Journal of Applied Chemistry

Investigation of the effects of polyelectrolyte, phosphate and pH values on the removal of impurities in the cane sugar juice clarification

Ziba Mohammadiyan Fard, Ali Alamo* and Hossein Askary

Department of Chemistry, Sharif University, Tehran, Iran

Article history:
Received: 23 November 2013
Received in revised form: 20 January 2014
Accepted: 12 February 2014

Abstract

The clarification of mixed juice has been the subject of research for decades, due mostly to its large impact on sugar quality. In this study, the Chemical precipitation parameters such as pH of the solution and phosphate and polyelectrolyte, were studied and optimized. Evaluation of the obtained data of performance polyelectrolyte type on effective parameters in coagulation of impurities such as turbidity, settling rate and mud volume indicated that the polyelectrolyte Accofloc Cheminova India is more effective than Taifloc3045 and BesflocK320 polyelectrolytes. Moreover typical juices from factory were clarified in laboratory trials under a range of pH and phosphate conditions. The results indicated that pH and phosphate had major effects on the residual concentrations in clarifier.The maximum capacity of adsorbent for impurities were obtained at pH =7/7 and P_2O_5 = 300 ppm.

Keywords: Sugarcane juice, Juice chemical impurities, Chemical addition.

1. Introduction

The main objective of this project has been to improve mixed juice (MJ) clarification. This juice contains a series of impurities compounds. During milling they are extracted with the cane juice and should be eliminated of the sugar.These impurities include dextran, starch, inorganic ash constituents such as potassium, sodium, silica, magnesium and calcium [1, 2]. The presence of dextran in the sugar factories leads to a falsely high polarization, increased viscosity, slowing of filtration, lower evaporation rates, elongated crystals (needle grain), longer wash and separation cycles in centrifuges and increase of sugar loss to molasses [3,4,5]. Existence 50-100 ppm of starch in sugar juice cause increasing the concentration of sucrose in molasses, reduce the purity of the sugar, increased viscosity of syrup, reduction of crystallization and centrifugation rates [6,7], also inorganic ions in cane juice cause the darkness of the sugar color and increase the molasses waste [8]. So far various metho ds for removal impurities in cane juice used for example application amylase enzyme [9], dextranases[10], membrane separation processes [11,12] and chemical precipitation processes[13]

Some of these methods such as using of enzyme amylase and membrane separation processes attention to high tonnage of cane sugar and the economic costs are not affordable. So chemical precipitation processes used as affordable method for removal impurities. The results of the clarification of juices with chemical precipitation processes depends to a great extent on the amount P_2O_5 present in the raw juice. The unsatisfactory results in clarification of cane juice have been explained by an insufficient amount of P_2O_5 per liter of juice; in addition to floc formed have a very important part in raw sugar clarification processes. Thus in this study, was measured amount of impurities in cane juice (Variety cp69) and also was studied performance the polyelectrolyte type on effective parameters in coagulation of impurities such as turbidity, settling rate and mud volume[14] and also optimized amount of phosphate and pH [15,16,17].

2. Experimental

2.1. Apparatus

Sulfo Molybdic acid, tin(II) chloride, potassium dihydrogen phosphate, hydrochloric acid, sodium hydroxide, trichloro acetic acid, standard dextran T40,

* .*Corresponding Author: E-mail: alamo@sharif.edu*

standard starch, ethanol absolute, acetic acid, potassium iodide, potassium iodate, calcium chloride, sodium chloride and potassium chloride[18].

2.2. methods

The pH of the juice solution was measured using a pH meter. The silica, dextran, starch and phosphate content were determined by the spectrophotometer. The amount of sodium and potassium were determined by flame photometer and concentrations of $Ca^{2+}$and Mg^{2+} determined by atomic absorption. Turbidity was determined using a spectrophotometer. Inorganic phosphate content was determined by the standard molybdenum blue colorimetric method.

In this study, the juice samples (mixed and clear juices) were analysed for dextran, starch, phosphate, sodium, potassium, calcium, magnesium and turbidity in order to obtain amount of removal percent of impurities in Clarifier. In order to improve the clarification system, samples of mixed juice were collected from factory to examine the effect of different polyelectric levels BesflocK32, Accofloc Cheminova India Taifloc3045 involved the following procedure:

•Heat the juice to 75°C;

•Adjust the P_2O_5 content of samples of mixed juice with tri sodium phosphate 45% at range of 250-350 ppm;

• Adjust the pH of each one litre sample using lime ($Ca(OH)_2$) to a selected value between 7-8.5;

• Heat the limed juice to boiling;

•Using of jar test for compare the usefulness of different polyelectrolytes;

•Addition polyelectrolyte at range 1-5 ppm on juice samples;

• Measurement of turbidity, sitting rate and mud volume;

•Collect samples for analyses.

