FACTA UNIVERSITATIS
Series: **Mechanical Engineering** Vol. 10, N° 2, 2012, pp. 113 - 124

EFFECT OF INTERNAL HEATING ON SENSIBLE BEHAVIOR OF SUGARCANE JUICE IN A STAINLESS STEEL POT

UDC 664.1.04; 621.1.016.4

Mahesh Kumar

Mechanical Engineering Department,
Guru Jambheshwar University of Science & Technology, Hisar (India)-125001
E-mail: mkshandilya1@gmail.com

Abstract. *In this research work, the natural convective behavior during internal heating of sugarcane juice in a stainless steel pot for jaggery making is reported on. Various indoor experiments are conducted for internal heating of sugarcane juice in stainless steel pot by varying heat inputs from 200 to 360 watts. The experimental data are used to determine the values of constants in the Nusselt number expression by simple linear regression method and then the values of the convective heat transfer coefficients are determined. The convective heat transfer coefficients are observed to increase with an increase in rate of heat input as well as in the operating temperature. The experimental errors in terms of percent uncertainty are also evaluated.*

Key Words: *Internal Heating of Sugarcane Juice, Jaggery Making, Sensible Heating, Convective Heat Transfer Coefficient*

1. INTRODUCTION

Jaggery (local trade name *Gur*) is manufactured from sugarcane mainly under the unorganized sector of the rural India. The concentrated form of sugarcane juice is prepared by heating and boiling sugarcane juice in large pans under open conditions over underground furnace. Jaggery is the most nutritious product among all the sweeteners and it is easily and cheaply available in India. In addition to its sweetening characteristics it has several medicinal properties and it increases food palatability. In India, about 273 million tons of sugarcane are produced annually. About 50% of the total sugarcane juice produced is used for manufacture of 8 million tons of jaggery due to its large scale consumption [1], [2], [3].

Expressions are developed to determine the rate of evaporation for distillation under indoor conditions [4], [5], [6]. Likewise, later on, various researchers have attempted to modify these relations under simulated conditions [7], [8], [9], [10]. Thermal models are also developed for heat and mass transfer without any limitations for indoor as well as

Received July 07, 2011

outdoor conditions by linear regression analysis [11], [12]. Tiwari et al. [13] have studied the effect of varying voltage and mass on heat and mass transfer of sugarcane juice during natural convection heating in an aluminum pot for external heating. Kumar et al. [14] have experimentally investigated the convective heat transfer coefficients of milk during khoa making which are found to vary between 3.00 to 6.01 W/m^2 ^{o}C. Recently, Kumar et al. [15] have reported on the performance of stainless steel and aluminum pot surfaces for external heating during sensible mode of sugarcane juice for constant mass by varying heat inputs from 200 to 360 watts.

For jaggery making the sugarcane juice is heated in order to induce evaporation of a large quantity of water present in it. The sugarcane juice heating process involves natural and boiling convection heat transfer mechanisms. In the present research work the effect of internal heating on natural convection (sensible) behavior of sugarcane juice in a stainless steel pot has been reported. Various indoor experiments have been performed for constant mass of the juice by varying heat inputs from 200 to 360 watts. The temperature ranges for natural convection heating of sugarcane juice is considered up to 90 ^{o}C [13], [15]. The present research work would be highly useful in designing improved sugarcane juice processing equipment for jaggery production.

2. Experimental Details

2.1 Experimental set-up and instrumentation

The schematic view of the experimental unit is shown in Fig. 1. It consists of a stainless steel pot fitted with a spiral shaped stainless steel immersion rod as shown in Fig. 2. The stainless steel heating immersion rod has been brazed inside the pot at its bottom and it is connected through a variac to control the rate of heating of the sugarcane juice. The temperatures of Juice (T_1), immersion rod surface (T_2), outer pot side (T_3) and surrounding air (T_4) are measured by a digital temperature indicator (least count of 0.1 ^{o}C) with calibrated copper-constantan thermocouples. Sugarcane juice free surface temperature (T_5) is measured by infrared thermometer (Raytek-MT4), having a least count of 0.2 ^{o} C with an accuracy of ±0.2% on a full scale range of -1 to 400 ^{o}C. The relative humidity (γ) and temperature above the juice surface (T_6) are measured by a digital humidity/temperature meter (model Lutron-HT3006 HA). It has at least count of 0.1% relative humidity (RH) and 0.1 ^{o}C temperature. The heat input is measured by a calibrated digital wattmeter having at least count of 1 watt. The mass of juice evaporates during its heating measured by an electronic weighing balance (capacity 6 kg; Scaletech, model TJ-6000) having at least count of 0.1g.

