An Experience With Pandia Continuous Digester on Agricultural Residues

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ABSTRACT

Pandia continuous digester in Mukerian Papers Ltd., Mukerian was commissioned in May, 1995. This plant is first of its type, because all the usable components of an old sprout waldron digester were used to build up a continuous Digester. The sprout Waldron digester was retrofitted by chellan marketing and consultancy Pvt. Ltd., Madras. The major components like, timer screw, inlet chamber etc. were used from this digester. In the due course inlet chamber was replaced due to frequent jamming. This paper deals mainly with the working of continuous disgester. The continuous disgester run with fairly low compression ratio, 1.35:1. In case of straws satisfactory results were obtained with such type of feeder with managable back blows.

Low steam consumption, less man power and uniformity of pulp etc., are the other advantages.

PREPARATION OF RAW MATERIAL

Sarkanda, before feeding to a conveyor, is cut in small pieces through straw cutters and stored on a platform. Wheat Straw is dedusted through duster drums, Bagasse is depithed before feeding to Main conveyor. All the raw materials are cooked separately.

DESCRIPTION OF THE PANDIA DIGESTER SYSTEM

The objective of continuous Pulping is to shorter the time of pulping, taking advantage of modern Computer controls, thus reducing Operating costs for producing more uniform pulp.

The detail flow diagram of the digester and wet cleaning plant is shown in **Figure No.1.**

The digester consists of mainly following sections:-

A). WET CLEANING PLANT.

B). SCREW FEEDER

C). TWO TUBES WITH TIMING SCREWS.

D). COLD BLOW DISCHARGER.

E) INSTRUMENTATION AND CONTROL

a) WET CLEANING PLANT

Magnetic Separator

Magnetic Separator, used for removing tramp iron, nuts bolts etc upto about 700 gms from raw material being conveyed from Bin feeder. It is installed over main belt conveyor, have sufficient lifting power. Magnetic separator should be tested as per manufacturers advice time to time in order to establish its lifting capacity. This is essential for checking the iron materials which may pass into the digester, causing stoppages and damaging other important components.

Dedusted wheat straw, cut sarkanda and depithed bagasse is stored in the storage yard. In case of wheat straw and sarkanda dust and sand particles comes along with the raw materials, 8 to 10% and 1 to 2% respectively. After dedusting, 5 to 6% sand etc. goes to wet cleaning plant in case of wheat straw. This raw material fed into the feeder bin. From feeder bin the raw material metered through a pin feeder to a belt conveyor which lead to a paddle washer (+13.5 M). Here the material is thoroughly mixed with water and the heavy particles like silica get

