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A MODERN SOLUTION TO THE PROBLEM OF STORING, CONDITIONING, PACKING AND LOADING SUPERPHOSPHATE

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(1) FACTS OF THE PROBLEM

The object of this study is to present a solution of the general problem of storage, removal from storage, conditioning, packing and loading, in a superphosphate factory with an annual production and shipping capacity of (metric) 100,000 tons.

In the example chosen, the manufacture and consignment may involve 4 concentrations of super, each to be stored and forwarded either as the powdered or granular product: the undertaking will of course be easier if there are fewer kinds of super.

The manufacturing process selected should be such that the super intended for delivery in powdered form can be treated as it leaves the super plant, so that it can be stored in heaps right away; this super should have a moisture content of not much more than 10% after one month of curing. Finally, the consignments of powdered super should not contain more than 5% of particles over 4 mm in diameter.

The actual despatch capacity aimed at is a maximum of 800 tons per day of super in bulk or in 100 kg bags, including all concentrations and qualities, whatever the form of transport used for despatch (railway wagon or lorry), calculated on a basis of loading into store and loading on to wagons and a normal working day of 8 hours.

This gives a maximum monthly despatch capacity of 15 to 20,000 tons, sufficient to meet the seasonal peaks of demand for a factory of this size.

The total storage capacity allowed for is 36,000 tons, which would be sufficient, in a factory dealing with 100,000 tons per annum, to ensure normal curing of superphosphate. Of course, the manufacturing tempo in such a factory can vary within quite wide limits (e.g. from 6000 tons to 10,000 tons per month) to follow the seasonal requirements.

II. GENERAL DESCRIPTION PLANT

1. Buildings (Reference should be made to attached diagram No. 1. giving general plan and transverse section of the installation)

The storage buildings consist of two large parallel sheds, 100m x 25m, metal-framed, separated by a central sheet of 100m x 30m used for packing and delivery.

The floor inside the two storage sheds is about 1 m. below the outside ground level and is hard surfaced to allow the passage of vehicles; these sheds are walled on the gable ends and sides by self-supporting reinforced concrete partitions heeled on the outside, independent of the supports of the building, about 9 m high, and divided transversely by partitions of the same kind, thus forming within each shed 4 silos each 25 x 20 x 9 m, 4,500 cu. metres of storage space. The storage capacity for super in each of the two sheds is thus about 4 x 4500 = 18,000 tons, or 36,000 tons for the two sheds together, and 8 different concentrations or varieties of super can be stored separately.

On the external side walls of these sheds gates are arranged so that, when the silo is almost empty, a bulldozer can be run down a ramp to shovel the rest of the super together in the middle and if desired to empty the silo completely.

In each of our storage sheds 20 m across the centre is left open without side partitions to house the fertiliser crushing and conditioning plant, as explained below.

For recovery of the fertiliser each of these storage sheds is provided with a gantry crane, details of which were given below, on rails about 12 m above the floor supported by the structural steel of the building. The roof of each of these storage sheds includes a lantern roof or gantry provided with a catwalk which will support a belt conveyor for inloading the fertiliser and also the rails for a transversely travelling tip-off carriage to facilitate feeding of the different silos. The flooring of the gantry is about 20 m. above the outside ground level, the roof ridge of the building being 25 metres high.

In the construction of these steel structure buildings, which are subject to constant vibrations because of the movement of the overhead cranes, the greatest precautions must be taken to ensure that the roof and lateral partitions are watertight and that there is adequate carrying-off of storm water.

The central area houses the fertiliser packing and loading unit, and is about 100 x 30 m. x 17 m. high at the ridge. The floor must be hard surfaced and connected with the outside road system in such a way as to permit the access and movement of vehicles of all sorts. This central area contains in addition two parallel rail tracks along the sides of the storage sheds, for bringing up wagons for loading. In the middle of this central shed, and placed symmetrically in relation to the transverse axis of the sheds, is a raised loading platform about 1 metre high and approximately 21 x 30 m. This platform is for the bagging and loading plant described later.

2. <u>EQUIPMENT</u>.

