Pretreatment of Wheat Straw to Make Its Black Liquor Suitable For Fluidised Bed Reactor

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ABSTRACT

It has been found that the Chloride contents in agricultural residues can be brought down by Wet cleaning .Thus black liquor from agricultural residues after wet cleaning can be made suitable to be fired in Fluidised Bed Reactor.By squeezing agricultural residues after soaking in fresh water to high consistency with screw press make more effective to reduce Chloride contents in treated agricultural cellulosic raw masterials.

INTRODUCTION

Fluidised Bed chemical recovery plant successful operation from soda based agricultural residues black liquor mainly depends upon having low Chloride contents in black liquor preferably below 0.5% as Nacl. Chloride contents in black liquor are mainly due to Chloride contents present in agricultural residues. The most of metals chlorides as salts have high solubility in water. During the cooking of agricultural cellulosic raw materials with Sodium Hydroxide, the Chloride contents in raw material goes with black liquor as Sodium Chloride. High Chlorides concentration in black liquor bring down the eutectic melting point of the resultant of Soda Ash obtained after combustion. Lowering of eutectic melting point of Soda Ash results in defluidisation of the bed of Fluidised Bed Reactor. Therefore, it becomes essential to give pretreatment of agricultural cellulosic raw materials, (Where Chloride contents present in the raw materials are more than 0.5% as Nacl) to reduce Chloride contents in them below 0.3% as Nacl. It has been found that Chlorides present in cellulsic raw materials are easily water soluble and can be removed by Wet Cleaning process with fresh water having low Chloride contents.

Studies were conducted to determine how effectively Chloride contents in agricultural residues can be reduced.

Shreyans has established the following Chloride testing method in raw materials, which can be corelated with the Chloride contents found in black liquor at plant scale.

The raw material is cut into small pieces, then weighed material is soaked with 10% w/v Sodium hydroxide solution preferable in a platinum crucible.

After drying, the soaked material is burnt in muffle furnace at 500-550^{0}C till complete burning takes place.

After cooling in desicator, the burnt material is dissolved in hot water and is filtered through a filter paper, collecting the clear filterate in a titration flask.

To the filtrate 2-3 drops of phenolphthalin is added and it is neutralised with 0.02 N Nitiric acid.

After neutralisation, 3 ml of 30% w/v Hydrogen peroxide is added and then the solution is titrated with 0.1 N Silver nitrate solution using 5 drops of Potassium Chromate solution as an indicator till a slight reddish tinge appears and Chloride content is calculated on oven dry material as Nacl. The same method has been adopted for determination of Chloride content in black liquor.

LABORATORY EXPERIMENTS

The main agricultural cellulosic raw materials used for the manufacture of paper are Bagasse, Wheat

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Table-I

Chloride contents in different raw materials

S.No.	Raw material	% age Chloride content as Nacl.
1.	Bagasse	.09 to 0.17
2.	Wheat straw	.95 to 1.87
3.	Rice straw	0.4 to 1.3
4.	Sarkanda	0.2 to 1.49
5.	Sabai grass	.23 to .25
6.	Kahi	.22 to .64
7.	Jute caddy	.02 to .03

straw, Rice straw, Sarkanda, Kahi grass, Sabai grass and Jute caddy. All above materials were analysed for Chloride content and test results are given in **Table-I.**

It can be observed that the Chloride contents in same species of agricultural residues vary depending upon the Geographical location. It is said that the harvesting time, the Geographical location and population affects the chemical composition and Morphology of the agricultural raw material.

The Chloride contents in Bagasse is always found to be below 0.17% as Nacl, where as another major agro-raw materials wheat straw being used by Shreyans has chloride contents as high as 1.87% as Nacl. Therefore, black liquor obtained from cooking as such Wheat straw is not suitable for Fluidised Bed-Reactor unless until chloride contents in Wheat straw are removed in order to keep Chloride contents in black liquor below 0.5% as to avoid defluidisation of Sodium Corbonate bed of Fluidised Bed Reactor. Therefore, a series of experiments have been carried to determine the effect of temperature, consistency and retention time on percentage of Chloride contents removed in agricultural residues especially Wheat straw.

EFFECT OF TEMPERATURE

During this experiment, the consistency of wheat straw during soaking in fresh water having Chloride contents was maintained at 5% and soaking time was given 30 minutes. Wheat straw having different initial Chloride contents was used.

In all experiments soaked Wheat straw are transferred on markin cloth and it was squeezed to about 22% consistency Squeezed samples were air dried before determination of Chloride contents reduction in washed Wheat straw at different, temperature. The test results are given in **Table-II** With the rise of temperature from 27^0C to 40^0C, there is major reduction in the Chloride content in the treated Wheat straw even soaking wheat straw in fresh water at room temperature, as can be observed from Table-II. There is slight improvement in reduction in Chloride content in treated wheat straw if temperature of water is raised to 40^0C from 27^0C, but there is no appreciable Chloride contents reduction in treated wheat straw when temperature of water is raised from 40^0C to 60^0C.

