Mill trial of the indigenously developed electronic on-line freeness tester

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Abstract

The conventional method to measure the freeness of pulp is to take samples and determine the freeness in the Laboratory either by a Schopper — Riegler apparatus or by the Canadian freeness tester. However, laboratory tests can not be done very frequently and they yield information far too slowly to be of any use for process control purposes.

The ON-LINE freeness measurement by the Electronic Freeness Tester is based on the measurement of the drainage time through the formation of mat of fibers on the screen. It gives a continuous signal of the drainage time at a frequency of 10 minutes. The advantages of the continuous freeness measurement are the most pronounced when (i) different types of raw materials are used and (ii) a large variety of papers are required to be manufactured on a high speed machine The present trend towards higher machine speed and use of variety of raw materials; addition of brokes of various quantity or quality, needs the continuous freeness measurement. The first step towards better control or refining, achieving paper quality, saving of steam and electrical energy and improving machine runnability is the on—line measurement of freeness by any suitable instrument.

Introduction

The function of any stock preparation system is to prepare, condition or treat the pulp or stock in such a manner that satisfactory sheet of paper can be produced.

Paper making fibers produced by the pulp mill or partially prepared from various materials are not suitable as such for the manufacture of paper. A sheet made from such fibers would have low strength, high bulk, an open irregular texture an wild uneven formation and would disintegrate readily when wetted by water. The term "Stock Preparation" is used to cover the operations such as the repulping and blending of pulps of different types, the addition of various chemicals and fillers and the mechanical treatment necessary to make fibers suitable for forming into a sheet of paper.

The behaviour of pulp suspension on the paper machine wetend and the strength of the sheet made from it is largely governed by the degree of beating the pulp It is measured by the Freeness or the rate at which the water will drain through a mat of pulp formed under pre-determined conditions of stock concentration i.e. Consistency and Temperature.

The influence of beating on the fibers may be described in the following way :—

1. Fibers become shorter, which normally occur linearly with the time of beating.
2. Fine material is produced, the quantity usually linearly dependent on beating time.
3. Delamination of the fiber wall i.e. fibers are softened thus making it easier for water to enter the fiber walls.
4. External fibrillation of the fiber surface.

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5. The water content of the fiber wall increases rapidly in the early stage of beating and the fibers swell and becomes more flexible.

Trend in Refiner Control.

A majority of the refiners are run using only an Ammeter to control the refining load backed up by the occasional laboratory checks on freeness at an interval of 2 to 4 hours.

These laboratory checks are very suspect and can be subjected to at least three serious deficiencies namely (i) Human (ii) Time and (iii) Method of drawing the samples (14).

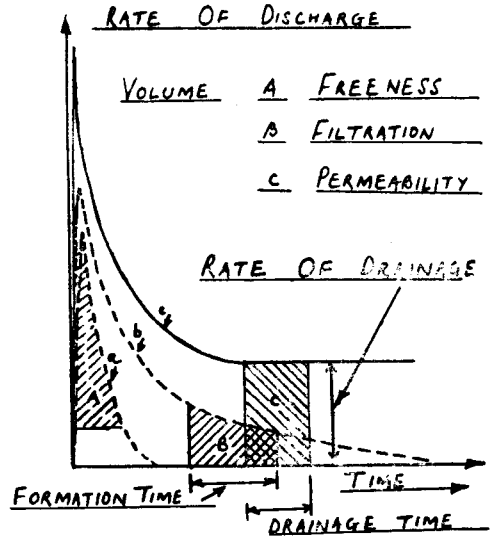
The human element in taking and testing samples for freeness can undertake some error Usually the interval between test can vary. If the test is done correctly the actual accuracy of the test can vary from person to person.

Time interal between two tests is usually high between 2 to 4 hours and a great deal of product has already passed through the refiner. Thus the laboratory tests have no significance in terms of controlling the refiner.

The method of drawing the samples is probably the gratest couse of error in sampling. In a majority of mills the samples are drawn through a relatively small valve or orifice or constant level box. The practice can cause dewatering and fractioning and can not be considered a truly representative samples verify the quality of the final pulp (14).