(a) <u>Loading in System.</u> For inloading the super, a rubber belt conver is located in the gantry of each shed discharging the fertiliser by means of a tip-off carriage to a transverse belt permitting accurate placing on the pile and the complete filling of the silos. This installation should be able to load either granular or powdered super, the latter having been pulverized directly after manufacture. The transport capacity should be calculated to match the super production, for example 20 tons per hour if production is continuous or more if it is not.

(b) <u>Recovery System.</u> Each storage shed is fitted with an overhead travelling crane with a grab with a lifting capacity of about 10 m. above the shed floor, and their bottom 2 m. or 1 m. above the floor of the platform occupying the centre part of the central shed.

These bins are provided, at various levels and in the direction of the larger transverse direction (6 m.), with arms fitted with scrapers. These arms can at need be caused to rotate, eliminating arches and facilitating flow of the product; the side walls of these bins can also be specially provided with a plastic lining in the lower parts to facilitate flow.

2 CONVEYOR BELTS, independent, for stocking these bins with ground super coming from the storage sheds. Using tip-off cariages these conveyors make it possible to store, in any bin, the material from any of the siloe in the storage sheds.

Each belt can carry 60 tons per hour.

Each of the conveyors is composed of an inclined part, between the storage shed and the upper part of the bins, running into a horizontal part, which meets the tip-off carriage above the bins. In its inclined part, the conveyor belt either takes the output from the elevator described above (crushed and screened), or it takes via a chute granular super directly from the distributor of the main grinding unit when running in reverse.

1 EXTRACTOR under each bin (8 extractors in all) in the direction of the larger transverse dimension (6 m.), removes the fertiliser at a regulated rate of 15 to 40 tons per hour. It is possible to run the extractor in reverse so as to enable the fertiliser to be brought out from either side of the line of bins.

1 FIXED RUBBER BELT CONVEYOR, on one of the sides of the row of bins, collects material removed by the extractors; this conveyor is reversible. Its carrying capacity is 40 tons per hour.

2 CONVEYORS to load the bulk product extending from the two ends of the collecting conveyor described above, and placed when in working position, to receive the fertiliser carried by it. These conveyors can be swung up and when raised should clear the top of the wagons on the adjacent line. When lowered, they should project into the inside of the wagon, through the main door, about 1 m. above the wagon floor.

Carrying capacity of each conveyor: 40 tons per hour.

EQUIPMENT for stowing the bulk fertiliser in the wagons, consisting of: - either a mobile spreader placed within the wagon to the right of the discharge of the above conveyor in the case of granular fertilisers.
- or a mobile conveyor belt with a short run (about 4 m.) in the case of powdered fertiliser.

In both cases, the position of the spreader or belt is reversed during the operation to ensure that both ends of the wagon are loaded.

2 WEIGHBRIDGES, each placed to the right of the loading conveyors described above, on the two railway tracks running each side of the loading platform. They can deal with the largest size of wagon used for loading of bulk super, and can weigh up to 50 tons.

4 ELEVATORS to take the fertiliser removed from the bins for bagging. These elevators are situated on the other side of the line of bins, and are of the vertical type. Each one is situated in line with the partition between 2 adjoining bins and can thus take, depending on the position of an inclined gate, the material

being emptied from either of the bins to which it is coupled.

The foot of these elevators is level with the floor of the platform, the head is about 3 m. higher and their length is about 6 m. Their carrying capacity, like that of the extractors, can reach 40 tons per hour.

Each of these elevators is provided with a fertiliser-sampling device at the top. This sampling apparatus is of the bucket-wheel type, and is driven by the elevator mechanism. The contents of the buckets are poured out and collected through a lateral chute, into a bag.

This apparatus must be regulated in such a way that the sampling occurs at the rate of 1:1000, or 40 Kg. per hour at the most.

4 INSTALLATIONS FOR BAGGING into open-mouth bags. They receive the fertiliser from the elevators described above.

Each of these consists essentially of:

- 2 small adjoining HOPPERS with a maximum capacity of 100 litres, whose common dividing wall is adjustable so as to divide into two portions, as equally as possible, the flow of material from the elevator.

- 2 HAND-OPERATED GATES (one on each hopper) releasing the fertiliser from the hopper in turn to the spouts of 2 scales on which are hung the bags to be filled (distance between the 2 scales: about 700 mm.)

