertilizer is to be used, and these tend to be spread over a short period of approximately three months, the necessity of storage at the points of application arises. Normally, some shelter is available, but often outside storage has to be resorted to, and the bags become subject to extreme weather conditions, varying from sub-zero temperatures to temperatures often in excess of 120° F.

Although the emphasis in this paper is placed on problems directly associated with the bagging of fertilizers, the conditions just mentioned have so integral a bearing on them that it is felt that they cannot be completely ignored.

Thus, to provide the customer - the end user - with a pack that reaches its destination in a whole and acceptable condition, - a problem-free condition - attention must be paid to its compatibility with the product to be clothed, the internal factory handling facilities and procedures, demands made on it during its journey, as well as those between its arrival at its destination and application in the field.

The proper selection of the bag type contributes considerably towards amicable relations between the supplier and user. Materials that have been used towards this end are as follows.

Jute or hessian woven sacks

Since fertilizer packs are essentially one-trip containers for a relatively inexpensive commodity, their costs are of major significance.

Jute or hessian with or without paper or plastic liners are one of the strongest packs available, and can be expected to survive most severe handling; but unfortunately they are also one of the most costly packs, and their application can only be warranted under very special conditions such as is sometimes presented by long distance shipping to venues where discharge facilities are severe or primitive, or at the specific request of the customer. Before roads were built, loosely packed jute bags, slung over the backs of donkeys, were the only means of conveying fertilizer from the railhead to Botswana.

The after-use potential of this type of sack often creates a customer demand.

Woven Plastic Sacks

These possess most of the favourable properties of the sacks made of natural fibre, and are very much more economically priced. These sacks are making some progress in fertilizer application, but still present problems as fibres tend to pull apart at the sewing line, and stacks are often found to be unstable, due to the low inter-sack co-efficient of friction. These sacks, possibly in a modified and even more economic form, warrant close watching.

Paper and Paper Combinations.

Before the replacement of paper by the plastic bag, it was the main work-horse and even today there is still a considerable field of opinion favouring its return, confined mainly to the more temperate areas.

On its own, it was only suitable for the clothing of chemically unreactive products such as muriate of potash.

The introduction of a bitumenised inner layer improved matters considerably, and permitted reasonably satisfactory outturns on the, then, current range of mixtures such as 5-13-5, 10-6-10 etc.

The production of our own rather chemically reactive phosphates from local igneous apatites proved a little too much for it.

The replacement of the bitumen layer by a 0.001 inch coating of polyethylene did improve matters considerably, but even then it was not completely dependable, and something more reliable was sought.

A loose liner of between 0.002 and 0.003 inches was the latest development, which provided a reliable and acceptable pack.

According to our experience, a sack with 4 plies of 80 gram extensible kraft was superior in behaviour to a sack constructed of 5 plies of natural kraft. With the 0.002 inch loose liner, 3 plies of 80 gram extensible kraft sufficed.

At the time of use of the loose-liner sack, no efficient secondary closure for its open-mouthed version was available and an expensive manually inserted valve had to be resorted to, which, although good, was unfavourably priced, and which assisted towards its disappearance from the scene. Problems experienced during this period were:

(1) Closure - Threads often became perished, but this complaint was eliminated on the introduction of synthetic threads of nylon or terylene. Threads cutting through the paper was experienced regularly, but its incidence was considerably reduced when a heavy rayon looper thread with a filler cord under the needle thread was used. The prevention of tears initiated along the needle line through very closely spaced stitches at the commencement of sewing, necessitated constant attention to sewing machine

feed dogs and pressure feet and their settings. The modern "swing needle" sewing machine should make this a problem of the past.
In the valved version, in-line sewing was of course not required.

(2) The in-transit behaviour of the paper bag was normally good, but breakage problems often arose through shocks inflicted on them during shunting, and the stopping and starting of the train, through loads shifting towards either end of the truck. Floor and side dunnaging and the prevention of contact with any protrusions in the truck, were necessary.
When the bags were torn under these conditions, it was normally found that the tears were large, and that the contents of the bags were badly spilt. In many cases small fragments of paper were mixed with the spillage, which, unless screened, were certain to block distributing equipment during use.
It was found that extensible kraft was less susceptible to fragmentation than natural kraft. Moisture, under extreme conditions, was not kind to these bags, even after a thin film of polyethylene was coated on to the outer ply. Scratches and pinholes resulted in moisture absorption under wet conditions with resultant paper ply weakening, and under extremely dry conditions, as experienced in our winters in the interior of the country, the paper became so brittle that the bags snapped in their centres when picked up.
In the case of the latter problem, humidification in stores was often introduced with good results.