Freeness, Slowness, Wetness permeability, Drainability and Drainage Time are the properties oftenly used to specify the quality of the pulp. As an on-line process measurment, most of the above have their shortcomings but it is obvious that any instrument based on any one of these would be best suited. Most mills rely on Schopper-Riegler (SR) or Canadian standard Freeness (CSF) tester. The instruments measure drainage and freeness respectively, both being satisfactory, for laboratory tests but not necessary suitable for on-line mesurement (14).

The main drawback when attempting to select either freeness or drainage units for online measurement is their sensitivity to hard and soft woods. In case of mixed blends or multifurnish process it would be almost impossible to correlate the output to an useful curve covering most eventualities. These principles can be divided into three groups, namely a, b, c, all operating with drainage either as a velocity or a Time measurement refer fig. 1.



THREE DIFFERENT MEASURING PRINCIPLES SHOWING FREENESS, FILTRATION & PERMEABILITY OF A FIBRE PAD. FIG No. 1

(a) Formation of a pad from a limited sample volume by draining off the water contained in the sample is made with freeness tester such as SR, CSF, Williams etc.

(b) Continuous formation with a continuous flow of fibre suspension towards the screen. A pad is formed on the screen as the water drains through. The rate or time of drainage is measured (The Mastercon Freeness Tester operates on this principles).

(c) Formation of fiber pad with a controlled amount of sampled fibers by use of a continuous water flow. As used in the BTG, in line refiner analyser. Measurement of permeability through a formed pad.

The limitations of the principle (a) above as an On-Line process instrument are due to the nature of the actual handling of the sample It is not easy to attempt and simulate the laboratory procedure in a process instrument when the sample has to be diluted to a 0.3% consistency. The sample drawn directly from the process line would be of too high consistency (4.5%) for this methods of measurement.

The principle (b) is a filtration process as the fiber consistency above the formed pad will remain unchanged. The main feature of this principle is that an On-Line instrument can be made. However the line pressure, fiber consistency, line temperature and fines in the process water are assumed to be constant.

Necessity for the Development of the On-Line Freeness Tester :

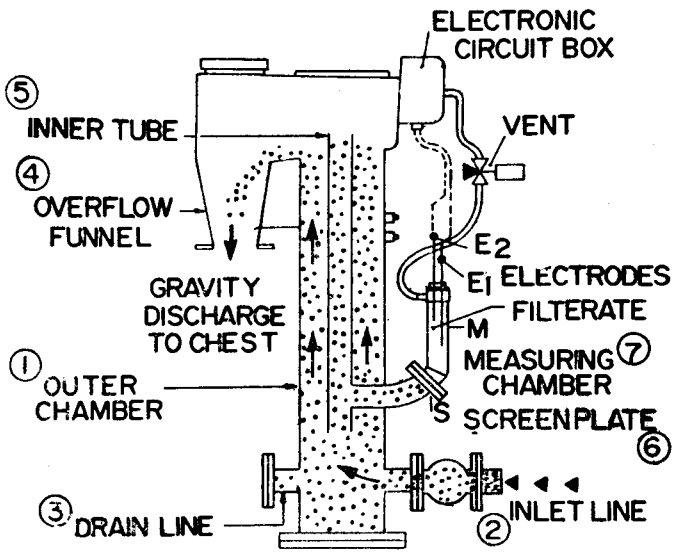
The freeness measurement in a paper mill though very important is usually done at an interval of 2 to 4 hours and this period is too long for detecting the short term changes and simultaneously implementing the immediate remedial measures which are necessary. A solution to this problem becomes more important with the increasing speed of production and growing demand for more uniform products. The lengthy laboratory test methods of freeness measurement have fallen behind the advanced pulp refining techniques. The enormous quantity of pulp produced per unit time have required more frequent freeness tests during the processing. A continuous freeness indication will help us to determine and maintain the degree of refining nearly constant at the desired freeness level.

The Electronic On-Line Freeness Tester :

Description of the Equipment :

The Electronic On–line freeness tester is a simple, continuous, on–line tester which measures the drainability of pulp suspension in seconds. Measurement with the electronic freeness tester can be co-related with the standard freeness test.

