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Process of Mathematical Model of Black Liquor Solids in Brown Stock Washing

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ABSTRACT

The procedure of mathematical modeling is regularly used to build scientific items, whose qualities compare in particular path to a specific certifiable framework. This present reality framework could allude to a physical framework, budgetary framework, social framework, environmental framework, chemical and process enterprises, telecom ventures, natural frameworks or basically whatever other framework, whose characteristics and reactions can be watched. A scientific project could be an arrangement of conditions, a calculation, a stochastic procedure, a geometric or arithmetical structure or even only an arrangement of numbers.The present paper makes an attempt to look at the process of Mathematical model of black liquor solids in Brown Stock Washing used during types of waste generated and treatment issues available for improving the quality of Pulp and Paper Mills.

Keywords: Efficiency, flexibility, low cost, pulp washing, effluent volume.

1. INTRODUCTION

Rising chemical costs and tighter pollutions are great incentives for the pulp and paper industry to increase the recovery of chemicals as well as utilize dissolved organic material. Also, it is advantageous to reduce the magnitude of mill effluent rather than treat large volumes of effluent after it leaves the mill. Recycling streams is a simple means of effecting part of this reduction. However, the consequences of recycling on dissolved solids concentrations and temperatures throughout the mill must be understood. Pulp and paper industry is very synthetic, work, contamination, vitality and water concentrated industry. It consumes approximately 10-17 tons of low pressure steam, 1300-1950 kwh electric energy, 250-350 m^3 of water and generates a pollution load of 300-400 ppm BOD, 1100-1300 ppm COD per ton of paper. During the process of manufacture of paper various operations are involved like, chipping, pulping, washing, dying, paper making, substance recuperation and

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Vol-22- Issue-14-December-2019

emanating treatment. Brown stock washing is one of the key steps, which inducts a direct impact on the economy of the mill as well as the surrounding environment. [Thesis, kukreja (1996)]

2. THE BASIC GOAL OF WASHING

The basic goal of washing is to remove black liquor solids from the pulp by spraying of water or weak wash liquor. Black liquor solids are removed mainly due to the following reasons:

- To obtain clean pulp for further processing.
- To recover expensive inorganic Na-salts in recovery section.
- To recover lignin based organic solutes for their heating values.
- To reduce consumption of bleaching chemicals in bleach plant.
- To reduce the total cost of effluent treatment.
- Strict pollution regulations forbid the swearing of chemicals.

Black liquor consists of dissolved organic (lignin derivatives) and inorganic (Na, Mg, Ca and K ions) solids. Aqueous organics (fundamentally lignin), if not isolated from the mash stream before fading, expends overabundance fading chemicals which creates more undesirable effluents, for example, AOX, shading, BOD, COD and other toxic emissions especially dioxins and chlorinated furans during bleaching. It may be pointed out that 1 kg of COD consumes about 0.4 to 0.8 kg of active chlorine. The lower the target Kappa number in the bleaching, the more Chlorine per kg of COD has to be used to get this Kappa number. Estimated cost of removing the AOX was $84/kg of AOX.

In a perfect world, there ought to be no flood of dark alcohol solutes with the washed pulp and no flood of filaments with the filtrate leaving the washing plant. Be that as it may, these perfect stipulations can never be met in the industry. Consequently, it is attractive that the mash ought to be washed ideally, i.e., utilizing least measure of wash water with most extreme evacuation of black liquor solutes.

The black liquor solutes occupy the space between the fibers (as displaceable solutes) and in the pores of the fibers (as non displaceable solutes) (Figure 1.1). These solutes are removed by water/weak wash liquor. The mechanics included is the aggregate of relocation of the liquor by development of water fitting controlled by liquid mechanics, scattering due to back blending, dispersion because of fixation slope and adsorption - desorption because of relative

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fondness of different solutes towards the fiber surface.