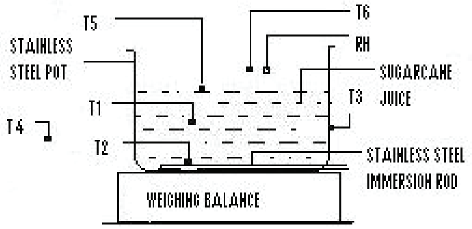

Fig. 1 Schematic view of experimental unit

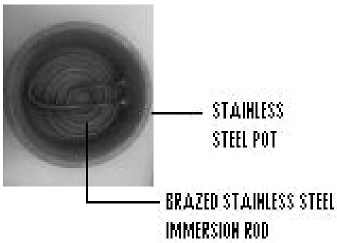

Fig. 2 A photograph of the pot for internal heating of sugarcane juice

2.2. Experimental procedure

In order to determine the effect of internal heating on natural convective behavior of sugarcane juice during jaggery making in a stainless steel pot the following procedure is employed:

1. Fresh sugarcane juice sample purchased from the local market is heated in a stainless steel cylindrical pot (200 mm in diameter, 102 mm deep and 1.6 mm thick) for different heat inputs ranging from 200 to 360 watts.
2. The data of temperatures, mass evaporated and relative humidity are recorded up to 90 ^{o}C (i.e. sensible heating mode range) after every 10 minute time interval.
3. By varying the input power supply from 200 to 360 watts different sets of heating of sugarcane juice are obtained which are reported in Appendix-A (Tables A1-A5).
4. For every run of the sugarcane juice heating, constant mass of the juice sample is taken i.e. 2200 g. The mass evaporated during heating of sugarcane juice are obtained by subtracting two consecutive readings in a given time interval.
5. In order to make a comparison, the above mentioned experimental procedure is also followed for water under the same working conditions. The experimental data for water heating at 200 watts are given in Table A6 (Appendix-A).

3. Theoretical Considerations

3.1 Thermal modeling

The heat transfer coefficient for natural convective heating of sugarcane juice is determined by using the following relations [16]:

$$Nu = \frac{h_c X}{K_v} = C(Gr\,\mathrm{Pr})^n \quad \text{Or} \quad h_c = \frac{K_v}{X} C(Gr\,\mathrm{Pr})^n \tag{1}$$

The rate of heat utilized to evaporate moisture is given as [17]

$$\dot{Q}_e = 0.016 h_c [P(T_c) - \gamma P(T_e)] \tag{2}$$

($T_c = T_1$ and $T_e = T_6$ Used from Appendix-A, Tables A1-A6)
On substituting h_c from Eq. (1), Eq. (2) becomes

$$\dot{Q}_e = 0.016\frac{K_v}{X}C(Gr\,\mathrm{Pr})^n[P(T_c) - \gamma P(T_e)] \tag{3}$$

The moisture evaporated is determined by dividing Eq. (3) by latent heat of vaporization (λ) and multiplying pan area (A_p) and time interval (t).

$$m_{ev} = \frac{\dot{Q}_e}{\lambda}A_p t = 0.016\frac{K_v}{X\lambda}C(Gr\,\mathrm{Pr})^n[P(T_c) - \gamma P(T_e)]A_p t \tag{4}$$

Let

$$0.016\frac{K_v}{X\lambda}[P(T_c) - \gamma P(T_e)]A_p t = K$$

$$\frac{m_{ev}}{K} = C(Gr\,\mathrm{Pr})^n \tag{5}$$

Taking the logarithm of both sides of Eq. (5),

$$\ln\left[\frac{m_{ev}}{K}\right] = \ln C + n\ln(Gr\,\mathrm{Pr}) \tag{6}$$

This is the form of a linear equation,

$$y = mx + c \tag{7}$$

Where $y = \ln\left[\frac{m_{ev}}{K}\right]$, $m = n$, $x = \ln(Gr\,\mathrm{Pr})$ and $c = \ln C$

Values of m and c in Eq. (7) are obtained by using the simple linear regression method and then constants 'C' and 'n' can be obtained from the above equations.