4 SCALES of the decimal type, fixed to the floor of the platform, and having a spout specially designed to facilitate rapid hooking and unhooking of the open bags. These scales can take either jute or paper bags (100 Kg. or 50 Kg.) The spouts of these scales are lined with plastic material to enable the fertiliser to flow smoothly.

The system of 4 bagging installations thus ends up in a line of 4 x 4 = 16 scales, on which filling and weighing of the open bags is done manually for each kind or variety of super.

It should be mentioned that when 100 kg. bags are being filled, the extractor concerned is adjusted to work at 30 tons per hour, and the corresponding bagging line with its 4 scales should be able to bag and weigh at this speed. The use of 50 Kg. jute or paper bags will reduce this figure by about 50%.

Finally, the control panel for the whole sequence comprising extractor and elevator is situated on the centre line of each bagging installation. Stopping or re-starting can be done very easily by push-button by one of the two weighing operatives.

- 4 LOADING RAMPS for loading bagged super into lorries or railway wagons. These ramps, one for each of the bagging installations described above, are for loading the bags of super as the[y] are filled, into lorries or wagons, say at the rate of 30 tons per hour envisaged above for the 100 Kg. bags.

They are of the bag-hoist type, bringing the bagged super to the door of the lorry or wagon, at a height adjustable to the floor of the wagon or lorry, ideally at shoulder height for the loading operative standing in the wagon.

These loading ramps are carried on a trolley running on a track located in a pit which completely surrounds the four sides of the loading platform at a level about 40 cm. below that of the floor of the platform. The ramps can therefore move right along the edge of the loading platforms, in such a way that they can be dropped into the working position, perpendicularly to this edge, at any point along it. When moving from place to place they are in the raised position, to clear the maximum height of the vehicles alongside the platform.

The trolley carrying the loading ramp is also provided with a tip platform where the newly-filled bags are sewn before being swung up to the bag-hoist; when the ramp is in the working position, a simple mechanism causes the tip platform to rest on the bottom of the pit so that the upper platform is exactly at the level of the loading platform. The weighing device has a two-piece cradle, against which the newly-filled bags stand upright in a slightly inclined position: a dial weigher makes it possible to check, as each bag goes through, that its weight lies between two red marks corresponding to the tolerance allowed; bags whose weight is not within these limits are immediately returned for adjustment to the correct weight.

The open jute or paper bags are sewn and labelled by hand by an operator with a portable electric sewing machine capable, when used by a skilled worker, of sewing 300 bags per hour, or 30 tons if 100 Kg. bags are being used, i.e. the capacity required of the bagging and loading plant. The operator sits on a seat of adjustable height carried on the trolly and facing the weighing machine dial, and has at hand;

-on his right, a shelf on which he can place the machine and its accessories and on which there is a spare machine in case there is trouble with the one in use, and the special machine for stitching paper sacks;

-on his left, a box containing the packets of labels for the super which is being loaded.

After sewing the bag, the operator presses a pedal to release the cradle holding the bag, so that the latter falls over on to the base of the bag-hoist, which lifts it to the wagon, the cradle returning automatically to its first position ready for the next bag. Note that the bag must not remain on the weighing platform longer than 12 seconds if a rate of 30 tons per hour is to be maintained.

Finally, it should be added that as each bag goes over the hoist, its passage is recorded by a counter with large dial, visible to the loaders, weighers or sewing operators. The system is to return the counter each time a vehicle is finished loading, or even sometimes when, in the same vehicle, a given category of super is finished loading. This is of course to ensure a systematic check on the number of bags loaded.

BAGGING PLANTS FOR GRANULAR SUPER IN OPEN-MOUTH BAGS. These plants are placed on the side of the bins opposite the elevators taking the fertiliser to be bagged. Each serves 2 adjacent bins. Their number varies in accordance with the size of the deliveries of granular super envisaged.

Each plant comprises:

1 REDLER CONVEYOR, about 8 metres long, with a carrying capacity of 40 tons per hour, inclined along the plane of the dividing wall of the 2 bins in question. The conveyor takes the flow from either of the extractors servicing these two bins.

1 symmetrical DOUBLE HOPPER, fed by this Redler conveyor, of a total capacity of about 4 or 5 tons, under which are situated:

2 automatic weighing machines to weigh the fertiliser before bagging. These are of the type currently in successful use for cereals, and granular products in general. The weighing process is operated by push-button.

