Chlorine Dioxide-New Prospects With Reduced Cost

Ramesh S. P.*

SUMMARY

The need to reduce cost of manufacture has come into existance for the very survival ofmany Paper Industries. Various causes can be attributed to this, viz. Obsolete machinery and high cost of various inputs.

The use of Chlorine Dioxide (ClO_2) is gaining considerable importance. Considerable amount of chemical and energy can be conserved in different stages.

Various stages of ClO_2 generation and consumption, where conservation of chemicals and Energy can be easily adopted.

Modern Pulp and Paper Industry in India made a rapid progress during first three five year plans. However the situation improved during late seventies. Today Indian Pulp and Paper Industry produces large variety of paper for different endures like printing paper, writing paper, packing and wrapping paper, paper board etc. Lately few mills have ventured into new products like Tetrapak, Sack kraft, water repellent kraft etc.

The capacity utilisation has come down alarmingly low level of 57.6% at end of 1986–87 is evident from Table–1, many reasons may be attributed. Cost of coal has gone up by 45% from what it was ten years ago. Power supply from grid has considerably deteriorated.

The need to reduce cost of manufacture has come into existence for the very survival of many units. Due to use of obsolete machinery and technology, shortage of raw material and high cost of various inputs. The quality of paper products in our country is very poor compared to other countries even at a higher price.

Use of Chlorine Dioxide (ClO_2) is gaining considerable attention now-a-days for producing high grade paper products. Even though large amount of energy is needed for the ClO_2 process, reduce the cost through various steps. Minimising chlorate and ClO_2 wastages through inefficient conversion and absorption stages and other leakages losses can reduce the cost considerably. More direct means of energy conservation, reduced cost and increased profits include.

1. use of electricity to that of steam inchilling of absorption water.
2. making stronger solution with warmer water and precooling the chiller feed with ClO_2 solution.
3. using preheated ClO_2 solution to minimize steam heating demand in the Bleach Plant.

SODIUM CHLORATE DISSOLVING AND EFFICIENT CONSUMPTION

Sodium Chlorate ($NaCl_3$) is supplied in crystal from and dissolved in water at the point of use. Recently $NaClO_3$ is being supplled in solution form whereby accurate ratio between NaCl : $NaClO_3$ can be maintained, which sustains higher conversion efficiency in R_2 & R_3 ClO_2 generation process. Howevcr the method is applicable with $NaClO_3$ generation point which is within the economic shipping radius, because a lot of water is transported.

The consumer should do whatever is necessary to convert $NaClO_3$ to ClO_2 as efficiently as possible and to

*Jr. Manager (Tech. Development) BPL Sarapaka.

TABLE—1

PAPER INDUSTRY IN INDIA-PROFILE

Number of Mills :	80–81	81–82	82–83	84–85	85–86	86–87
Large Mills	22	22	23	23	26	26
Medium Mills	9	10	11	15	16	16
Small Mills	105	125	141	211	229	237
All Mills	136	157	175	249	271	279
INSTALLED CAPACITY (LAKH TONNES) :						
Large Mills	11.15	11.28	11.61	11.72	13.71	13.92
Medium Mills	1.20	1.49	1.68	2.36	2.56	2.56
Small Mills	4.22	5.40	5.86	9.42	10.28	10.88
All Mills	16.57	18.17	19.15	23.50	26.55	27.36
PRODUCTION (LAKH TONNES) :						
Large Mills	8.55	8.95	8.49	7.84	8.15	9.04
Medium Mills	0.75	0.83	0.17	1.04	1.26	1.20
Small Mills	1.72	2.57	3.10	4.83	5.31	5.52
All Mills	11.02	12.35	12.36	13.71	14.72	15.76
CAPACITY UTILISATION (%) :						
Large Mills	76.7	79.3	73.1	66.9	59.4	65.0
Medium Mills	50.3	55.7	45.8	44.1	49.2	50.0
Small Mills	31.9	44.2	52.9	51.3	51.7	50.0
All Mills	66.6	68.0	64.5	58.3	55.4	57.6

Large Mills : Units manufacturing above 20,000 t.p.a.

Medium Mills : Units manufacturing above 10,000 t.p.a. and below 20,000 t.p.a.

Small Mills : Units manufacturing less than 10,000 t.p.a.

see that a minimum of the ClO_2 produced is lost through poor absorption and from storage. The first conservation is to maintain minimum of loss of chlorate which may occur through spillage, leaking pump glands, pipes and valves. Leakage of water into the chlorate solution should be minimized as this contributes to increased acid use, inefficient $NaClO_3$ consumption and losses and also increased Steam consumption.

PRODUCTION OF CHILLED WATER

In ClO_2 production, chilled water at 5°C to 12°C required to absorb ClO_2 gas. The quantity depends on the concentration of ClO_2 desired. For example a typical 8 gpl concentration 125 tons. of chilled water is necessary per ton of ClO_2 gas (chilling unit is measured in standard commercial tons of refrigeration rated at 288000 Btu/day/ton, approximately equals to the latent heat of fusion of one tone of ice at O°C) Energy for chilling water is dependent on quantity being chilled, water is dependent on quantity being chilled, temperature of water fed and discharged from chilling unit and type of chiller used.

