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Judicial Use of Process Chemicals in Sugar Industry

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Abstract: In any process industries of production, quantity & quality is most important criteria of finished product. Quantity of finished product depends upon plant utilization capacity, while quality of finished product depends upon plant performance efficiency. Quality of raw material and quality of input material which are directly related on quality of finished product are also equally important. In sugar factory cane is raw material and process chemicals are input material.Quality of both things needs to be considered however this paper is limited to only process chemicals & their judicial use.

I. INTRODUCTION

In sugar industry juice is obtained by crushing of the cane in milling tandem. The extracted juice is acidic in nature, sweet in taste, turbid, cloudy & having light gray to dark green colour. Its composition varies with cane maturity and cane verity from which is extracted. Normally 1kg of juice content-

1) 840 grams of water
2) 140 grams of sucrose
3) 5-10 grams of reducing sugar
4) 2-5 grams of organic substance (impurities)
5) 3-5 grams inorganic substance (impurities)

The nature of these organic and inorganic impurities may be suspended, colloidal, dissolved and coloured. All these impurities need to remove to produce brilliant clear juice from which white sugar is obtained by carrying further steps of process like evaporation, crystallization and separation. Sulphitation is main clarification process used in Indian sugar industries to remove these organic and inorganic impurities. In this process three basic chemicals viz. lime, sulphur and phosphate are used along with heat treatment. The roles of these chemicals in clarification process their quality and judicial use is explain in this paper.

The Role of Process Chemicals

A. Lime

Lime is main clarified agent & used as milk of lime (MOL) i.e. white milky liquid containing slaked lime in solution. Lime used for clarification process shall be fresh because on storage it reduces its strengths.

The following are action taking place when lime is added in juice.

1) Lime first neutralized the free organic acids present in juice and produced calcium organic salt.
2) Lime reacts with both phosphoric acid (added and present) and gives calcium tri phosphate
3) Lime combine with nitrogen impurities like albuminoids and gummy substance and partly precipitate
4) Lime combines with pectin and forms soluble and insoluble compounds.
5) Lime combine with colouring matter like chlorophyl and Anthocyanin and forms precipitate.

B. Sulphur

Sulphur is second clarified agent & is used as sulphur dioxide gas (SO_2) Commonly known as sulphurous acid. It may applied in either of two forms as liquid or gas. Liquid forms being used in beet sugar industries while the gases forms being more generally used in cane sugar industries. The gases form is generated in sulphur furnace.

It is used for

1) Neutralization of excess alkalinity caused by addition of lime.
2) Bleaching of juice by action on coloring matter.
3) To reduces the viscosity of juice.

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C. Phosphate

The phosphate is third clarified agent and is used as soluble inorganic phosphate (mostly orthophosphric acid). The presence of phosphate in juice is essential for good clarification.

1) It reacts with lime and gives heavy flocculated precipitate which remove colloidal and other impurities.
2) It absorbs colouring matter and diminishing the Ca content of juice.
3) It acts on free lime and neutralized the solution.

II. QUALITY OF PROCESS CHEMICALS

Table No. 01 Specification of **lime** as per standard IS- 1540-1980

Sr. No	Content	Percentage
1	Active CaO	85 % min
2	MgO	1.0 % max
3	Fe_2O_3, Al_2O_3	1.0 % max
4	Silica as SiO_2	1.0 % max
5	SO_4	0.5 % max
6	Moist.%	1.0 %

Table No. 02 Specification of **sulphu**r as per standard IS 8851-1978

Sr. No	Content	Percentage
1	Purity	99.8 %
2	Moist.	1.0 % max
3	Ash	0.1 % max
4	Bituminous substance	0.25 % max
5	Arsenic	0.05 %

Table No. 03 Specification of Orthophosparic acid as per standard IS10508-2007

Sr. No	Content	Percentage
1	Purity of H_3PO_4	85 % min
2	Nitrate mg/kg	5 max
3	Volatile acid mg/kg	10 max
4	Chloride mg/kg	20 max
5	Sulphate % by mass	0.15 %
6	Lead and heavy metal mg/kg	15 % max

III. LIME DOSE FIXATION STUDY FOR MAXIMUM REMOVAL OF IMPURITIES

A. Procedure

Five liter juice is divided into five equal parts. One part is retain for analysis as untreated juice while four part are heated at 70 ^{0}c temperature and one by one treated with milk of lime of 12 brix to obtained shock P^H 9.25, 9.75, 10 & 10.25. These limed juice neutralized with $S0_2$ gas up to p^H 7.00 and reheated to boiling point. Boiled juice transfer to glass cylinder to carry out settling test. After sedimentation clear juice is taken by decantation and analysis for various parameters like purity, phosphate content, colour of juice, CaO content etc. Settled mud are used for analysis mud volume.

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Table No. 04 Judicial fixing of lime dose for good clarification.

