

# Instrumentation and Control Systems in Kerala Newsprint Mill with Particular Reference to Paper Machine

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The Kerala Newsprint Mill is producing 300 tpd of nespwrint using 30% Chemical Pulp from reeds and 70% Chemi-Mechanical Pulp from Eucalyptus Grandis. This is an integrated mill having its own chemical recovery, utility boilers, and captive power generation etc.

All the plants of the mill are highly instrumentation oriented with lot of automatic control and monitoring devices. Major portion of controls, indication, recording instruments are pneumatic type and about 10% of total insru-ments are electronic type.

Major application in process are flow, level, temperature, pressure, analysis, consistency etc. Many of the instruments and controls in the plant are identical to any other chemical process industries and some are unique for paper mill. Only such unique systems of paper mill are illustrated in further pages.

We are using TAYLOR 1400 series instru-ments in control panels TAYLOR 300 series transmitter in field and final control elements of Dezurik, Jamesbury, Fisher, Flowell, Dezu, Novel etc. In the electronics field, we use 02 & 0 & C Analyser of Taylor make, Nucleonic instruments M/s. Kay Ray make for density control, M/s. Philips make nucleonic instruments for chip level control, Magnetic Flowmeters of Taylor make and Basis Weight and Moisture control of M/s. Boyles.

An overview of instruments in the mill are as follows: Total cost of instruments and its erection and commissioning and spares in the mill is about Rs. 4 crores.

Total no. of instruments	: 2400
No. of control loops	: 400
Field instruments	: 600
Panel instruments	: 1160
Control Valvea	: 580

Control panel	: 48 Metres
Cooper Tubing	: 65 Kms.
Cable	: 23 Kms.
Impulse piping	: 5.5 Kms.
Air headers	: 6.0 Kms.

Above figures for paper machine alone are as follows :

Field instruments	: 150
Panel instruments	: 200
Control Valves	: 163
Panel	: 15 Metres

## PAPER MACHINE INSTRUMENTATION :

In Paper Machine systems are divided as follow :

1. Stock Preparation.
2. Machine instruments.
3. Dry End instruments.
4. Chemical Additive Preparation.
5. Finishing House.

In stock preparation area, unique instru-ments of paper mill are consistency control and flow control by Magnetic Flowmeters. These two systems are explained in brief here. All other normal controls such as pressure, level, temperature etc. are not explained.

### Consistency Control

Consistency is a very important variable which affects paper making process. In both pulp mills too same type of consistency control is adopted. In stock preparation high consistency stock is drawn from HD Chests at 10% and reduced to 4.5. to 5% when pumped into LD Chests. Consistency is further reduced to 4%

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when stored in refiner chests after passing through refiners. In blending chest, it is further reduced to 3.7% and finally in machine chest 3.5% stock is stored. On finally reaching wire part of the machine, consistency is around 0.5%. Consistency regulation is done only upto the outlet of machine chest. (Ref. Fig :-4)

In this mill, in all positions we are using FOXBORO make 19C model transmitter which is having a stationary sensor blade and works on shear force principle. The instrument is mounted directly on pipeline in an adapter flange welded in the pipeline.

We are facing certain problems with this type of instrument, as the output is not proportional to consistency change and an increase or decrease of output signal indicates only change of consistency not the amount of change. Due to this characteristic, dilution control valve operation becomes difficult. At present, the controllers are tuned for operation in a very narrow proportional band. If the control point shifts due to some reason, the control becomes ineffective.

Also the line velocity or pressure change affects indication. Hence, action is underway to fix rotary type transmitters at the outlets of CP & CMP HD Chests to begin with

#### **On Machine Instruments**

On machine instruments are many supplied with the machine. Out of them, all operations of the machine are hydraulic or pneumatic. General system of hydraulic and pneumatic controls are briefly described indicating the positions of use. Other important control loop is Head Box Pressure Control.

#### **Paper Machine Head Box Pressure Control**

The high turbulence type Head Box interior stock pressure is measured in two ways. One with a Loadcell, measuring amplifier and digital indicator for direct pressure indication in press bench board. The other one is a pneumatic-transmission type d/p cell for control function. Both are mounted in a measuring chamber with water purging connected to head box.

In this transmitter +ve side is subjected to actual head box pressure and -ve side is fed with a pneumatic signal equal to the head box pressure required as per machine speed. -ve side feeding pneumatic pressure is also converted as an electrical signal by loadcell and digitally indicated in press bench board. Output of the

d/p cell will be the difference between actual and set head box pressures and connected to a centre zero pneumatic controller with set point kept at zero. Output of the controller is converted to 4-20 mA electrical signal and fed to Thyristor control drive of secondary fan pump for effecting speed variation for change of pressure. (Ref. Fig :-1)

#### **Hydraulic Controls**

Mainly Duoformer, Presses, Calender and Reels controls are effected hydraulically. For this hydraulic control boards with various hydraulic components such as oil aggregate axial piston pumps, pressure limiting valves etc., are provided as two compact units, one in wet end and another at dry end.