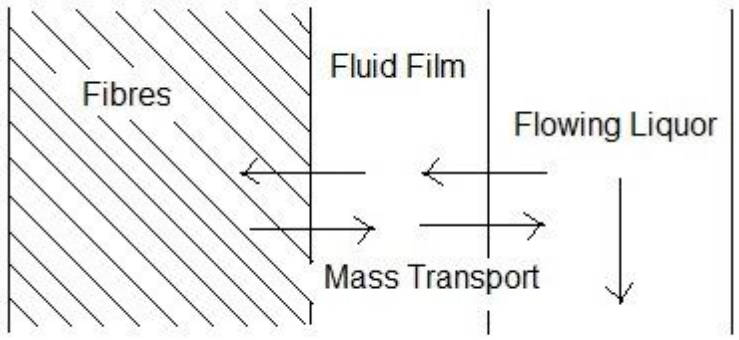

Figure 1.2: Schematic representation of different zones

3. WASHING METHODOLOGY

The washing methodology is based on the following operations:

(a) **Displacement washing:** In removal washing the liquor in the mash cushion is uprooted with feeble wash liquor or clean water. Blending at the interface between the wash liquor and the liquor being uprooted from the mash ought to be limited.

(b) **Dilution - agitation - extraction washing:** In the dilution extraction operation the pulp slurry is weakened and altogether blended with frail wash liquor or clean water and afterward thickened by sifting or squeezing. Weakening extraction does not expel all solutes unless it is rehashed commonly utilizing clean water.

The mechanism of pulp washing is further complicated by mass transport phenomena like dispersion, adsorption, desorption, foaming and channeling. Time allowed for diffusion of washable substance out of fibers is also an important factor.

4. SCHEMATIC PORTRAYAL OF A ROTATIONAL WASHER

A variety of equipments are available in the market for brown stock washing. Notable among these are rotary vacuum washer, pressure washer, belt washer, wash press, screw press, diffusion washer, pressure diffusion washer and fiberfuge continuous centrifuge washer. Of all these equipments, rotary vacuum washer is the oldest and is very commonly used equipment in the industry. It has under gone continuous modernization and development in its decades of application. In industry a battery of 3 to 4 rotary vacuum washers connected in

ISSN:0971-1260
Vol-22- Issue-14-December-2019

a counter current manner is used to wash the pulp. A rotational vacuum washer comprises of a wire work canvassed chamber which pivots in a vat containing slurry. As the drum pivots inside the vat different zones are framed. These are cake arrangement, first dewatering, washing, second dewatering, blow, release and no man's lands. Cross sectional perspective of a revolving vacuum washer is given in Figure 1.2. The component of each zone is clarified hereunder.

Pulp of approximately 1% consistency is fed inside the vat. A layer of filaments is stored on the external surface of the drum because of vacuum inside the drum.This layer of fibers becomes progressively thicker and thicker till at the end of cake formation zone. At the outlet of the cake formation zone the mat consistency is approximately 10%. On the upper part of the drum, water/weak wash liquor is applied with the help of nozzles at a pre determined temperature and quantity. Certain portion of the drum before and after the washing zone is left out under the influence of the driving force (vacuum) to assist the removal of black liquor trapped inside the fibers. Black liquor, water and air collected through different zones are withdrawn with the help of pipes connected with the respective zones. Pressure differential is not applied after the drying zone which causes the cake to lift up from the wire mesh. The cake is removed with the help of a doctor blade. In a counter ebb and flow washing framework cleanest wash water is connected just at the showers of the last washer for monetary reasons. Effluent from any stage is used for two purposes, to dilute the pulp coming from the previous washer and as shower liquor for previous washer. (Thesis,kukreja (1996)).

