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Determination of Flocculant Concentration to Increase Quality of Dilute SAP in Sugar Mills

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***Abstract*— The quality of the sugar produced at a sugar factory depends on the dilute sap from the refining station process stages. The quality of the diluted liquid is influenced by the amount of impurities present. The more impurities contained in the diluted sap, the lower the rate of the diluted fluid obtained. To separate the contaminants present, process aids are needed, and one of them is flocculant. The concentration of flocculant used must be precise to maximize the separation process of sugar and impurities. The determination of flocculant addition has traditionally been based on visual observations of the dilute sap obtained. The results of the research show that the addition of flocculant that has the most influence in improving the quality of diluted sap is a flocculant concentration of 3 ppm, which has a turbidity of 28.69 NTU, pH 7, pol 10.82%, brix 12.88%, and a purity value of 84.01%.**

Keywords: Raw sap, Flocculants, Diluted sap quality, Turbidity

I. Introduction

The Sugar Factory consists of several process stages in processing sugar cane into white crystal sugar. The process stages are milling, refining, evaporation, crystallization, and separation. The quality of sugar produced depends on the dilute sap produced from the refining station process stage. The refining station is a stage of the sugar production process that is very important in producing the quality of sugar products. This stage aims to separate impurities (not sugar) mixed with raw sap as much as possible. Removing these impurities does not require a long time, and the sucrose content in the sap is maintained [1].

Raw sap purification generally consists of 3 types: defecation, carbonatation, and sulfidation. Defecation is a simple type of purification using quicklime to neutralize the acids contained in sap [2]. Carbonatation is the purification of sap by using carbon dioxide and milk of lime in larger quantities than in the sulfidation process to produce more non-sugar deposits [3]. Sulfidation is a purification that uses lime milk in excess and then neutralizes it with sulfur oxide gas (SO_2) [4].

High-purity sap is obtained during the purification process using impurities contained in the raw sap, undergoing a process of precipitation and separation. Parameters affecting raw sap's purification process are temperature, residence time, coagulant concentration, and flocculant. Flocculants in raw sap purification function to help the precipitation process; this process is also called flocculation. Flocculation is the stage of clumping dissolved materials, colloids, and those that cannot settle in water. Small particle clumps formed in the previous process will form larger clumps with the addition of process auxiliaries in the form of flocculants. Larger clumps of particles will settle faster. Particle clumps will be bound to each other through flocculant threads. Flocculant threads become a place to adsorb colloidal clumps in the sap and become a bonding link between one colloidal clot and another so that the resulting sap becomes clearer [5].

The use of flocculants as process auxiliaries in the refining station must be at the right concentration. If the addition of flocculant is not in the right concentration, the separation between sugar and impurities will be low. The addition of flocculants at the refining station in the sugar factory is carried out based on the results of visual observations of the dilute sap obtained. This affects the

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efficiency of flocculant use and the quality of the dilute juice produced. The quality of diluted sap is influenced by the amount of impurities present. The smaller the amount of impurities (non-sugar), both dissolved and insoluble impurities [6], the better the quality of diluted juice. Coagulants and flocculants are needed to remove impurities (non-sugar) in raw sap. The coagulant used is the milk of lime, and the flocculant used is kuriflock PA 331.

The brown liquid from the raw sap purification process is called dilute sap. [7] suggested that the sap purification stage's result is clear juice. Clear juice from jar tests will be tested for parameters such as determining CaO levels and measuring pH, turbidity, purity values, and clear juice color. This study to test the quality of dilute sap in Sugar Factories refers to the parameters of turbidity, pH, pol, brix, and purity value [7].

II. Research Methodology

A. Materials

Materials used in this research are Kuriflock PA 331 flocculant, aquadest/ distilled water, sulfurized raw sap, filter paper. The equipment used includes an Atago RX-5000 refractometer, SAC-i polarimeter, turbidity meter, pH meter, thermometer, jar test apparatus, glassware, stove, asbestos gauze, filter funnel, cuvette, and stopwatch.

B. Methods

1. *Preparation flocculant*

Preparation of 100 ppm flocculant solution, 0.1 gram of Kuriflock PA 331 flocculant was dissolved with 1000 mL of distilled water. The 100 ppm Kuriflock PA 331 solution was diluted to solution concentrations of 1 ppm, two ppm, three ppm, and four ppm.