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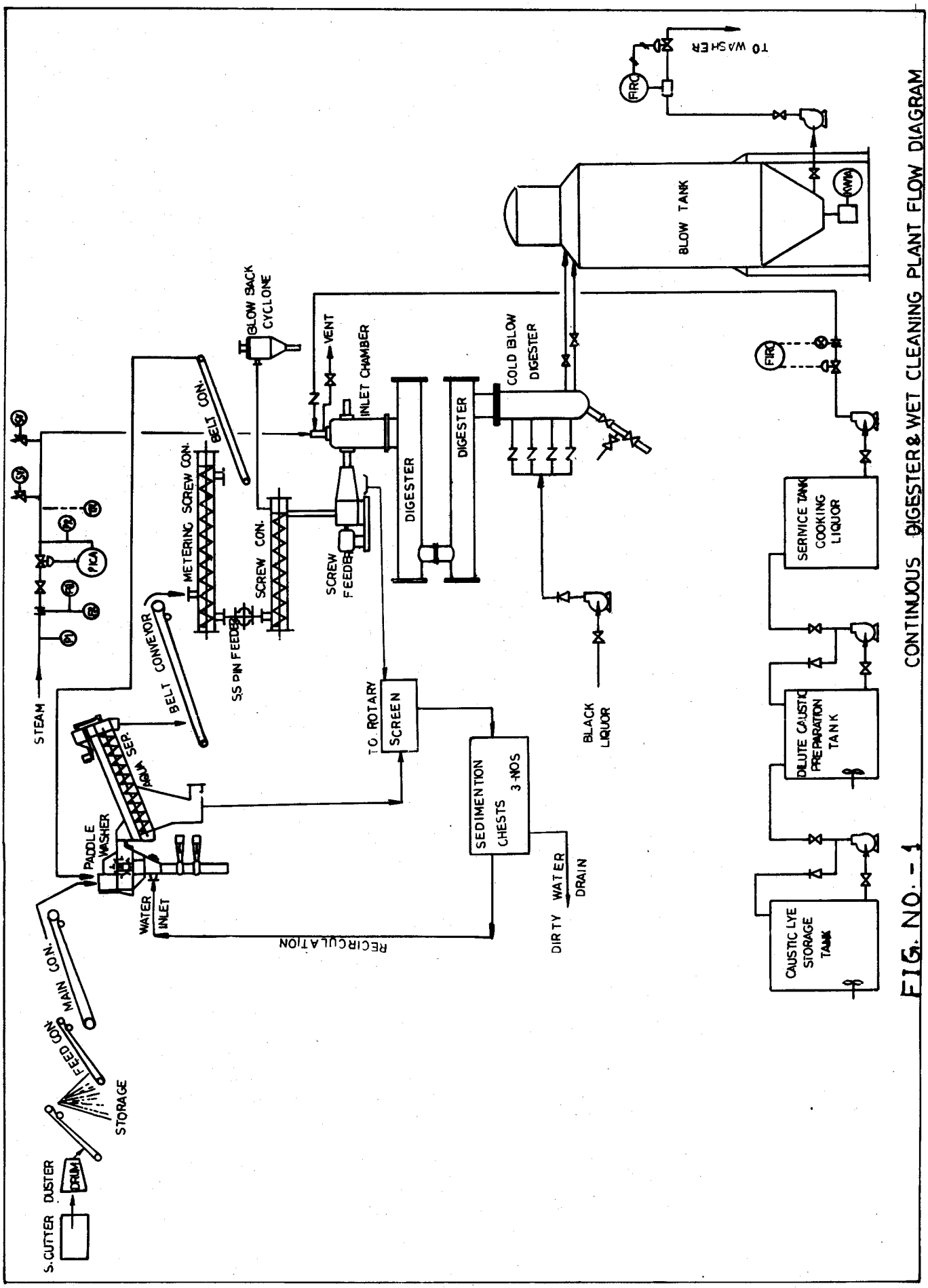

FIG. NO. - 1 CONTINUOUS DIGESTER & WET CLEANING PLANT FLOW DIAGRAM

Table No. 1					
Life of Feeding Screw For Different Kind of Raw Materials And Nature of Plug Formation					
Raw Materials	**Life of Screw Feeder (Hrs)**	**Sizes of Plug Diameter (mm)**	**Pipe Length (mm)**	**Nature of Plug**	**Back Blowing**
SARKANDA	1200	375	170	VERY HARD	ALMOST NIL
WHEAT STRAW	600-900	390	FLANGE THICKNESS-10	HARDER	RARE
BAGASSE	1000-1200	370	200	HARD	ATTENTION IS REQUIRED

settled at the junk traps which is periodically removed through a set of valves.

From paddle washer the stock over flows into the aqua separator. Here the stock is completely washed. The washed water rejected from the aqua separator is screened to remove the impurities from the water, and recycled into the system. The washed stock from the aqua separator is fed to the metering screw conveyor at 70% moisture through a belt conveyor. The foreign materials i.e. sand etc. in case of wheat straw is washed out by 65 to 70% in the system.