The tester consists of an outer chamber (1) with the bottom portion totally closed. There is an inlet (2) and a drain line (3) as shown in the fig. 2. A portion of the pulp flow is continuously diverted from the pulp line to the instrument inlet line (2) by means of a by–pass shunt line as shown in Fig.(3). The pulp passes through the outer chamber (1) & overflows into the Funnel (4). There is also an open ended inner tube (5) fitted inside the chamber as shown in Fig. (1). Pulp also fills the open-ended inner tube (5) to the same level that it fills the outer chamber. The inner tube (5) is extended above the pulp level; hence pulp is prevented overflowing and is isolated from the flow occurring in the outer chamber. A constant head of the pulp is thus formed which forces the pulp from the inner tube on to the screen (6). This forms a progressive mat on the screen. A known volume of aqueous suspension of pulp is thus drained through the fiber mat formed on the screen. The filtrate is collected in the measuring chamber (7) which is also graduated in milliliters. The time required to drain a fixed volume of the filtrate is the indication of the freeness number of the pulp.



ON LINE

FIG 2. ELECTRONIC FREENESS TESTER

The measuring chamber (7) also contains two electrodes E_1 & E_2. The filtrate level rising in the measuring chamber first make contact with the electrodes E1 which starts an electronic timer When the filtrate make contact with the upper electrode E2. the timer is switched off. The time lapsed is an indication of the drainability of the pulp. The signal can be suitably used to indicate/ control freeness.

After the completion of the measuring cycle, compressed air is allowed to enter the measuring chamber (7) back-flushing the filtrate through the screen and expelling all the pulp from the inner tube. The cleaning and the measuring cycles are repeated alternatively.

The instrument has the following features :—

* No moving parts.
* All stainless steel material.
* No leakage, no turbulence.

* Auto-alarm facility (10 ms).
* Auto/manual reset.
* Easy to calibrate
* Digital display.

Specification :

Type	: Drainage rate Type.
Principal	: Measurement of the drainage time through the formation of mat of fibers on the screen.
Range : Time	: 0–9m 59s
Resolution	: 1 sec.
Consistency Range	: 2.5 to 5%
Pressure	: Non-pressurized gravity discharge
Flush air pressure	: 60 Lbs./sq. inch
Sampling line pressure	: 3.5 kg/cm²
Supply Voltage	: 230 volts 50 c/s A.C.
Stock inlet	: 10 cms.
Stock Outlet	: 15 cms.
Sampling chamber material	: Equivalent 316 SS Acid-proof steel.

Complete Instrument :

1. Drainage Rate Indicator :
   Size 200×165×80 mm.
2. Stainless Steel Chamber :
   Size 1400 (Ht)×1000 (L) 500 (W)
3. Electro-pneumatic Controller :
   Size 330×330×230 mm,

* Test/ Hr. : Approx. 4 to 6 per hour depending on the pulp quality.

Continues Freeness Measurement at Ballarpur Industries Ltd. Unit Shri Gopal, Yamunanagar, Haryana (India)

A continues freeness measurement system indigenously developed has been installed at the pulp mill II at machine No. 4, about 2 months back refer Fig. 4. The machine produces different qualities of paper within the basis weight of 52 to 175 g/m². The machine has deckle of 3.15 meter and runs at a speed of about 290 m/minute. It has 21 cylinders before and 12 cylinders after the sizing press and consumes steam approximately 2.7 tone per tone of paper. The machine produces 76 tones of paper per day approximately consuming about 70 tones of pulp. The instrument samples about 30 tones of pulp per day.

The Pulp Mill II have two pulp lines called street A and street B. Street A produces pulp from softwood and hardwood whereas street B presently uses Kahi and some amount of brokes. The Machine no. 4 uses a blending of street. A pulp and street B pulp and brokes in different proportions. The instrument has been installed in the street B having a line pressure of 2.5 kg./cm². The pulp is refined by a set of three conical refiners which can be either operated in series or in parallel. The refiners are usually connected in series having equal load. The refiners are installed with 80 H.P. motors and draw 50 Amps. at no loads. The refiners are loaded to a maximum load of 100 Amp. each depending on the type of raw material. The instrument is under operations for the last two months and the freeness values are checked in the stock preparation no. 2, using Canadian Freeness Tester.