EFFECT OF CONSISTENCY

As shown in **Table-III**, there is major reduction in the Chloride content of treated Wheat straw if the consistency during soaking of Wheat straw is changed from 6% to 4% and no major reduction in Chloride content in treated wheat straw if consistency during soaking is brought down from 2% to 1%.

EFFECT OF RETENTION TIME

As shown in **Table IV**, there is no major change in the reduction of Chloride content in treated wheat straw if soaking period is increased from 60 minutes to 120 minutes. Major reduction in the Chloride content in treated wheat straw take place within fifteen minutes of soaking in fresh water.

Table-II

Effect of temperature on the reduction of Chloride content in Wheat straw after soaking in fresh water of 5% consistency for 30 minutes.

S. No.	In original Wheat straw	% age of chloride content in wheat straw					
		After soaking in fresh water at 27°C		After soaking in fresh water at 40°C		After soaking in fresh water at 60°C	
		In Treated Wheat straw	% age reduction of Chloride	In treated Wheat straw	% age reduction of Chloride	In treated W. Straw	% age reduction of Chloride
1.	1.87	0.45	75.93	0.41	78.07	0.39	79.14
2.	1.85	0.21	88.65	0.18	90.27	0.17	90.80
3.	1.26	0.12	90.47	0.09	92.86	0.08	93.65
4.	1.6	0.30	81.25	0.22	86.25	0.20	87.5
5.	1.72	0.32	81.39	0.21	87.79	0.21	87.79
6.	1.28	0.19	85.15	0.10	92.18	0.08	93.75

Table-III

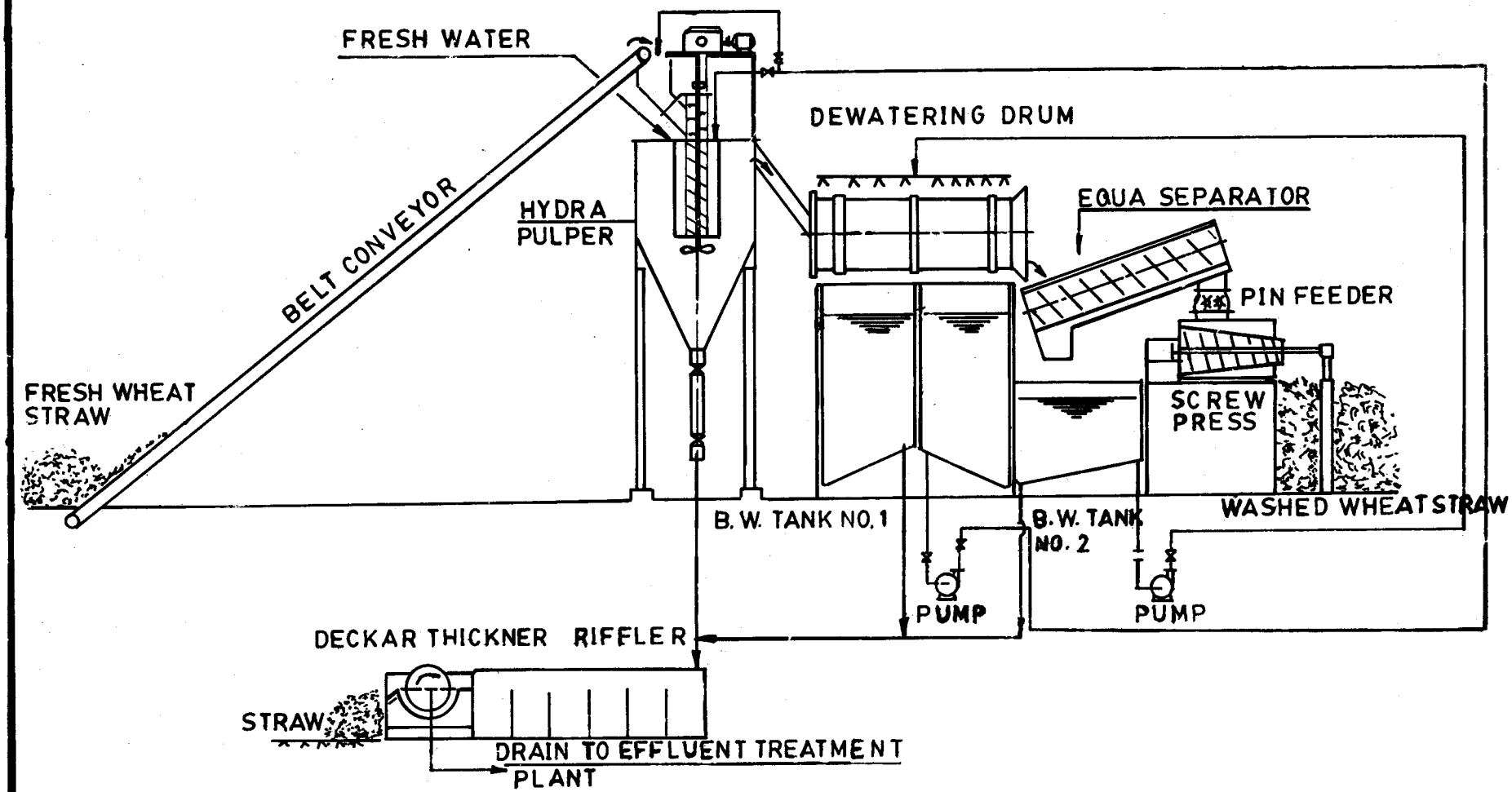
Effect of consistency on removal of Chloride content in Wheat straw after soaking in fresh water at 27°C (Room temp.) for 30 minutes.

