Electrical Conductivity Of Sugar Cane Juice

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***Abstract*- The electrical conductivity of fresh unfiltered cane juice, filtered juice, lime added juice at 298.15 K ,318.15 K,373.15 K, taking CO-1148 cane variety have been measured .The conductivity of fresh unfiltered juice ,filtered juice and lime added juice at 298.15 K were found to be 172,180,584 ,(µS/cm) respectively .The conductivity is found to be increasing as temperature increases ,but order of magnitude of conductivity remains same across the temperature range tested .The higher observed conductivity of lime added or clarified juice ,probably have its origin in the inclusion or adsorption of impurity (non sugar, protein, colloids, mud's etc) .The value of specific conductivity of different grade of juice could be used to judge the quality of sugar. Results shows order of conductivity lime added >unfiltered >filtered were found.**

Keywords-electrical conductivity, temperature, cane juice, impurity, sugar

I. INTRODUCTION

In India sugar industry is one of the largest agro based industries. In sugar industry the sugar is manufactured by unit operation .The crushing of cane followed by its milling ,and the extracted juice undergoes clarification for desired treatment to make the juice purified and concentrated by making of crystallizable sugar [1].The convention process for the processing of the cane juice has the following limitations (a)in efficient removal of substance like gum ,ash, silica, reversible colloids during clarification which adversely effect the color of the final products (b)inversion of sucrose leading to augmentation of molasses's formation and finally (c) concentration of juice by evaporator and condensation of same before crystallization [2] A typical composition of raw sugar cane [3].

Table 1.typical composition of raw sugar cane

	Consistituents	Percentage
.1	Water	75-88
.2	Sucrose	10-21
.3	Reducing sugar	0.3-3.0
.4	Organic matter	0.5-1.0
.5	Inorganic composition	0.2-0.6
.6	Nitroenous bodies	0.5-1.0

Hence the above assessment it becomes an objective to evolve relevant parameter for better and exact control of the system .However control is based on two aspects i.e. for quality and quantity assessment .The purpose of present study is pivoted on quality of end products [4].Studies shows that the dependence of temperature is usually expressed a relative change per degree Celsius at particular temperature commonly percent / at 25 ^{O}C and thus is called the slope of solution [5].Although measurement of electrical conductivity to the relative suitability of pH for centre of end points of the first carbonation process were investigated [6].

II. MATERIAL & METHOD

For the conductivity measurements a glass cell with platinized platinum electrode was employed. The resistance, R, of the solution was measured with an A.C. bridge(Wayne Kerr 6425)in the frequency range ω = 500 Hz-5 Hz and true resistance were obtained by extrapolation of R vs. ω-1 at infinite Frequency . The volume of the cell was 30 cm^3. One set of experiment was performed under isothermal condition at 298.15 K. In A second set juices concentration varied and with a experimental temperature (from 298.15 to 373.15 K). A themostated ethylene water bath was used to control the temperature of the super cooled solution with in +- 0.05K .,and a kerosene /oil bath was used to control the temperature for the measurement at 298.15Kwith in +- 0.02K.The cell constant was determined as function of temperature employing the reported electrical conductivity of solution of known concentration ,aqueous KCL as temperature above 273.15K (7) and ethanol solution of KI for Temperature below 273.15K (8) .The cell constant varied from 0.1002cm^{-1} at 248K,down to 0.0957cm^{-1} at 323K,and the value at 298.15Hwas 0.0968+- 0.0006cm^{-1} .Solution were prepared with demonized water free of CO_2 and nitrogen was bubbled into the solution to minimize CO_2 solubilization prior to the measurement. In all cases specific conductivity of pure juice in water was determined to correct the measure specific conductivity by the contribution of ionic impurities of the disaccharide or residual CO_2.

III. RESULTS AND DISCUSSION

The specific conductivity versus temperature for the different variety of juice under study are shown in Fig(1).The order of specific conductivity for unfiltered ,filtered ,lime added juice at 298.15 K were 172,180,584 (µS/cm) respectively .The higher observed conductivity for lime added juice at all temperature seems to be attribute to their higher concentration of impurity (non sugar proteins ,colloids ,mud's etc).Results reveals that filtered juice shows that minimum pH value i.e. 5.2 with a conductivity value 210 µs while unfiltered juice shows conductivity 202 µS/cm value at 5.2 pH. The raw juice was treated with the milk of lime under constant stirring to raise its pH from around 5.3 to 8.1 .The liming was carried out at 298.15 K .Experiments conducted with dry lime revealed that's

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around 2.5 grams of lime was required per 1000 ml of juice to raise its pH to 8.1. The treated juice was then kept unstirred for around 2 hour to facilitates the settling of the solids (mud's, collides, materials proteins etc).The clear greenish –brown colored supernatant juice at pH 8.1 shows maximum conductivity i.e.584 µS/cm (fig2) .On carry out the Fig (3) shows a slightly linear relationship between conductivity in µS/cm and % dilution (up to 5 % only).

