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CHEMICAL OPTIMISATION OF PULP MIXING IN PAPER INDUSTRIES

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ABSTRACT:
Paper industries are using manual chemical control methods to apply the chemicals to the digester. The main objective of the project is to increase the quality of the paper by increasing the brightness of the pulp. The brightness of the pulp is inversely proportional to the pH value. Hence, the pH value should be maintained in the range of (2-4) to achieve the maximum brightness range 85%. Initially, concentrated sulphuric acid is pumped from the filtrate to the stand pipe in which the pulp is present. This mixture is mixed with the bleaching agent (ClO2 solution) in a D0 mixer. The acidity is controlled by the brightness given by a device. The industries are facing difficulty in calculating the accurate amount of acid to be supplied. The brightness shows fluctuations and makes it more difficult. In order to solve this problem, we are introducing pH meter(to detect the acidity of the solution) parallelly to the mixer .Due to this, the wastage of the pulp and chemicals is reduced and the quality of the paper is increased.

INDEX TERMS: pH;D0 stage; bleaching stage ,micro controller,Clo_2,Do mixer, ph electrode.

INTRODUCTION:
Trees provide the primary raw material for the paper and board industry. Wood is made from cellulose fibers that are bound together by a material called lignin. In a pulp mill, the fibers are separated from one another into a mass of individual fibers and after separation the fibers are washed and screened to remove any remaining fiber bundles. The washed pulp is dried and then paper is made by paper making machine. There are several chemical and mechanical pulping methods used for delignifying wood, separating fibers and removing discoloration. All integrated pulp and paper mill involve the same general steps in the manufacture of pulp and paper. This step include : 1.raw material preparation(debarking and chipping),2.mechanical or chemical separation of the wood fibers (grinding, refining, or digestion(cooking)to dissolve the lignin and extrsctive,3.removal of coloring agents (primary residual lignin)by bleaching ,4.paper formation and manufacture.
The chopped wood chips are taken to the digester to make pulp. Initially the wooden chips are taken through conveyor to digester. In the digester the wooden chips are cooked at high temperature and pressure. The white liquor is added in digester to remove the lignin pigment present in the wood chips. The white liquor is made up of sodium hydroxide, sodium sulfide, sodium carbonate, calcium chloride and calcium carbonate.

The process of removing lignin is known as Kraft process. The waste product from Kraft process is black liquor, which is recycled and reused. Then the pulp is washed and bleached to get bright colour.
The pulp is then given to dryer section, where the pulp is dried and pressed. The pressed pulp is then given to paper making machine and paper is made from it. In finish housing the papers are cut into required size and shape by automatic paper cutting machine. Finally the papers are packed and stored in storage bin.

PROCESS FLOW DIAGRAM:

The cooked pulp from the unbleached tower is sent to the P0W#2.From the P0W#2,the cooked pulp is sent to the stand pipe(D0 stage) via the heater mixer. Pulp is generally a base which contains maximum amount of NaOH where the pH of the pulp is in the range of (10-11),hence to reduce the pH, concentrated sulphuric acid is added to the stand pipe and the mixture becomes semi solid.

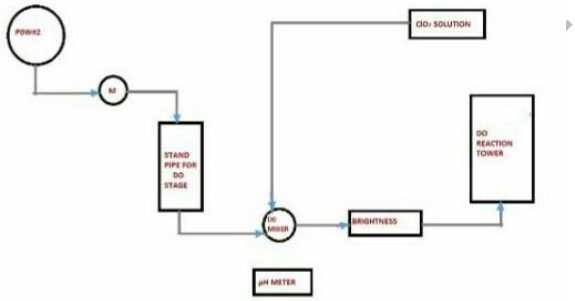

Figure 1Block diagram of D0 bleaching stage

The pH of the mixture is not immediately determined, since the reaction takes place for few minutes. After complete reaction ,the pulp is sent to the D0 mixer, where the pH is assumed to be in the range of (0-7) (acidic range).Then,ClO2 solution (bleaching agent)is given to the D0 mixer to increase the brightness of the pulp .The brightness is determined by the brightness (IR)sensor which is kept after the D0 mixer. Depending on the value of the pH, the brightness is either increased or decreased since the pH and the brightness are inversely proportional to each other.
In this range, the brightness obtained should be in the range of (50-64%). If its not obtained, then the above process should be repeated until the maximum brightness is obtained. Hence, it results in the wastage of cooked pulp and chemicals which is a great disadvantage. In order to overcome the above limitation H meter is introduced ,which is kept parallelly down to the mixer to determine the pH value of the pulp .In this stage, the pH value should be in the range of (2-4)to get the required brightness(50- 64%)

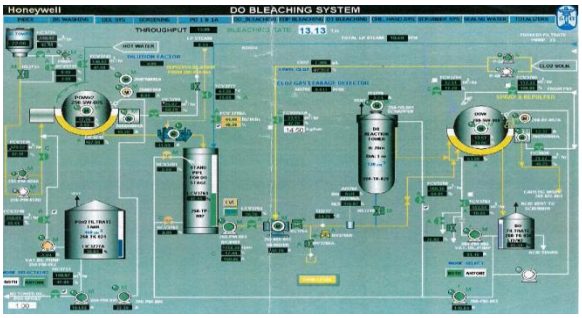

Figure 2 Process flow diagram D0 bleaching stage

Hence, the amount of chemicals to be supplied to the stand pipe and the D0 mixer is automated based on the pH value of the pulp to get the maximum brightness ,so that the wastage of the chemicals is reduced and thus the quality of the paper is also increased.