Lowering and Lifting of breast roll cantilevering of top and bottom wire sections for wire change, swivelling of wire stretcher beam filler blocks, high pressure showers of wire section, operation of 3 presses for loading and unloading, take off doctor oscillation etc., are effected by hydraulic control system installed at wet end.

Calender nip pressure control, lowering and lifting of calender stack, lowering lifting of swing arms, reel spool breaking etc., are effected by hydraulic control system installed at Dry End.

#### **Pneumatic Controls**

Mainly pneumatic controls are used in Duoformer Presses, Dryers, Calender and Reel etc. Pneumatic controls are effected through various components such as precision pressure controllers, filters, oilers, solenoid valves, throttling devices etc, installed at various positions of the machine.

Lifting and lowering of suction couch rolls, doctor oscillators, wire stretchers, vacuum flap controls, operation of wire and felt guides, locking of third presses, doctor lift units, transfer blow pipes, knock off shower operation etc., are done pneumatically.

Dryer felt guides, sweat dryer doctor controls, calender load relieving system, calender roll locking, doctor oscillators, reel spool starter, rope transfer system, carrier drum drainage are major controls operating pneumatically.

#### **Dry End Instrumentation**

At the dry end, main control is incorporated for steam and condensate system which is a unique control system of this mill, even though instruments used are all normal type.