Fig 1 showing conductivity (µS/cm) and concentration of lime added cane juice may be understood in terms of changing concentration of Ca^{++} ions .Conductivity value of lime added juice is higher with the fact that ionic concentration of Ca^{++} ions which contribute to the higher conductivity. The formation and dissociation of H_2CO_3 and its reaction with Ca $(OH)_2$ is governed by a well known mechanism where stoichiometry may be found elsewhere 21, 21.Table 2 shows removal of non sugar other than CaO is recorded, as reported by Jenkins 22.

It is evident from above discussion that conductivity data provides satisfactory evidence that the minimum is the conductivity value; higher will be the purity of cane juice; could also employed as a parameter for the judging the completion of the first carbonation reaction .Although, the fundamental reaction of first carbonation has been extensively studied in the past, but it is still offers simple scope for further investigation ,so we have therefore attempts to investigate some relevant information .The observed results of non sugar present in cane juice responsible for conductivity generation is good agreements of data published by author in cane sugar and molasses [Vikesh2009].

Clarification of cane juice is primally controlled by maintain optimum pH .It is clearly shows from Table 2 and 3 that the clarification that the deviation of pH value in cane juice from 5.1 to 8.1 .It is difficult to relies the importance of such deviation and its impact on overall clarification process .However, lesser change in pH, which is practically ignored in sugar processing .On the other hand conductivity values (Table 2 and 3) clearly indicates higher deviation 180-235 µS/cm i.e. almost three times higher than initial value, showing more reproducibility. This is due to fact that non sugar part of sugar house products gives more indication about purity of sugar than sugar part as discussed by author in recent years [Vikesh 2009].

It is evident from above discussion that electrical conductivity and pH measurement was made simultaneously during clarification [Lime adding] .It is observed from the analysis that electrical conductivity data shows a sharp change with respect to pH. Although, comparison of pH and electrical conductivity suggest that electrical conductivity is a better controlling parameter than pH, indicating the additional increase of lime in mixed juice.

Table 1

Temperature	Conductivity (µS/cm)
Unfiltered	
298.15 K	172
318.15 K	266
373.15 K	443
Filtered juice	
298.15 K	180
318.15 K	277
373.15 K	464
Lime added juice	
298.15 K	584
318.15 K	675
373.15 K	862

Table 2

pH	Conductivity (µS/cm)
Unfiltered	
5.3	202
Filtered juice	
5.2	210
Lime added juice	
8.1	584

Table 3.dilution effect on conductivity

Dilution%	conductivity (µS/cm)
Unfiltered	
1 %	172
2 %	271
3 %	390
4 %	455
5 %	543
Filtered juice	
1 %	187
2 %	282
3 %	396
4 %	458
5 %	554
Lime added juice	
1 %	593
2 %	695
3 %	792
4 %	894
5 %	1080

Fig 1 Specific conductivity vs. temperature plot for different variety of Juice

Fig 2 Specific conductivity vs. pH plot for different variety of juice

Fig 3 Dilution effect on conductivity of juices unfiltered, filtered, lime added

IV. Conclusion

Electrical conductivity measurement of juice and other sugar products could be made qualitative .Hence under the above constrain to control the process for its ongoing assessment it becomes an objective to evolve relevant parameter for better & exact control of the system.