Mill experience in the Installation of the electronic On-line Freeness Tester :

The pulp mill II bave two streets, A and B. The street A is connected to the double disk refiner (DDR) which refine the softwood and hardwood where as the street B is connected to the Jordon/ Conical refiners (3 nos,) which usually refine the Kahi and brokes Fig. 4.

Since the consistency and the flow rate in the street A is very closely controlled it was resolved to install the instrument in the street A after DDR and immediately after the magnetic flow meter. The 8" pulp line was cut and a branch line of 4" dia was taken out and the pulp was allowed to pass through the instrument. Since the main pulp line did not have enough pressure hence, the pulp supply in the branch line was not sufficient and the instrument could not get regular supply of pulp. After six days trials and observations it was resolved to remove the instrument from street A and place it in the street B in the Jordon /Conical refiner line.

The street B had sufficient pressure of about 2.5 Kg/cm² which can be dropped to 1.5 Kg/cm² by open-

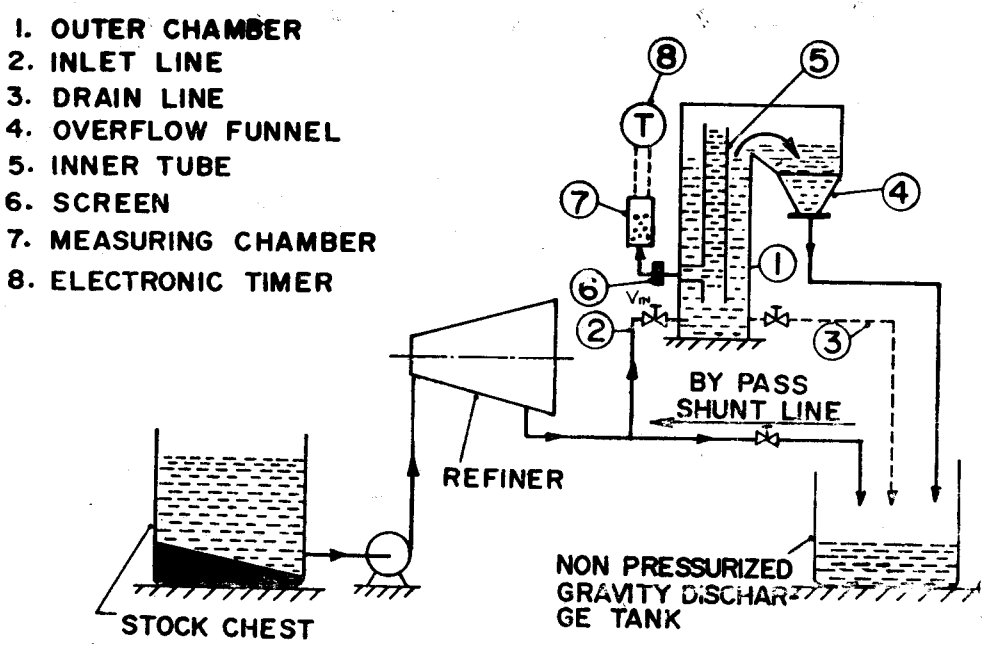


FIG 3 SCHEMATIC DRAWING OF ON LINE FREENESS TESTER

ing the manually operated valve V 1 installed at the discharge end of the pipe as shown in the figure 4. the pressure in the line usually is 1.0 to 3 kg/cm² depending upon the demand load.

The street B was found to be an ideal line as it could supply the pulp continuously to the instrument without any chocking of the pulp in the branch line or the instrument discharge lines.

To avoid the splashing of pulp in the chest, the pipes P_1 and P_2 were extended long and were found to be fully immersed in the pulp when the level in the pulp chest goes high. This caused a suction at the end of pipe P_2 (Fig. 5). Thus causing disturbance in the measurement of the drainage time. This can be overcome by putting a large diameter pipe across the discharge pipe P_1 which will avoid the suction at the discharge end.