3.2 Thermal physical properties of humid air

The different thermal physical properties of humid air, such as specific heat (C_v), thermal conductivity (K_v), density (ρ_v), viscosity (μ_v), and partial vapor pressure, $P(T)$ are determined by using the following expressions [18].

$$C_v = 999.2 + 0.1434T_i + 1.101\times10^{-4}T_i^2 - 6.7581\times10^{-8}T_i^3 \tag{8}$$

$$K_v = 0.0244 + 0.7673\times10^{-4}T_i \tag{9}$$

$$\rho_v = \frac{353.44}{(T_i + 273.15)} \tag{10}$$

$$\mu_v = 1.718\times10^{-5} + 4.620\times10^{-8}T_i \tag{11}$$

$$P(T) = \exp\left[25.317 - \frac{5144}{(T_i + 273.15)}\right] \tag{12}$$

Where $T_i = (T_c + T_e)/2$

3.3 Experimental error

The experimental errors are evaluated in terms of percent uncertainty (internal + external) for the mass of sugarcane juice evaporated. The following two equations are used for internal uncertainty [19]:

$$\%\ \text{internal uncertainty} = (U_I/\text{mean of the total observations}) \times 100 \quad (13)$$

And
$$U_I = \frac{\sqrt{\sigma_1^2 + \sigma_2^2 + \ldots \sigma_N^2}}{N_o} \quad (14)$$

For external uncertainty, the least counts of all the instruments used in measuring the observation data are considered.

4. Results and Discussion

The convective heat transfer coefficients for internal heating of sugarcane juice in stainless steel pot during natural convective heating mode are calculated by using the experimental data from Tables A1- A5 (Appendix A). These data are used to determine the values of constants (C & n) in the Nusselt number expression. After evaluating the values of constants, the values of convective heat transfer coefficients are determined from Eq. (1). The results for the constants and the convective heat transfer coefficients are reported in Table 1. It can be seen from Table 1 that the values of convective heat transfer coefficients increase with the increase in the rate of heat inputs.

Table 1 Values of C, n and h_c for internal heating of sugarcane juice and water in a stainless steel pot at different heat inputs

Heat input (W)	Weight (g)	C	n	h_c (W/m^2 ^{o}C)
Sugarcane juice				
200	2200	0.99	0.22	2.81-3.12
240	2200	1.00	0.22	3.02-3.51
280	2200	0.99	0.23	3.36-4.02
320	2200	1.00	0.24	3.68-4.74
360	2200	1.01	0.24	4.18-5.09
Water				
200	2200	0.99	0.28	5.64-6.82

The effect of rate of heat inputs on the convective heat transfer coefficients for sugarcane juice heating in stainless steel pot during internal heating is shown in Fig. 3. It can be seen from Fig. 3 that the convective heat transfer coefficients increase with the increase in heat inputs. Further it can also be seen that the convective heat transfer coefficients increase with the increase in operating temperature for each rate of heat inputs. These results are in accordance with those reported in the literature [13], [15].

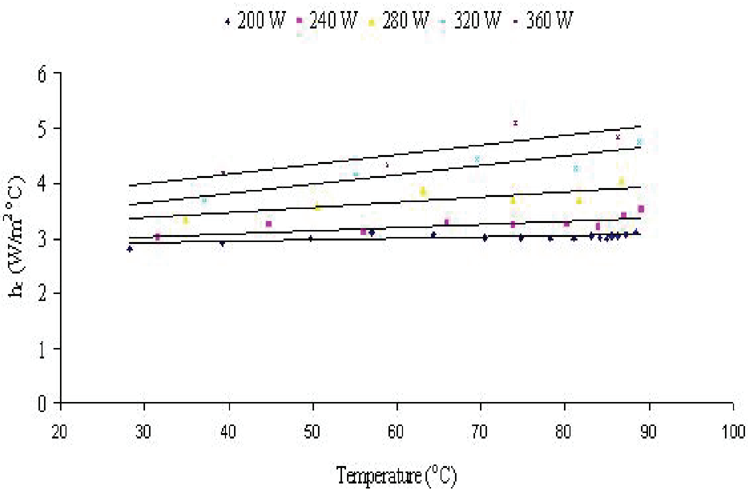

Fig. 3 Variation in h_c *vs* Temperature at different heat inputs

The average values of convective heat transfer coefficients for internal heating of sugarcane juice are also calculated and are compared with the results reported for external heating of the sugarcane juice by Kumar et al., [15] which are illustrated in Fig. 4. It can be seen from Fig. 4 that the convective heat transfer coefficients during internal heating of sugarcane juice in a stainless steel pot are higher than that of externally heated. The convective heat transfer coefficients during internal heating are observed 12.82% higher for the given range of heat inputs which could be due to the increased effective heating area.

