

OPTIMIZED AUTOMATION AND CENTRALIZED MILL DATA ACQUISITION TECHNIQUES FOR PAPER MAKING



Muralidhar Ekambaram

Abstract:

In order to have sustainable operations, many Small & Medium Paper mills have been seeking cost effective Automation and Centralized Management Information Systems for improving their operational productivity, achieving better machine efficiencies. The tremendous technological developments that have taken place in Instrumentation & Communication engineering facilitate simple but most performing automation solutions for many paper mill applications. This paper discusses many such technologies that meet the requirements exactly and how they are effectively employed. The paper includes brief details of specific applications and few case studies gainfully integrated in to mill operations mainly in the Paper machine & finishing sections. In addition to the above, the paper also discusses most modern real time data acquisition systems with simple - maintenance free communication technologies like GPS/ GPRS/ Radio modem etc. deployed for creating Centralized Real Time Mill Data base for fast & efficient decision making. The paper brings about many similar references of Data communication successfully employed in other industrial verticals like Cement, Mining, and Power etc. briefing the applications. Finally the paper concludes with financial returns that adaptation of such technologies bring to paper mill operations.

1. Introduction

Innovation & adaptation of manufacturing technologies were optional in earlier times which have now become essential to sustain operations and grow with minimum integration of newer technologies greater than 20%. Drawing management analogies of Innovations in any business - Core/ Adjacent/ Transformational innovations, technology adaptation plays critical role in any Paper mill growth. It is like Technology Replacements/ Retrofits/ Upgrades. Advancements in automation technologies – artificial intelligence, machine learning, communication engineering and robotics have ushered a new era of most efficient and highest speed manufacturing operations be it in any industrial vertical - Steel, Cement, Coal, Power and Paper or so. Automation of activities enable businesses improve performance, by reducing errors and improving quality, repeatability and speed, and achieving results that are far superior to human efforts. Automation has become a necessary constituent of any manufacturing process for ensuring business sustenance. World over industry have accepted that although less than 5% of total activities can be automated

100%, more than 30% of 60% of total industrial activities can be automated which poses tremendous work ahead. The effort of this paper is to identify few technologies, processes and activities in Paper making that can be automated with simple solutions as well as low cost methodologies for keeping electronic track of processes & activities and provide a factual real time information system for effective and correct decisions.

The five deciding factors for adaptation of automation techniques

- Achievability
- Implementation cost
- Tangible – intangible benefits
- Return on Investment
- Regulatory & Social compliance

Potential Automation Venues

- Repeated processes & actuations
- Machine / Process data analysis
- Remote Real Time Data Acquisition & Reporting

Few Simple machine/ process automation in Paper making & converting

The below listed applications are few good examples where the automation techniques can be deployed for achieving better & higher productivity, quality, reduced machine break downs and increased MTBF

- Computed hydraulic/ pneumatic or Direct load cell feedback based belt tensioning arrangement for mechanical transmissions where belts are employed as transmission elements especially for medium & high power installations
- Electronic Torque monitors for fixed speed Induction motor applications for safeguarding equipment as well as process controls
- Refiner controls through MIMO Controllers for Temperature, Consistency, Energy, Flow & Freeness
- Wire tension maintenance in Fourdrinier section & Tension controls on Press felts & drier screens through feedback based closed loop controls

- Nip load measurements & controls through Load cell deployment in Press & Calendar sections
- Tension – Nip – Torque Controls at Pope section in paper machine & Two drum winders
- Slitter position displays/ motorised Slitter positioning systems in two drum winders & sheeters
- Deployment of mechatronic subsystems like direct cutter servo drives, synchronised overlapping & lay boy sections in Sheeters
- Deployment of market available digital data loggers & integrating all the operations and machine status/ information in Central data base with real time stamping through various communication modes & protocols – hard wired/ optic fibre/ wireless as per ground situations.

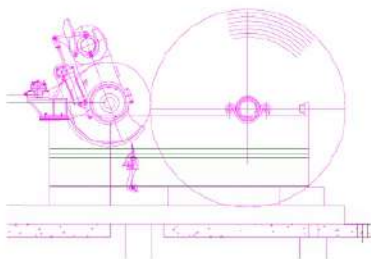
Developments in Sensors Technologies

Sensor technology too in parallel grew at rapid rate meeting with application demands, speeds, and accuracies and also incorporating all the advancements that are taking place in communication engineering and making the field sensors smart by themselves having sensing element, low power microprocessor and specific communication technology. These sensors are developed with high precision to suit harsh industrial environments with high demands for reliability. A smart sensor may also include a number of other components besides the primary sensor like transducers, amplifiers, excitation control, analogue filters etc.. A smart sensor also comes with associated software-defined elements that provide functions such as data conversion, digital processing and communication to external devices.