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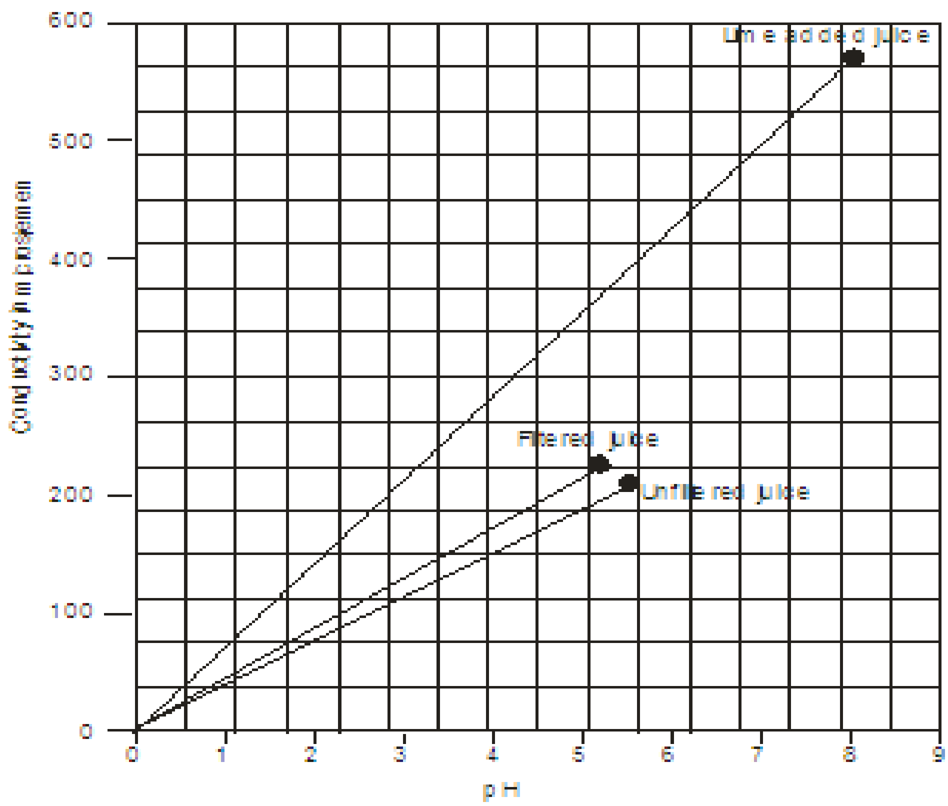
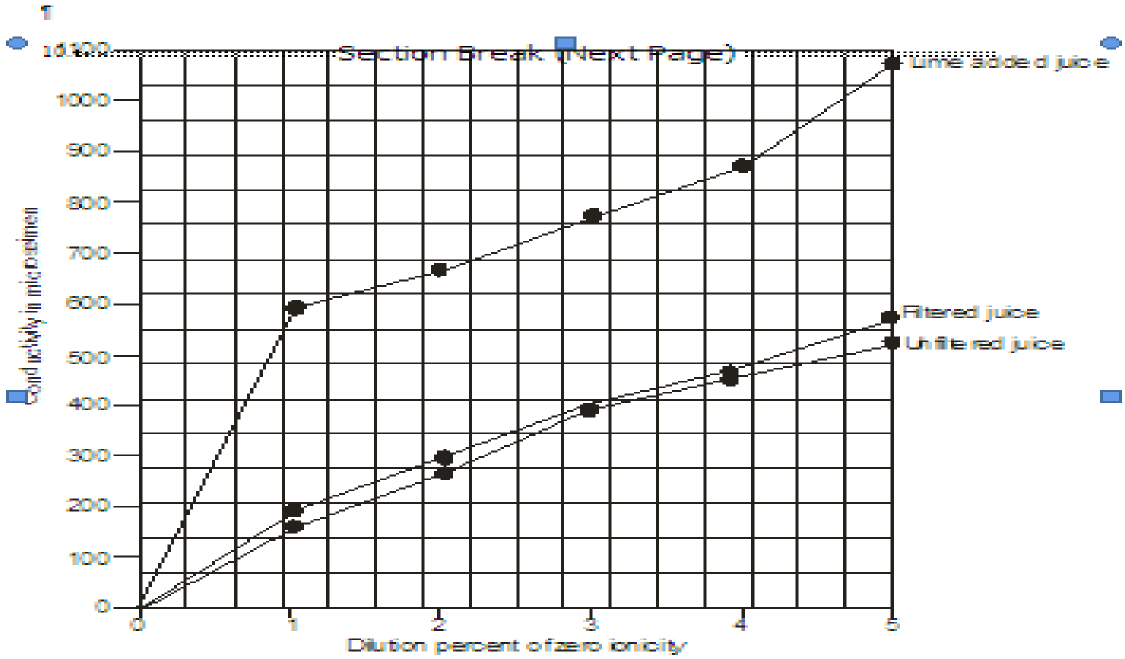


Specific conductivity vs. pH of different variety of juices

Fig. 2



Dilution effect of conductivity of juice

Fig. 3