# HEAD BOX PRESSURE CONTROL SYSTEM OF PAPER MACHINE

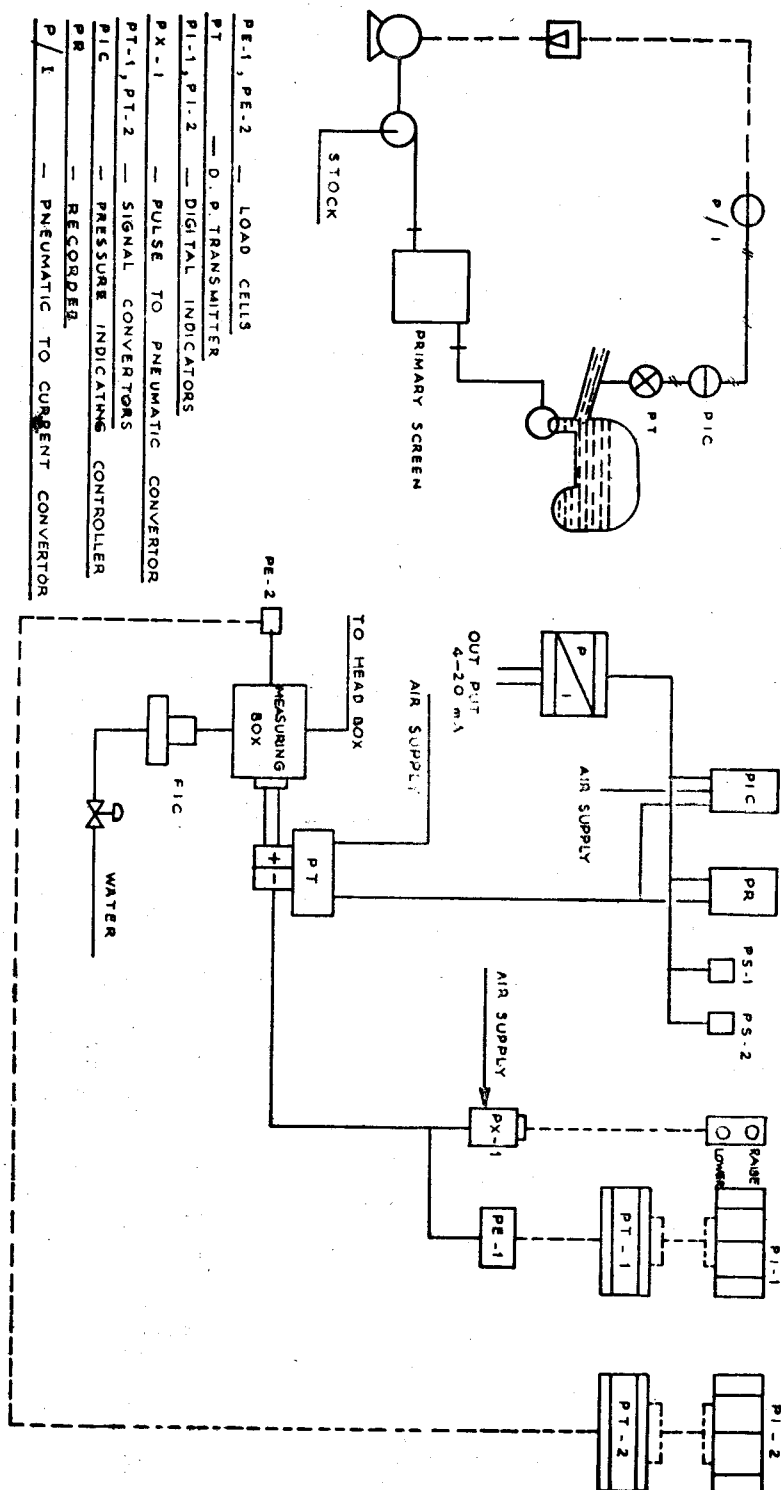


FIG - 1

# STEAM AND CONDENSATE REMOVAL OF PAPER MACHINE

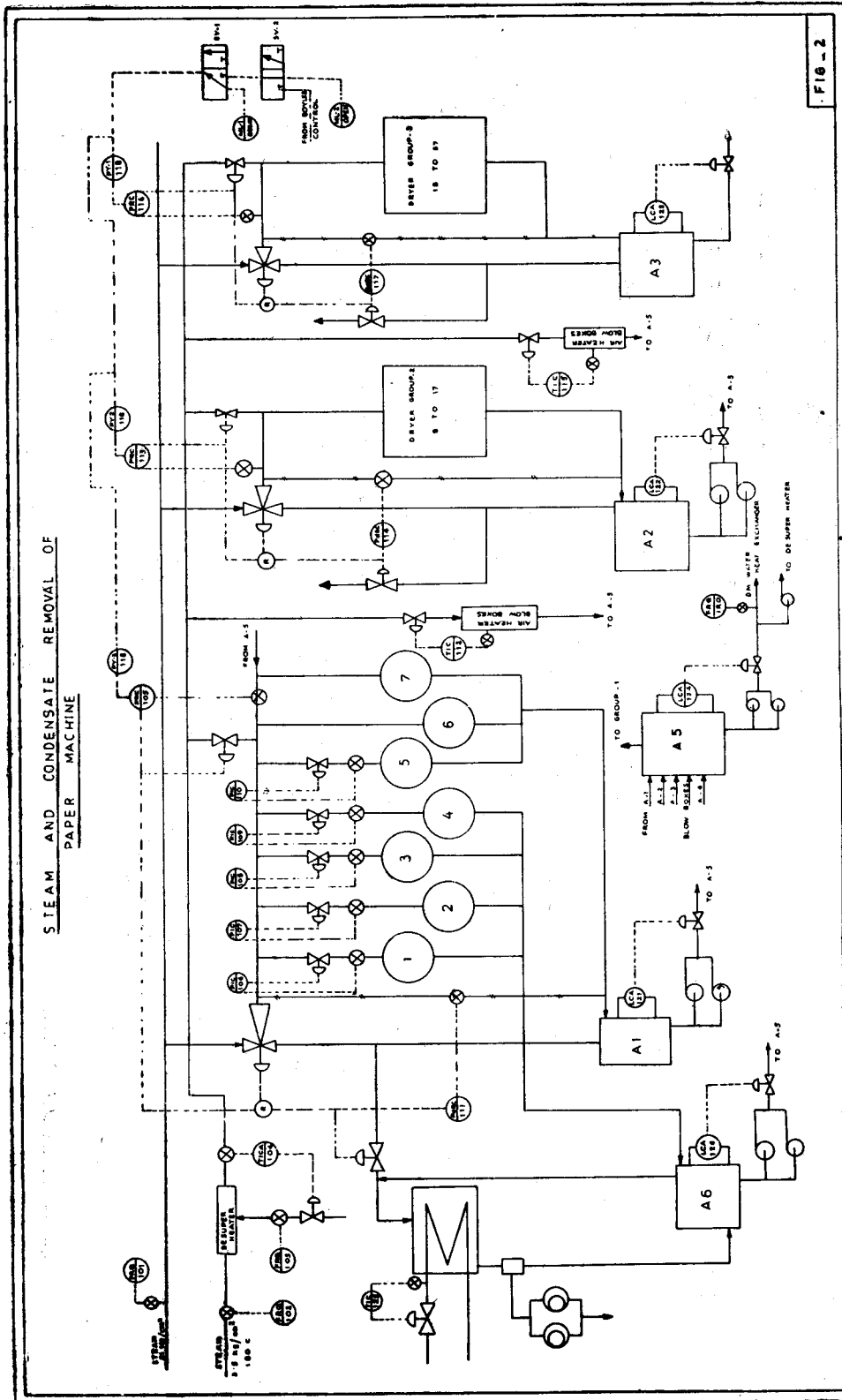


FIG - 2

## Paper Machine Steam & Condensate System

For heating of paper coming from press section, there are 37 nos Fig 2. Dryers arranged in 3 groups of 7, 10 & 20 Dryers respectively. Moreover there are two pocket ventilation systems one interposed between first and second heating sections and the second between second and third heating sections.