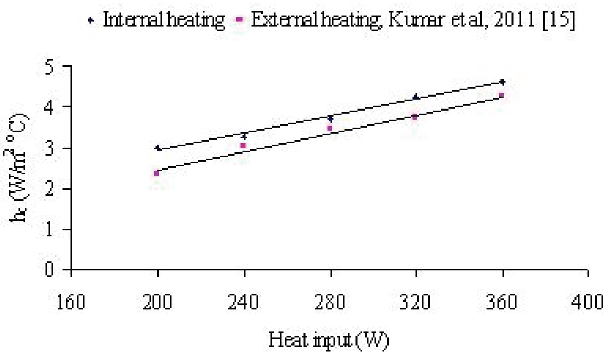

Fig. 4 Comparison of ‘hc’ for internal and external heating of sugarcane juice

In order to make a comparison, the convective heat transfer coefficients for water under the same working conditions are also determined at 200 watts which are also reported in Table 1. These results are also shown in Fig. 5. It can be seen from Fig. 5 that the convective heat transfer coefficients for sugarcane juice are lower in comparison to water which may be due to the presence of sugar and other minerals particulates. The convective heat transfer coefficients for water are observed as being for 81.28% higher than that of sugarcane juice.

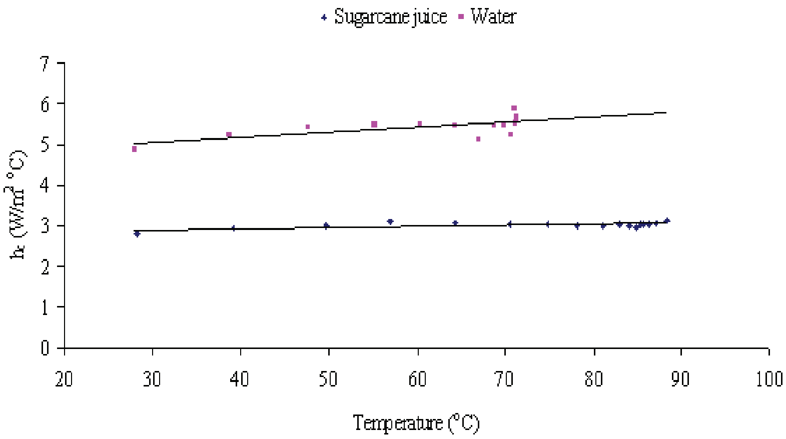

Fig. 5 Variation in 'h_c' *vs* Temperature for sugarcane juice and water at 200 W

The experimental percent uncertainty (internal + external) is observed to be in the range of 37.73 % to 51.30% and the different values of the convective heat transfer coefficients are found to be within the range of the percent experimental error. The error bars for convective heat transfer coefficients are illustrated in Fig. 6.

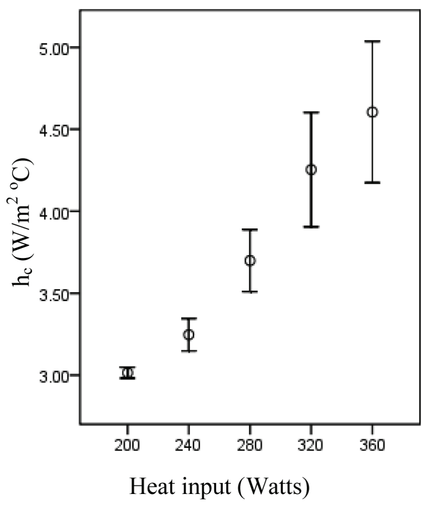

Fig. 6 Error bars for convective heat transfer coefficients

CONCLUSIONS

The following results are drawn from the present research work:

1. The values of convective heat transfer coefficients increase with an increase in rate of heat inputs from 200 to 360 watts. They are observed to vary from 2.81 to 5.09 $W/m^2\,^oC$. The convective heat transfer coefficients are also observed to increase with an increase in operating temperature for the given range of heat inputs. The experimental errors in terms of percent uncertainty are found to be in the range of 37.73 % to 51.30%.
2. In comparison to external heating, the convective heat transfer coefficients for internal heating are observed as being for 12.82% higher for the given range of heat inputs which could be due to the increased effective heating area.
3. The values of convective heat transfer coefficients of sugarcane juice are observed to be for 81.28% lower at 200 watts in comparison to water which may be due to the presence of sugar and other minerals particulates.
4. The present research work would be highly useful in designing improved sugarcane juice processing equipment for jaggery production.