3. Results and discussion

3.1. Analyses of the mixed juice and clear juice

The averaged results for selected species in mixed juice and Clear juice are shown in table 1. The concentration of all the species in CJ has decreased except for calcium oxide. Ca2+concentration increased as pH increased also the sodium oxide and potassium oxide levels do not change markedly on clarificatio

2.3. Effect of Addition of polyelectrolyte at different Concentrations as a Flocculants on Quality of Sugar Cane Juice

The studywas designed to evaluate the use of different concentrations of polyelectrolyte (1-5ppm) on effective parameters in Coagulation of impurities such as turbidity, settling rate and mud volume. Addition of polyelectrolyte at a concentration of 1-3 ppm showed a reduction in amount of mud volume and turbidity and an increase in settling rate.

Measurements of higher sedimentation rate and lower volume of mud have shown that polyelectrolyte Accofloc Cheminova India is more effective than BesflocK320 and Taifloc3045 in clarification system (Figure 1 and 2). Also Figure 3 indicate a decreasing in turbidity under 20 NTU for polyelectrolyt e Accofloc Cheminova India and Taifloc3045. Thus the overall results of this work indicate that the polyelectrolyte Accofloc Cheminova India is more effective than the other two.

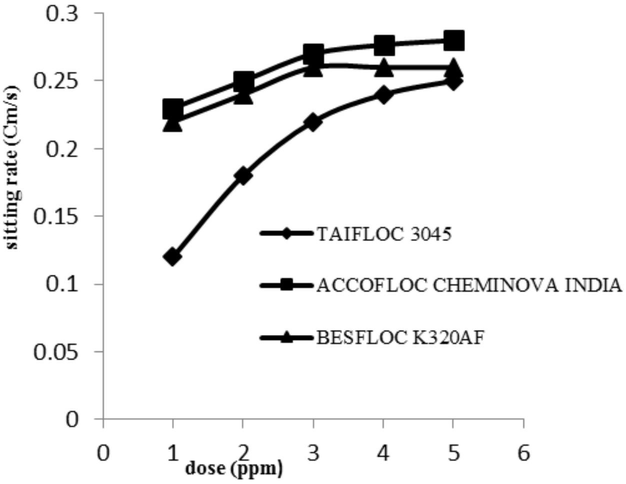

Figure 1. Effect of dose polyelectrolyte on sitting rate.

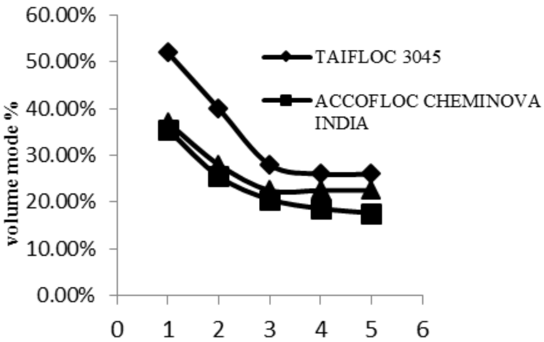

Figure 2. Effect of dose polyelectrolyte on mud volume.

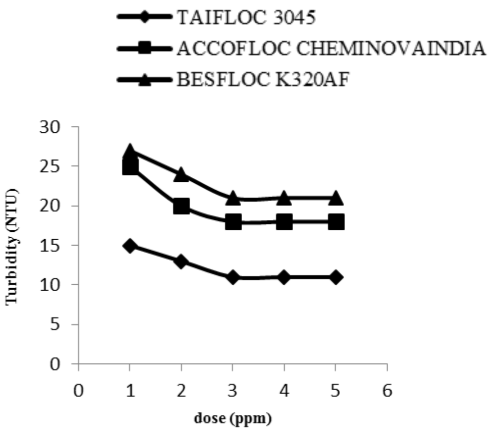

Figure 3. Effect of dose polyelectrolyte on turbidity.