The manually operated valve V_1 as shown in Fig. 4 is connected at the discharge end of the main pipe, when disturbed under different demand load conditions, caused a change in the drainage time. Thus it is essential to note that the valve should not be disturbed very frequently. To monitor the effect of variation of pulp flow rate in the instrument a pressure gauge (PI) was locally mounted and a maximum pressure of 0 07 kg/cm° was monitor. Fig.(4). By changing the demand load in the street, B the supply load was found to change across the instrument. This can be overcome by suitably incorporating the instrumentation as shown in Fig. 5. Though this system has not been incorporated at the mill sight.

While measuring the freeness of the pulp the consistency should be kept constant. It was observed that the consistency was varying anything between 2.6 to 4.5%. An electronic consistency indicator which has been indiguenously developed by Master Control is being planned to be placed in the incoming line of the freeness tester.

Experience in the re-start of the Instrument after 22 days shut down :

The instrument was given a shut down period of 22 days and was restarted to measure the freeness. Following observations were made in the re-starting of the instrument.

(a) The Electrodes need to be cleaned, dried and check should be made that they are not short circuited with the earth or the body of the sensing chamber due to the accumulation of dust, dirt and moisture.

CONICAL REFINER SYSTEM AT BILT, YAMUNA NAGAR

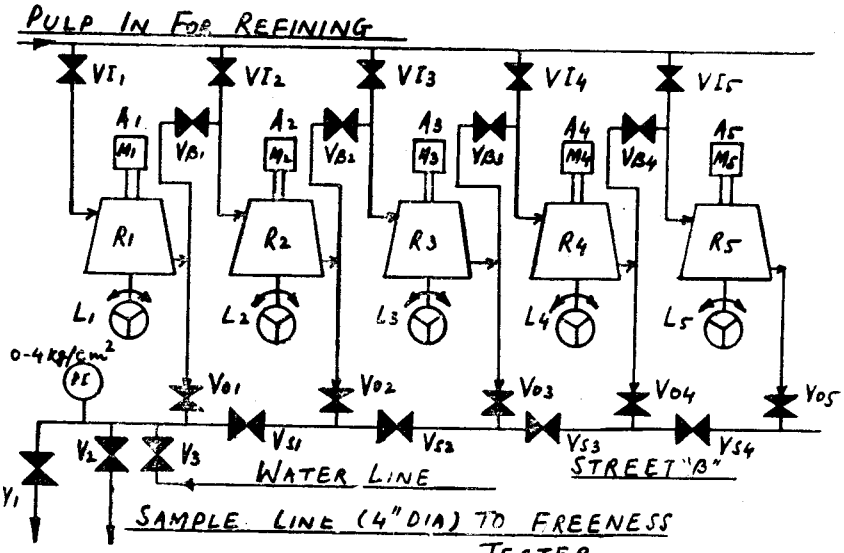


FIG NO 4

(b) The instrument should be thoroughly cleaned with water and old pulp should be flushed out by closing the valve V_{in} and opening the valve V_{out} Fig, 3.

(c) The instrument can be checked by passing clean water and measuring the drainage time of water which was about 22 seconds in the instrument at specific electrode position.

(d) Keep the inlet pressure of the pulp constant. A surge tank has been incorporated in the inlet line of the instrument to reduce the fluctuations as shown in the fig. 5.

(e) The flush air pressure should be kept constant and moisture should be removed from time to time to avoid any corrosive effect in the solenoid valves.

(f) The pneumatic controller should be switched on first and the flush air should be applied for sometime to clean the wire mesh before every start. This can be done by the manually operated switch given in the system.

(g) The instrument should be brought from manual to Auto-mode position and then the electronic controller should be made on.

