Best Practices For Copier And Paper Sheet Storages : A Case Study From TNPL

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ABSTRACT

Automated Storage and Retrieval systems (ASRS) are high-bay storages used for storing and retrieving products automatically with high in feed and out feed throughputs per hour. This technology carefully weaves in the hardware with software to insure quick and large transfers with error free and safe handling and delivery of the product. Due to mill expansions, industry as a whole is facing severe shortage of space. ASRS are being preferred in paper mills at their Finishing house and utilized with great success as an intermediate production buffers and finished products shipping storages. TNPL was at forefront in paper industry to implement Automated Storage and retrieval systems with advanced technology. With ASRS, TNPL effectively utilized the floor area through vertical stacking for 2000 MT Copier paper carton storage and 7500 MT Printing & Writing paper sheet bundles storages. ASRS paved way for handling of high through puts and prompt dispatches at TNPL. The implementation of ASRS have resulted in great space & cost savings with simplified but automated material handling around and integrated storages system all due to diligent use of modern technology.

Introduction

Material handling is the back bone of any Industry. However, there were days when Material handling, tracking and dispatch were taken for granted and considered purely as manual function and was getting least priority. Things have changed today with the advent of the state-of-art high speed Paper machines with high capacities. Eventually the Material handling and automation has now taken front seat due to higher volume and throughput handled, as beyond certain throughput, ASRS has become inevitable to avoid bottlenecks and to insure high efficiency and profitable operation of any Industry. This is true especially for Paper Industries where the production and throughput rates exceed 100 per hour.

Understanding the above aspect clearly, TNPL had carefully configured the automatic storage requirement and gone in for two ASRS which has inbuilt Warehouse management system enabling automatic tracking, handling, storage and retrieval system making it error free, safe and total quality system with enhanced throughput with approx. 10 to 15 days stock storage capacity. These systems compliment the main production and finishing facilites as well as take in to account the market fluctuations so as to cope up with the flexible storage and dispatch requirements.

The Need For Vertical Storage ASRS In TNPL

TNPL has gradually increased the production from 2,30,000 tpa in 2005 to 400,000 tpa of paper in 2011 with a break up of 200,000 MT reels, 100,000 MT sheets and 100,000 MT copiers. Copier is produced in the form of A4 sheets. The over all sheet to reel ratio would be 50:50. Due to progressive capacity build-up, TNPL faced HIGH THROUGHPUT situation in addition to shortage of space for storage.

Hence, the need for upgrading the finished goods facilities was necessary and vertical storage facility like ASRS is the only option that would give the following benefits:

- Nearly 3.3 times savings in floor space
- Multiple storages / retrieval and flexible high bay storage facilities.
- Retrieval of the product on First-in-First-out basis.
- Less manpower
- Higher rate of handling with mechanization with dedicated highly efficient automatic stacker cranes
- Uniform Product quality with minimum possible damage to the product during handling.
- Round the clock operations with very high uptime
- Maximum availability and 98 to 100 % reliability

An automatic warehouse management system with ASRS happened to be the only economical and practical solution and TNPL implemented in phases as follows:

Reels

The impact on the inventory of saleable paper during lean market seasons made it necessary to consider a much larger

overall warehousing capacity for about one month production. Accordingly, a new reel go-down was built for storing 12500 MT. However the foundations of the centralized go-down complex were so designed and cast to suitably modify the go-down into an ASRS for future storage volume needs.

Copier

A high-bay vertical storage semi-automatic storage and retrieval system for Copier for storing 4000 MT in 1600 sq.m area was considered. In PhaseI, an ASRS system with two cranes for storing about 2000 MT of copier was completed during 2007 using a floor area of 800 sq.m and vertical height of 17.3 meters. Typically, by using ASRS, 2.5 MT of material could be stored per sq.m of floor area, representing 3.3 times more than manual stacking. A provision is made in the layout for PhaseII construction of ASRS consisting of installing two more cranes at the same location in 800 sq.m area to increase the storage capacity form 2000 MT to 4000 MT.