The metering screw conveyor helps to maintain the stock level at the pin feeder. The excess stock from the metering screw conveyor conveyed back to the paddle washer through a return belt conveyor, as shown in **fig. No.1.** All conveyors and paddle washer are interlocked with metering screw.

b). SCREW FEEDER

Screw feeder is designed to feed the raw material into the digester against a steam pressure of 8 kg/cm^2. The screw feeder is equipped with a tapered feed screw and therefore pushes the raw material forward under increasing compression through the tapered throat. Plug is formed through a plug pipe, a continuously moving plug of sufficient density to seal the steam pressure effectively without any leakage of steam. The size of screw feeder is 18" and material of construction of screw is carbon steel. The feeding capacity of screw varies with size and speed of screw. The compression ratio of the screw feeder is designed to 1.35:1. The life of screw feeder in different raw materials is shown in **Table No.1.**

INLET CHAMBER AND BLOW BACK VALVE

The inlet chamber is the first portion of the pressurized section of the continuous digester. Raw material passes through this chamber as a compact mass in plug form which then enters the digester tube no.1 for chemical treatment. The inlet Chamber is mounted on the inlet branch of the digester tube and on top of this chamber are located the main steam and liquor inlets.

Opposite to the inlet from the screw feeder is placed a stop valve known blow back valve. This is fitted by a double acting pneumatic cylinder. The stroke of which is 950 mm. The function of blow back valve is to prevent the escape of steam from the digester with consequent loss of pressure in the system should the plug of raw material coming from screw feeder fail as a seal. The operation of the valve is made automatic by connecting it with the electrical "low Load" of the screw feeder motor.

c). TWO TUBES WITH TIMING SCREW

Intimate mixing of raw material, chemicals and steam takes place in the tubes. The continuous digester has two horizontal tubes, of 800 mm diameter and 40 feet length. A conveyor screw termed as "TIMER SCREW" extend to full length of each tube. The cooking time of all agricultural residues vary slightly and retention in timers can be adjusted in tubes through variable dyano drive speed control. It is known that for every 10^{0}C rise of temperature, cooking time is reduced to half for a particular K.No.

d) COLD BLOW DISCHARGER (CBD)

The function of the discharger is to transfer the cooked pulp from the high pressure zone to atmospheric pressure continuously and uniformly. The CBD unit is attached from digester outlet flange. High pressure ring dilution of black liquor from Ist brown stock washing, which is stored into a tank is pumped at 13 kgs/cm^2 to dilute the cooked in range of 5 to 7 & cy%. The dilute pulp is continuously blown into blow tank which is controlled by automation valve.

Table No. 2

Comparative Study of Continuous Digester V/S Spherical Digester For Avg. Consumption of Steam Men Power Etc. Per MT. of Unbleached Pulp

Tpye of Digesters	Power (KW)	Steam (M.T.)	Cooking Time (Mints)	Bath Ratio	Man Power (Nos.)	Knotter Screen Reject (%)	Uniformity Pulp
Spherical Digester	32.5	2.40	180+120+210	1:2.8	0.5	3.0 to 3.5	Non-Uniform
			(Total Cycle)				
Continuous Digester	74.5	1.80	15	1:3.7	0.2	1.0	Uniform

e) INSTRUMENTATION AND CONTROL

Computer control application has found its place in continuous cooking process. Both analog and digital computering systems are deployed. The cost of installation is justified where rated production is very high.

Success of computer application in the mill largely depends upon accurate, dependable measuring devices, trouble free and sustained performance. This will be feeding data to the computer network.

The instrumentation control plays an important role in maintaining the quality of the product and the economy of the operation of continuous digester (Fig-2). The entire functioning is controlled through a DCS, through nine no, of loops, which include-

a) Cooking Liquor Feed Control

Consisting a level indicator for the cooking liquor tank. Set points is given of DCS which controls the feeding of liquor. Physical check up of charge of liquor is checked time to time.

b) Digester Temperature and Pressure Control

Digester tube pressure and temperature is controlled through DCS set point. All temp valves pressure curves may be checked on DCS. Everyday readings may be collected from DCS, like pressure and temp. records, total steam consumed etc.

c) Cooking Time Control

Cooking time is achieved by varying the speed of the screw timers.

d) Blow Back Valve

This work in conjunction with screw feeder load to avoid any blow back. This also can be controlled manually through a pneumatic valve installed on the pneumatic cylinder.

e). CBD

Overloading of timer No.2, continuously blowing is controlled through DCS set point maintaining CBD temp. around 135^0C.

