Fluidized Bed Soda Recovery System At Shreyans Paper

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ABSTRACT:-- Black liquor from cooking agricultural residues has high silica content and can not be concentrated to high soild contents to enable its burning in conventional recovery systems. Conventional soda recovery system can not be adopted unless silica content in black liquor is reduced. Therefore, Shreyans Papers has installed fluidised bed soda recovery system where the weak black liquor having high silica content when being concentrated to 25-35% in multiple effect Evaporator to avoid hard scale formation in the evaporator tubes. Scale formation in evaporator is very prominent in black liquor when concentrated to more than 40% solids. Weak Black liquor is concentrated to 30% solids in M.E. Evaporator and it is further concentrated to 38 to 45% by flue gase in Venturi Scrubber and Cyclone system. Then this heavy concentrated black liquor is sprayed into Fluidised Bed Reactor (FBR).

The inorganic portion is converted into Sodium Corbonate in Pellet form by maintaining the Fluidised Bed Reactor around 700°C. Sodium Corbonate can be converted into Sodium Hydroxide in a Recausticizer Plant or can be sold as such.

This will lead to elimination of Pollution load caused by discharge of black liquor from agricultural residue based medium sized pulp mills.

INTRODUCTION

Shreyans Papers has installed a Fluidised Bed Reactor for its Soda Recovery as a long term environmental policy. The mill decided to use Fluidised Bed Technology of chemical Recovery for black liquor from agricultural residues having high silica content based on experience from South Africa, Mexico and USA.

The main features of this process are:

- Chemical Recovery is more than 85%.
- Smooth and trouble free operation of the plant.
- It occupies minimum floor area
- Initial investment is low as well as gestation time is very low.
- No smelt formation, therefore the chances of explosion are eliminated.
- Carryover with flue gas is controlled by Wet Scrubbers. Therefore air pollution is minimum.
- It is not essential to go for Recausticizer plant and Sodium carbonate in the form of pellets can be sold to other chemical Industries.
- It is suitable for any cellulosic raw material being used for paper making.
- Once Fluidised Bed Reactor becomes steady no auxilliary fuel is required in the normal course of

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operation.

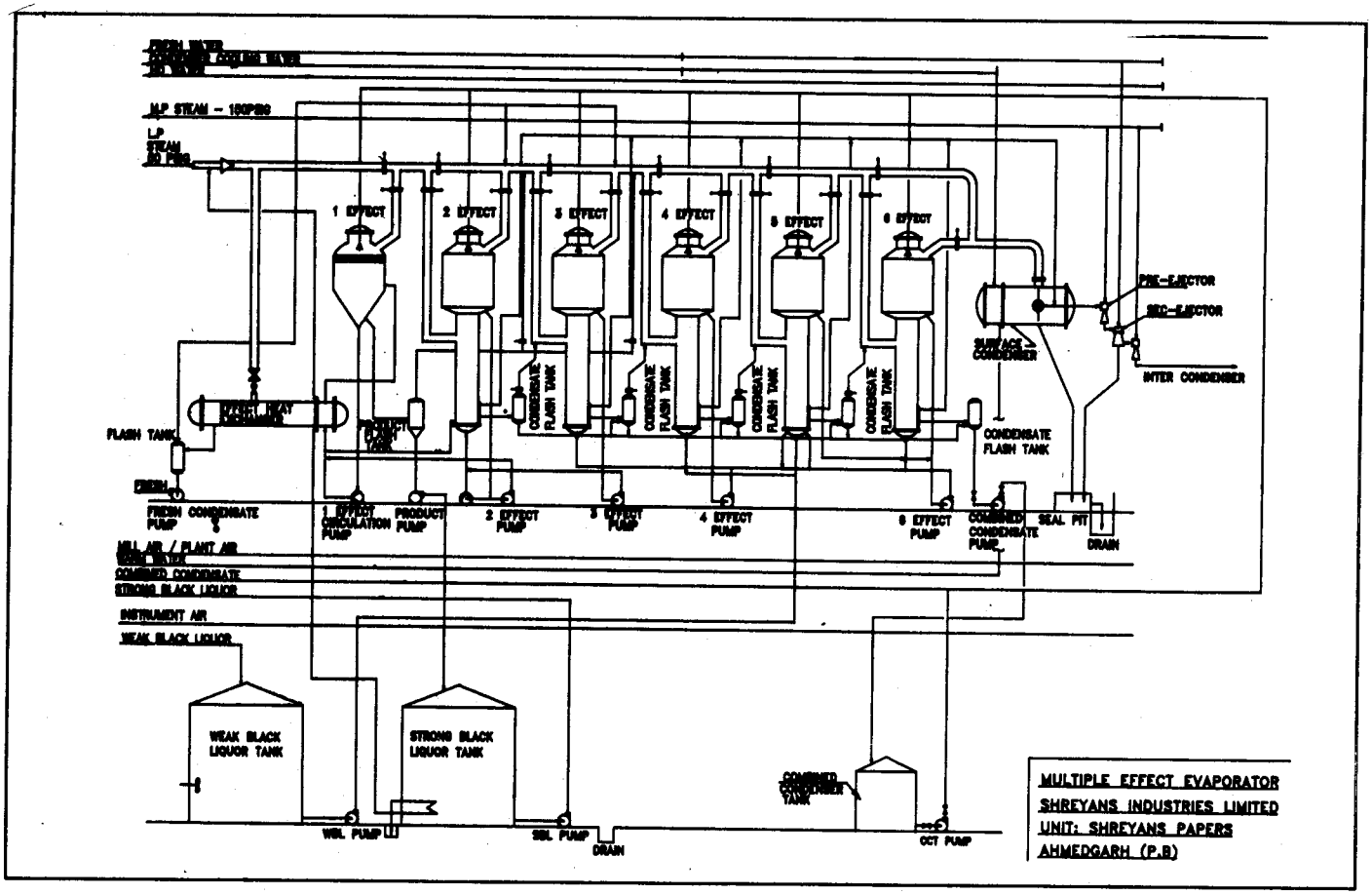
- Fluidised Bed Recovery System can be operated by only three persons per shift.
- Black Liquor having solid contents only 38-45% is burnt in the Reactor.