These weighing machines deal with a flow of 15 tons per hour each, or 30 tons in all when 100 Kg. bags are used.

Under each of these weighing machines, and in one piece with the frame work of the hopper is:

1 supporting clamp to hold the bag whilst it is filled with the pre-weighed charge.

To operate the plant, the working of the Redler and of the extractor supplying the hopper must be capable of being automatically stopped or restarted, according to the load of material in the hopper, so that the head of material above the weighing machines remains constant.

The sewing and loading of the bags thus filled are, of course, carried out by means of the loading ramps described above.

BAGGING PLANTS for granular super in 50 kg. valved bags. These machines, which vary in number depending on the size of the consignments envisaged, are placed parallel to the above machines and, like them, consist of a Redler feeding a triple hopper on which there are 3 valve filling machines, each with a stand for bagging and weighing 50 Kg. valve bags at the rate of 10 tons per hour each, or 30 tons for all three. One worker places the bags for filling on each of the 3 spouts, and 2 workers take the full bags and stow them on the platform of a handtruck in one-ton loads which a third worker pushes direct to the door of the wagon or lorry, without the use of the loading ramps, described above.

Inside the vehicle, 3 workers are required to stow the load and empty the handtruck.

Note that 2 trucks are needed, one for loading at the base of the bagging machines and the other for unloading into the vehicle.

III. WORKING CONDITIONS IN THE UNIT AS A WHOLE

1. The staff required to work the unit at the maximum rate of 800 tons per day is made up as follows:

1 Head of the Despatch Department) On monthly basis: not
1 Despatch Foreman) included in figures of workmen staff

6 Skilled workers in the storage sheds: (3 per shed : 1 overhead-crane driver
1 supervising the grinding and screening machines
1 assistant on the mechanical shovel

36 workmen forming the 4 loading teams of 9 men each, each team including 4 skilled workmen (2 weighers, 1 sewing operator, 1 team leader) and 5 labourers (2 trolley pushers and 3 loaders in the wagons or lorries).
1 unskilled worker to bring the bags to the bagging points with an auto-truck shuttling between the bag-making shop and loading platform.

the outgoing train, and are replaced by empty wagons for the next period.

The lorries for loading stop at the right of one of the two platforms provided, depending on whether they are to carry powdered super in open bags, or granular super. Each of the loading platforms can receive 6 lorries: in principle a lorry should be loaded, from beginning to end, without having to change its position, and one naturally always endeavours to stand the vehicle to the right of that bagging unit which is dealing with the particular concentration of super which it is desired to load, or at least with the concentration forming the main part of the load.
The Head of the Despatch Department, after setting up his programme of work for the following day, will give all necessary instructions to:

(a) The two supervisors of the grinding units in the storage sheds, who will ensure that the various bins on the loading platforms are stocked at the desired rate with the various concentrations and qualities of super.

(b) The forewoman in charge of bag making, to prepare containers, labels, etc. To be on the safe side, the quantities of super, ground or ready for consignment, and of the various concentrations, should at the end of each working period be sufficient to cover the packaging and consignment needs of the following period, namely about 400 tons in the case under consideration: it is only at the end of the week or immediately before a holiday that the bins can be allowed to be almost empty.

The use of these bins for the different concentrations or varieties of super obviously depends on the daily programme; in theory the different bins are each reserved for different concentrations or varieties of super, but their use in practice varies, depending on the amounts of this or that concentration or variety to be despatched: the essential point is that the packaging and loading of any concentration should be carried out, even if it represents only an infinitesimal part of the tonnage dealt with during the day.

This having been said, the optimum productivity of this installation will be attained when a certain number of simple rules are as far as possible followed:

- load simultaneously, on each of the loading tracks, a number of wagons related to the number of teams (for example, 2 wagons on each of the 2 tracks, where 4 teams are used, as with us);

- in disposing the wagons in accordance with the delivery notes, arrange for each of them to receive tonnages which will take approximately equal times to load, bearing in mind especially the conditioning required, the aim being to move on, by one single operation after loading, the 2 wagons on each of the two tracks and to replace them by 2 fresh ones, without holding-up the work of any of the teams;

- Assuming that the 4 teams are engaged in loading railway wagons and that a lorry unexpectedly arrives for loading, it will be loaded by the team which is bagging the concentration required for it, in principle immediately after the currently loading wagon is dealt with, provided this does not keep the lorry waiting more than half an hour; otherwise the lorry is loaded straight away, the loading of the wagon being interrupted: the number of bags stowed in the wagon having previously been carefully noted in view of resumption;

- if the demand for lorry deliveries is predominant, wagon loading will be kept back for quiet periods in lorry loading, the lorries being loaded without interruption in the order of their arrival, at the average rate of 4 x 25 tons = 100 tons per hour or, for example, 10 ten-ton lorries per hour.