Few of presently available technologies are listed below:

- Adjustable Gap sensor/ Gap scan technology/ Force / Axial vibration sensors for Disc Refiners

Most common pope reel configurations -



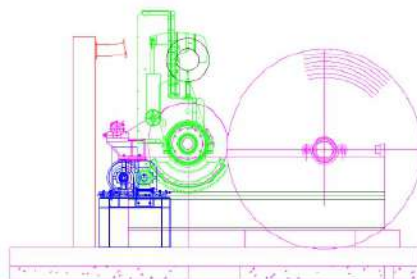
- Induction motors with electronic power monitors operating as Active Power sensors
- Belt tension monitors either by sound/ light measurements
- Magnetic Linear encoders/ LVDT for Paper reel diameter measurements in Pope & two drum winders
- Magnetic Line encoders for Slitter position displays/ Servo motorised Slitter positioning system in two drum winders & sheeters
- Inclination sensors for pope reel instantaneous diameter measurements for Tension & Nip controls
- Strain gauge/ LVDT based tension measuring load cells & allied amplifiers for Nip load & Paper tension measurements

All the above technologies have been developed suitable for harsh ambient conditions especially highly humid & dusty with high temperature prevalent in paper mills. Also excepting for few, most of the sensors have output configured to be in compliance with international communication protocols like RS 422/ RS 485/ RS 232 etc. to directly interface with PCs or PLCs for further processing of data & final controls.

Benefits from adaptation State of Art Sensor & Closed loop automation technologies in Mill operations

- 1) Improved paper formation and achieving desired quality consistently
- 2) Higher productivity & lesser paper breaks in machine
- 3) Proactive equipment safeguards
- 4) Fastest corrective/ compensative responses
- 5) Timely alerts on extreme operative situations
- 6) Lesser broke generation & reduced reconversion cost
- 7) Achieving highest industrial safety standards

Recommended upgrade with automation



Techno- Commercial study on a potential example

I. Pope upgrade:

Typical Upgrade details

- Primary arm replaced with alternative mechanical configuration
- Primary arm hook actuation through new hydraulics with proportional hydraulic elements
- Secondary arm actuators – Existing Pneumatic/ Hydraulic may be retained
- Introduction of reel spool starter
- Primary arm rotation through new brake mounted motor transmission
- Introduction of field sensors – Proximity, Angle, Reel diameter etc. sensors
- Introduction of Pope safety, sequential & proportional logic PLC controls

Benefits assured

- Consistent flush reeling from reel spool diameter to full roll
- Broke due to primary arm reeling reduced to approx. 5 ks from the present industry average of 40 – 60 kg per jumbo
- Tension & Nip are controlled throughout reeling for better runnability at winder
- Adaptation of Reel change over Automatic/ Easy Manual possible
- No water sprinkling during re-reeling after paper breaks
- Ejection reel spool at any diameter possible
- ROI expected within 8 – 12 months

Case Study - Two Drum Winder - Upgrade on a II hand equipment

The winder was II hand of Voith make with 4.8 mtr/ 1200 nmpm capability. The winder had DC motors with old analogue drives & yesteryear PLCs for automation. The equipment was inducted in to operation for processing kraft paper of 120 gsm to 300 gsm with parent roll width of 4.55 mtr & diameter of 2.3 mtrs. The upgrade was carried out as below:

- Individual Digital DC drives for both the drums of 200 kW each
- State of art – latest origin PLC for automation

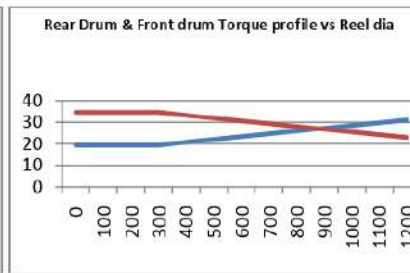
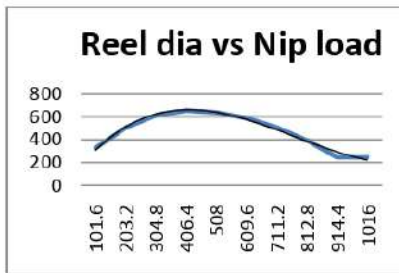
- Diameter computation based Digital tension control with GD2 compensation, stall tension, crawl tension & momentum compensation etc. features
- 1.2 mtr long Magnetic Linear encoder for instantaneous daughter reel diameter measurement
- Electro - Pneumo-Hydraulic nip relieving controls based on daughter reel instantaneous diameter
- Differential Drum Torque control for achieving TNT winding
- Lowered daughter reel diameters due to non flush cut reeling
- Non acceptance of finished reels in export markets

Performance post upgrade:

- Near zero paper breaks
- Perfect conveyance of paper to slitting & winding sections due to controlled tension on paper
- Easy separation of adjacent daughter reels without effort
- Near ideal winder performances during acceleration, deceleration and speeds up to 1000 – 1200 mpm.
- Daughter reel diameters built perfectly up to 1200 mm
- Export quality achieved

Performance prior to upgrade:

- Paper breaks of 2 to 3 per set
- Paper wandering & adjacent reel interleaving
- Max. Line speeds up to approx. 500 mpm



Highlight of the project

- 1) The successful practical implementation of theoretical Nip load & differential torque values through mathematical modelling & linearization was the main highlight of the project making it possible to commission the upgrade as per time scheduled
- 2) Adaptation of dust & moisture proof magnetic linear encoder for daughter reel dia measurement which form the central fulcrum of trouble free computation & controlling of Nip relief & differential drum torque.