Superheated 3.5 bar 180°C steam is entering the battery limit of the plant and the same is desuperheated to 150°C before entering different groups of dryers.

The three heating sections operate under different steam pressures which is being maintained by 3 pressure control stations. The first five cylinders of the first heating group operate under vacuum. For this a vacuum system comprising of vacuum pumps, separators and a heat exchanger is provided. The blow through steam and condensate from first four cylinders are extracted by a rotating syphon arrangement and collected in A6 tank. Blow through steam is separated and sent to a condenser and non-condensibles are removed from the system by a vacuum pump. Individual pressure controls are provided in the feed lines to first 5 cylinders of 1st heating group in which the steam pressure is gradually increased from 0.5 ata to 1 ata to avoid thermal shock of paper.

Blow through steam and condensate from dryers 5, 6 & 7 of 1st group are collected in another condensate tank and blow through steam is separated and used in the 1st group itself by raising the pressure with the use of a thermocompressor. Any excess blow through steam can be sent to condenser of first four cylinders to adjust the differential across cylinders.

All the dryers contained in second heating group operate under same steam pressure. Similarly dryers of third group operate under same steam pressure except 37th Dryer, which is used as a swing dryer for cooling the paper, if necessary.

Condensate and blow through steam is collected in A2 & A3 tanks for second and third groups respectively. Flash steam is used in the same group itself by raising the pressure with the use of thermocompressors. Excess flash steam of second and third group, if any, is vented to atmosphere. Condensate collected in A1, A2 & A3 tanks are pumped out to collection tank A5 after maintaining a level by level controllers condensate from A5 tank is partially used for desuperheating 3.5 bar steam and balance sent boiler house for reuse.

Unlike the cascade heating system, this is a

thermocompressor based system, in which the flash steam from a particular heating section is utilised in the same section by the help of a thermocompressor. The thermocompressor utilises high pressure (21 Kg/cm<sup>2</sup>) motive steam to entrain the low pressure flash steam and discharges the mixture at an intermediate pressure.

The pressure and differential pressure controls of a heating section is illustrated in Fig. 3. The pressure control valve PCV is air to open type and operates on full pneumatic pressure range of 0.2 to 1 Kg/cm<sup>2</sup>. The controller PIC is a reverse acting type so that when the header pressure increases and PT Output increases controller output decreases, to throttle the valve PCV.

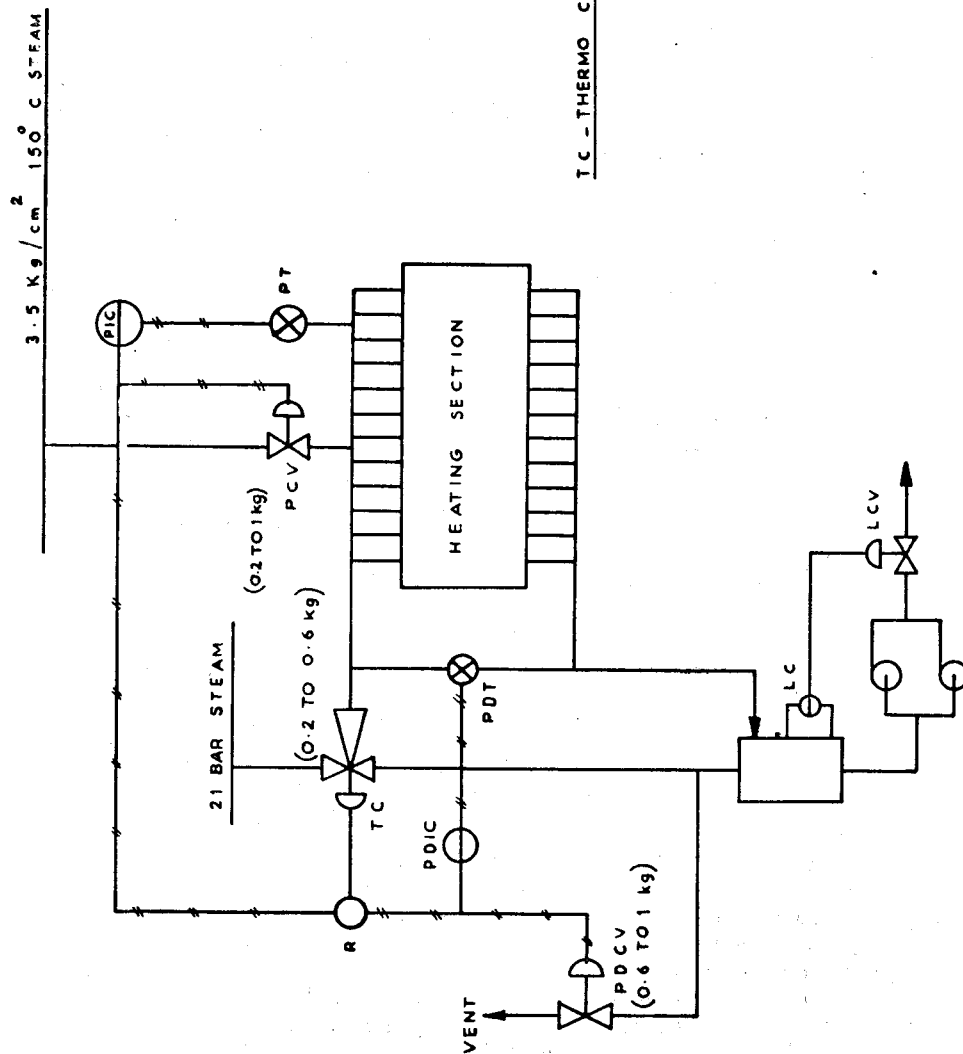
The thermocompressor is supplied with a 0.2 to 0.6 Kg/cm<sup>2</sup> split ranged positioner and also the Vent valve POCV operating from 0.6 to 1.0 Kg/cm<sup>2</sup> signal. Relay 'R' selects lowest of the input signal from PIC & POIC and feeds to thermocompressor positioner to modulate the actuator of the thermocompressor. With a paper web passing PCV will be throttling on PRC output of 0.2 to 1.0 Kg/cm<sup>2</sup>. Differential pressure across the heating section will be maintained by modulating the thermocompressor spindle. The lower signal from PDRC will pass to the thermocompressor and the higher output signal from PRC will be blocked by relay 'R'.