The positioning of the lorries along the loading platforms will be arranged by the despatch foreman, bearing in mind particularly the concentration and variety of super required, the rule being that once the vehicle is in position it should, without further movement, take on all its load, whatever the concentration and packing, and in the order required by the lorryman (except in our particular case of granular super in valved bags).

If we add that, by reason of the arrangement of the whole plant as described above, the loading of every vehicle (wagon or lorry) will be automatically checked since:

- the number of samples taken is equal to the number of concentrations of super,

- the weight of all loaded bags is checked before they enter the wagon,

- the number of bags loaded with each quality is automatically counted,

- and the operations are carried out with the maximum speed and without excessive delay for the lorrymen,

we believe that we may conclude that the aim which we had in view and which we recalled at the beginning of this section, is achieved the more surely since we have made the operations of recovery from store and screening, where there is always a risk of stoppages, practically independent of those of bagging and loading, and this while avoiding building-up a stock of previously bagged merchandise for later loading.

IV. CONCLUSION

The criticism will certainly be made to the solution proposed that there is the risk of loss of time on the part of the staff composing the loading teams, since it is laid down that they shall carry out bagging of the super only when the transport to move it away is at its loading position. In fact, time is lost only by the staff engaged in packaging and, on the other hand, we economise on the labour of taking up and moving around of a bagged stock prepared in advance. We have every reason to believe that the average productivity of the whole of the operation is improved, provided of course that the total tonnage to be moved during an 8-hour day composed of two working periods is approximately regularly distributed over this period. If, for example, 800 tons had to be loaded onto lorries in the 4 hours of the second work period, the arrangement proposed would not be satisfactory, since it would be necessary to build up a stock of 400 tons of bagged merchandise in the 4 morning hours and to ensure during the afternoon that this stock was taken out, concurrently with the bagging and loading of a similar tonnage. However, we believe that, in practice, the problem of superphosphate delivery does not take this form, bearing in mind in particular the greater flexibility in loading the wagons.

The criticism will also be made that the average yield from labour reached with this installation will not be very much greater than that found in practice in factories of similar size and output. In actual fact, we estimate from our own experience

6 tons. The grab is of a special form to facilitate penetration into the fertiliser to be removed, and its usable capacity is 3000 litres, or about 3 tons of super. The crane is capable of rapid manoeuvre, and with an average carrying distance of 30 metres, it can carry out 20 operations per hour (one every 3 minutes or 60 tons/hour).

In addition, provision is made for a mechanical shovel to assist in the recovery, as it is able to penetrate into partly empty compartments.

(c) Crushing and Screening Equipment. (See the general sketch No. 2, attached)

This equipment is placed in each store, in the centre bay not used for storage. It consists essentially of:

1 LARGE HOPPER to receive the contents of the grab on the excavating crane, and of a capacity of at least 9 tons (3 operations of the crane). The upper level of the hopper should be about 10 metres above the outside ground level. Its walls are provided with a hammer system to ensure its complete and rapid emptying, without manual intervention, when the type of super is changed and, consequently, to come into action only at that moment.

1 DISTRIBUTOR covered and fed by the above hopper and consisting of a Conveyor with side struts about 1 m. 20 cm. wide. The flow from this distributor should be regulated, by a gate, to about 60 tons per hour, with a mean accuracy of 10%. Finally, the distributor should be reversible, depending on whether it is distributing powdered or granular super.

1 DISINTEGRATOR to treat the powdered super. It is placed under the outlet of the distributor. It consists of a single disc rotating in a horizontal plane around a vertical axis located below the conical hopper for the unground product, and appropriately shaped to avoid projections. It should be possible to carry out disintegration correctly at the rate of 60 tons per hour, given super of normal consistency, with a disc of diameter 1m. 70 cm. and 170 rotations a minute.