3-3. Determination the optimum of pH and phosphate

Effect of the amount of phosphate was investigated on removal of impurities in the presence 3 ppm of polyelectrolyte Accofloc Cheminova India at a pH of 7-8.5. Figures 4, 5, 6 and 7 show that the lowest amount of silica, starch, dextran and turbidity were obtained at 300 ppm and pH 7.7. When lime is added for adjusting pH, the calcium content of the juice increase. So in this study, amount of CaO increased asmagnesium decreased as the pH of samples increased. The overall results indicated that the optimum pH and phosphate for clarification were 7.7 and 300 ppm, respectively.

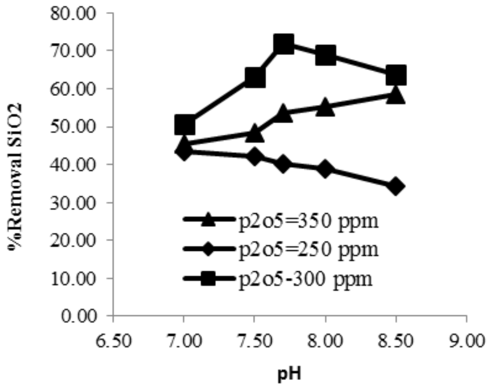

Figure 4. Effect of pH and phosphate on removal of SiO_2.

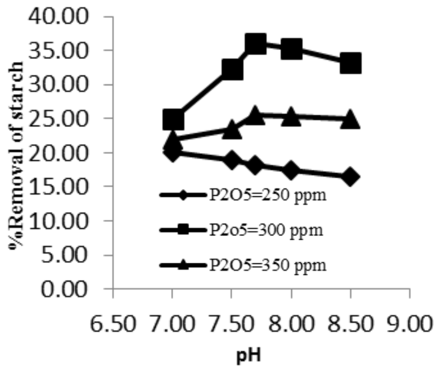

Figure 5. Effect of pH and phosphate on removal of starch.

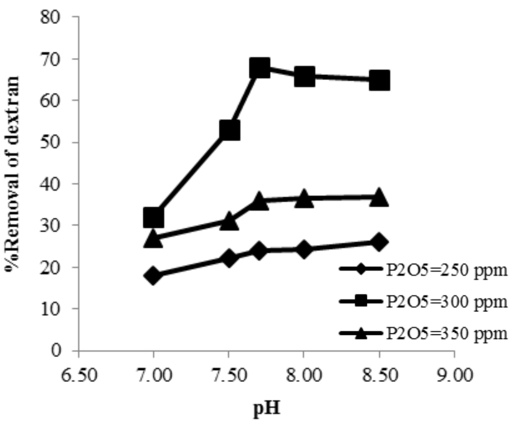

Figure 6. Effect of pH and phosphate on removal of dextran.

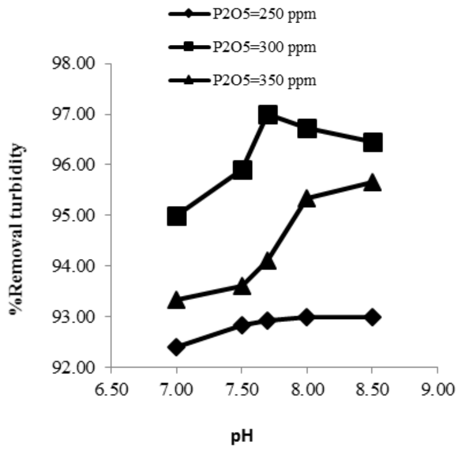

Figure 7. Effect of pH and phosphate on removal of turbidity.

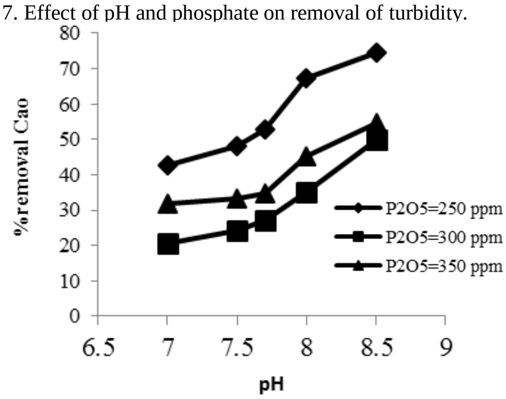

Figure 8. Effect of pH and phosphate on removal CaO.