S. No.	Percentage of Chloride contents in Wheat straw								
	In original Wheat straw	At 1% consistency		At 2% consistency		At 4% consistency		At 6% consistency	
		Chloride content in Treated Wheat straw	% age reduction	Chloride content in Treated Wheat straw	% age reduction	Chloride content in Treated Wheat straw	% age reduction	Chloride content in Treated Wheat straw	% age reduction
1.	1.17	0.24	79.49	0.24	79.49	0.25	78.63	0.35	70.08
2.	1.04	0.12	88.46	0.13	87.50	0.15	85.57	0.23	77.88
3.	0.94	0.16	82.98	0.18	80.85	0.25	73.4	0.29	69.15
4.	1.01	0.13	87.13	0.15	85.15	0.19	81.19	0.27	73.26

Table-IV

Effect of soaking time (Retention time) on the Chloride removal from Wheat straw after treatment with fresh water at 5% consistency at 27°C

S. No.	Untreated Wheat straw	Wheat straw soaked for 15 minutes		Wheat straw soaked for 30 minutes		Wheat straw soaked for 60 minutes		Wheat straw soaked for 120 minutes	
		Percentage Chloride contents in Treated and Untreated Wheat straw							
		Chloride content	Reduction % age	Chloride content	Reduction % age	Chloride content	Reduction % age	Chloride content	Reduction % age
1.	1.17	0.37	68.37	0.33	71.79	0.28	76.07	0.28	76.07
2.	1.04	0.44	57.69	0.39	62.5	0.26	75.0	0.25	75.96
3.	0.95	0.37	61.05	0.31	67.37	0.23	75.79	0.21	77.89
4.	1.01	0.39	61.38	0.32	68.3	0.27	73.27	0.27	73.27



WET CLEANING SYSTEM

TO REDUCE CHLORIDE CONTENTS IN WHEAT STRAW

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Table-V

Reduction in ash content in different raw materials after soaking in fresh water for 30 minutes at 5% consistency at 27°C

S.No.	Raw materials	% age of ash contents	
		As Such	After wet cleaning
1.	Wheat straw	6.1	5.6
2.	Bagasse	2.0	1.8
3.	Sarkanda	4.4	3.7
4.	Kahi	6.6	5.7

It can be observed from **Table-V** that there is reduction in the ash content by soaking Wheat straw or any other agricultural residues.

On the basis of above experiments, Wet cleaning system as shown in **Figure-I** was installed to reduce Chloride contents in Wheat straw. Heavy reduction in Chloride content in treated wheat straw on the plant scale is being observed as given in **Table-VI.** It can be seen with higher degree of squeezing of Wheat straw in screw press, the higher percentage of Chloride contents reduction in treated Wheat straw is found.

With present system 50% Wheat straw alongwith the bagasse is being used for pulping and maintaining 0.5% Chloride content in black liquor without having any defluidisation in Fluidised Bed Reactor by burning above black liquor.

CONCLUSION

It is essential to bring down the Chloride contents in agricultural residues, where its black liquor is processed in Fluidised Bed Reactor to avoid defluidisation of Sodium Carbonate pellets bed.

During the cooking of raw materials rayon grade caustic lye should be used.

Table-VI

Effect of consistency of Wheat straw on the reduction of Chloride contents being discharged by Screw Press

S.No.	Moisture %	Percentage of Chloride contents
1.	65	0.12
2.	69.4	0.23
3.	70.9	0.25
4.	71.7	0.27
5.	73	0.28
6.	73.1	0.30
7.	73.7	0.33
8.	74.2	0.35
9.	75.5	0.37
10.	75.9	0.39

Chloride contents in agro-residues can be easily bring down by soaking raw materials in fresh water, then squeezing out water from soaked raw materials.

In the plant scale care should be taken to have screw press to squeeze out water from fresh water treated materials to maximum extent to get low Chloride content in raw materials. To get very low Chloride contents in the raw materials a number of stages of dilution with fresh water, then squeezing out excess water can be installed.

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