SAFETY DEVICES

The pandia continuous digester has not posed us any acute problems. Periodic checks have been sufficient for the smooth operation of the system. The total system is interlocked starting from feed conveyor to main conveyor and at wet cleaning plant is interlocked with metering screw. Screw timer no. 2 is interlocked with screw timer no.1. Overloading of timers are connected with buzzers. As well as screw conveyor feeding to screw feeder is interlocked with pin feeder. A spare blow back valve is ready and kept assembled.

ADVANTAGES OVER BATCH DIGESTERS

a). Less Man Power

Batch digester system usually require several more men than that required in operating continuous digester. Details are shown in **Table No.2.**

b) Reduced & Steady Steam Consumptions

Because of continuous cooking is more efficient steam requirement is considerable lower. Also load on boiler does not fluctuate as steam is fairly constant.

c) Lower Corrosion Problem

Continuous digester shells are pressurised all the time during operation, and temp. in both the tubes stay constant, which effectively inhibit corrosion. With batch system on the other hand, corrosion is a major cost item.

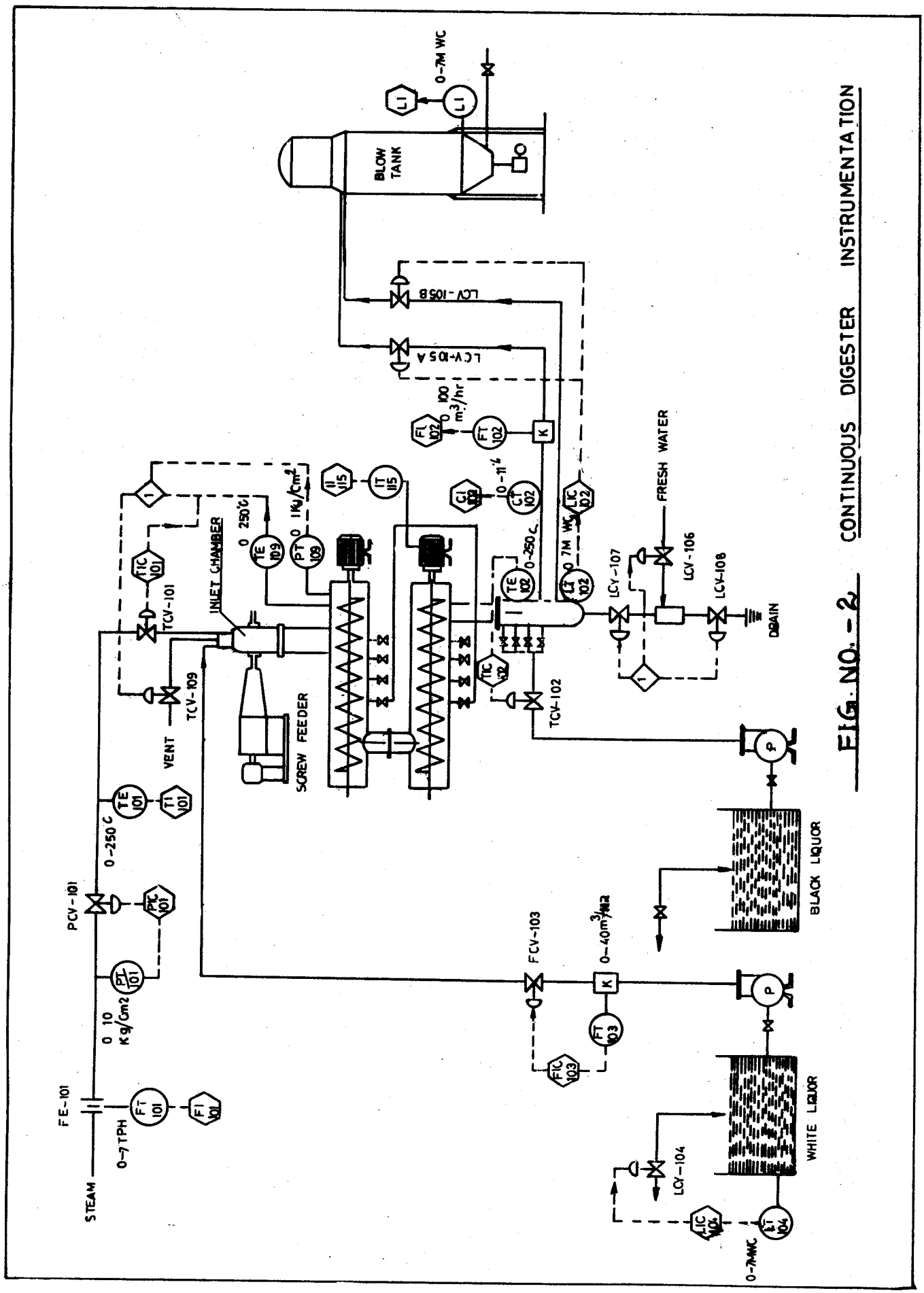

FIG. NO. -2 CONTINUOUS DIGESTER INSTRUMENTATION

Table No. 3				
Bleached Pulp				
R/MATERIAL	CONTINUOUS DIGESTER		SPHERICAL DIGESTER	
	T.F	B/L (MTS)	T.F	B/L (MTS)
Sarkanda (Washed)	52-54	3200-3600	48-50	3000-3500
Bagasse (Depithed & washed)	50-52	3000-3200	48-52	2800-3200
Wheat straw (washed)	51-53	2860-3200	50-52	2950-3400

d) High Yield

Uniformity of cooking in continuous digester means virtual elimination of uncooked fiber bundles.

e) Better Pulp

Pulp fiber degradation is presented in continuous digester by cooking the stock well below the point where mechanical handling could cause damage before discharge begins. This feature, pulp optimum cooking condition give pulp of superior breaking length and tear factor as compared with batch system pulp. Shown in **Table No.3.**

f) Less Cost of Bleaching

Due to uniformity in the pulp produced in the continuous digester, bleaching chemical consumption is low.

g) Lower Chemical Consumption