The major draw back of this system is that there is no generation of steam. Steam required for ME Evaporator etc is to be supplied from other sources. M\s Shreyans Papers has gone for High Pressure Boiler and utilise the exhaust steam from turbo generation set for evaporation

Process:

Weak Black Liquor having total solids of 8% are fed to ME Evaporator as shown in figure-I, having sextuple effects and one heat exchanger. Generally all six effects will be under operation. From time to time one of the effect is being taken out for tube cleaning, thus maintaining steam economy of above 4.5, fresh steam is fed at 3.5 to 4.5 kg/cm^2.

The Black Liquor is concentrated at 25 to 30% in the ME Evaporator and is collected in semi concentrated form in storage tank provided with agitator and heating arrangements to raise the temperature of Black Liquor if it gets coolled down during storage, especially during the winter. This black liqour is pumped to ventur Scrubber which operates as a direct contact type evaporator. This Black Liquor is sprayed in fine mist form and gets in direct contact of flue gases in the venturi scrubber. Then it is passed to Cyclone where the concentrated black liquor is seperated from the flue gases and is taken out from the bottom cyclone partially for recirculation and partially to heavy liquor storage tank. The heavy Black Liquor has a concentration of 40 to 45% Total solids. This heavy black liquor is pumped to a specially designed feed gun, which sprays this liquor either with compressed air or steam into the upper free gas space of Fluidised Bed Reactor (Free Board). In the free board water is evaporated from concentrated black liquor by the hot gases generated by combustion. As the partially dried liquor solids falls into the fluidised bed, the burning of black liquor solids takes place and the temperature of the fluidised bed is