Proper storage and covering was absolutely necessary to avoid exposure to rain and very special care had also to be taken to ensure that the trucks were well sheeted en route.

In-transit breakages were also prevented, to a great extent, by the adoption of a suitable loading pattern in trucks. The method was basically to load the bags crossways to the length of the truck, using a bolster bag to load the bags on the floor to obtain an inwards slant and to keep the sacks from touching the truck sides.

A firm load, acquired through using the correct number of lines of bags over the length of the truck, together with attention to the placement of the last bags prior to completion, had a most beneficial effect on the stability of the load, and the prevention of individual bags being scuffed against the truck sides.

Although not many complaints were received once the bags had satisfactorily reached their destinations, tactful education of the users, for example, on how to store on dry floors, not to walk over stacks with hobnailed boots, and so on, did facilitate their preservation.

Plastic sacks are now extensively used, and since this appears to be the current pattern in most countries, problems associated with their usage will be more fully covered.

The selection of the correct grade of plastic is of paramount importance.

In addition to the specification of their physical properties, which were most ably covered at last year's conference, attention must be paid to the following:

(a) Its stability under climatic extremes. Experience has shown that certain low density, high melt index polymers, when used during our summer months become so softened as to "flow" and distort during transit. Handling during off-loading resulted in a multitude of punctures or bruises incurred by fingers, when not picked up gently. Cradling the bag by placing the hands under it, appears to be a much better method than the handling gangs gripping the bag with their fingers. At the other extreme during our winter months, some of the higher density, low melt index polymer sacks became so embrittled as to rupture at their seals during handling. A medium density resin 0.920-0.923 with a melt index of approximately 0.5 appears to be most satisfactory under South African conditions.
A point of interest here is that different extrusion and conversion processes can so considerably alter the film characteristics, that a strict polymer specification just cannot be instituted.

(b) It has also been found that the optimum thickness of bags is best determined in field experiments by the load the bag is to carry, rather than by the normally accepted theory that the thicker the bag is, the better and more problem-free it should be.
The combined effects of its physical strength and elasticity appears to determine its functionability, and on 100 lb. bags it was actually found that the performance of a 0.008 inch thick film was far superior to that of a 0.009 inch film.
Tests are still under way to prove whether this gauge is the ultimate, although problems of thin film perforation by jagged granules can be fore-seen if the calibre is reduced to a much greater extent.

(c) Additives to the polyethylene can be the cause of dire consequences, and if found necessary or desirable, it is strongly recommended that they be thoroughly field tested prior to adoption. Unsuitable pigments have been noted not only to discolour or bleach completely when exposed to weather, but also to cause excessive seal de-lamination.

In our case, a milky appearance was desired in the film. This is normally attained by the inclusion of a small amount of titanium dioxide during extrusion. After field observation which showed rapid film deterioration, it was found that this pigment, which was of anatase origin, assisted in ultra violet light degradation. Titanium dioxide of rutile origin, appears to be superior in counteracting the unfavourable effects of ultra violet light.

Care too must be taken in the incorporation of additives to counteract ultra violet degradation, as well as slip and electrostatic effects.

An excess, or the physical migrational characteristics of some of these, can severely affect the sealability of sacks.

(d) Bag design, in addition to the physical properties of the film previously referred to, can also assist in reducing the problems of breakages.

The bag size must be adequate to clothe the product. Too small a bag is not only difficult to fill but also, unless an ullage of at least 4 inches is allowed for, the chances of seal breakages are greatly increased. The variation of bulk density in the same bulk pile is often quite noticeable, to say nothing of variations found in different runs of the same commodity.

Too long a bag is difficult to handle, and economically wasteful.

The correct bag dimensions must be carefully assessed for every commodity, and this must be constantly checked. The ratio of the length to breadth of the bag must be such as to be suited to the vehicle in which it is to be transported. Too long a bag invariably results in scuffing against the sides of the vehicle, whilst too short a bag results in stack instability.

(e) Cut bags: sharp endings on bag seals are to be avoided because of their cutting ability.
Jagged bag ends act similarly.

Seals should be square to the length of the bag and never concave towards the contents. This latter sealing defect is often the cause of seal failures when bags are subjected to shock, and is normally caused through incorrect sealer feeding.