In Pulp Mill practise three type of chillers are used. Evaporative, Absorptive and Mechanical.

EVAPORATIVE CHILLING

In this technique, chilling is produced by evaporation of water from water being chilled. A very high vacuum about 28″ Hg vacuum is required to produce 5°C water. Due to high vacuum, the boiling temperature of water is reduced causing is to vapourise. Chilling occurs as water gives up sensible heat to supply the latent heat absorbed by the vapour when evaporation occurs. Steam is consumed by jet ejectors which maintain vacuum. Electrical energy is consumed in pumping large amount of the water required.

The temperature of cooling water available for the chiller's condenser has a great effect on the steam consumption. Steam consumption depends on design capacity and vary less on load.

ABSORPTIVE CHILLING

Water is chilled by reduced boiling temperature under vacuum. The water being chilled is by indirect contact with captive supply of refrigerant (water) which is chilled by same mechanism as far evaporative chilling and recirculated within the chilling system.

Heat transfer to the water within the chiller causes it to boil and vaporize vapour carrying heat from chilled water is condensed and absorbed into Lithium Bromide Solution (usually) in absorber section. The absorber is diluted and hence pumped to heat exchanger where water is boiled off. The unit operates within low-pressure steam and even hot water can be used for evaporation of water from diluted absorber solution. This is a major economical advantage over evaporative chiller.

MECHANICAL CHILLING:

Mechanical chilling involves indirect absorption of heat from the water into an organic refrigerant usually from compounds. The liquified refrigerant after chilling is expanded to a reduced pressure and evaporated, the gas is then reliquified through compression with indirect removal of heat to air or water only electrical enegy and cooling water are consumed.

Care shuld be taken in selecting a chilling plant, as energy and steam cost varies from mill to mill The question on reliability and maintenance must be weighed in final decision.

ENERGY CONSERVATION IN ClO_2 GENERATION-

Control of ClO_2 solution concentration at specified level is very important. Decrease in ClO_2 solution concentcation caused by gassing off in storage contributes to increased chilled water use losses can be minimized by insuluting the storage tanks to reduce heating of solution, by having the solution enter the tank below the surface and by preventing outside air from being drawn through the tank via leaking relief devices and unsealed overflow pipes.

Production of stranger solution with warmer water produce more substantial energy saving. For example a Mill in Canada used 120°C water for absorpion reducing water requirement to 231 tons at 10 gpl concentration 278 tons of water. The changeover to 120°, reduced 40% on refrigeration demand and 26% on heating load to the Bleach plant. This saved the mill $ 160000/yr on energy which used 10 tpd. of clO_2 for bleaching.

ENERGY CONSERVATION THROUGH HEAT RECOVERY IN ClO_2 BLEACHING :

ClO_2 bleaching involves large amount of energy, both in form of steam and electricity. Conservation of energy is essential, which is usually done with "Plate and Frame" heat exchanger. Low grade heat source can be obtained from Bleach plant effluent, contaminated condensate or other condensate and chillerfed. it self. With Chillerfeed water benefits can be doubled, i.e. feed water will be cooled, reducing chiller load and the ClO_2 solution will be warmed, this will not heat to as high a temperature as might be possible from warmer sources. But further heating would be still possible by using another heat source whereby steam consumption in bleach plant will be reduced. The choice of operating temperature affects the total heat conserved.

A Pulp Mill in Cannada installed a plate and frame heat exchanger for 42000 and used ClO_2 solution of 8 gpl at 8°C (fed) and assuming : 1.2 X ClO_2 solution flow is available as a 55°C bleach plant or other effluent source. Cost of steam is 4/miliion B.t.u. overall heat transfer coefficient is 550 Btu/hr/ft^2 °F the basis of 18°C on chillerfeed at 1.05 X ClO_2 solution flow.

It should rise in ClO_2 solution temperature 6°C to 15°C and chillerfed temperature fall from 35° to 18°C this reduced steam demand about 100 X 10^6 Btu/day in bleach plant while chiller load from 434tons to 133 tons of refrigerant and in year it saved $ 496000.

CONCLUSION :

To obtain more benefits from the existing systems available one has to crefully evaluate the benefits and of each systems over the other.

If the heat source is used from bleach plant effluent, contaminated or other condensate to warm the ClO_2 solution, it will save considerable amount of steam in bleach plant.

Loss of ClO_2 and chlorate should be kept at minimum which may occur through leakage, inefficient conversion and absorption this also results in excess of costly acid consumption.

It has been seen in mechanical chilling there will be no direct reduction in power consumed as some power is required at no load and increased as load increases.

If a chiller is absorptive type steam consumption can be reduced to a greater extent but pumping cost will be relatively unaffected.

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