MATERIAL HANDLING AND SUPPLY CHAIN MANAGEMENT IN FERTILIZER PRODUCTION – A CASE STUDY

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ABSTRACT
The fertilizer bagging line operation for packaging and conveying to the final delivery trucks was a source of problem for one fertilizer producer referred to here as Company "N". This resulted in frequent maintenance activities from constant machine breakdown, loss of production, and the attendant loss in plant revenue. To overcome this, a technical study was conducted to address the problem. Plant site visit and technical inspection revealed the breakdowns were primarily due to fertilizer granules being trapped on the packaging/bagging conveyors, and as a result of fast acidic corrosion causing rust and eventual seizures of the conveyor rollers and lines. The resistances to free roller movement induce a drag load on the drive motors, with the additional loading causing failures of the electronic control sensors and stoppages. The unreliability of the bagging operations in the unplanned, repeated start-stop sequence in the packaging operation also led to safety concerns, with a few incidences of injuries being recorded. The engineered solution is presented in this report.

I. INTRODUCTION

Company "N" was set up to meet the fertilizer demands of local farmers, and also to utilize the excess gas resources of the country. The products of the Company are Ammonia, Urea and NPK fertilizers. Ammonia is the major raw material in the production of Urea and NPK fertilizers. Expected total daily production of Urea and NPK type fertilizers without machine breakdown and no loss of time on the part of the bagging personnel, for three shifts (8 working hours per shift), in the bagging/material handling section of the Company "N", is about 1500 tons for its eight bagging lines (four each for Urea and NPK type bagging).[1] This is operationally managed into six production/packaging line units (three each for Urea and NPK); with one stand-by each. However, due to frequent maintenance activities from bagging machine breakdowns, and improper orientation (in form of training) on the part of the packaging line/bagging personnel (often hourly paid contract staff), the bagging target was never achieved. This was a huge loss in revenue to the company and source of worry to the government Agricultural Ministry in meeting annual farming plans and targets.

The bagging lines had teething installation challenges before final commissioning. [2] Bagging personnel were often recruited on contract basis and immediately engaged in active packaging of fertilizers, without proper orientation and training. Plant maintenance crew gangs often had other responsibilities in other plant sections and unable to give full attention to the increasing bagging machine line breakdowns.

In the sections that follow is a brief description of the fertilizer packaging line operation - Fig. (1); the identified machine problem source points, and the preventive and corrective maintenance actions required.

II. THE BAGGING/PACKAGING OPERATION OF COMPANY "N"

A typical bagging line arrangement consists of: (1) an in-feeder chute (provided with bag clamp and sensor, and pneumatic operation), where the bag is fed with the material (either Urea or NPK) to be bagged. (2) The bags when loaded with the product (50 kg quantity of product), then drops on to a slate/wooden conveyor, which conveys the bag to, (3) the sealing machine unit for the sealing of the

inner bag (polythene – protection against moisture), and (4) then conveyed on to the sewing machine for sewing of the jute type bag, from where it is, (5) conveyed on to the bag turner; it is (6) further conveyed on to the compressing unit, and finally on to, (7) the loading plate which is in a pallet form. A pallet contains twenty (20), 50 kilogram (kg) bags of product (Urea or NPK Fertilizers). (8) The Pallet is finally carried off the bagging machine by a forklift to the storage, awaiting the delivery trucks.

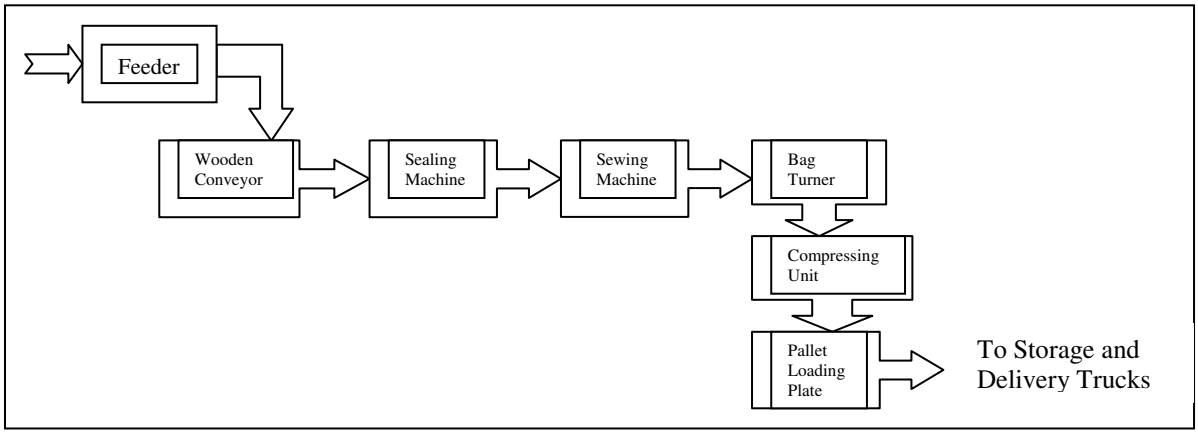

Fig.(1): Original Installed Fertilizer Bagging Line-to-Storage/Delivery Trucks

III. SOURCE OF MAINTENANCE PROBLEMS

Identified are two major problems. Machine associated problems, and the issues that affect worker productivity.