On a paper break the pressure in the steam header will rapidly increase because the condensing load in the dryers is drastically reduced. To maintain the set pressure, the signal from PIC will decrease tending to close the valve PCV. When the output of PIC becomes less than that of PDIC, the thermocompressor is automatically transferred to PIC control by selector relay 'R'. The signal from PDIC will now be in the range of 0.6 to 1 Kg/cm<sup>2</sup> and will maintain the differential pressure by venting the flash steam through PDCV to atmosphere.

There are three modes of set point control of individual heating sections

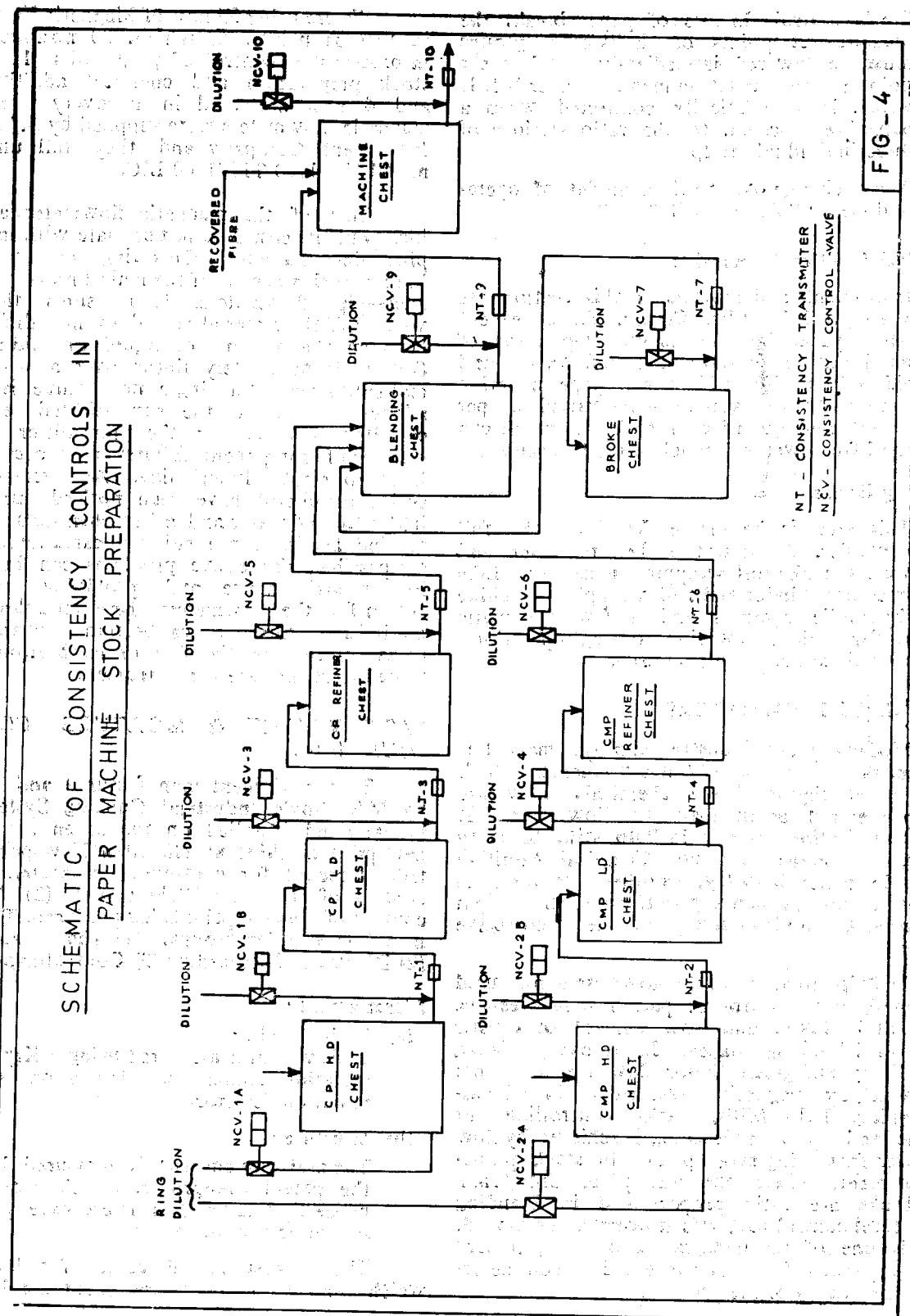
- (a) Computer Control—In this mode during normal running condition, pressure set points of three groups are controlled by the moisture controller computer output which goes to three ratio stations of three groups and keeps the set point as per the ratio selected.
- (b) Pressure Control—In this mode, if computer control is inoperative, the set points are adjusted by a manual loader ML2, the output of which goes to three ratio stations of three group and keeps the individual group set points as per ratio selected.