RAPID DISPLACEMENT HEATING PLANT PROCESS:

In this process, the wood chips along with the black liquor and white liquor with the steam are cooked well in a digester to get the pulp. In the operating cycle of the RDH system, the digester is charged with chips and packed with liquor or steam. The technique increases packing density by upto 10%,thereby increasing pulp production per digester. The digester is then filled with warm liquor at 100°C.The elevated pressure in the digester serves to uniformly impregnate the chips .The warm liquor is replaced with hot, white and black liquors. The displaced liquor is collected in an accumulator. The digester is discharged either with compressed air or by using pumping machine. Special heat exchangers are employed to preheat the white liquor for the next cook to about 155°C.

WASHING STAGE:

In this stage, a pressure knotter is kept where the cooked pulp is either accepted or rejected. If accepted, the pulp is sent to the next stage and if rejected, the pulp is sent back to the digester and the above process is repeated .The brown stock from the blowing goes to the washing stages where the used cooking liquors are separated from the cellulose fibers .Normally a pulp mill has 3-5 washing stages in series .Washing stages are also placed after oxygen delignification and between the bleaching stages as well. Several processes are involved: thickening (or) dilution ,displacement and diffusion .Lower dilution factor reduces energy consumption ,while higher dilution factor normally gives cleaner pulp.

Several types of washing equipment used are:

1. Pressure diffusers
2. Atmospheric diffusers
3. Vacuum drum washers
4. Drum displacers

BROWN STOP WASHER:

There are three brown stop washers in this stage in which the pulp is washed in black liquor, since because when the pulp is being washed, the brightness is increased .At the end of this stage the brightness obtained is in the range of (25-30%)

OXYGEN DELIGNIFICATION STAGE:

Here the pulp is mixed with oxygen to increase the brightness range. This reaction takes place for about 56minutes.Hence,it is sent to the reaction tower for further process.

LOW CONSISTENCY TANK:

Low consistency tank is nothing but a storage tank which is used to store the pulp. The consistency is measured based on the amount of water and the solid contents present in the pulp(which is in the form of semi solid).If the amount of water content is high ,then it is called low consistency and if the amount of solid present is high ,then it is high consistency.

SCREENING STAGE:

Screening of the pulp after pulping is a process whereby the pulp is separated from large shives, knots, dirt and other debris. The material separated from the pulp is called reject. The screening section consists of different types of sieves (screens) and centrifugal cleaning. The sieves are normally set up in a multistage cascade operation because considerable amounts of good fibers can go to the reject stream when trying to achieve maximum purity in the accept flow. The fiber containing shives and knots are separated from the rest of the reject and reprocessed either in a refiner and/or is sent back to the digester .The content of knots is typically 0.5-3.0% of the digester output, while the shives contents is about 0.1-1.0% .

D0 BLEACHING STAGE

Figure 3 D0 bleaching stage

The cooked pulp from the unbleached tower is sent to the P0W#2.From the P0W#2,the cooked pulp is sent to the stand pipe(D0 stage) via the heater mixer .Pulp is generally a base which contains maximum amount of NaOH where the pH of the pulp is in the range of (10-11),hence to reduce the pH ,concentrated sulphuric acid is added to the stand pipe and the mixture becomes semi solid. The pH of the mixture is not immediately determined, since the reaction takes place for few minutes .After complete reaction ,the pulp is sent to the D0 mixer, where the pH is assumed to be in the range of (0-7) (ie).acidic range.Then,ClO2 solution (bleaching agent)is given to the D0 mixer to increase the brightness of the pulp. The brightness is determined by the brightness (IR) sensor which is kept after the D0 mixer. Depending on the value of the pH ,the brightness is either increased or decreased since the pH and the brightness are inversely proportional to each other .In this range ,the brightness obtained should be in the range of (50-64%).If its not obtained, then the above process should be repeated until the maximum brightness is obtained.

D1 BLEACHING STAGE:

The pulp from the EOP washer is sent to the D1 bleaching stage This D1 stage is similar to the D0 bleaching stage where the ClO2 solution (bleaching agent) is mixed with the pulp from the EOP washer in the reaction tower and the reaction takes place for few minutes. Then the pulp is sent to the D1 washer and the final pulp is obtained with the maximum brightness range 85%.