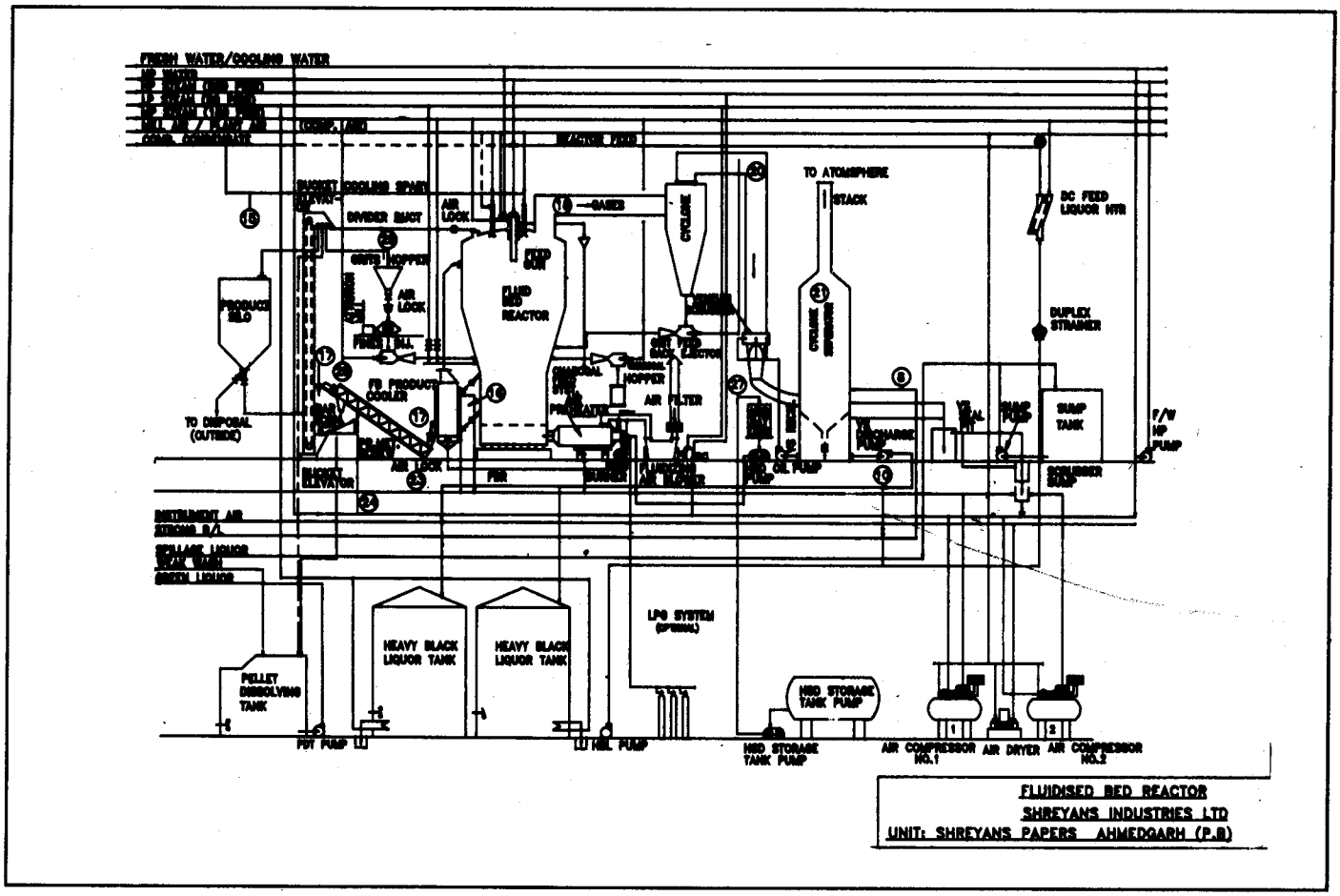


maintained at around 700°C. Organic material is converted to carbondioxide and water vapour while the inorganic part is converted into Sodium Carbonate in granular form. Sodium Carbonate pellets are withdrawn through the side of the Reactor at a rate equal to the rate of accumulation of Sodium Carbonate granules obtained with the help of a variable speed metering screw. Since the sodium carbonate pellets coming out of reactor are very hot the metering screw is water cooled. The sodium carbonate pellets are either transported to silo with the help of bucket elevator or can be directly filled into the bags or taken into the dissolver for preparation of green liquor. Silica goes with Sodium Carbonate pellets and can be segregated in green liquor clarifier.

The Reactor bed material is kept in a fluidised state by the flow of combustion air entering the bed through nozzles in an orifice plate. The orifice plate distributes the air uniformly and also supports the weight of the bed. The space in the Reactor below the orifice plate is retfered to as a windbox and it assists in the distribution of the air coming in from the fluidizing air blower through the start up air preheater.

The Injection of Soda ash particles (fine dust) is required at times to have proper particle size distribution which ensures complete and reliable fluidisation of bed material. The fines of Sodium Carbonate pellets are produced by grinding in attrition mill. The fine dust is injected with steam, or compressed air into the fluidised bed.

The Reactor is provided with automatic control system to control the temperature of the bed within ±5°C. In case temperature of the bed goes high there are chances of melting of Sodium Carbonate and formation of big lumps. On the other hand if the temperature goes down there is every chance of incomplete combustion of organic substances and getting soda ash of low purity having unburnt Carbon. Close temperature control is essential.



Arrangements has been provided to spray water or weak black liquor to bring down the temperature of the Reactor while auxiliary fuel like Charcoal or furnace oil can be used to increase the temperature.

During the startup, the bed of Sodium Carbonate pellet is made. The fluidized air is heated to approximate 540^0 with the help of furnace oil. Once the bed reaches this temperature, granular charcoal is injected into the fluidized bed. Combustion of charcoal will rise the bed temperature to 650^{0}C then the spraying of black liquor is introduced. Once the system is stabilised, there is no need of using charcoal or furnace oil. Occasionally auxiliary fuel is used for short periods to maintain the temperature of the bed.

In this system Chlorides content should be maintained very low to avoid lump formation in the bed and it should not be more than 1%.

Special features adopted at Shreyans Papers for F.B. Soda Recovery System:

The fluidized air blower being the heart of the fluidised bed Reactor requiring 500 BHP is preferably run by steam turbine on co-generation principle with inlet steam pressure of 42 kg per square centimeter and exhaust steam pressure of 8 to 9 kg per square centimeter. The exhaust steam will be utilised in the pulp mill and in ejector of ME Evaporator.