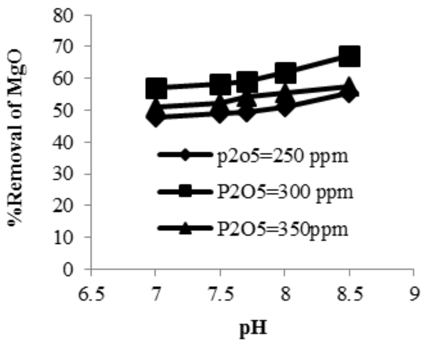

Figure 9. Effect of pH and phosphate on removal of MgO.

4. Conclusions

In this study, was measured amount of impurities in cane juice (Variety cp69) and also were studied performance of polyelectrolyte type, phosphate and pH on removal of impurities. Considering the results obtained, treatment polyelectrolyte Accofloc Cheminova India (3ppm) was defined the as the most adequate for the clarification of sugar cane juice for the consumption. The results indicate that optimum pH and P2O5 for the clarification of juice are respectively 7.7 and 300 ppm

References

[1] P. Honig. Hand Book of Principles of Sugar Technology. *Elsevier Publishing Company*. **1**(1993) 178- 194, 291.

[2] A. Steinbuechel and S. Rhee. Polysaccharides and Polyamides in the Food. *International Sugar Journal*. **1** (2005) 291.

[3] S. Bose and L. Singh. Problems associated with dextran, the major microbiological cause of sucrose loss and their remedies. *Indian Sugar*. **31** (1981) 603.

[4] E. Abdel-Rahman. Influence of dextran concentrations and molecular fractions on crystallization kinetics in pure sucrose solutions. *World Perspectives for Sugar Beet and Cane*. **6**(2007) 260.

[5] R. S. S. Satindar Kaur. Dextran and its effect on the flow behaviour of molassesand crystallization rate. *Journal of Food Engineering*. **86** (2008) 55.

[6]M. M. Zhou, C. A. Kembing and G. Eggleston .Issues of Starch in sugarcane processing and prospects of breeding for low starch content in sugarcane. *Sugarcane International*. **26** (2008) 3.

[7] M. Zhou, C. A. Kimbeng and G. Eggleston. Prospect of Breeding for Low Starch Content in Sugarcane. *Proc ISSCT*. **34** (2007) 724.

[8] P. Sahadeo. The Effect of Some Impurities on Molasses Exhaustion. *Proc. S. Afr. Sug. TechnolAss*. **72** (2009) 285.

[9] S. L .Eggleston. Seasonal Variation in Optimized Application of Intermediate Temperature Stable Amylase in Raw Sugar Makufacture. *International Sugar Journal*. **112** (2010) 472.

[10] G. Monge and A. Eggleston. Optimization of Sugarcane Factory Application of Commercial Dextranases. *Process Biochemistry*. **40** (2005)1881.

[11] S. C .Davis and S. B. Mkhize. Raw Sugar Filterability Improvement with Ion Excheng. Pros S Afr Sug Technol Ass. **78**(2004) 453.

[12] N. K. Saha. Polymeric Membrane Fouling Sugarcane Juice Ultrafiltration Role of Juice Polysaccharides. *Presented at The 10th Aachen Membrane Colloquium.* **189** (2006) 59.

[13] S. L. John. Floccution and Sedimentation of Cane Sugar Juice Particles with Cationic Homo-And-Co-Polymers. Journal of Applied Polymer Science. **90** (2006) 316.

[14] A. Ghada and A. Isam. Effect of Addition of Separan at Different Concentrations as a Flocculant on Quality of Sugar Cane Juice. *International Journal of Biological and Life Sciences*. **6** (2010) 88.

[15] B. Barker. Liming in Diffusers Calcium Saccharateor Milk of Lime. *Proc S Afr Sug Technol Ass*. **74**(2000)314.

[16] G. Eggleston and A.Monega. Sugarcane Factory Performance oF Cold Intermediate, and Lime Clarication Prosses. *Journal of Food Processing Preservation*. **26** (2002) 433.

[17] D. w, Rackemann and W. O. S. Doherty. Aspects of Calcium Phosphate Chemistry in Sugarcane Clarification. *International Sugar Journal*. **111**(2009)448.

[18] D. Verlag. International Commission for Uniform Methods of Sugar. *Laboratory Procedures for the Analysis of Sugar*. **1**(2009) GS7-21, GS 2-10, GS2-17, GS1-15, GS1-16, GS 6-7, GS 6.