2. *Flocculation Process*

Flocculation process, 250 mL of sulfurized raw sap was heated to 100ºC. After heating, the sulfurized raw sap was added to flocculants with concentrations of 0 ppm, 1 ppm, 2 ppm, three ppm, and 4 ppm and stirred using a jar test with a rotation speed of 200 rpm for 5 minutes. The raw sap filtrate, diluted sap, was analyzed for turbidity, pH, pol, brix, and purity rating.

3. *Turbidity parameter*

Turbidity parameter: Diluted sap was put into a cuvette of 10 mL and then measured using a Turbidity meter.

4. *Pol parameter*

Pol parameter: 100 mL of diluted juice was added with 5 mL log solution and 5 mL distilled water. The solution was then homogenized and filtered. The filtrate from the filtering result was put into the pool vessel. Polarization rotation is observed using a Polarimeter tool. The equation is as follows [8]

$$Po = legible\ pol\ x\ \frac{26}{bjx100}\frac{110}{100} \quad (1)$$

5. *Brix parameter*

Brix parameter: Three drops of diluted juice were put into the Atago Brix device, and the brix number was observed. The equation is as follows [8]:

$$Brix = brix\ value\ read + temperature\ correction \quad (2)$$

6. *Purity Score*

Purity Score: The purity rating of diluted sap is obtained from the ratio of pol to brix and multiplied by 100%. The equation is as follows [8]:

$$Purity\ Score = \frac{\%pol}{\%brix} x\ 100\% \quad (3)$$

III. Results and Discussion

The sap used in this sample was sulphitised sap. The filtrate of raw sap filtration results improved after the addition of flocculants compared to the filtrate of raw sap without the addition of flocculants, which can be measured based on the parameters of turbidity, pH, pol,

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brix, and purification rate.

Table 1. Raw sap testing results

Flocculant	Flocculant Concentration (ppm)	*Turbidity* (NTU)	Pol (%)	Brix (%)	Purity rating (%)
No flocculant	-	171,67	10,29	13,50	76,18
Kuriflock PA 331	1	65,67	10,48	12,98	80,79
	2	56	10,60	12,91	82,14
	3	28,69	10,82	12,88	84,03
	4	74,33	10,46	13,02	80,32

A. Turbidity

Turbidity testing was measured using a Turbidity Meter. The turbidity parameter shows the level of turbidity of dilute sap. The turbidity test results of dilute sap can be seen in Figure 1, which shows that dilute sap without the addition of flocculant 171,67 NTU and the addition of flocculant concentration of 1 ppm to 4 ppm respectively 65,67 NTU; 56 NTU; 28,69 NTU and 74,33 NTU. The turbidity value decreases in the flocculation process; the particles that form small flocs after being added with flocculants form larger flocs that quickly settle. These settled particles cause the sap to become more apparent.

The results show that the higher the flocculant concentration, the lower the turbidity of dilute sap obtained, except the addition of flocculant concentration of 4 ppm has increased. This is because there are still impurities (not sugar) that have not been precipitated. After all, the process of precipitation of impurities is not optimal. After all, the dilute sap has reached the saturation point. Research conducted by [7] showed that the addition of flocculant with a concentration of 4 ppm decreased the speed of precipitation and the volume of sediment because the flocculant given had passed the optimal point so that the flocculant was less than optimal in binding impurities. The addition of flocculant doses at 3 ppm was effective in precipitating impurities in sap. In addition, adding a flocculant with a dose of 3 ppm produces turbidity, CaO content, clear juice color, and purity with the best quality.