2.5 MW Turbo generator is also being installed to take care of extra load created by Fluidised Bed Recovery System as well as to reduce purchased power demand from State Electricity Board. The exhaust steam from turbo generator is fully utilised in ME Evaporator and in paper machine.

The weak black liquor from Agricultural residues has been analysed and the characteristic of black liquor are given below:-

a. Total dissolved solids : 8.5 to 9.8%
b. Residual active alkali : 1.85 gm per litre as NaOH
c. pH : 11.2
d. Organic compounds (By loss of ignition) : 72%
e. Inorganic compounds (by difference) : 28%
f. Carbon (C) : 38%
g. Silica (SiO_2) : 4.2%
h. Sodium (Na) : 18.5%
i. Hydrogen : 4.2%
j. Gross calorific value on 100% solids : 3300 Calories per gm

Viscosity

At 30 % dissolved solids : 35 m Pa S
At 40% dissolved solids : 190 m Pa S
Swelling volume ratio ml/gm : 6.5

DTA Analysis

a. Charcoal burning starts at 665^{0}C
b. Charcoal burning completes at 705^{0}C

TGA Analysis

Temp ^{0}C	Weight Loss %
200	10
645-700	67

The sextuple effect evaporator has been erected and it is expected that steam efficiency will be more than 4.2. The dissolved solids in black liquor expected at different stages in ME Evaporator are as given below:

S.No.	Effect	1st	2nd	3rd	4th	5th	6th
1.	% dissolved solids in black liquor at inlet	24.5	17.0	14.0	8.5	8.5	10.8
2.	% dissolved solids in black liquor at outlet	35.0	24.5	17.0	11.0	10.8	17.0

As it can be observed that maximum dissolved solids in black liquor are well below 40%, Therefore no operational problems of sealing and very high viscosity in black liquor is expected in ME Evaporator.

The temperature control and maintaining the desired height of fluidised bed is most critical in smooth operation of Fluidized Bed Reactor. Latest instrument system in the F.B. Technology has been adopted. Instrumentation system consists of DISTRIBUTED CONTROL SYSTEM (DCS) with colour printer and single loop controllers, DCS provides flexibility and sophistication to medium scale

plants. It consists of Man Machine Interface and control/data acquisition sub system.

Operator station is a Man Machine Interface and provides the operator with various process information on colour to monitor control and monitor. It has panel display keys for the user to have standard display panels like overview, Alarm, Control, Tuning, Trending, Dynamic Graphics etc.

The single loop controller are programmable type.

Communication to supervisory station is through peer way.

The following controls are provided in the fluidised bed Reactor.

a. Heavy black liquor flow control to Reactor.
b. Weak black liquor/combined condensate spray to control temperature.
c. Blower Air flow control to Reactor by Pitot tube.
d. Bed level indication by differential pressure before and after orifice plate.
e. Blower Air Flow Control to product cooler by Pitot tube.
f. Level controls for product cooler and cyclone separator.
g. Venturi Recirculation flow control.
h. Density control of Heavy black liquor and green liquor.

The following are the interlocks provided in the Fluidized Bed Reactor:

1. Either Venturi level goes above a certain limit or Venturi Recirculation flow goes below a certain limit, Blower turbine will be stopped.

2. If the temperature inside the Reactor goes below the limit or Air flow to Reactor is not sufficient automatically heavy black liquor flow to Reactor will be stopped.

3. Reactor wind box temperature goes above the required temperature, air preheater bed burner will be stopped.

4. Product cooler water pressure drops below a limit, heavy black liquor flow will be stopped.

Inside reactor at various elevations temperature is also measured. Temperatures have been found in one of Fluidised Bed Reactor under operation are as given below:

Lower Bed	:	695°C
Middle Bed	:	705°C
Upper Bed	:	705°C
Free Board	:	700°C

The Shieves analysis of Sodium Carbonate pellet available from Fluidised Bed Reactor are as follows:

	Mesh Size	Percentage
1.	10	7.5
2.	20	30
3.	30	20
4.	40	25
5.	50	10
6.	60	7.5

The above shieve analysis shows that mostly sodium carbonate pellet size is between 20 to 50 mesh.

In causticizer plant the operation will be as it is in conventional causticizer plant and no problem of difference is expected to convert green liquor into white liquor in the Recausticizer plant.

It is expected after the operation of Fluidized Bed Recovery System 80% of cooking Chemical will be recovered including the chemical losses in the pulp mill.

CONCLUSION

Fluidised Bed Soda Recovery System is not a new technology and has been in operation in other countries like South Africa, Mexico.

It is easy to operate Fluidized Bed Reactor. The main drawback in this system is that it has low thermal efficiency but it is very suitable where raw

materials having high Silica are being used.

Control of the temperature at the height of Fluidized Bed in the Reactor is essential for smooth operation. makeup chemicals to be used should have low chloride contents.

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