Sheets

There are about 200 varieties of writing paper based on the GSM, customer need, dimension, weight etc as given below. These are identified through bar codes.

THE SUMMARY OF SHEETS SIZE, NO OF REAMS PER BUNDLE, BUNDLE WEIGHT AND HEIGHT OF BUNDLE IS GIVEN AS TABLE 1.

TABLE 1: The Summary Of Sheets Size, No of Reams Per Bundle, Bundle Weight and Height of Bundle.

GSM	Width in cm	Length in cm	Ream WT in kgs	No.of Ream per Bundle	Bundle wt in kgs	QTY in MT	Height in cm
47- 80	33.5 - 76	42-102	3.9-34.9	3-9	31.2-69.9	7500	9-34

To cater the above, an ASRS with automatic tracking features, surpassing conventional manual storage system addressing the rapid cycles/swings in the throughput was installed for sheet bundles stacking for a capacity of 7500 MT was built in 2010 at an area of 3400 sq.m

General Description Of The "ASRS" in TNPL

Copy Paper Carton Storage System

The system is designed for storing A4, A3 and folio size copier paper reams packed in cartons.

General System Specification

Racking system : Closed type Single deep
No. of Cranes : 2
Pallets : Re-usable steel reinforced plastic pallets
No. of pallet locations (Bins) : 2200
Weight of pallet with paper : 1000 Kgs (including pallet weight)
Storage Capacity : 2000 MT approximately
Qty received and stacked : approx. 20 MT per hour
Qty retrieved and delivered : approx. 40 MT per hour

Building size : 800 sq.m (73 meters (L) * 11 meters (W) * 17.3 meters (H))

LAYOUT & OVERALL VIEW OF COPIER STORAGE ARE GIVEN AS Fig. 1 & 2.
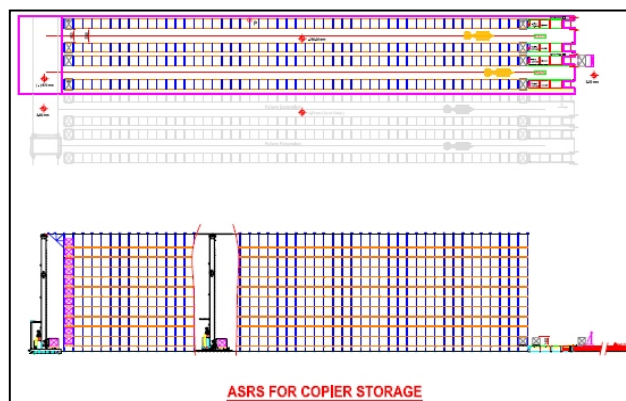
Fig. 1 LAYOUT OF COPIER STORAGE

Fig. 2 OVER VIEW OF COPIER STORAGE SYSTEM

Key Features

- Pallets are designed for cartons such that there is interlocking of cartons in different layers for stability and stack height.
- Two conveyors are used as input conveyor and two are used for Output conveyor.
- Each pallet has unique barcode label permanently fixed on the pallet for individual pallet identification by the system.
- A barcode scanner is fixed on each Input conveyor to scan the barcode label on the pallet while the pallet is moving on the conveyor.
- **Racking System** is a closed type Single deep storage system to store the material in pallets. The racking structure consists of vertical members (uprights) which are connected by horizontal members / diagonal members at regular intervals to form a bolted frame.
- Upright have an omega section with 9 bends which gives it immense rigidity and strength which is crucial for tall applications as ASRS.
- 2nos. of fully Automated Stacker Cranes are operating between the 2 aisles of the ASRS as shown in the layout enclosed herewith. Stacker Crane is customized automated fixed path equipment designed to carry pallets and store them in High Rise ASRS system. The Stacker Crane is guided on 2 rails, one at the bottom and one at the top.
- To communicate between the stacker Crane and the computer in the aisle, Infra-red communication devices are

provided, to facilitate wireless communication for real time transfer of data with the Warehouse Management System (WMS).