REFERENCES

1. Uppal, S.K., Sharma, S., 1999, Evaluation of different methods of jaggery (Gur) storage in subtropical region, Indian J Sugarcane Technol, 14(1), pp. 17-21.
2. Madan, H.K., Jaiswal, U.K., Kumar, S., Khanna, S.K., 2004, Improvement on the Gur (Jaggery) making plant for rural areas, J. of Rural Tech., 1(4), pp. 194-196.
3. Anwar, S.I., 2010, Fuel and energy saving in open pan furnace used in jaggery making through modified juice boiling/concentrating pans, Energy Conversion and Management, 51, pp. 360-364.
4. Dunkle, R.V., 1961, Solar water distillation: the roof type still and a multiple effect diffusion still, International Development in Heat Transfer, ASME, Proc. International Heat Transfer, Part V, University of Colorado, pp. 895-902.
5. Cooper, P.I., 1970, The transient analysis of glass cover solar still, Ph.D. Thesis, Unversity of Western Australia, pp. 69-77.
6. Clark, J.A., 1990, The steady state performance of a solar still, Solar Energy, 44, pp. 43-49.
7. Tiwari, G.N., Lawrence, S.A., 1991, New heat and mass transfer relations for a solar still, Energy Conversion Management, 31, pp. 201-203.
8. Adhikari, R.S., Kumar, A., Kumar, A., 1990, Estimation of mass transfer rates in solar stills, Energy Res., 14, pp. 737-744.
9. Adhikari, R.S., Kumar, A., Sodha, M.S., 1991, Thermal performance of a multi-effect diffusion solar still, Energy Res., 15, pp. 769-779.
10. Adhikari, R.S., Kumar, A., Sotha, G.D., 1995, Simulation studies on a multi stage tray solar still, Solar Energy, 54(5), pp. 317-325.
11. Kumar, S., Tiwari, G.N., 1996, Estimation of convective mass transfer in solar distillation system, Solar Energy, 57(6), pp. 459-464.
12. Tiwari, G.N, Minocha, A., Sharma, P.B., Khan, M.E., 1997, Simulation of convective mass transfer in solar distillation process, Energy Conversion Management, 38(8), pp. 761-770.
13. Tiwari, G.N., Kumar, S., Prakash, O., 2003, Study of heat and mass transfer from sugarcane juice for evaporation, Desalination, 159, pp. 81-96.
14. Kumar, M., Prakash, O. and Kasana, K.S., (In press), Experimental investigation on natural convective heating of milk, Journal of Food Process Engineering, accepted July, 2010.
15. Kumar, M., Khatak, P., Kumar, R., Prakash, O., (In press), An experimental study on sensible heating of sugarcane juice, International Journal of current research, accepted May, 2011.
16. Tiwari, G.N., 1997, Solar Energy Fundamentals, Design, Modelling and Applications, Narosa Publishing House, New Delhi, pp. 58-74.

17. Malik, M.A.S., Tiwari, G.N., Kumar, A., Sodha, M.S., 1982, Solar distillation, Oxford Pergamon press, New York, 1982, pp. 1-58.
18. Kumar, A., Tiwari G.N., 2007, Effect of mass on convective mass transfer coefficient during open sun and greenhouse drying on onion flakes. Journal of Food Engineering 79, pp.1337-1350.
19. Nakra, B.C., Chaudhary, K.K., Instrumentation, measurement and analysis, Tata McGraw Hill, New Delhi, 1985, pp. 33.

