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STUDIES ON KINETICS OF CRYSTALLIZATION OF SUCROSE IN PURE SOLUTION "EFFECT OF VARIATION OF SPEED OF THE STIRRER"

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ABSTRACT:

Crystallization plays an important role in the economics of the sugar factory., To increase the rate of crystallization various additives, methods and procedures have been adopted of these some salts and amino acids will increase the rate of crystallization in pure sugar solution. The present work deals with the true role of some salts and amino acids on rate of crystallization in pure solutions and also to evaluate the kinetics and thermodynamic parameters for the crystallization rate of sugar.

KEYWORDS: *sugar crystals , speed of stirrer, temperature.*

INTRODUCTION:

Crystallization must surely rank as the unit operations and it plays an important role in successful functioning of the sugar factory. The economy of the sugar factory is mainly dependent on the rate of crystallization of the sucrose because it is directly related to the attractiveness, purity, storage problem etc. If the rate of crystallization more, it will produce more quantity of sugar in unit interval of resulting in low cost of production. To achieve this various methods and procedure time have been applied for this purpose in pure solution of sucrose some additives have been found helpful of these manganese and cobalt salts in minute quantities have been reported by kakuo susoki a Japanese Scientist Anon. Jackson (6-11) and Indian Scientist Dr. Jenekar G.M. and Dr. Khodaskar S.N.(13-14) tried nickel and Zink salts and certain amino acids in minute quantities to increase the rate of crystallization have been found helpful and also reported the significant and usefulness of the compound on the rate of crystallization of sugar.

1.2 The above authors have observed the effect of variation of speed of the stirrer on crystallization constant temperature. However no work is available in the literature on the effects of true role of additives on crystallization rates. In the present study the rate has been determined by maintaining the same super saturation coefficient in pure and presence of additives to see their true role on crystallization rate by applying kinetic equation.

EXPERIMENTAL:

Sucrose Analar (BDH) sucrose was used. The sucrose content of sample was determined by employing a known concentration of sample for polarization and was found to agree with value reported.

2.2 Procedure:

The procedure for starting crystallization was devised in such away so as tom ensure minimum error arising out of the following factors viz.

(i) Constancy of Temperature
(ii) Maintenance of Super saturation coefficient in the solution
(iii) Measurement of refractive Index of solution at different interval of time.

The sucrose of high degree purity was used. The course of crystallization was followed by means of successive refractometer reading on the solutions from which the sugar were crystallizing.The method was essentially that employed by Jenkins (12) and Abbe refractometer was used water at constant temperature was circulated through the jacket and all readings were taken at constant temperature.

The crystallization were carried out in a 100 ml wide mouth conical flask, the stopper of which was fitted a glass stirrer. The flask was immersed in a thermostat kept at the devised temperature +0.02° C. The rate of stirring during crystallization was about 100, 150& 200rpm.

The sucrose solution were prepared at approximately at the boiling point and were then allowed to cool to the desired constant temperature of the thermostat. The initial concentration of each was determined by making a refractometer readings on a few drops of the solution. Five grams of fine seed crystals were then added for each 100 grams of the solution and the stirring was started simultaneously. The time adding the crystals and the time of taking each subsequent samples were noted. The pipette was attached to the flask to withdraw few drops required for each determination and the refractive index measurement were carried out at different time interval and at constant temp during the crystallization.

The measurement were carried out 40°
The plot of (nt-noo) against time were linear indicating that order of crystallization is unity.
From the slopes the rate constant of crystallization were calculated and also calculated by using following formula.
$K = 1/t \times 2.303 \log\{(no-n\infty)/(nt-n\infty)\}$
Where, t Time interval of refractometer reading
no = The refractometer reading taken after the addition of seed crystals.
nt = The refractometer reading after each interval of time
n∞ = The constant refractometer reading.

The activation energy associated with the growth of the crystal is calculated by using Arrehenius equation.

i.e. $K = Koe^{-Eac/RT}$
Where, K= rate constant
Ko= Frequency factor
EAC = Activation energy associated with process of growth
R=Universal gas constant
T= Absolute Temperature
The graph were plotted between 1/T and In k and from the slopes the activation is calculated.
The enthalpy ΔH is calculated by using formula
$\Delta H \neq \Delta E \neq RT$

Where,
ΔE=Energy of activation
R = Universal gas constant
T= Absolute Temperature.

Entropy, free energy and K are calculated by using the following formulas.
$A = RT/Lh \times e\Delta \neq /R$

Where, on L - is the Avgadro Number
R - is the gas constant
T - is the absolute Temp.
H - is the plancks constant

$$\Delta G \neq \Delta H \neq -\Delta S \neq$$

$K=RT/Lh \times e^{\Delta S\neq/R}\, \Delta H\neq/RT$
Where, $\Delta S \neq$ = Entropy of activation
$\Delta H \neq$ = Enthalpy of activation

TABLE 1
Rate constant of pure sugar crystallization in pure solution at constant S.C. (1.2) and at different speed of the stirrer.

Speed RPM	Temperature 40°C
100	1.88×10
150	1.98× 10
200	2.68× 10

TABLE 2
Kinetics parameters for crystallization rate of sugar at S.C. =1.2

Temp in ^{0}C	Ea. (KJmol^{-1})	$\Delta H^{\neq}$	$\Delta S^{\neq}$	$\Delta G^{\neq}$	Log Ko	Ko (sec^{-1})
40	27.70	24521.24	-185.34	80679.91	3.21	21320.23

RESULTS AND DISCUSSION

3.1 Table 1 gives the rate constant of sucrose crystallization in pure solution at different speed at S.C. =1.2. It is clear from the result that rate constant fairly as the speed of stirrer increases.
3.2 The rate of crystallization of sucrose in pure medium obey first order equation.
3.3 Kinetic parameters i.e. constant Ko. energy activation associated with the presence of growth, enthalpy change AH. Free energy change AG and entropy crystals change AS are evaluated at constant S.C. The values are given in Table 2.

CONCLUSION

It is observed that the higher speed of the stirrer is favourable for increasing the rate of Crystallisation of pure sugar solution.