Sr. No	Parameters	Sample No. 01	Sample No. 02	Sample No. 03	Sample No. 04	Sample No. 05
1	pH	4.8	9.25	9.75	10.00	10.25
2	MOL required (ml)	--------	2.5	3.3	4.5	4.7
3	Purity	85.37	86.68	87.47	87.75	87.66
4	Rise in purity	--------	1.31	2.1	2.38	2.29
5	P_2O_5 content (ppm)	346	7.3	6.1	5.2	8.1
6	Reduction in phosphate	------	97.90%	98.24%	98.50%	97.66%
7	Color IU	14700	7086	7630	7406	7551
8	% colour removal	------	51.80	48.00	49.60	48.60
9	CaO content (ppm)	950	1320	1210	1220	1150
10	Min. Rise in CaO content (ppm)	------	370	260	270	200
11	Starch content (ppm)	133	61.50	71.0	59.0	46.0
12	% removal of starch	------	53.7	46.6	58.0	65.4
13	Dextran content (ppm)	375	224	240	140	142
14	% removal of dextran	-----	40.3	36.0	62.7	62.1
15	Mud volume (ml)	------	350	250	240	190

From above table it is observed that four parameters are satisfied at P^H 10.00 hence optimum dose of lime (4.5ml) required for good clarification.

IV. CONCLUSION

In sugar factory juice clarification process is carried out in two steps.

1) Addition of excess lime up to optimum P^H (10). In this steps lime reacts with phosphate gives calcium triphosphate.

2) Neutralization of excess liming by SO_2 gas up to neutral P^H (7). In this step excess lime reacts with SO_2 gas & gives calcium trisulphate.

Both flock calcium triphosphate & calcium trisulphate adsorb suspended, colloidal & colored impurities while settling in clarifier.

It is observed from table that excess lime does not help in removal of more impurities, rather it create scaling problems in evaporators & pan, it increases viscosity on latter stage. If lime added below normal dose then it creates processing difficulties due to impurities present in the juice.

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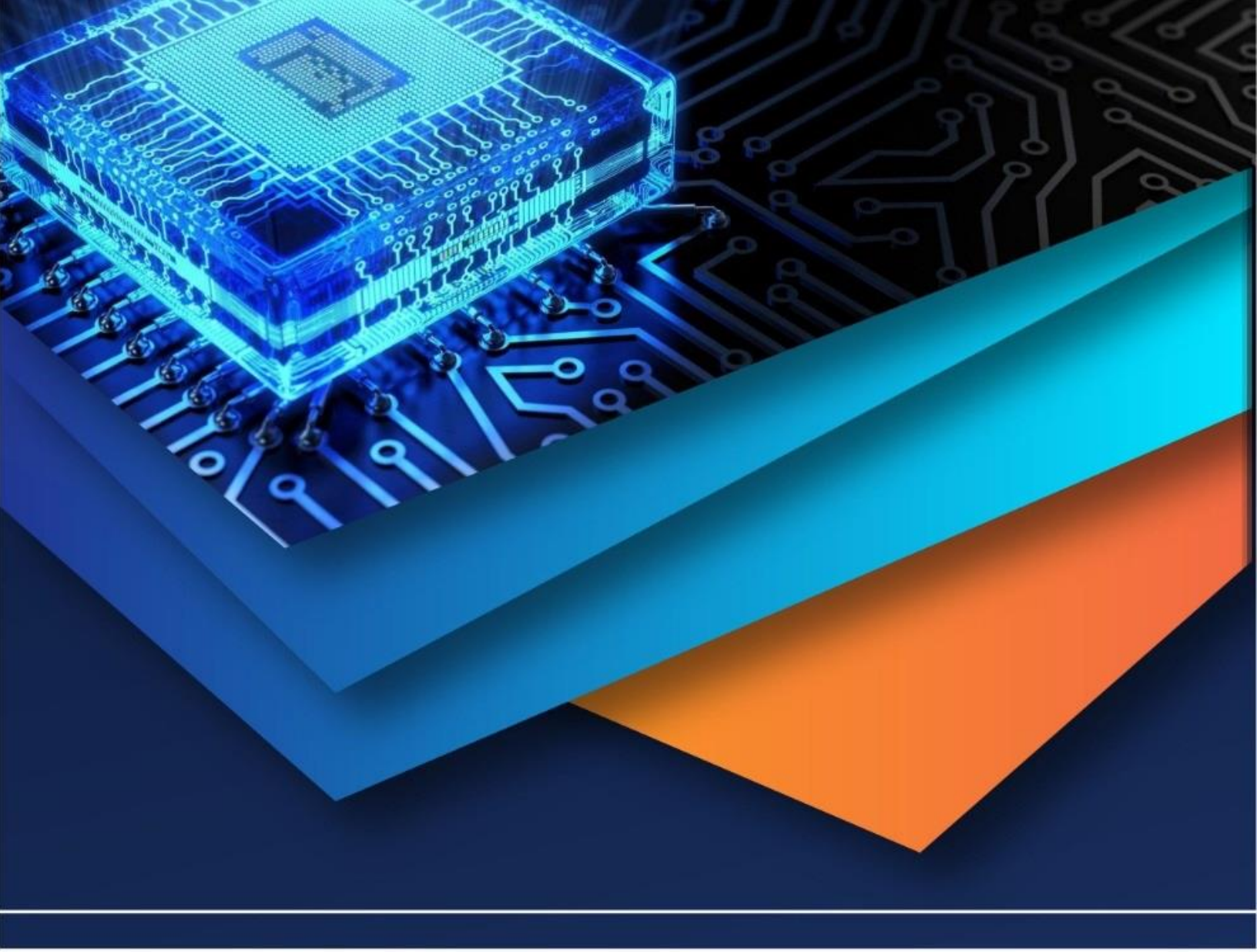

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