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Conduction technology for sugar industry

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ABSTRACT

The proposed study is aimed to target the better way for electrolytic clarification of cane juice without any adverse effect on sugar house process. Electrolysis literally means decomposition or breaking of a substance or a compound into its constituent components and flow of electricity, which takes place in solution through the electrolytes, accordingly the migration of ions under the influence of applied potential difference. The electrolysis process provides oxidation and reduction without involving any other chemicals for clarification. The importance of this study is the introduction of conducting polymer material for carrying out the electrolysis of cane juice, which involves low potential i.e. save of power, easy maintenance of electrodic material, and is expected, that problem of scaling will be remove to greater extent. One more important factor in the mind is to avoid the introduction of undue material into the juice affecting the clarification processes. © 2012 Trade Science Inc. - INDIA

INTRODUCTION

The use of electricity for clarification of cane juice has attracted the attention of many research workers in the past. Gunderman^[1] made an attempt to remove inorganic and organic impurities from sugar solution by electrolysis and electro dialysis. Weisssegger^[2] electrolyzed cane juice between aluminum electrodes. Lima^[3] obtained a patent for electrolytic clarification of cane juice. The process involved passing the electric current through the juice using aluminum electrodes. Later on Ghosh^[4,5] employed iron electrodes for clarification of cane juice, which was comparatively cheaper and suggested the mechanism of the process.

Cane juice contains two types of colloidal impurities viz. Soluble or hydrophilic and insoluble or suspended or hydrophobic. Gums and vegetable proteins form soluble colloids whereas dirt, fiber, hemicelluloses etc corresponds to the insoluble or hydrophobic colloids. The soluble colloids are assumed to be protective in nature while the insoluble colloids are peptizing.

When raw cane juice is electrolyzed between two iron plate electrodes, the electrolytic gas (oxygen and hydrogen) bubbles and removes the dissolved colloids mostly as froth by adsorption at gas- juice inter phase. When these protective colloids are removed, the suspended colloids automatically settle down. After electrolysis with iron sheet anode, it was suggested that Fe²⁺ ions generated in accordance with Faraday's law of electrolysis enter in the bulk of the juice and forming insoluble iron salts^[6,7].

Further Doss et. Al^[8] has made certain modifications in the process of clarification and found that electrolysis of juice in acidic condition is more advantageous than at higher pH. Taking these observations into account, Ghosh^[9] made another modification and suggested the use of phosphoric acid and active carbon for complete removal of iron from clarified juice. Also the production of organic acid by the destruction of reducing sugars in the clarification, process is of great significance. The organic acids produced, react with lime forming calcium salts which contribute appreciably

to the CaO content of the clarified juices. Matthew and Jackson^[10] studied the decomposition of reducing sugars between pH 5 - 9 in the temperature range of 50^o to 100^oC. It was also reported that the destruction of reducing sugars increased rapidly with increase in temperature and pH. Chaturvedi et al^[11] observed a decrease in the pH due to destruction of reducing sugars was very marked at high temperature is discussed (TABLE 1). The decrease in pH during the alkaline destruction of reducing sugars observed by various workers^[12] has been attributed to the production of organic acids during the reaction. This has been studied qualitatively by Isbell^[13] Kiliani^[14] Nelson and Browne^[15], and Scheibler^[16].

EXPERIMENTAL AND METHODS

Materials & reagents used

- Pyrrole, 0.67gm. 10mmol (Merk make)
- Sodiumparatoluenesulfonate, 1.94gm., 10mmol (Sigma-Aldrich).
- Calcium hydride (Merk)
- Double Distilled water (From Monodest – 3000 plant).

Equipment & glassware used

- Potentiostat (Regulated D.C. power supply Elnova).
- Electrolytic cell with graphite rod, conducting glass electrode, saturated calomel electrode (SCE).
- Volumetric flask (100ml.)
- Source of dry nitrogen

Method

Pyrrole is distilled slowly from calcium hydride under reduced pressure prior to use and stored in the fridge in brown bottle at 4^oC. 0.7 ml of distilled Pyrrole and 1.94 gm. of sodium Para toluene sulfonate has been taken in a volumetric flask of 100ml. and D.D water was added to up to the graduation. The solution thus prepared was poured into the self fabricated electrolytic cell. The conducting polymer electrode i.e. polypyrrole coated graphite electrode is prepared in a special type self fabricated electrolytic cell. The electrolytic cell is flat bottomed and cylindrical in construction and has a gas inlet and two side-arms with female quick fit joints into which are inserted two male joints

terminated with sintered glass frits. The conducting glass electrode, is then attached to a crocodile clip with a long wire contact, which is clipped so that the crocodile clip is above the surface of the liquid. The graphite rod and saturated calomel electrode (SCE) are then placed in the side arms provided (separated from the solution by a sintered glass frit).