(f) Ink discoloration: an aesthetically acceptable design on bags is often spoilt through the use of inks which fade or are incompatible with the product.

New bags should not only be carefully handled during their storage prior to filling in order to avoid cuts and bruises, but should be stored away from sunlight, which has a nasty habit of causing side crease failures at inconvenient times.

A sound practice too is to adopt a strict policy of using the oldest bags first and keeping stocks down to a working minimum. Polyethylene bags show no physical improvement with age.

From the production point of view most problems associated with bagging have been found to originate on the bagging platform; a potential source of mechanical and and human error, but which, with due care, is not too formidable an obstacle. The investigation and recognition of trouble points and appropriate action, must be a constant practice.

Filling spouts are normally the culprits in valve tube collapse on filled bags which cause spillage.

Valves, especially of the patch type, are easily damaged if the packer spout is of too great a circumference, externally built up with fertilizers, or the saddle is not correctly adjusted. An initial small tear along a patch seal is often found to grow during handling and transport.
Remedial action is obvious.

Open-mouthed Filling Spouts cause problems through:

Physical damage by projections - mostly fertilizer built up.

Excessive height above the discharge landing, causing excessive shock on release, whilst snags against the spout structure could be incurred, if too low.

Pneumatic clamps must be carefully adjusted to avoid film damage through excessive pressure, especially on improperly designed clamping surfaces. Clamps with too small a contact area result in localised film stretching, at scale discharge.

The inner film surface of sacks is often electrostatically charged by abrasion against the spout structure, with consequent dust attraction. Plastic covering of the spout has in cases assisted towards repelling charges.

The impact of product discharge from too highly placed scales is also the cause of dust accumulation.

A spout of too large proportions or of wrong shape can result in sack placement difficulties with consequent reduced output.

A properly designed bagging spout should protect the bag during the filling operation.

Other than the possible contact with potential snag points on its travel from the spout to the sealer, no reason for damage should occur at this juncture.

Rubbing of bags against guides etc. at the time of filling is often the solution to the presence of cross-directional cuts, only observed much later - normally on the premises of a not-too-happy recipient.

The sealer is the most critical item in the bagging line and even with the best of mechanical attention, many problems encountered in the field arise at this source.

A survey of these includes:

(a) Seal de-laminations (mainly the opening of the secondary seal) which on investigation reveals:

(i) sealing at too low a temperature;
(ii) the use of bags of different sealing characteristics in the same run - possibly products of different suppliers, or from the same supplier but made at different times under variable processing conditions or from different resins;
(iii) excessive localised corona treatment for print adhesion - this results in failures in the same position on the seal in practically every bag;
(iv) excessive calibre variations, which preclude sufficient heat from reaching localised areas of the seal interface;
(v) contamination on the interface through dust;
(vi) bags with insufficient ullage;
(vii) excessive additive inclusion, as also the inclusion of additives in the film which migrate to the surface.

(b) Seal tears, experienced immediately below the sealing line, can normally be attributed to:

(i) too high a sealing temperature, resulting in film embrittlement;
(ii) too high a sealing pressure, resulting in cross-directional extrusion with consequent localised film thinning and weakening;
(iii) inadequate ullage can often be noticed by the incidence of seal failures, especially in combination with one or both of the first mentioned conditions;
(vi) certain sealer belt dressings through their adverse effect on the film, cause ruptures adjacent to the sealing line;
(v) sealing heads when set too high above the sack conveyor, result in stretching of the film in its softened state, and consequent thinning and weakening;
this is mainly confined to sealers which do not have bag carrier or gripping chains;
(vi) sealer belt speeds when not exactly synchronised with bag conveyor speeds often result in cross-directional breakages immediately adjacent to the sealing line;
This too is mainly confined to sealers which do not have, or have inadequately designed, carrying chains;
in the case of sealers with bag carrying chains it has been found that this source of trouble, when it occurs, is attributable to varying speeds between the sealing bands and these chains, normally the result of link stretch incurred through chain adjustments.

The above, although appearing to be quite a formidable array of causes for unsatisfactory out-turns and complaints, can fortunately be detected at the time of sealing through manual drop tests on the sealing platform.

It has been found that bags which survive three drops on either side crease from a height of four to five feet, seldom exhibit any of the above problems in the field.

Suspect seals are a certain cause of trouble and should never be loaded.