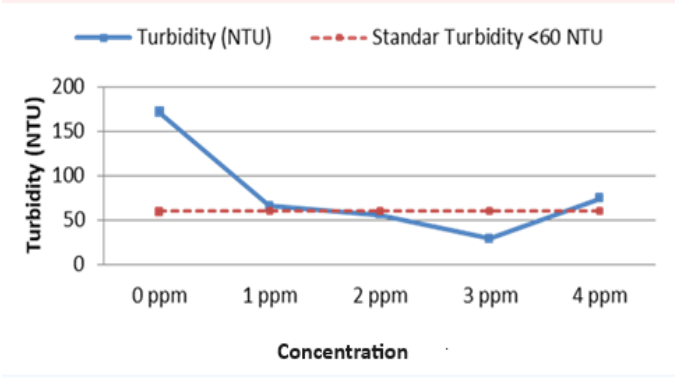

Figure 1. Turbidity values

The turbidity value of dilute sap in [8] is <60 NTU. Dilute sap with a turbidity value that meets company standards is found in dilute sap after adding flocculant concentrations of 2 ppm and 3 ppm. However, dilute sap with the lowest turbidity value is found in dilute sap after adding flocculant with a concentration of 3 ppm. The lower the turbidity value of dilute sap, the clearer the dilute sap obtained.

B. pH test

The pH parameter at the purification station is used to determine the reaction that takes place in the raw juice purification process. In Table 1, it can be seen that there is no change in pH either before or after adding flocculant; it remains at pH 7. The flocculant kuriflock PA 331 also does not change the system's pH [6]. Based on the test results of dilute sap without the addition of flocculant and dilute sap with the addition of flocculant concentrations of 1 ppm to 4 ppm, the pH value meets the standards of the [8], namely pH 7-8.

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C. Pol parameter

The pol parameter shows the amount of sucrose content dissolved. The results of the dilute sap pol test can be seen in Figure 2, which shows that the pol of dilute sap without the addition of flocculants obtained 10.29%, and the pol of dilute sap after the addition of flocculants with a concentration of 1 ppm to 4 ppm successively obtained 10.48%; 10.60%; 10.82% and 10.46%.

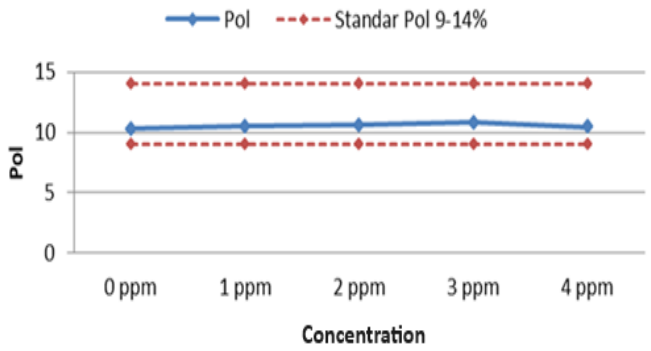

Figure 2. Graph of flocculant testing on pol

The poll results obtained in dilute sap without the addition of flocculant and dilute sap with the addition of flocculant concentrations of 1 ppm to 3 ppm showed that the higher the concentration of flocculant, the %pol increased except for the concentration of 4 ppm, which decreased. This is because the solution has passed the saturation point in the addition of 4 ppm concentration so that impurities (not sugar) are not deposited optimally. Impurities that do not settle increase the turbidity of sap. The clearer the diluted juice, the easier the detection of sucrose content in diluted juice on this polarimeter. The highest value of dilute sap pol is found in dilute sap after adding a flocculant concentration of 3 ppm. This is related to the turbidity obtained. Dilute sap with the lowest turbidity is found in dilute sap after adding flocculant with a concentration of 3 ppm. However, for the pol value, diluted sap without addition and sap with the addition of flocculant concentrations of 1-4 ppm are by the Sugar Factory standard for sucrose content or pol in sap of 9-14%.

D. Brix

The next test of the quality of diluted sap was brix testing. This brix observation uses the ATAGO RX-5000 Refractometer. The brix parameter shows the total suspended solids (sugar and non-sugar) dissolved in the solution. The results of brix testing of diluted sap can be seen in Figure 3, which shows that raw sap without the addition of flocculant obtained 13.50% and raw sap with the addition of flocculant concentration of 1 ppm to 4 ppm respectively obtained 12.98%, 12.91%, 12.88%, and 13.02%. The brix results show that adding flocculants affects the quality of dilute sap obtained. Diluted sap with the highest brix is found in sap without adding flocculants. This is because the impurities in the diluted sap have not been separated and precipitated. Research conducted by [7] showed that raw sap without adding flocculants has a higher brix value due to dissolved dry substances that are not sugar in the sample not being perfectly precipitated. The higher the flocculant concentration, the lower the brix of diluted sap, except the addition of 4 ppm concentration increased. This is due to dilute sap reaching saturation point at the addition of these concentrations. The Sugar Factory standard for brix of diluted sap is 10-15%, so for brix, all variables are appropriate.