RESULT AND DISCUSSION

Pyrrole will form a polymer on a wide variety of electrodic material for eg graphite electrode, over choice of potential if potentiostatic, or of current density if galvanostatic, in a wide variety of solvents including water, with a great range of electrolyte salts. Electrolysis may be terminated to give an adherent electrode coating or else continued until the film formed is thick enough to precede the electrolytic clarification of cane juice in an electrolytic cell (Figure 1).

The electrochemical polymerization of pyrrole on graphite electrode produces a strongly adhered, durable film with enhanced and good electrode properties. Our interest in the preparation of durable, conducting organic graphite electrode surface led us to this approach. We now present the method by which the electrochemical polymerization of pyrrole^[18] is done in the self fabricated electrolytic cell under controlled condition.

With the potentiostat (D.C power source, Elnova) on stand by, the graphite electrode was attached to the positive terminal of regulated. D.C. Power source & saturated calomel electrode as well as conducting glass electrode were attached to the negative terminal of regulated D.C. power source respectively. When potentiostat was switched on and a potential of + 1.0V versus saturated calomel electrode was given to the graphite electrode & performing the electrolysis for about one hour, a thick black film of polypyrrole was formed on graphite electrode. The polypyrrole coated graphite electrode will be further used in electrolytic clarification of cane juice.

The ultimate and overall aim is to carry out clarification of cane juice electrochemically using conducting polymer electrodes to develop a safe, economical and eco friendly method at the pilot plant level followed by Industrial level. It is expected that the proposed project will promote the sugar industry in reducing the process

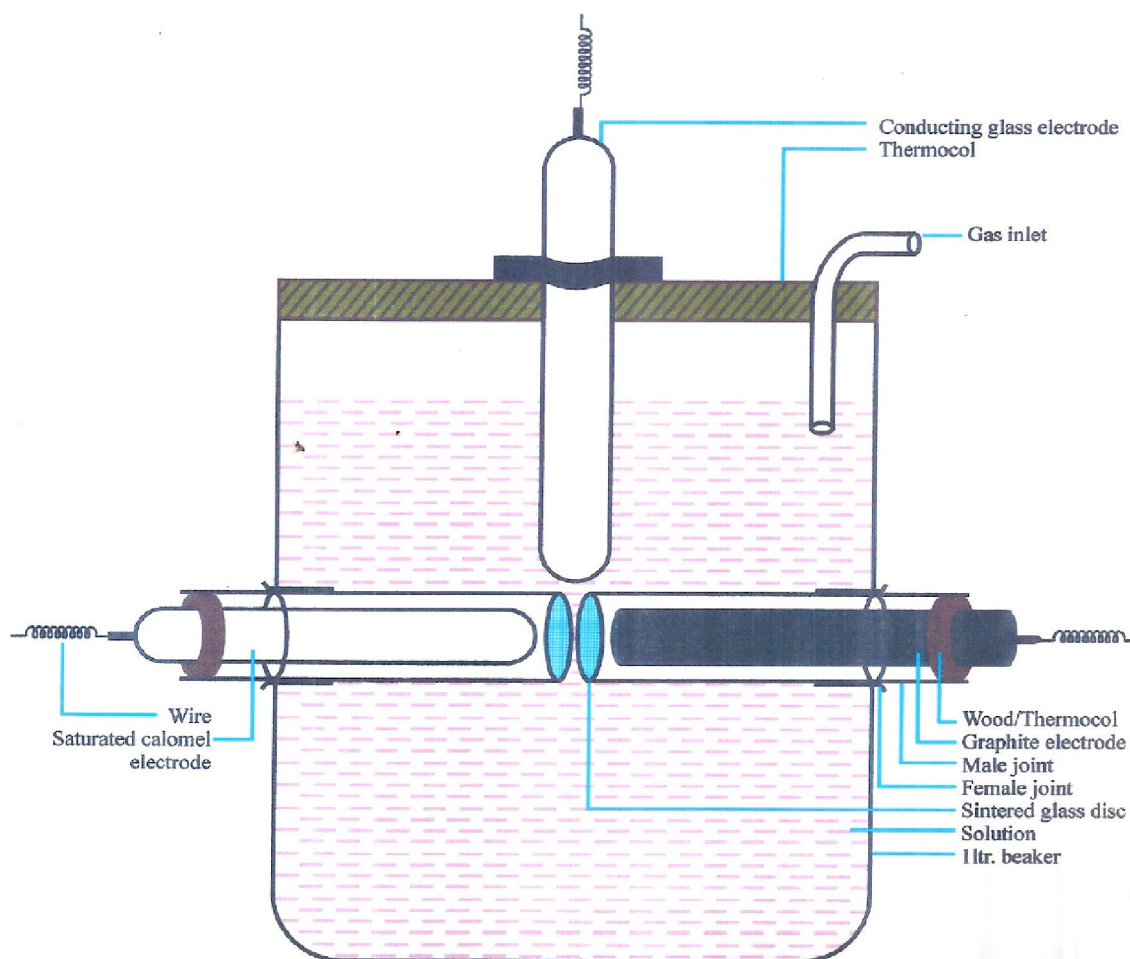


Figure 1 : Electrolytic cell

cost and accordingly the cost of final product i.e. sugar.