Communication technology

In the previous chapters, how few of the machine and process parameters are acquired and actuations are locally controlled with local intelligence effectively for smooth plant operations. However it is necessary to have single point centralized “Management Information System” integrating all the information collected on “Real Time” basis for quick & effective decisions. For this an aptly fast communication for data transfer becomes need of the hour especially with various sections of mill operations are farther from each other making hard wiring and maintenance a tedious & laborious task.

The explosion in digital communication technology had been fuelling the technological developments at a fast pace for automation & information techniques all around the world in all the industrial verticals. India too had seen this evolution last three decades or so. Few instances of the communication engineering in road in to automation techniques where the author has been totally or partially involved are enlisted chronologically

- 1) 1989 - Remote Sluice gate control with status information for a Indian longest river canal project by means of satellite communication
- 2) 2002 – A Car manufacturer located in North witnessing test results of Ribbed belt environmental endurance test rig located in down south through internet
- 3) 2006 – Not so easily available spare part of a Internationally built Classic luxury sedan car being located in a godown in Barcelona & importing in to the country

within a reasonable time period of 10 days with the help Pan- World inventory package through internet

- 4) 2011 – An hydel dam data acquisition like rain in catchment areas, water inflow, dam gate opening & control etc. and real time public reporting through data acquisition & web enabled systems on internet.
- 5) 2012-14 – real time data of majority of Indian railway locomotives anywhere in the country viz. location, health etc. being monitored at Hyderabad for centralised Remote management information & decision making
- 6) 2015 – A Dairy product company in Hyderabad initiating a project for real time plant performance monitoring through individual machine monitoring, data acquisition and centralised real time logging with the help Local Area networking.
- 7) 2016 – Controlling rotating actuators with the help radio modem communication & remote machine controlling & diagnosis through web enabled PLC for a Wire & Cable machine to be located in a foreign soil & monitored remotely from the country

There is a long list of communication & centralised reporting examples that keep growing as the days pass by web enabling the control systems for global communication & control enabling timely remote control & apt & quick management interventions.

Few of the data transmission technologies that have grown in stature & had been successfully implemented are

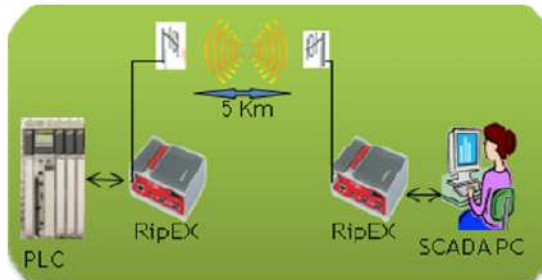
- Hard wired communication (through wires & optic fibres) establishing communication between various equipment through internationally standard networks – Serial & Parallel
- Wireless communications of data transfer through VHF/UHF, GSM, GPS & GPRS, Line of sight & Non line of sight Radio frequency modem and so on

However every communication technology has limitations like laying of wires/ min. bending radius or wifi signal shadow situations etc. To overcome these empirical bottlenecks, a composite communication package is developed and employed with site geographical detailed surveys

Wire free Communication

Wireless communication of data had one of the forerunners of the comm. Technology due to its capabilities & economics. Most of harsh environmental applications are catered to by this technology in Power, Cement, Mining industries including mobile applications

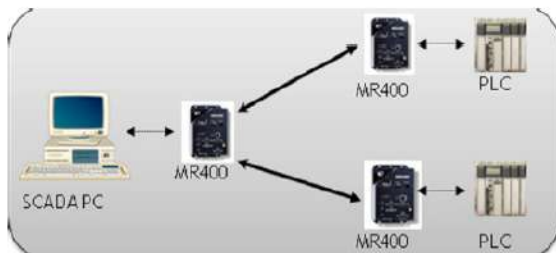
- 1) Remote monitoring & control of pumps in power plants & water treatment plants – 8 km remote



- 2) Coal reclaimer & stacker controls in cement works – 3 km remote



- 3) Remote I/O mirroring for stackers/ reclaimers and monitoring and control a local PLC control in a jetty at a distance of 4 to 10 km in many Cement works



- 4) Daiphragm temperature transmission – through wireless transmitters – 100 m – cement works



- 5) Collision between stackers & reclaimers – 250 m through line of sight of radios in cement works
- 6) Wagon monitoring – through radio transmission – 5 Km



Conclusion

So it is apparent from the above, the mill – be it from any segment of industry gets to gain multi-folds in its operations, productivity, efficiencies by adapting to newer technologies as they unfold over a period of time. It is prudential to effectively cross integrate these automation technologies successfully employed in other industrial verticals, but of course after a detailed due diligence on the empirical situations prevail in paper industry unique to itself.

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