**Sulfitation of Sugar Cane Juice**

Juice Sulphitation is the process of purification of cane juice by employing lime and sulphur dioxide gas. This process generally used for clarification of sugar cane juice in plantation white sugar manufacturing industry.

The juice which is free of Baggase & weighed in the weighing tank of pH (5.2-5.3) is heated in the juice heater at 70oC to 75oC. This juice is subjected for continuous liming & sulphitation process to get sufficient removal of non- sugars and finally maintained neutral pH of 7.0 to 7.1.

After the addition of lime and SO2 gas, the sulphited juice heated slightly above the boiling point i.e 102oC to 103oC and it is passed to juice clarifier through the flash tank for setting the mud.

**Mechanism of Juice Sulphitation :**

The inhibition of colour formation is reportedly (Vercellotti and Clarke, 1997; and Chen, 1971) brought about by the combination of the sulphite group with reducing sugars, thereby blocking the carbonyl function which is necessary for caramel and melanoidin formation. It is well-established (Getaz, 1989) that sulphitation will inhibit Maillard-type reactions, also by combining with carbonyl groups, although this reaction is reversible. In particular, sulphited carbonyls are prone to losing the sulphiter groups over time, as these compounds are slightly unstable.

**Reaction taking place during liming and sulphitation process:**

Precipitation Of Calcium Sulphite (CaSO3) & its Solubility:-

The solution of Ca (OH)2 will dissociate completely as.

Ca (OH) 2 ↔ Ca++ +2OH– (Dissociation Of Ca (OH)2) Ca++ + 2OH– – → Ca (OH)2

The pH of the lime solution is above 12.6 at 30 oC , when SO2 gas is passed liquid H2SO3 (Sulphurous acid) is formed.

SO2 + H2O ↔ H2SO3

The sulphurous acid get dissociated at high initial pH into H+ & SO3— ions.

H2SO3 ↔ 2H+ + SO3—

Immediately the product of (Ca++) and (SO3—) which exceed the solubility product of CaSO3 & more CaSO3 precipitate will result.

Ca++ + SO3— ↔CaSO3

Meanwhile the OH– ion from Ca (OH)2 molecule will react with H+ ions & with H2SO3 to form undissociated water molecule.

2H+ + 2OH– ↔ 2H2O

With continues sulphitation furthermore & more CaSO3 will be precipitated. Resulting gradual decrease in the Ca++ ions the stage will come when the solubility product of Ca++ and So3-2 → solubility product of (CaSO3) with minimum Ca++ ions remain in the solution.

Ca(OH)2 +H2SO3 ↔ CaSO3 + 2H2O

**Calcium bi sulphite formation:**

If we pass more SO2 gas than the pH will be on the acidic side, with decrease in pH dissociation of more & more HSO3 ions are possible. Then stage will come where system is try to maintain the balance of SO3— ion concentration as it is reduced by dissolving CaSO3 precipitated.

 H2SO3 ↔ H+ + HSO–3

Dissolved CaSO3,

CaSO3 ↔ Ca++ + SO3—

 SO3— + H+ ↔ HSO3–

precipitated CaSO3 = Dissolved CaSO3

CaSO3 + H2SO3 ↔ Ca ( HSO3)2 (Calcium bi sulphite )

**Methods of juice sulphitation:**

 There are different methods of addition of these two as given below.

**1. Pre-Liming**

**2. Pre sulphitation followed by liming and sulphitation.**

**3. Simultaneous Liming and Sulphitation**

**Pre-Liming**

The pre liming of raw juice is conducted to pH of 6.8 – 7.2. It is done in separate tank in order to have the retention time of maximum 2 mins. During this period the lime reacts with phosphate available in the juice to form precipitate of Ca3(Po4)2 which absorbs lot of coloring impurities. This process helps in increasing the mud density.

In the second stage the pH of the juice is raised up to 9.5 to 10.0. The juice kept on this pH only 10 to 12 sec. And sulphur dioxide is added and maintained at 7.0 to 7.1 pH. This method is useful in case of stale cane or burnt cane or during high mud level period.

**Pre sulphitation followed by liming and sulphitation**

In this process the 70oC heated raw juice comes in contact with SO2 Gas & pH is brought down from 5.2 to 4.2 to 3.8, then it is again increase to 7.5-8.0 by liming. The lime juice pH is further reduced to the neutral pH that is 6.9-7.0 by SO2 gas.

The drawback of this process is that the juice remains in acidic main for 3-4 min which cases sucrose inversion.

The advantage of the method pre sulphitation of juice leads to better settling characteristics of mud in the case of immature cane. Destruction of reducing sugars can be minimized or eliminated.

**Simultaneous liming and sulphitation**

In this process the lime is introduced just the entry of raw juice in the juice sulphitation tank & then it is immediately neutralized by SO2 Gas to get the pH 7.0.

Simultaneous liming and sulphitation system are basically emerged to avoid disadvantages of both presulphitation as well as pre liming system.

The simultaneous liming and sulphitation system of can juice clarification is more similar to presulphitation system. The only difference is in pre sulphitation the presulphitation time is maintained is about 3 to 4 minutes but in simultaneous liming and sulphitation. The presulphitation time is just few second.

During whole reaction the pH of juice main tend below 8.0 pH and in most of cases below 7.5 pH. Due to this juice is not subjected to high alkalinity and this result in minimum destruction of reducing sugar. but at the colloids and other impurities are not fully precipitated out as the driving force the resultant clear juice obtained by simultaneous liming and sulphitation reaction always contains high turbidity generally more 20%.

**Advantages**

Better terminal settling velocity as well as lower mud volume, minimum Cao rise from mixed juice to clear juice. Better clarity of clear juice than the previous methods.

**Disadvantages:**

Lime and SO2 gas may directly come in contact before precipitation of impurities and get neutralized. This increases unnecessary lime and sulphur consumption.

The clear juice quality obtained by this method is very poor in respect of color than the shock liming. This indicates the lower impurities are precipitated and which resulted in low removal coloring impurities.

**Advantages and disadvantages of sulphitation**

On comparing the practical results of sulphitation with those of ordinary defecation, the following advantages and disadvantages may be noted.

**Advantages:**

a) The juice settles more rapidly (hence improved capacity of subsiders).

b) The massecuites are less viscous and boil faster.

c) Better crystallisation in consequence.

d) Marked improvement in colour of the sugar.

e) Savings in time in clarification and boiling.

f) Slight gain in capacity of centrifugals.

g) Better elimination of phosphates and waxes (Douwes Dekker7), leading to better refining quality and filterability of the sugar produced.

**Disadvantages:**

a) The major drawback of the system is higher sulphited ash content of the sugar obtained. The SO2 content in the final product having approximately 30 to 70ppm.

b) Because of use of Sulphur in plantation white sugar process, the pH of syrup goes quite low which causes high inversion losses

c) Due to acidity of the SO2 gas the corrosion of equipment having in higher side.

d) The lime dosing required for injection water to maintain the pH.