- WMS, the key element for the entire ASRS facilitates safety, efficiency and reliability, attributed to this sophisticated and intelligent warehousing system.
- The WMS consists of 3 main modules. viz:

  ❖ Inventory Control software
  ❖ Location Management Software Module
  ❖ Handling Control Software module

- The front end of WMS is Visual basic and back end is Oracle and interfacing software with TNPL's mill OIIS.

Typical Automated Operation Cycle

Command will be given from the PC in the office to perform either storing or retrieving operation. Following is the operation cycle and material flow

Typical Input Cycle

1. Among the empty pallets available in the staging area, one pallet will be chosen.
2. The cartons will be palletized manually onto this pallet in the various pre designed configurations.
3. The relevant information of the material such as type of paper (A4,A3,folio), GSM, Quantity, etc. will be entered in the Computer against the chosen pallet (each pallet has a unique identity)
4. Then the pallet will be kept on input conveyor with the forklift / hand pallet truck
5. Scanner fixed on the input conveyor reads the barcode and relates the pallet to the paper grade with data accessed from mill information system.
6. WMS allocates the pallet location based on grades and movement. The fast moving grades will be allotted to the front locations if required. This allotment of storage area is flexible and can be changed in the system depending on requirement.
7. Subsequently, barcode scanner sends the signal to the stacker crane through WMS to pick the pallet from input station.
8. Then, the Stacker Crane travels and picks the pallet from input station and stores it the location defined by the WMS.
9. After the pallet is stored, the pallet and the location are locked in the WMS.

Output Cycle

10. For retrieval operation, the operator will either enter pallet number / grade/ etc. to be retrieved in the computer.
11. The system identifies the location of the pallet / grade and shows on the computer.
12. After the operator gives the command from computer, the WMS gives the instructions to Stacker Crane to retrieve the pallet from the storage system.
13. The Stacker Crane retrieves the pallet and keeps on the output conveyor.
14. The pallet travels to the end of output conveyor where it will be picked by the forklift / hand pallet truck

Writing Paper Sheet Bundles Storage System

General System Specification

Racking system	:	Closed type Double deep
No. of Cranes	:	4
Pallets	:	Re-usable steel reinforced plastic pallets
No. of pallet locations (Bins)	:	6408
Weight of pallet with paper	:	1380 Kgs (including pallet weight)
Storage Capacity	:	7500 MT
Qty received and stacked	:	approx. 75 MT per hour
Qty retrieved and delivered	:	approx. 150 MT per hour
Building size	:	3400 sq.m (87 meters (L) * 39 meters (W) * 19 meters (H))

Layout

THE LAYOUT & OVERVIEW OF THE WRITING PAPER STORAGE SYSTEM ARE GIVEN AS Fig. 3 & 4.

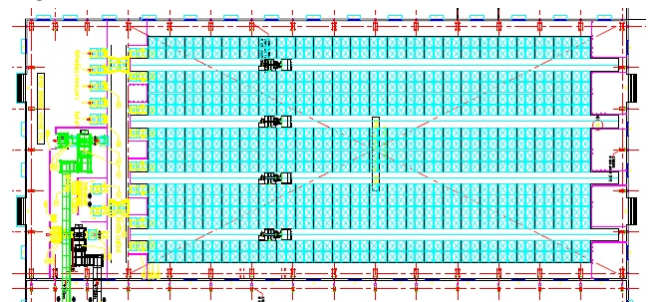Fig. 3 LAYOUT OF WRITING PAPER STORAGE SYSTEM