The use of capping strips over seals is favoured, as in many cases of seal failure these provide a satisfactory closure and do provide a second chance.

Bag conveying equipment (in-plant) too, has been found to be the cause of many cases of bag failure, which is mainly reflected as cuts in the direction of travel, or snags.

(i) Chutes are most notorious, as any projection or unevenness could result in a cut partially or completely penetrating the film. In the case of the latter, where the break is obvious, remedial action can immediately be taken, but unless regular drop testing at the loading point is conducted, this malady is only noticed on its arrival at destination. Butt drops are most effective in this case, and need not necessarily be conducted as often as the side drops previously referred to.

(ii) Micro-perforations in the film on the faces of bags too, often appear at this stage, through the abrasive action of jagged granules or lumps in bags. They cause film weakening, and are most obvious on printed areas of the bag where they show up as small rounded specks of ink removal.

The ideal arrangement for the elimination of these is the replacements of all chutes or slides by conveyors. Here the bags are carried to their destinations and no scouring effects are inflicted on the thin film.

(iii) Ploughs and other equipment used in directional changes of bags on belts are notorious in their scuffing and wherever possible should be designed to have their actuating surfaces moving with the bag.

In-transit damage is normally evident by snags, tears and cuts in the bags, as well as spillage of product from the ruptures, aggravated by the movement of the vehicle.

Control of this damage can be obtained by:

(1) Proper truck preparation and dunnaging. All extraneous material must be removed from the floor and sides of the truck at the time of cleaning. With regard to dunnaging

a cushion provided by a layer of sawdust or wood shavings has given excellent results. Truck sides, when required, are protected by lining with heavy paper or corrugated kraft.
Any protrusions on the truck sides such as flanges, rivets, etc. must be well padded, and it has been found that a used bag filled with scrap paper,etc,will practically eliminate damage from these sources.

Truck ends, especially when rivets are present, must be especially well protected.

(ii) The handling of the bags during placement must also be carefully watched. Damage incurred by finger nails, belt buckles, etc. is often encountered.

(iii) The stacking pattern, which must be stable, contributes much towards the elimination of breakages during transit. Experimentation with various stacking patterns on polyethylene bags has shown the under-mentioned to be most suitable:

(a) Bags are stacked crosswise to the length of the truck.

(b) Stacking is commenced from either end of a truck by placing a bag lengthwise against each side.

(c) The first layer of crosswise stacking is placed with one end of a bag against the side of the truck on the bag stack, lengthwise, and a third is placed in the centre.

(d) Subsequent cross layers are laid by first placing the centre bag and then the two side bags, always maintaining an inward slope on the outer bags. Even distribution of the bag contents is important.

(e) The third and subsequent layers in each stack are loaded away from the truck sides.

(f) After the requisite number of cross lines of threes have been placed, the stack is ended by a line of two bags, on which one is superimposed.

(g) Trucks are normally loaded from either end, and every effort must be made to have the final lines arranged similarly to the rest, otherwise undesirable movement and damage result in transit.

(h) Air occlusion in bags not only makes stacking difficult, but is also dangerous through collapse on to packing personnel, and must be countered accordingly.

(i) Any broken bags noticed must not be loaded - these result in collapsed stacks.

(j) In the closure and sheeting of trucks, walking over the top layers with heavy boots is to be avoided.

<u>The discharging</u> of the truck can also result in damage,

and breakages are often laid at the door of the supplier. Although many factors of rough handling previously mentioned apply, a notorious source of breakages is the contractor's vehicle. This often has rough welds, bolts, rivets, etc. on the floor areas, and the encouragement of use of dunnage used during the original loading of the rail truck is strongly advocated.

Prior to the fertilizer application, small tears, cuts, etc,in bags can be advantageously repaired with plastic sticky tape.

Punctures incurred during any part of the process such as in air release, granular penetration, scuffing, etc. adversely affect the condition of fertilizer when stored outside and subjected to rain showers. With the capillary attraction between the bags in contact with each other,and surface tension, a blotting-paper-like action takes place, which results in fertilizer not at all suitable for mechanical application.

A vent for air removal on the interruption of a seal approximately 2 inches from either side of the sack, under a capping strip has been our most successful method of venting, and which, through its positioning, resists water intake.

A 2 mil polyethylene sheath, tied over the stack, is also a further insurance factor at the time of outdoor storing.