# THERMO COMPRESSOR OPERATION IN THE PAPER MACHINE DRYER SECTION



TC - THERMO COMPRESSOR

FIG - 3



- (c) Break Control—In case of paper break, the pressure set points of individual groups must be lowered immediately. A low set point pressure is set on manual loader ML 1, which is automatically connected, when a paper break occurs, to the ratio stations of three individual groups.

Above change over to three modes of operation are done by Solenoid SV1 & SV2.

#### Chemical Additive Preparation

Instruments and controls of this section are mainly supplied by M/s. Cellier, France except flowmeters, panel instruments etc. Operation of the plant is automatic through on/off valves and solenoid valves. For additives to paper metering pumps are used whose speed can be varied as per requirement and quantity of stock. Controls can be effected from wet end panel of paper machine.

#### Finishing House

This area is having a VOITH make full width winder, Jagenburg make rewinder and Kleinwefers make roll wrapping machines. Like paper machine winder and roll wrapping machine have hydraulic controls and a few pneumatic controls for loading, lowering, raising operations. Rewinder all controls are pneumatic.

#### MAGNETIC FLOWMETERS

Modern paper industry employs magnetic flowmeters for various flow measurements. Stock flow, black liquor flow, chemicals flow are mostly metered using magnetic flowmeters. It finds application mostly in Pulp Mill, Recovery Plants, stock Preparation and Chemical Additive Plants in paper industry, as other type of meters cannot function in such applications when medium has suspended solids or slurries or one of corrosive nature.

In Pulp mills, magnetic flowmeters are used in closed loop control of pulp flow in screeners, chlorination tower and flow control of caustic hypo in bleaching stages. In recovery plants, black liquor and green liquor flow measurements are done by magnetic flowmeters. In Chemi-Mechanical Pulp Mills, ratio controlling of caustic and hypo in bleaching is achieved by flow measurements using mag—pipes. In stock preparation plant, where chemical pulp, CMP/TMP and broke are ratio proportioned in Blending Chest level control magnetic flowmeter employed. This is one of the important closed loop control as far as paper industry is concerned which determines the quality of the product.

We are using 35 nos. of Magnetic Flowmeters in various plants, of which, 20 nos. are applied in process flow control of pulp mills. 11 nos. in stock preparation and chemical additive plant and 4 nos. are used in Recovery plant. The magnetic flowmeters were supplied by M/s. Taylor Instrument Company and they fall under the model No. 1100 TIC/1100 LIC.

Cost of the magnetic flowmeters are fairly high but its cost does not escalate with increasing pipe line diameter. Operating power cost is high and this is one of the main disadvantages of mag—pipe flowmeters. It measures the total volume of the material and does not differentiate between the amount of liquid or solid material. Output is completely linear over a wide range and calibration at a single flow value is usually adequate. Due to the sophisticated electronic circuitry involved in the transmitter portion, chances of component failures may occur which leads to erratic functioning. Also sensing head coils short circuit have been noticed due to the infiltration of water and other chemicals into the sensing heads. Since coil and cards replacements are possible, the above problems can be solved. Proper maintenance and providing protective covers for the flowmeters these troubles can be minimised. Also a calibration apparatus is necessary in case the factory calibration is disturbed to recalibrate the instrument.