Figure 4 D1 bleaching stage

PH MEASUREMENT:

Most often used pH electrode is the glass electrode .It is made up of glass tube ended with glass bubble The electrode is filled with buffered solution of chlorides in which silver wire covered with silver chloride is immersed. pH of internal solution varies-for example, it can be 1 (or) 7.Active part of the electrode is the glass bubble. While tube has strong and thick walls, bubble is made to be as thin as possible. Surface of the glass is prorogated by both internal and external solution till equilibrium is achieved. Both sides of the glass are charged by the adsorbed protons, this charge is responsible for potential difference .This potential is inversely proportional to the pH difference between solutions on both sides of the glass.

The majority of pH electrodes available commercially are combination electrodes that have both glass H+ ion sensitive electrode and additional reference electrode conveniently placed in one housing. For some specific applications separate pH electrodes and reference electrodes are still used-they allow higher precision needed sometimes for research purposes. In most cases, combination electrodes are precise enough and much more convenient to use.

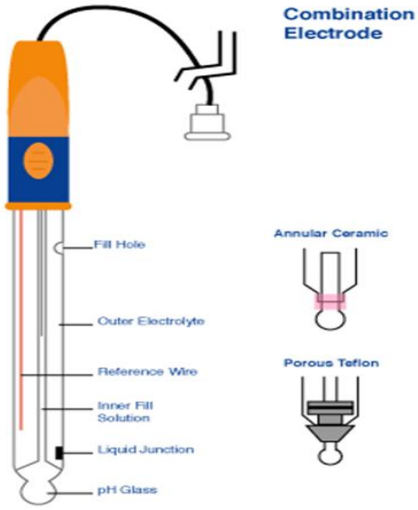

Figure 5 pH bleaching stage

Construction of combination electrode is in large part defined by the processes that must takes place when measuring pH. We need to measure potential difference between sides of the potential. To do so ,closed circuit is required between the internal and external and the pH meter. However ,for stable results of measurements, reference electrode must be isolated from the solution so that they will not cross-contaminate. Connection is made through a small hole in the electrode body. This hole is blocked by porous memebrane .Internal solution flows very slowly through the junction, thus such electrodes are called flowing electrodes. To slow down leakage ,in gel electrodes, internal solution is gelled.

Figure 6 pH sensor

pH MONITOR AND CONTROL:

The pH monitoring and control unit is designed with pH sensor, microcontroller, LCD display, ADC, amplifier unit and driver circuit and relay.

pH sensor is one type of transducer which measures the PH values. Depends upon the pH values the sensor generates the voltage signals. These voltage signals are in the range of milli volts so the signals are fed to amplifier unit. The amplifier unit is used to amplify the voltage level. After the amplification the signals are fed to ADC.ADC is nothing but Analog to Digital Converter. ADC received the analog signal from the amplifier unit and converts it to the corresponding digital signal. Then the converted digital signal is given to microcontroller.

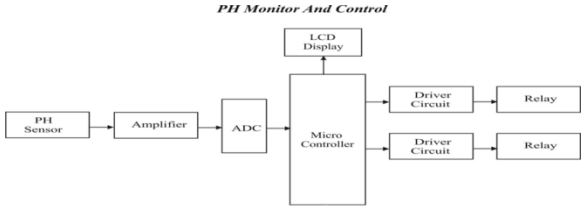

Figure 7 Block diagram of pH monitoring and control

Here the microcontroller is the flash type reprogrammable microcontroller in which we have already programmed the standard PH value. The microcontroller receives the digital signal from the ADC and it is compared with stored value. If the measured value is lower than standard value, microcontroller activates the one relay driver circuit. Driver circuit consists of transistor to turn ON and turn OFF the relay. If the stored value is higher than the standard value, the microcontroller activates another relay driver circuit. If measured value is normal, the microcontroller turns off both the relays. Depends upon the relay operation the flow rate of acid will be controlled. The controlled acidity flow will be maintained the pH value below range(2-4).

RESULT:

Thus by maintaining the pH value of the pulp, the brightness is increased and so the quality of the paper. For various values of the pH, the corresponding values of the brightness is tabulated.

pH	Brightness (%)	Stage
1.9	64	D0
2.1	56	D0
2.4	86	D1
2.5	86	D1

CONCLUSION:

The brightness of the pulp is inversely proportional to the pH value .Hence, the pH value maintained in the range of (2-4) achieved the maximum brightness range 85%. The acidity is controlled by the brightness given by a device. By measuring the pH value we are introduced pH meter(to detect the acidity of the solution)can easily calculating the accurate amount of acid to be supplied. The brightness value will be automatically increased and in order to avoid fluctuations problem. Due to this, the wastage of the pulp and chemicals is reduced and the quality of the paper is increased.

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