In conclusion, it is hoped that too grim a picture has not been painted of the problems incurred in fertilizer bagging, but as stated, with reasonable care from the bag specification to its final handling, satisfactory results are more often obtained than not.

DISCUSSION

MR. BURGER (Fisons (Pty) Ltd): The paper that I am about to read to you was erroneously given as having been prepared by J.J. Porter of Fisons Pty Ltd., South Africa. In effect Mr. E.F. Wiehahn has prepared it. The outline of the report is possibly in contrast with the papers read so far, in that this is a bit of history as far as we are concerned. Most of the other papers were advancements whereas this paper covers the progress made in packaging in South Africa over the last 10 or 15 years. I must give you some background as to the application of fertilizers and the problems encountered in South Africa.

The country is roughly 500,000 sq. miles in size. It measures across from the Indian to the Atlantic Ocean some 1200 to 1300 miles at its widest point. The fertilizer industries are virtually concentrated in 3 very distinct regions. This would give you an indication of the problems encountered in bagging and despatching fertilizers. It is not uncommon for despatches to be "en route" for up to a fortnight. Vehicles are possibly bigger than found in Europe. The nominal sizes or carrying capacities of railway trucks are up to 42 tons per vehicle. Arrangements are being made to increase this capacity to 54 tons.

As far as packaging material is concerned we have available in South Africa today the following materials: jute or hessian or woven plastic sacks, or polythene sacks. Jute or hessian are still being used but their use is rather limited, in so far as these are very expensive materials to pack fertilizer in. Woven plastic sacks have only recently come to South Africa and are not being extensively used at this stage. It seems obvious that the woven plastic not being impervious, these materials would need liners. Paper and paper combinations have been discarded as such as not being suitable for modern fertilizer packaging. Progress with paper was made up to the point where the inner paper layer was coated with a thin film of plastic. Even this did not prove sufficient protection for subsequent degradation and was not resistant enough to withstand any chemical attack from the gases in the fertilizer. In-transit behaviour of the bags gave many problems in so far as they could not stand rough handling or long journeys under extreme conditions of heat and low humidity. This led us to use plastic bags almost exclusively in the fertilizer industry in South Africa today.

What we like to look at before choosing a type of plastic is first of all its stability under extreme conditions. With temperatures varying between sub 0 and up to 130°F, it is obvious that a lot of attention must be paid to the melt index of the resins used. Embrittlement during low temperatures is a common result of using a high density polyethylene. Similarly during normal high temperatures a low density high melt index polyethylene flows easily and renders the bags virtually useless. We use field experiments very exclusively in determining the type of bag, the type of material and the handling characteristics of these bags. So far we have determined that a bag thickness of approximately 0.008 inch is the best thickness to be used.

Additives to the polyethylene can cause a lot of problems, as we have experienced. The main additives used are those for counteracting ultra violet light effect and titanium dioxide for colouring the bag material white. It was found that titanium dioxide of anatase crystal type virtually never has the effect of the ultra violet inhibitor. The rutile origin of the titanium dioxide appears to be better.

Due to different vehicle sizes a lot of attention must be paid to the design of the bags and an eminent ullage of roughly 4 inches is thought to be the least that we can use. Against plastic bags are the following items: bags are easily cut, any sharp ending on bag seals can cut the bag adjacent to it. Printing is difficult and inks discolor very often. Sunlight has a detrimental effect and, at this stage, we have not been able to provide a bag that can stand up to South African conditions for more than 6 months. Naturally bags must be stored away from sunlight before use. Fertilizer build up on either the bagging spouts, the conveying equipment or the chutes is a major deterrent for the use of plastic bags, since any minor cut would show up consequently in the hands of the user. All surfaces contacting polythene bags should be free from burs or sharp protrusions.

Some of the major problems in sealing these bags are seal de-laminations due to seal temperatures either having been too low or bags with different sealing characteristics in the same run or excessive localised corona treatment or calibre variations in the bags, contamination on the interfaces through dust, bags with insufficient ullage and excessive migrating additives. Often seals tear just below the sealing line, and this can be attributed to excess of sealing temperature and pressure, inadequate ullage, sealing belt dressings, sealing heads too high above the bags (in other words the bag hangs on to the sealing belt) and speeds of equipment not synchronised. Bad sealing can easily be detected by regularly drop-testing bags after sealing.

Quite a lot of attention is being paid to the dunnaging of trucks. Trucks are cleaned up very carefully, a layer of sawdust is put in the bottom and the whole circumference of the truck is well dunnaged with fluted single-faced kraft or any odd paper that might be available.