The greatest maintenance activities occur in the sealing machine unit, pallet pusher chain, sewing machine. A source of problem is fertilizer product granules being trapped at sections of the bagging machine unit. The acidic nature of fertilizer also has a deteriorating corrosive effect particularly on the pusher chain-links. The conveyor chain links slowly rust away, leading to complete fracture of chain parts, thus resulting in difficulty in conveying the bags since the broken ends of the chain link, hook on to the conveyor rail. The conveyor rollers are also affected.

Issues affecting worker productivity result from sluggish operational activities like work permit issuance delays, supervisory instructions time lag and prioritization in repair personnel allocation, delays in request for replacement spares from materials warehouse, resulting in the actual production time not exceeding 4 hours per shift. This implies an actual total production time of 12 hours for the three shifts.

The question then is, “can these production delays and lapses not be minimized to the barest or if possible, done away with completely. A careful study of the bagging techniques was conducted to find solutions.

IV. FINDING SOLUTIONS

The technical services engineering consultants in collaboration with the plant maintenance engineers and the final product distribution unit, made some modifications to the production-to-distribution supply chain in which they scrapped the sealing unit and entire palletizing units for six of the eight bagging lines (three each for Urea and NPK bagging lines.), and adopted a just-in-time [3] loading method since the breakdowns often result in the delivery trucks queuing for hours and in certain instances, days.

The reduced bagging/production-to-distribution chain activities carried out are:

1) Feeding the bag with the product;
2) Loading it on the wooden/slate conveyor;
3) Sewing the bag, conveying it on, and loading it straight on delivery trucks, or send for storage.

The modifications made to the original bagging line are shown in fig. (2).

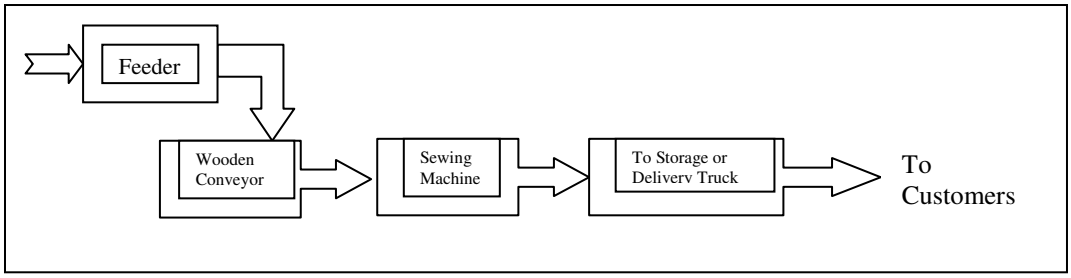

Fig. (2): Modified Fertilizer Bagging Line-to-Storage/Delivery Line

A preventive maintenance approach with an in house cleaning/routine maintenance to handle the corrosion problems in the conveyor chain links was adopted. Also, a general weekly maintenance on the entire lines is carried out on Sundays, since there is no bagging activity for that day. These weekly maintenance plans include, putting back to service out-of-use lines with new chain links which are often machined at the general service machine shop, to avoid delays in order delivery of out-of-stock Overseas re-order spare chain replacements. Old and worn conveyor rollers are also replaced during this period.

V. RESULTS AND DISCUSSIONS

These slight modifications, allowed for better just-in-time material flow [3] and increased the total production time to between six to seven hours per shift, with some lines recording no loss time due to breakdown, in a 24-hour continuous production period. The truck queues were completely reduced with slight queues only experienced in the weekend preceding the restart of production on Monday. It was observed that, the increased emphasis placed on safety, and proper training for bagging personnel also added to the improved productivity.

VI. CLOSING

Significant increase in the *life* of the machines and improvements in packaging line/bagging activity was achieved. *Life* here, referring to machine time spent in continuous packaging/bagging with fewer breakdowns. The changes to the original installed design made the packaging/bagging operation more manual but reliable and stable.

The study was unable to deduce if the problems were as a result of poor installation from onset, but it was suggested that in future expansion of the plant operation, designs for new bagging line units take into considerations the observations made, and modifications effected.

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