To pass along granular super which does not require breaking, the distributor is put into reverse to direct the material towards the Conveyor removing the final product.

1 INTERIOR HOPPER, with the shape of a truncated V, placed beneath the disc to guide the ground product onto the upper part of the screening system. A powerful hammer system is needed here too to deal with stoppages as soon as they occur, and at all changes of concentrations.

1 SCREENING SYSTEM for the ground product, consisting of a number of shaker screens or inclined vibrating screens with either square 5 mm. mesh of non-corroding steel, giving openings of 4 mm. x 4 mm., or rectangular mesh giving openings of 9 mm. x 4 mm., the larger dimension being disposed horizontally. It will be remembered that the admissible particle size of the finished product is not greater than 4 mm. diameter. In order to give satisfactory output with a flow from the crusher of 60 tons per hour, the screening surface must be fairly large (at least 6 sq. m.); it may be composed of several removable units, easily inspected and replaced. There is a danger that the rate may be greatly affected by blinding of the screens, and provision must be made for this by systematic clearing and replacement by clean screens after each period of work, ideally every day. Special tools should be provided for the rapid and complete clearing of these screen units, which obviously must be done outside the actual machine.

1 CRUSHER for oversize particles, fed by a vibrating conveyor from the screens. This crusher is of the type described above but with two discs rotating in opposite directions and of smaller diameter (about 1 m.). It should be able to deal with up to 20 tons per hour of large tailings from the screening process.

1 ELEVATOR for the crushed tailings, with a carrying capacity of 20 tons per hour. It receives the material leaving the tailings crusher, raising it into the hopper situated above the first grinder, where it mixes with the super proceeding to the first grinding.

1 COLLECTING HOPPER for the finished product, receiving the material passing the screens, as airtight as possible, of a truncated V shape and hammered all the time to eliminate choking and to facilitate the flow of the product.

1 COLLECTOR for the finished product, consisting of a rubber belt below the collecting hopper, conveying the crushed and screened fertiliser to the foot of an elevator placed near the wall of the storage shed adjacent to the central shed: belt capacity is 60 tons per hour.

1 ELEVATOR for the finished product, with a carrying capacity of 60 tons per hour, which raises the fertiliser to the height required for it to feed the equipment which finally discharges it into the storage silos.

Note that the top of this elevator must be at a lower level than that of the track of the overhead travelling crane, in order not to obstruct the latter's movement.

1 MACHINE FOR CORRECTING OR REDUCING CONCENTRATION of super, consisting essentially of a hopper independent of the machinery described above, placed towards the centre of the shed and ending in a cylindrical-conical part above a turning-disc distributor. This hopper is to receive the material used to reduce concentration (sand, chalk or other substance with a maximum moisture content of 5%).

This machine must be able to effect reductions of up to 6% in concentration, and should therefore be capable of a flow of 3 to 4 tons per hour with satisfactory accuracy. The supply of the additive to the hopper is carried out by means of the overhead travelling crane with a semi-open grab, from a store situated on the floor of the outer side of the shed, to the right of the grinding and screening unit. A system must be provided for instant checking on the regularity of the flow from this machine. The additive is chuted towards the centre of the main crusher of this unit.

The mechanism of the distributing disc must be independent of that of the crushing unit, and when the concentration is to be reduced or corrected, it must work with the main distributor, and be stopped automatically when the upper hopper is empty.

(d) Equipment for Conditioning and Loading Superphosphate
(See diagram No. 3 attached)

This equipment consists essentially of: - a series of 8 adjacent METAL BINS (one for each silo in the storage shed), of a capacity of about 100 tons of fertiliser each, standing upright along the transverse axis of the central shed.

Each of these bins is of a horizontal rectangular section of about 6 m. x 2m. and is V-shaped at the bottom: their top is

3 female workers including a forewoman (skilled worker) occupied solely in making the bags;
or a total of 45 workmen and women, of whom 23 are skilled.

It is assumed in the following paragraphs that the 23 skilled workers by means of their qualification, make up the permanent staff of the factory, working throughout the year and supplemented as required by unskilled labourers recruited from outside the works and bringing the total up to 45 at peak periods of despatch.