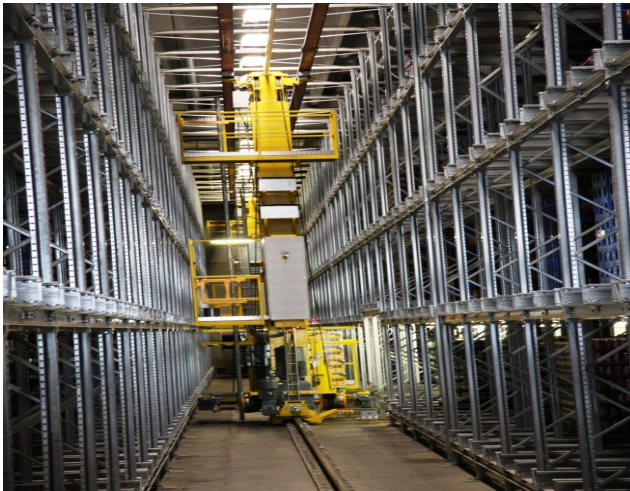

Fig. 4 OVERVIEW OF WRITING PAPER STORAGE SYSTEM

PICTURE OF HIGH SPEED TROLLEY TRACK IS GIVEN AS Fig. 6

SECTIONAL VIEW OF THE STORAGE SYSTEM IS GIVEN AS Fig. 7

Fig. 6 HIGH SPEED TROLLEY TRACK

Fig. 7 SECTIONAL VIEW WITH STACKER CRANE

Advance Scheduling Requiremnet

Automatic storage and retrieval systems perform with max efficiency when there is adequate advance planning done. At the same time the scheduling could also be done as it is and where it is basis on each morning based on the customer order and truck schedule though it is possible to plan in advance to improve the dispatch system. ASRS becomes a flexible tool depending on the market requirement and truck schedules to insure the required dispatches far quicker than floor storage and manual tracking system. Works on first in first out concept.

Key Features

– **Automatic palletizers**   Fully automatic in feeding / out feeding of pallets. Bundles are fed to palletizers through conveyors and bundle bar code is read automatically. The bundles are stacked on pallet as per loading pattern for different sizes. The WMS insures that the pallet is filled up full thus optimizing the operation without exceeding the boundary Keeping in view that there are different sizes and types of bundles the palletizing is worked out mathematically matching the number of bundles and their area over the available area on the pallets.
– **Conveyors**   Roller conveyors are used to move/feed bundles to palletizers. Whereas chain conveyors are used to move pallets.

PICTURE OF CONVEYORS FEEDING TO PALLETISER IS GIVEN IN Fig. 5

Fig. 5 CONVEYORS FEEDING THE PALLETIZER

Function : Moves boxes to pallet.

– **Transfer cars** The main function of transfer car is picking and delivering pallet from storage and palletizer. The transfer trolleys become the bridge between the manual handling side and automatic handling ASRS and are designed to cope up with the through put in addition to having the pallet configuration check device to avoid any projection of the bundles beyond the pallet which would not be fit for the storage in the ASRS.
– **Racking system** Racking structures are made from special rolled and roll form sections fabricated carefully so that the deflection are minimum and the modulus of rigidity is maximum.
– **Stacker cranes** - Double mast high speed stacker cranes are machines created for the automated storage of materials by automated movements, being able to travel the length of the aisles and elevate to the height of the warehouse. They store and retrieve material at great speed by driving and lifting simultaneously.

PICTURE SHOWING STACKER CRANE MMI IS GIVEN AS Fig. 8

– **PLC's, Wireless communication system** PLC's is main component of automation which receives and executes the tasks from WMS. Also exchange the data from stacker crane and transfer cars to WMS and Mill Computer System (MCS)
– **WMS server and clients**. WMS server is the heart of ASRS which generates task for PLC and based on PLC feedback keeps record of pallet location and status The main function of WMS to track pallet and bundle ID, Data exchange and integrated monitoring and troubleshooting and report generation
– **Warehouse Management System (WMS)**
WMS includes following software:
❖ Simatic WinCC7.0 SCADA
❖ Microsoft SQL server 2008
❖ Microsoft windows 2003 server standard edition R2