#### BASIS WEIGHT & MOISTURE CONTROL EQUIPMENT

This equipment manufactured and supplied by M/s Boyle Industrial Gauging Systems Ltd., England and installed on the seven metre wide newsprint machine at Hidustan Newsprint Limited, is meant for continuous measurement and control of (1) Basis Weight and (2) Moisture content of the newsprint being produced. The equipment has 3 major groups. (1) The Measurement. (2) Display and Recording (3) Controlling.

##### Measurement :

- (a) Basis Weight :  
Basis weight is measured using a Krypton 85 radiation source and Ionisation Chamber radiation detector.
- (b) Moisture :  
The moisture content is measured based on the patent Scanpro Double Frequency Resonance System using a microwave pulse and resonator technique.

The sources and detectors for both basis weight and moisture measurement are housed in



one assembly which is carried across the paper machine continuously, with the newsprint passing through the assembly, by a chain and pulley system. This movement called scanning is controlled by a servo system using a Thyristor controlled 1/4 H.P. DC motor.

Temperature controllers are provided for controlling air gap temperature and source temperature on this assembly.

#### **Display and Recording :**

Using two intelligence units incorporating micro computers necessary data based on the measurements and set values are continuously collected and processed for video display as well as print-out on a Dot Matrix Printer. Several pages of informations are possible to be displayed and printed.

#### **Control :**

Based on the data collected and processed by the data collection unit, control signals are given to the pulp flow controllers and steam flow controllers for the wet part and dryer part respectively of the paper machine. These signals are given at fixed intervals based on the average deviations of the measured basis weight and moisture from their respective set points.

This equipment, if properly utilised, can effect a lot of economy in the operation of the paper machine. This type of nuclear control systems are very common now in all developed countries in paper industry.

### **GENERAL DESCRIPTION OF NUCLEONIC GAUGES IN THE MILL**

In Paper Industry ratio isotope gauging is employed in the monitoring of process parameters like Basis Weight, Density control of black liquor and level measurements. Mostly transmission gauges of Gamma source and Beta source finds application in paper industry. Gamma source is used for level measurement and density control while Beta source is used in the basis weight control of paper.

In Hindustan Newsprint Mill, nucleonic gauges are used in paper machine—basis weight control, CMP Plant—wood chips level measurements in buffer vessel and steaming vessel and in the density control of black liquor in recovery plant.

Basis weight measuring unit is supplied by M/s. Boyle Industrial Gauging Systems Ltd.,

England. Basis weight is measured using a Krypton—85, 450 millicurie source and ionisation chamber is used as the detector. Its control modules incorporate highly sophisticated electronic circuitry, which enables to provide a feed back control on the basis weight of the paper. Automatic source decay compensation too is provided. Certain problems were noticed in the microprocessor based control units and display systems recently. Due to the sophistication involved, proper maintenance and servicing is required for this instrument.

In recovery plant, boiler fuel is black liquor, which is concentrated and supplied from the Evaporators. The density control of the black liquor is monitored using a Gamma isotope gauge. In HNL the density measuring instrument is supplied by M/s. Kay-Ray Inc., U.S.A., which comprises of a 200 millicurie Cesium 137 gamma source and ionisation chamber as the radiation detector.

In the CMP Plant of HNL, Buffer Vessel and Steaming Vessel Eucalyptus chips level control is achieved by means of radio gauging. Both the units were supplied by M/s. Philips Analytical Systems AB, Sweden. The isotopes used are 60 millicurie CS 137 and detectors are G.M. tubes. The unit is capable of giving out a linear output signal, which controls the speed of the parascraws which feed material to the conveyor belts. Adaptive level controllers which takes care of the time lag are incorporated in the loop to achieve automatic level control of the vessels. Mostly the strength of the source used in paper industry are very low, in the order of millicuries, hence the safety regulations can be practised without much difficulty in the erection and maintenance of these gauges.

Radio isotopes gauges have a number of advantages over the conventional techniques, such as high sensitivity and stability, scanning a longer area. The use of Nucleonic Gauges have increased productivity by preventing costly plant shut downs and by providing better control over critical process parameters of the process. They improve processing operations, product quality and plant safety. M/s. Electronics Corporation of India Limited have designed and developed Nucleonic Gauges suitable for paper industry for level measurement and for conveyor belt weight measurements.

### **GENERAL DESCRIPTION OF FINAL CONTROL ELEMENTS IN THE MILL**

Since the success of Instrumentation depends

on the performance of the final control elements, we have given much importance in selection, installation, testing and commissioning of control valves in our mill. Classifying these control valves with respect to actuation and valve bodies, we have control valves with pneumatic, hydraulic and electric actuation. Of the pneumatic type diaphragm operated valves are maximum and valves with piston activation and power cylinder activation are also many. While maximum number are of throttling type, some are of on-off type.