As discussed in the experimental part, the electrochemical polymerization of polypyrrole on graphite electrode was done by using three electrode sys-

tems electrolytic cell. Electrolysis was carried out for about one hour. The black thin film was formed on the graphite electrode which was peeled off from the graphite electrode and IR spectrum of same is dis-

TABLE 1 : IR absorption frequencies

Observed IR Frequency of Absorption, cm^{-1}	Assignment
3480.53	Nearest to 3400cm^{-1} , which is the peak of secondary amine? Therefore it is confirmed that the peak at 3480.53cm^{-1} is of N-H stretching.
3373.70	The N-H group has two spikes at 3373.70cm^{-1} and another at 3200cm^{-1} .
3065.45	This peak through not intense not sharp which is nearest to 3110cm^{-1} . This is the IR frequency of C-H stretching. Here it is interesting that the CH bands are weak as they are in pyrrole dimer and trimer.
1600.37 to 563.7	This region of IR absorption frequency contains the pyrrole ring vibrations.

cussed.

Thus on the basis of infrared spectra we can say that the black film coated on the graphite electrode is of polypyrrole.

The need of present work that is Physico chemical

studies on electrolytic clarification of cane juice has come into existence because the conventional method of the cane juice clarification i.e. double carbonation Double sulphitation and double carbonation has many disadvantages. The milk of lime, which is added in mixed juice