ELECTRONIC ON-LINE FREENESS TESTER INSTALLATION AT BALLARPUR MILLS LTD

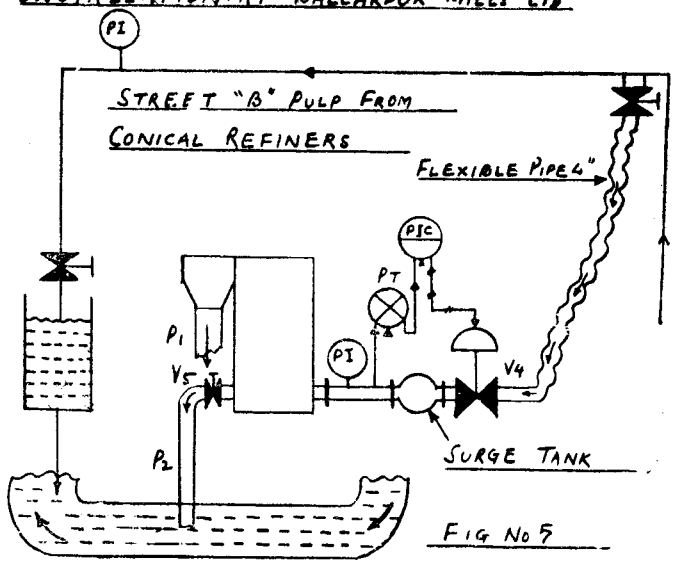


FIG NO 5

The instruments took about ten minutes to restart. The first readings should be ignored as to give sufficient time to stabilize the measuring operations.

Observations :

The pattern of the observations during the trial was as given below and may be modified to incorporate other information if required at the latter stage.

1. Sr. No. (usually 20—22 readings can be taken in one shift).

2. Flush air pressures

   (a) Maximum 60 lbs./inch^2. (Higher pressure will be desirable).

   (b) Minimum 40 lbs./inch^2. (at the end of the cleaning cycle)

(The pressure should not go below 60 lbs/inch^2 the higher value are preferred as it will offer better cleaning of the wire mesh.)

3. Air Flushing Time : 4 Minutes.

(This time can be adjusted from 0 to 5 minutes. Different time intervals were selected and 4 minutes time was found to be the best value)

4. Drainage time : Average value 4 5 minutes for Kahi grasses (Saccharum Spontancum) and 3 0 minutes for hardwood bleached pulp.

When the average time for Kahi grass pulp crossed 5 minutes, steam consumption at the driers in the machine no. 4 was excessively high. The load on the motor was only 50 Amp. i e. the refiner was operating on no load. The higher consumption is predicted due to use of dirty Kahi and addition of the brokes of coated papers in the street B.

5. Refiner Load

	no load	full load
L_1	50 Amp.	100 amp.
L_2	50 Amp.	100 amp.
L_3	50 Amp.	100 amp.

6. Steam consumption at the drier end

   Time — i. ii. Temperature

7. Date, Day, Time Lot No.
   GSM/Type of paper

8. Refiner line pressure (output) 1.5 to 3.5 kg/cm^2

9. Instrument Inlet pressure Minimum 0.06 for Kahi and 0.07 for hardwood, being measured by a manometer driven by a diaphragm.

10. Consistency variation — 2.6% to 4.5% approximately.

11. Freeness variations — 240 to 400 csf.

12. Drainge Time variations from 2 minutes to 7 minutes.

    (depending on the type of pulp refiner load and consistency).

13. Drainage Time for water—22 seconds (average of 8 readings).

Economic Importance of the On-Line Freeness/ Drainage time Measurement

The On-line freeness/drainage time measurcment gives the indication of the load to be given to the refiners, when no automatic control system is available on them. A more beaten pulp will consume more power and will generate more fines which in tern will increase the drainage time and effect the runnability of the machine. The larger drainage time have reflected in the larger steam consumption at the paper machine No. 4. The saving will be achieved through better product quality, better paper machine runnability, saving of electrical power at the refiner as well as saving of steam in the driers The drainage time being measured at an interval of 10 minutes may also help us to give a guide line for the addition of brokes or blending of two different types of pulps. High quantities of coated brokes are occasionally used in the street B including the coating strips which contains varying quantity of additional chemicals which also enter the paper machine No. 4 thereby imparting poor pressing efficiency and consuming more steam in the drier section.

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