The 23 skilled workers forming the nucleus should be largely interchangeable among the different jobs in the unit and should in particular be able to carry out the processes of moving and loading the super.

2. A study will now be made of the variations required in the staff for working the factory, depending on the tempo of the work.

In the following table the first column shows, for each month of the year, the total tonnage to be despatched. Dividing this number by 25 gives us the daily rate to be maintained (column 2). The total of the monthly shipments is of course the 100,000 tons a year aimed at. The tonnages given for each month represent the demand, during a recent year, at a number of factories, and they give a representative picture of the seasonal variations in despatch of super in France.

The third column gives the number of bagging and loading teams needed to meet the planned daily tonnage, bearing in mind that one team can carry out the loading of 8 x 25 tons = 200 tons/day and that the number of teams needed is increased by any excess tonnage (for example, if the daily tonnage required is between 200 and 400 tons, say 350 tons, we shall show 2 teams).

The fourth column shows the number of workers needed for each month. It is calculated by multiplying the number of teams by 9 and adding the personnel required in the other parts of the works; when the number thus obtained is less than 23, the number of permanent staff, the figure 23 is entered.

Column 5 gives, for each month, the number of man-hours used in the production and consignment of super)obtained by multiplying the number of workers in column 4 by 200 hours (25 8-hour days).

In the 6th. column the relationship between output and time is given for each month in terms of hours per ton of super despatched. The average time per ton for the year is given at the bottom of this column:

Month	1 Tonnage despatched per/month	2 Mean daily tonnage despatched	3 No. of teams required	4 No. of staff needed	5 Man hours worked	6 Hours per ton
January	11,000 t.	440 t.	3	36 units	7,200 h.	0.65h.
February	14,000 t.	560 t.	3	36 "	7,200 "	0.51"
March	16,000 t.	640 t.	4	45 "	9,000 "	0.56"
April	6,000 t.	240 t.	2	25 "	5,000 "	0.83"
May	4,500 t.	180 t.	1	23 "	4,600 "	1.02"
June	4,500 t.	180 t.	1	23 "	4,600 "	1.02"
July	3,500 t.	140 t.	1	23 "	4,600 "	1.31"
August	6,500 t.	260 t.	2	25 "	5,000 "	0.77"
September	8,000 t.	320 t.	2	25 "	5,000 "	0.63
October	11,000 t.	440 t.	3	36 "	7,200 "	0.65"
November	7,000 t.	280 t.	2	25 "	5,000 "	0.71"
December	8,000 t.	320 t.	2	25 "	5,000 "	0.62"
	100,000 t.				69,400	0.694h./tons.

It might appear surprising, on looking at this table, to see that the maximum staff, 45, is needed only for one month (March) and this to ensure a daily throughput of 640 tons of super, which is less than the envisaged maximum of 800 tons. But in fact, demand conditions can require the consignment on certain days during the month, of 800 tons, making the extra staff necessary.

Also to be noted is the lower productivity per hour of the off-season (May, June, July). The permanent staff here is obviously under-employed. The production per hour is improved by giving leave during this period to a proportion of this staff.

We shall return in the conclusion to the average output per hour, which is about 0.70 hours per ton of super delivered, on the basis of the unskilled labour used.

It should be noted in passing that production per hour averaged over the year is considerably higher than that obtained by simply adding the times allowed for each part of the operation, namely:

Recovery of super from store, grinding, screening and putting into bins: 50 tons/hour with a team of 3 men	0.06 hr/t.
Bagging and loading: 25 tons/hours with 1 team of 9 men	0.36 hr/t.
Other staff: 3 for 25 tons/hour	0.08 hr/t.
Total	0.50 hr/t.

The discrepancy arises from an imperfect utilisation of the shop staff, caused partly by the need to retain a permanent minimum of staff and party by the unavoidable variations in the consignment tempo, in view of which it is necessary always to have sufficient staff to meet the peak traffic.

3. It remains now to show how an organisation of this kind can in practice meet all demands for super up the the maximum of 800 tons per day, in 100 Kg bags, keeping normal working hours under the best conditions of labour costs, speed and control of working.

Let us therefore take the extreme case of 4 bagging and loading teams that of the month of March in the table above, and a target of 800 tons per day.