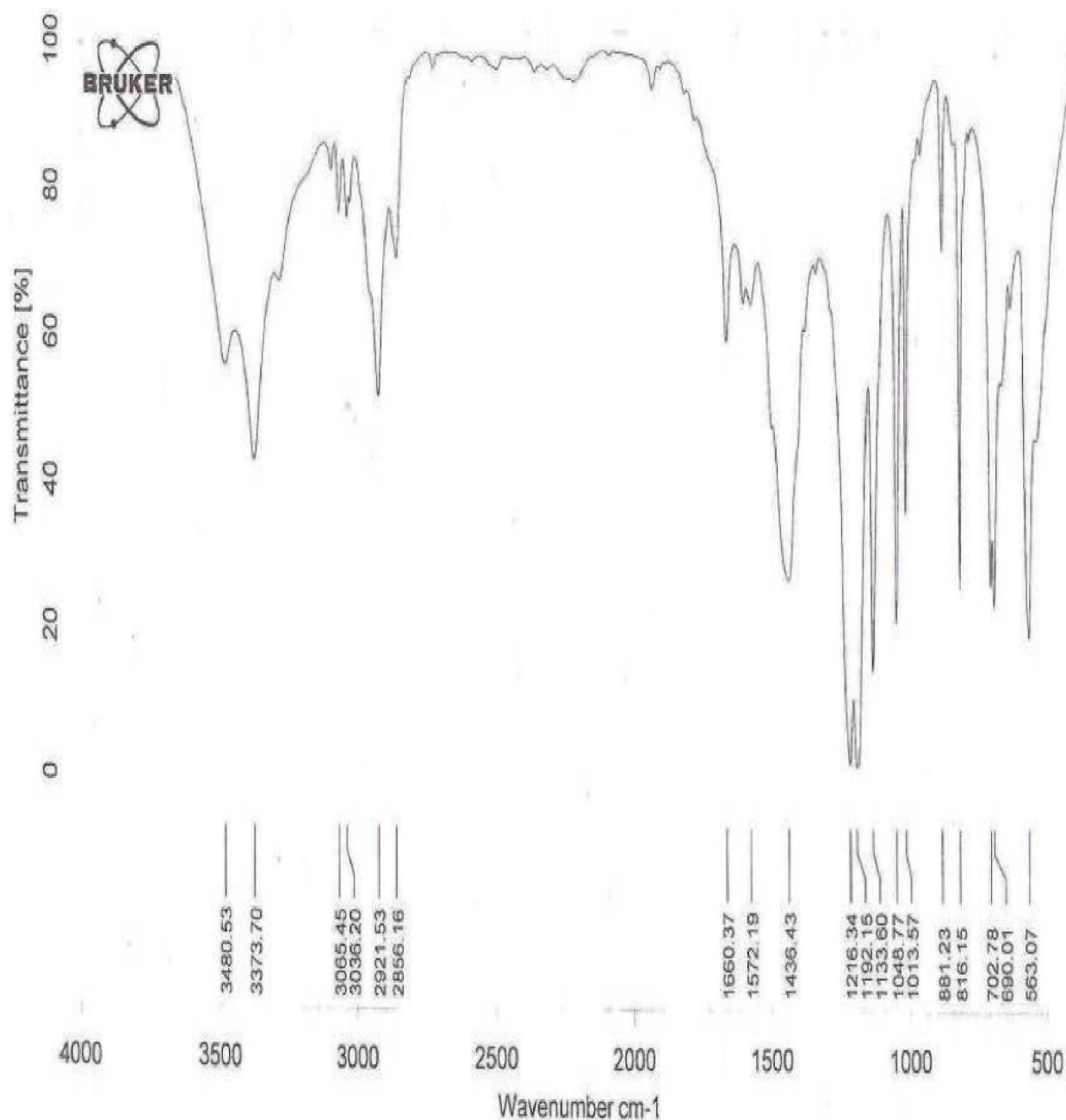


Figure 2

after heating, increased the concentration of calcium from 650-800 ppm to 900-1200 ppm in clarified juice. The high calcium content in clarified juice leads to the formation of salts and organic acids.

The calcium ions with small amount of magnesium combined with sulphates, phosphates, organates, silicates and sesquioxides is responsible for scale formation in juice heaters, evaporators and pans etc. The high concentration of calcium also increases the viscosity of syrup and massecuits leading to higher loss of sugar in

the molasses and the final sugar obtained is of poor quality. The grain size of sugar crystals developed in the pan becomes irregular due to poor circulation.

Moreover, the melassigenic nature i.e. formation of molasses due to the loss of sugar during crystallization, increased with increase in ionic concentration in cane juice. Queen and Mobes^[17] had confirmed that the melassigenic effect of alkali and alkaline earth ions decreased in the order of $K > Na > Ca > Mg$ and that the Potassium and Sodium ions are very much melassigenic

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than Magnesium and Calcium ions. The high melassigenic effect of Potassium and Sodium than Magnesium and Calcium ions is usually assumed to be due to their salting out effect.

The SO₂ used in the clarification process is also a major problem regarding economy and health point of view. The sulphur is an expensive chemical because it is imported from other countries. The saving in use of sulphur will help in saving the foreign exchange. The sugar obtained from the above mentioned methods i.e. double carbonation, double sulphitation contains sulphur dioxide (SO₂) in the range of 30 ppm to 60 ppm. The SO₂ content in the molasses and sugar makes it unfit for edible purposes.

REFERENCES

- [1] Gundermann; *Cetnt.Zuckerid.*, **50**, 315-323 (1942).
 [2] Weisseger; *Ger.Patent*, 736455, (1943).
 [3] Lima; *U.S.Patent*, 1953653, (1934).
 [4] D.N.Ghose; *J.Ind.Chem.Soc.*, **9(3&4)**, (1946).
 [5] D.N.Ghose; *Proc.Ind.Acad.Sci.*, **38(77)**, 453-462 (1953).
 [6] D.N.Ghose; *Indian Sugar*, **2**, 141-148 (1957).
 [7] D.N.Ghose; *International Soc.of Sugar Cane Tech.*, **2**, 218-226 (1956).
 [8] K.S.G.Doss, et al.; **2**, 227-235 (1956).
 [9] D.N.Ghose, *ISJ.*, (1960).
 [10] J.A.Mathew, R.F.Jackson; *Bur.Stand.Jou.Res. Wash.*, **11**, 619-633 (1953).
 [11] H.S.Chaturvedi, G.N.Gupta, V.S.Kusswaha; *Proc.Sugar Tech.Assoc.India*, **12**, 165-171 (1943).
 [12] H.S.J.Isbell; *Res.Nat.Bur.Stand.*, **29**, 227-232 (1942).
 [13] H.Kiliani; *Ber.*, **15**, 710-712 and 2953-2960 (1885).
 [14] E.K.Nelson, C.A.Browne; *J.Am.Chem.Soc.*, **51**, 830-836.
 [15] C.Scheibler; *Ber.*, **12**, 2212-2217 (1880).
 [16] Quentin Moebes; *International Sugar Journal*, 103 (1979).
 [17] A.F.Diaz, R.W.Murray; in *Proceeding from 'Symposium on Silylated Surfaces Midland, Michigan, May* (1978).
 [18] A.Dall'olio, Y.Dascola, V.Varacca, V.Bocchi; *Compt.Rend.*, **C267**, 433 (1968).