Fig. 8 STACKER CRANE MMI
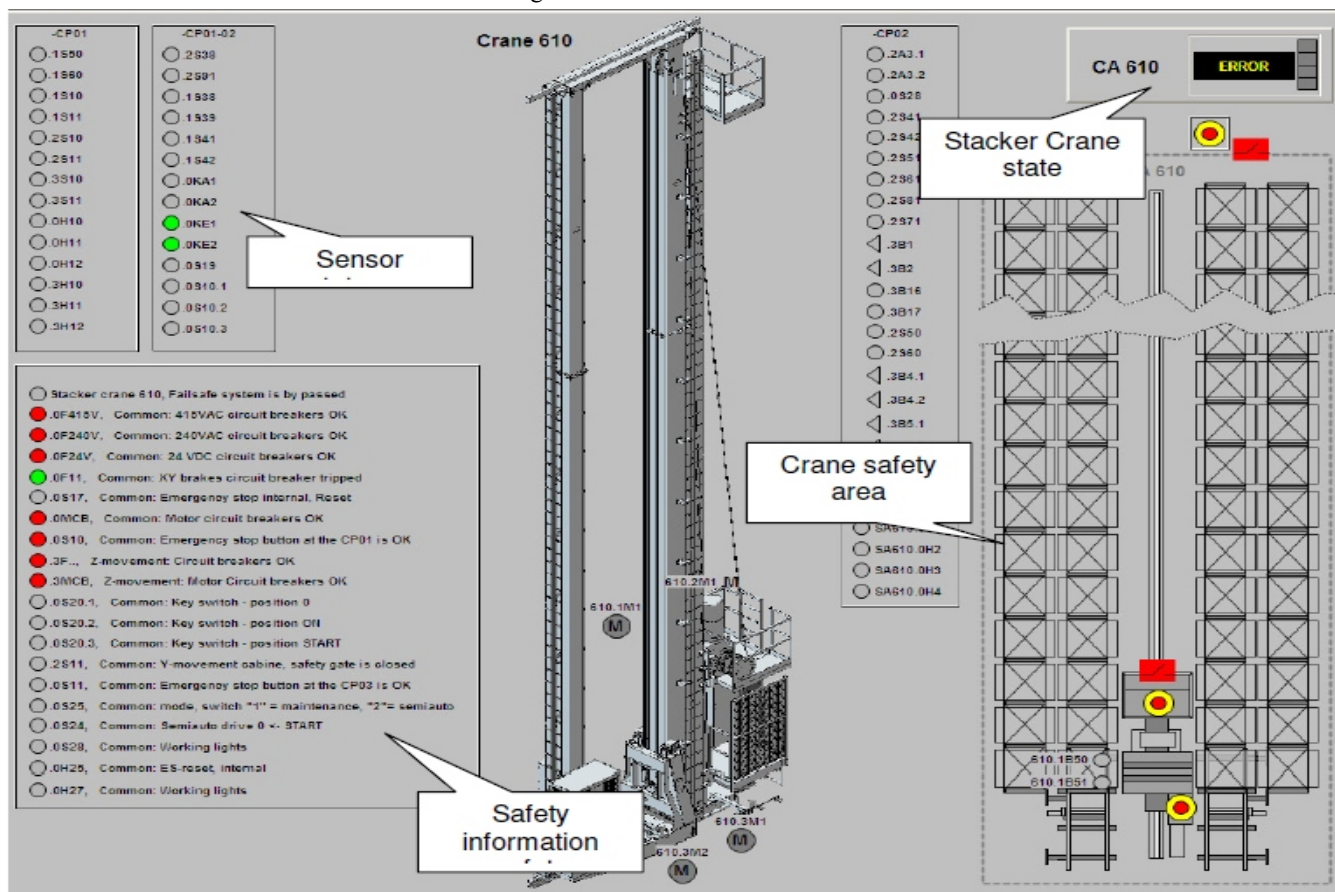
- Stacker crane drive speed up to 3,0 m/s, acceleration 0.5 m/s^2
- Stacker crane hoist speed up to 0,7 m/s, acceleration 0.5 m/s^2
- Telescopic fork / stacker crane loading capacity 3,000 kg
- Number of cycles/stacker crane according FEM 9.851 standard up to 40 c/h

Typical Automated Operation Cycle

Operator feeds the bundles through the infeed conveyor of palletizer and bar code scanner reads the bundle bar code in the beginning. After reading bar code label WMS fetches data of bundle from customer ERP system. Conveyor moves boxes to the palletizer. Palletizer stacks bundle on SRP pallets as per loading pattern for particular bundle size. When pallet is ready it will be moved to transfer car by chain conveyors. Pallet dimensions are checked by profile checker when it is being transported to transfer. If dimensions of pallet is not as per system requirement it will be rejected and sent to reject conveyor.