We have Globe type, V ported, Ball and Butterfly type of valves with either sliding stem or rotary stem and having linear and equal percentages characteristic, except a few on-off types. With regard to material of construction of valve body and trim, a large number of control valves are of trim with corrosion resistance stainless steel of various type including hastalloy 'C'. For high temperature and cavitating conditions, creep resistant alloy steel containing chromium and molybdenum valves are also available. In a number of cases, the valve plugs and seats are stellite to withstand wire drawing and erosion problems.

Most of the valves are used in stream line flow application and in a few cases high pressure valves are used especially in steam line services. The application of tight shut-off is very limited. Control valves with heavy guiding for the valve plug are also few in our mill.

Depending on applications, valves are with radiating fins, extended bonnets or plain bonnet with gland packing of various types such as graphited asbestos, asbestos with inconel, reinforcement, teflon ropes, PTFE packing and 'V' teflon packing in some cases.

Also the valves are used for controlling of variables like pressure, temperature, flow, level, conductivity, pH and density of controlled media, air, water, condensate, demineralised water, black liquor, white liquor, green liquor, acid, alkali (both weak and strong), chlorine gas and steam. Butterfly and Ball valves are mainly used for thick and dense liquids like strong black liquor, liquid lime, slurry etc., and rotary plug and globe type are used for other type of thick and clean liquids. Acids and alkali valves are of special material to prevent abnormal corrosion.

The valves at Kerala Newsprint Mill are from 15 manufactures, indigenous as well as foreign, either through direct procurement or through vendor supply. Despite our best efforts

in inspection, testing and installation, we had come across a number of problems on control valves. A major problem was blocking of valves by foreign particles like welding rods, chips, mud, lining material of pipe lines etc., resulting in damages of plug and seat.

Leakage at closed position or passing beyond permissibility has affected the control applications and created lot of problems. Repeated lapping was the only remedy. Even then the result was unpredictable. For further improvement the only course left is changing of plug and seat.

We had come across instances where adequate velocity consideration was not given in selecting material of construction through sizing of the valve was proper. Consequently, the problem of valve damage was very serious.

In another case, the shape of the plug was found not suiting the process and it was getting damaged by erosion. When the shape of the plug was changed from 'globe' to 'needle' type, the problem was reduced.

#### CONCLUSION :

Owing to inappropriate selection of instruments and due to long storage at Mill site before installation, certain instruments did not give expected service after installation and commissioning. Efforts are in progress to overcome the problems faced on such instruments by way of repairs, modifications and in certain cases replacements. To quote a few examples, certain important temperature measurements, particularly in the boiler house, where the originally supplied capillary type temperature transmitters were found not suitable and were failing because of the measured temperature being higher than the allowable temperature range and sensing portion of the instruments are to be replaced with temperature transmitters of a different type. For this, an order is being processed for Thermocouple to Pneumatic Converters. This change over involves laying of thermocouples and compensating leads also which are in progress. Some control valves bought indigenously are also being replaced with better ones. In certain cases sizing of the valves were wrong and in certain other cases the quality of manufacturing of the valve was poor. The system for weighing of Chlorine tanks using Loadcells and connected electronic circuits bought indigenously did not give satisfactory performance. For this also replacements are being made. A glaring example causing us considerable expenditure and worries is the Basis weight and Moisture control equip-

ment of the paper machine. Owing to mainly the poor quality of the components used partly due to the effect of long storage at the mill site before installation, the equipment failed soon after it was partly commissioned in 1982. It could not be even commissioned fully at that time because the Video Display Unit and Print-out had already been defective. Subsequently, certain items were sent to England for repairs and they were received back after repairs which costed us £ 18000. Later in 1984, another attempt was made to commission the equipment by supplier's personnel. This attempt was also not successful. In total, the service obtained from this equipment is very negligible and for short durations only. Presently, we are in touch with various agencies to see if this equipment can be revived. M/s. Accuray Corporation, U.S.A. have suggested some modifications on the scanning mechanism. For this, certain parts are being procured from Accuray for a cost of about USD 10,000. Further modification will have to be carried out also on the electronic portions to get the entire equipment back into service.

Instrumentation being of vital importance to any industry, particularly the pulp and paper industry, it is our recommendation that utmost care should be taken at the time of selection and erection of all instruments. There had been a considerable amount of problems during the erection of the instruments also in this mill owing to incomplete documentation from Consultants and incomplete ordering of instruments and erection materials. In the course of the erection, shortages were noticed and orders had to be issued for additional instruments and erection materials, the delay in respect of which also affected the progress of the erection work. Although the bulk of the instruments had been supplied by M/s. Taylor Instrument Company, the responsibility for the erection and commissioning was not fixed on that Company, but it was on M/s. Bells Controls Ltd. This also led to certain amount of difficulties. It is desirable to get the erection and commissioning also done by the supplier of the instruments itself so that the supplier takes the responsibility till the instruments are in satisfactory service.