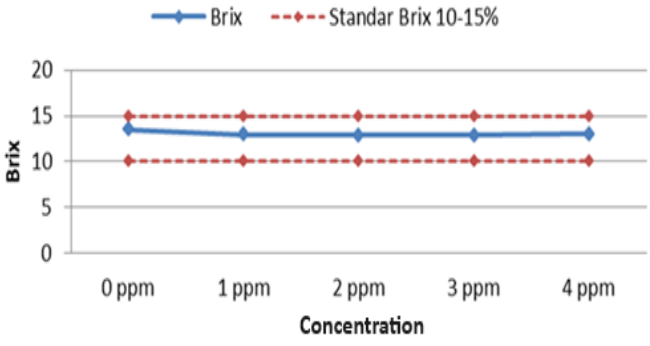

Figure 3. Graph of Flocculant Testing on Brix

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E. Purification rate

The purity rating of dilute juice is obtained from the comparison between %pol and %brix. Diluted juice that has a high purity value will produce high-quality sugar.

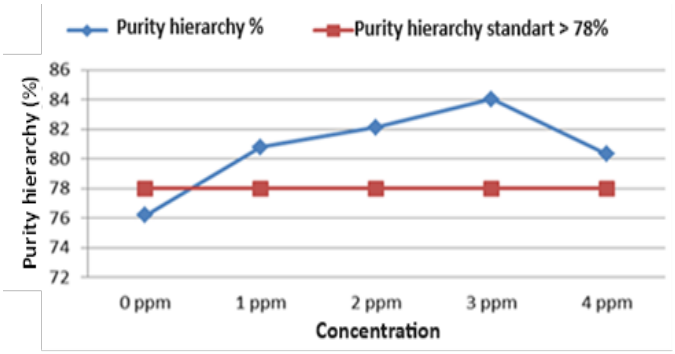

Figure 4: Graph of Flocculant Testing against Purity Score

The test results of the purity hierarchy can be seen in Figure 4, which shows the purity hierarchy of dilute sap without the addition of flocculant obtained at 76.20% and the purity hierarchy of dilute sap after the addition of flocculant with a concentration of 1 ppm to 4 ppm successively obtained 80.79%, 82.14%, 84.03%, and 80.32%. The higher the flocculant concentration, the higher the purity obtained, except adding a flocculant with a concentration of 4 ppm decreased. This is due to the addition of a flocculant with a concentration of 4 ppm, which has passed the saturation point of the solution. Research conducted by [7] showed that the purity level also increased with each additional flocculant dose. The precipitation of sap, brix value, and pol value influence this. If the precipitation process is not optimal, the purity value is reduced because the sugar and impurities have not been separated.

Dilute sap with a high purity level is found in dilute sap after adding a flocculant with a concentration of 3 ppm. If the purity value of dilute sap is higher, it will obtain good sugar quality—Pol and brix influence the purity value. The purity value is obtained by comparing %pol and %brix. The purity standard in [8] is >78%. The addition of a flocculant that meets the company standard for purity level >78% is the addition of a flocculant with a concentration of 1 ppm to 4 ppm. However, adding a flocculant with the highest purity value adds a flocculant concentration of 3 ppm. This is related to turbidity, pol, and brix obtained. Turbidity dilute sap on the addition of flocculant concentration of 3 ppm obtained the lowest turbidity value, pol dilute sap on the addition of flocculant concentration of 3 ppm obtained the highest %pol value, and brix dilute sap on the addition of flocculant concentration of 3 ppm obtained the lowest %brix.

IV. Conclusion

The results showed an effect of flocculant addition in improving the quality of sap in the Sugar Factory. The effective flocculant addition in improving the quality of dilute sap in Sugar Factory is 3 ppm flocculant concentration, which has a turbidity of 28.69 NTU, pH 7, pol 10.82%, brix 12, 88%, and purity level 84.03%.

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