If pallet is accepted by system then transfer car delivers the pallets at infeeding conveyor of storage and stacker crane picks and stores pallet in racking position assigned by WMS.

For retrieving pallet from storage operator creates order for product to be retrieved. Based on order WMS generates tasks to retrieve the product and selects the item which was stored first. The stacker crane picks pallet from racking and delivers on outfeeding conveyor, transfer car picks the pallet and delivers on exit conveyor from where operator removes the pallet manually.

There are 4 aisles for the stacker cranes and there are four stacker cranes which pick up the in feed pallets from in feed conveyor and deliver the out feed pallets to the out feed conveyors. The stacker cranes are literally moving and lifting computers as they have the memory to track all the pallets handled by them based on the bar code to place them, reposition them and retrieve them based on the daily plan and program. Special task allotment could be in such a way that the crane in feeds the pallet and while returning is able to pick up the dispatch pallet to save time. This is possible due to optimization of the movements and enhancing the through put and efficiency.

Operational And Maintenance Limitations In ASRS

In an ASRS system, key equipments like high speed stacker cranes, double deep telescopic forks etc. and the racking system are the major equipments in the system that requires high degree of performance for operational stability and for optimal system performance. Key issues are:

➤ *Ensuring Beams and uprights deflections in the racking system are in accordance to the FEM standards.*
➤ *Limited racking clearances, demands high degree of safe*

working environment. Constant monitoring is essential to ensure that damages to the equipment and the product are not happening due to falling of finished product (Copier boxes/Sheet bundles) from the racking system.

➢ *Regular maintenance checks in mechanical parts including Input conveying system.*
➢ *Enhanced reliability in Control & Automation and Warehouse management systemensuring quick trouble shooting and diagnosis.*
➢ *To have online support with OEM to avoid software errors. Eg: Stacker crane data handling, false alerts during stacking and retrieval process, etc.,*
➢ *Annual Maintenance Contract with OEM to ensure system reliability and availability*
➢ *Ensuring dust free environment.*
➢ *Ensure working of smoke detection/ fire protection systems.*

Benefits of ASRS operations by TNPL

1) Saving in space is the primary benefit.
2) Assured safety and quality in operations.
3) Higher through put in feed/hour and out feed /hour
4) Automatic palletizing using kinematics rather than robots thus making the system easy to maintain and operate
5) Automatic storage and error free dispatch
6) Full freedom to store and retrieve according to the needs either with FIFO (First in First Out or LIFO (Last in First out).
7) Easy tracking
8) Quick dispatch possible
9) Ready inventory data
10) Better MIS
11) Part dispatch of the pallets and recycling the part pallets possible
12) Pallet configuration check at the trolleys before being loaded

13) Least deflection on the structures as per FEM norms
14) Stacker cranes effective as per FEM norms
15) Rejects of bundles at entry by tail gate system at in feed
16) Rejects of bundles at delivery end through loop conveyor possible
17) More safe operation as the whole area of ASRS is fenced and protected
18) Max efficiency with planned in feed and dispatches

Conclusion

High bay vertical storage systems have unmatched capacity with smallest storage foot print compared to other alternatives. In line with the saying "Less is more", ASRS with simplified layouts, have high operational efficiency. With limitless handling and sorting capacity, TNPL gained advantage in maximum storage capacities for COPIER & PAPER SHEET BUNDLES compared with other alternatives from the traditional storage systems.

ASRS is a boon and becoming inevitable part of Paper mills as it manages multiple grades/varieties, avoids material handling accidents, insuring highest turnovers of materials received and retrieved per hour, safe and reliable operations with modern Warehouse Management system which is manually unthinkable.

Acknowledgement

References

1. Mill experience in Implementation and operation of ASRS.
2. Contract specifications with M/s. Godrej Efacec Automation & Robotics Ltd & M/s. Pesmel Oy, Finland.