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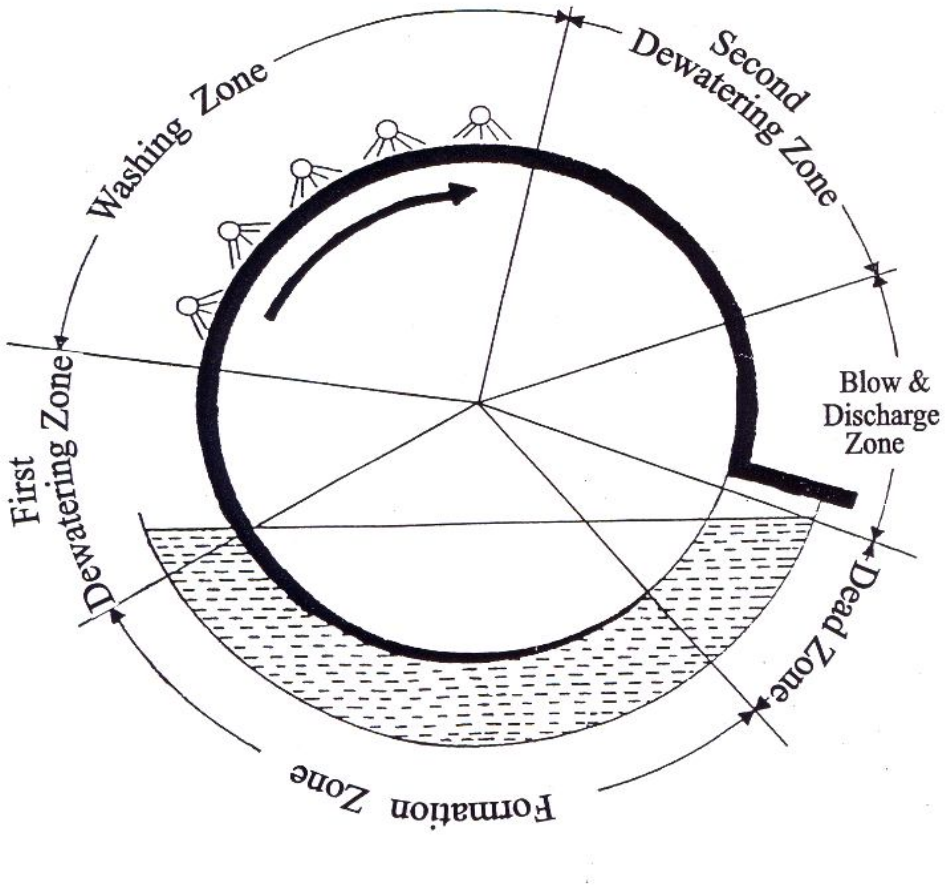

Figure 1.3: Schematic portrayal of a rotational washer

During washing the speed at which the diffusion of black liquor solids inside the fiber voids and the surrounding liquor takes place is dependent on the concentration difference between black liquor solutes at the inside and at the outside of the fibers, temperature of slurry, turbulence around the fibers and the size of the molecule. The larger the concentration difference, the higher the temperature and turbulence and the smaller the molecule size, the faster will be the diffusion rate and the faster the equilibrium will be reached.

1.5 FACTIRS AFFECTING PULP WASHING

During each rotation of the drum various zones are formed. Out of these zones the overall performance of the washer depends mainly upon the cake formation and washing zone. In a rotary vacuum washer working for brown stock washing and bleach washing the total area combining these two zones is more than 50 %. In this manner the greatest measure of filtrate (both thick and thin) from these zones will contribute most extreme to the aggregate where as

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Vol-22- Issue-14-December-2019

different zones, for example, dewatering and drying, are occupied with releasing nearly substantially less measure of filtrate. Other than filtrate, real measure of air is likewise extricated through these zones alongside the filtrate, showing a two stage stream circumstance. Commitment of air towards the dislodging of dark alcohol is not all that high. Dead and release zones have for all intents and purposes practically zero commitment to the era of the filtrate.

The development of cake amid cake arrangement zone is exceptionally reliant upon the delta vat consistency, fragmentary submergence of drum, speed of the drum, weight drop over the cake and particular resistance of the cake. Amid cake washing zone porosity, cake thickness, time of washing, liquor speed inside the cake pores, measure of wash water connected and mass exchange rate are real factors. Though, in first and second dewatering zones, cake immersion is a key variable due to concurrent stream of two liquids to be specific liquor and air. Typical scope of various parameters being followed in industry is given in Table 1.1.

Table 1.1: Normal range of different parameters

Parameters	**Units**	**Range**
Inlet vat consistency	%	1-2
Outlet vat consistency	%	10-12
Cake thickness	m	0.025-0.004
Dilution factor	kg/kg	1-5
Fractional submergence of drum	-	25-45
Liquor speed in cake pores	m/s	0.003-0.006
Pressure drop across the cake	Pascal	20000-50000
Pulp temperature	°C	60-90
rpm	-	1-4

6. CONCLUSION

The general transient mathematical model for a rotary vacuum filter used for pulp washing, was developed using phenomenological principles. Sodium loss due to sorption is significant and it is essential to include sorption effects in washing efficiency. Reduce bleaching requirements by process design and operation. Aim for zero discharge wherever feasible.

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Hence a uniform analysis is the need of the hour to increase the washing efficiency and to decrease pollution load.

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