Lastly the venting of bags presents problems, especially as far as outside storage is concerned, and any small cut or abrasion can render the fertilizer difficult to use. A vent incorporated in the manufacturer's seal and covered with a capping strip is being used exclusively by Fisons and the incidence of moisture contamination due to vent holes normally punched in bags has been eliminated.

DR. A. BROWNLIE (S.A.I. Ltd., United Kingdom): I am very pleased to open the discussion on Mr. Wiehahn's paper entitled "Problems in Fertilizer Bagging". Some 15 to 20 years ago in the fertilizer industry caking of fertilizer was a severe problem, and very often the contents of the bag would tend to form a single large piece of fertilizer with no free flowing granular material. Apart from the rotting of hessian bags in some cases due to excess acidity, the main accent on research lay on the contents rather than on the packaging material. Naturally, when the caking problems were solved the contents of the bags began free flowing and this is a generally accepted standard of quality today. However, if the fertilizer is free flowing the package has to be perfect with no holes or tears in the material used. Similarly as the nature of the material in the bag has changed over this period of time to particularly soluble and high analysis fertilizers the function of the packaging material as a water barrier has become more critical. Lastly as the rates of production and packaging have gone up, the material used for packaging has to be strong enough to stand up to the mechanical handling required, as well as the human handling. And so we see that as problems on one aspect of the industry are solved, others are created which must be solved in their turn to provide in every instance the most economic and the most practical solution. It is quite clear that the quality of the package is as important as the quality of the contents if economy is to be maintained and complaints avoided.

I must say I have read this paper with considerable interest. The factors applying in South Africa to the fertilizer industry, including long transport distances and methods of transport, the quality of the labour, the nature of the terrain, the wide temperature range and the short season for fertilizer application all serve to increase the difficulty of finding a solution to the form of packaging, and the author has obviously studied all these aspects. The guidelines for good practice which are set down and the diagnostic treatment for bag use which he outlines will undoubtedly be of value to us all. I should just like to start the discussion going by asking a few questions.

For example, on page 8 paragraph (a) (ii) can Mr. Burger say how important in frequency rate of failure is the bag sealing variation within one manufacturer's products, and has he felt it necessary to introduce a quality control check on a routine basis for sacks received from one manufacturer? Under (a) (v) a few lines further down, can he indicate how the dust is removed or reduced in quantity? On page 9 paragraph 4 regarding the use of capping strips, can he say whether these are applied and sealed across the 4 layers of bags and sealing strip at one time? Again on the same page under bag conveying equipment, paragraph one, has the author tried plastic material such as polypropylene for forming chutes, etc? Also, in the next paragraph concerning tearing by jagged granules or lumps in bags by abrasion, could some of the tears also be caused by frictional melting? Whether this is so or not, this still leaves the problem which might also be tackled at the manufacturing end by a still further improvement in fertilizer granule quality or shape. Finally on page 10 paragraph (iii) (h) the author points out that the air occlusion must be countered and he mentions on the following page that this is done by inclusion of vents. Perhaps Mr. Burger could say a little bit more about the technique of making these vents?

MR. BURGER: With regard to the first question about the different sealing characteristics in the bags or in the bag material, this is important and quality control tests are being done on all bags supplied by the manufacturers. Normally the frequency rate of this is very low and consequently not easily detectable. Very often the use of these bags show up the fault. Your second question, the contamination on the interface with dust is still a problem. We have not been able to eliminate the dust and even vacuum extraction from the filling spout has not provided us with the ultimate answer. Your third question, the use of sealing strips necessitates the sealing of four layers of plastic simultaneously. Fourthly the use of polypropylene or any other material for chutes has been tried but has not been found very effective under our very dry conditions. You have mentioned that frictional heating could melt the polythene thus leading to a perforation. We agree with you but have not been able to detect it as such. Your last question concerned the technique of venting. The bag is transported crosswise across the venting machine before being sealed by the manufacturer and, as is normal, vacuum cups are applied to both outside faces of the bag and used to open the bag, immediately followed by two rollers, 2 small $\frac{3}{8}$ inch long rollers, with paint on them thus preventing the 2 strips so painted on to the inside surface of the bags from sticking to each other during sealing operations.

In order to illustrate a few points brought up by Mr. Brownlie, Mr. Burger showed a few slides.