The Head of the Despatch Department will arrange, each day, his work programme for the next day, on the basis of the super delivery notes due for execution in accordance with their degree of urgency, up to a limit of 800 tons.

He presents, in good time, his request for the rolling stock needed (after deducting the tonnage - if any - to be delivered by lorry) to the appropriate department of the factory, which will make it available as follows:-

About an hour before the beginning of each working period, i.e. twice a day, the factory's Transport Department places on the two loading tracks the number of empty wagons required for that period's work (for example, 10-20 ton wagons on each track, or a total of 20 wagons needed to load the 400 tons envisaged for this period) the head of the line of empty wagons being placed within reach of the capstan, so that they can be moved up, in groups of 2, for example, for loading at the point selected, and then moved on when this operation is completed. All these manoeuvres at the capstan are carried out by the loading teams without the use of any other source of traction: at the end of each working period, the two lines of wagons loaded during this period are removed by the factory's Transport Department to make up that the gain on labour is about 33%; this means that on the average 1.05 hours of labour per ton of product are used in recovery from store, conditioning, bagging and loading in our present workshops, as against not more than 0.70 hours with the proposed installation and as calculated in section 2 above. While by no means negligible, a gain of this size on labour may be considered rather small to justify remodelling existing installations. Such things are best left to the individual to form his own judgement.

For our part, we consider that the essential and great advantage which can be expected from the proposed plant resides fundamentally in the great flexibility and ease which it brings to the problem of despatching super in a large factory faced with very variable demand from its customers, a demand which it can meet with a smaller working staff composed basically of permanent, skilled workers. In particular, export shipments of super can be carried out at the rapid rate often required in this kind of operation.

It is however striking to observe how great a proportion of the costs of Super Factories is due to the cost of the labour used in the recovery from store and the shipping of super; it represents, on the average, one third of total labour costs in a superphosphate factory manufacturing its sulphuric acid from pyrites. It is always very much higher than the cost of equivalent bagging and loading operations in a similar industry, such as the cement industry which does however deliver its product almost solely in 50 kg bags. This is obviously in part due to the fact that the cement is stored in silos, whereas the super is in the heap, requires breaking up before bagging, and lends itself less well than cement to the operations of bagging in valved bags. However, it must also be said, that no progress will be made in this respect until such time as our industry, taking an example from numerous others, the cement industry for example, imposes upon its customers the delivery of superphosphate in a standard package, which is far from being a reality today, at any rate in our country. Here again, technical progress will come only from standardisation.

We have of course borne in mind, in our study of the solution suggested for the problem of superphosphate deliveries, the practical conditions under which these deliveries are demanded, in France at least; the large proportion, varying from day to day, shipped in lorries; the practice of including different concentrations in the same load; the variety of packagings, sometimes provided by the client, etc. Further, we followed the rule in this study, of considering only installations or plant of which we had industrial experience, except in certain matters of arrangement which could present no serious risks to us; the resulting bagging and loading times can be considered very probable ones.

But we understand that, in the not very distant future there will appear on the market high-output machines for bagging super in valved bags, be fed by vibrating hoppers and equipped with very accurate automatic weighing devices. If, as we are told, all the qualities and varieties of super can be handled by this machine, and if also the standardisation of packaging has been accepted by that time, we shall not be very far removed from the working and productivity conditions of cement factories. While retaining the general framework described in this study, such a machine could easily be installed at the end of the elevators fed by the bin extractors, together with a conveyor receiving the bags ejected by the machine and carrying them to the foot of the loading ramps on the vehicle. If the machine can turn out 30 tons per hour planned for each team, then this quantity could be handled by the man in charge of the machine, 3 loaders in the wagon and the team leader, or 4 workers instead of 9 as in the proposed solution; and the production per man hour would be increased by more than 50%.

We expect the technical progress described here to become a reality in the months to come, and we believe that it would be interesting and profitable for all if, at each of our meetings, one of our colleagues were to describe, in a paper on this subject, the results recorded in this part of our profession.

P. CAMBAU.

P.S. - The present study covers the problems of storing the despatching superphosphate. We think we should stress, however, that the plant suggested would be perfectly well adapted to the solution of the same problem in a mixed super and compound-fertiliser factory, so long as these fertilisers did not require to be stored in conditioned premises.