Chemical consumption in case of continuous digester (as NaOH) is comparatively low by 1.0 to 1.3% in different raw materials. The comparative study is given in **Table No.4.**

PROBLEMS & MODIFICATIONS

A number of modifications and addition were made from the original design to suit our operating experience, we have gained during the operation of pandia for the last three years. When the digester was commissioned in May'1995, it was commissioned at a lower screw feeder speed producing 25-30 MT of unbleach pulp per day due to small inlet chamber which was used of old sprout waldron DIGESTER. At the higher speed frequent jamming of inlet chamber and then tripping of main motor occurred. Problem was overcome by changing inlet chamber of bigger size and blow valve then screw feeder speed was gradually increased. Unbleached pulp production reached to 65-70 MT./day.

RESULTS & SUGGESTIONS

When we compare the properties of pulps from batch spherical digester and continuous digester the (Table-2 & 4) give the comparable picture.

These results show in continuous digester good control system and the advantages of cooking at higher pressure which results in strong and clean pulp.

Runnability of paper machines, specially the high speed machines improve if the pulp characteristics are consistent.

In case of the batch digester the characteristics of the pulp from different batches will vary where in case of a continuous digester, uniformity is maintained.

CONCLUSION

Table No. 4				
Comparative Ave. Caustic (As NaOH) Consumption of Spherical Digester V/S Continuous Digester on O.D. Raw Material				
RAW MATERIAL	SPHERICAL DIGESTER CAUSTIC (AS NaOH) AVG. %	K.NO.	CONTINUOUS DIGESTER AVG. CAUSTIC (AS NaOH) %	K.NO.
Sarkanda (Fresh)	12.0	11 to 12	11.0	11
Sarkanda (OLD)	12.5	12 to 14	11.40	12
Wheat straw	14.0	13 to 15	13.2	11-12.5
Bagasse (Depithed)	12.2	12 to 14	11.5	11-12

The pandia digester though designed for agricultural residues is capable of making fairly good quality chemical pulp by the soda process, for the manufacture of quality writing & printing papers. Alongwith high yield pulp by the semi-chemical process. When the paper industry is seized with the problems of conservation of raw materials, continuous pulping equipment like Pandia is bound to become very popular.

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