NOMENCLATURE

A_p	Area of pan, m^2
C	Experimental constant
C_v	Specific heat of humid air, J/kg ^oC
g	Acceleration due to gravity, m/s^2
Gr	Grashof number = $\beta\, g\, X^3\, \rho_v^2\, \Delta T / \mu_v^2$
h_c	Convective heat transfer coefficient, $W/m^2\ ^oC$
$h_{c,av}$	Average convective heat transfer coefficient, $W/m^2\ ^oC$
K_v	Thermal conductivity of humid air, W/m ^oC
m_{ev}	Mass evaporated, kg
n	Experimental constant
N	Number of observations in each set of heat input
N_o	Number of sets
Nu	Nusselt number = $h_c\, X / K_v$
Pr	Prandtl number = $\mu_v\, C_v / K_v$
$P(T)$	Partial vapor pressure at temperature T, N/m^2
$\dot{Q}_e$	Rate of heat utilized to evaporate moisture, J/m^2 s
t	Time, s
ΔT	Effective temperature difference, ^oC
w_1	Weight of sugarcane juice /water, g
w_2	Weight of empty pot, g
W	Heat input, watts
X	Characteristic dimension, m

Greek symbols

β	Coefficient of volumetric expansion (K^{-1})
γ	Relative humidity (%)
λ	Latent heat of vaporization, J/kg
σ	Standard deviation
μ_v	Dynamic viscosity of humid air, N s/m^2
ρ_v	Density of humid air, kg/m^3

APPENDIX-A

Table A1 Observations for internal heating of sugarcane juice in a stainless steel pot (Heat input = 200 watts; w_1 = 2200g; w_2 = 2110.4g)

Time interval (min)	T_1 (°C)	T_2 (°C)	T_3 (°C)	T_4 (°C)	T_5 (°C)	T_6 (°C)	γ (%)	m_{evp} (g)
-	15.8	15.9	17.6	18.6	17.0	18.8	61.4	-
10	28.3	30.8	21.0	19.0	27.6	19.2	71.6	0.1
10	39.2	41.0	25.2	19.1	36.8	19.4	74.3	0.2
10	49.8	51.9	29.0	19.5	45.2	22.3	84.2	5.3
10	57.0	59.4	31.3	19.6	48.4	23.2	87.8	7.4
10	64.4	66.7	33.6	19.7	51.0	23.4	87.3	8.6
10	70.5	72.7	36.1	19.8	59.8	25.8	92.9	12.4
10	74.8	77.0	37.5	20.0	60.8	26.2	92.9	16.6
10	78.2	80.3	38.8	20.1	61.2	25.9	93.0	16.5
10	81.1	83.2	40.0	20.3	64.8	25.2	91.8	19.8
10	83.0	85.3	40.6	20.3	64.8	27.5	93.3	17.7
10	84.1	86.3	40.9	20.4	68.8	30.1	94.4	26.5
10	84.9	87.0	41.2	20.4	70.6	28.5	94.7	26.5
10	85.4	87.7	41.5	20.6	71.4	30.5	94.6	26.9
10	85.6	87.9	41.3	20.6	73.8	33.6	95.2	28.9
10	86.3	88.6	40.7	20.6	74.4	34.7	95.3	31.0
10	87.2	89.6	39.4	20.6	74.8	32.7	96.0	33.3
10	88.4	91.0	39.8	20.7	73.2	33.3	95.7	32.6

Table A2 Observations for internal heating of sugarcane juice in a stainless steel pot (Heat input = 240 watts; w_1 = 2200g; w_2 = 2110.4g)

Time interval (min)	T_1 (°C)	T_2 (°C)	T_3 (°C)	T_4 (°C)	T_5 (°C)	T_6 (°C)	γ (%)	m_{evp} (g)
-	15.7	15.8	18.0	18.7	16.8	15.1	59.3	-
10	31.6	33.6	21.2	19.2	30.2	19.5	61.5	0.7
10	44.9	47.7	24.8	19.4	42.2	20.1	69.9	2.9
10	56.1	58.4	28.5	19.7	50.6	21.8	77.0	7.7
10	66.0	69.0	31.2	20.0	51.8	21.6	78.5	9.7
10	73.8	76.6	33.5	20.2	59.6	22.0	86.3	13.5
10	80.2	83.1	35.8	20.4	64.4	26.1	91.5	19.6
10	84.0	86.8	37.0	20.5	74.2	27.1	91.7	23.8
10	87.0	90.7	36.2	20.6	72.2	29.4	92.4	29.8
10	89.0	93.2	38.1	20.6	76.8	27.6	92.2	33.0

Table A3 Observations for internal heating of sugarcane juice in a stainless steel pot (Heat input = 280 watts; w_1 = 2200g; w_2 = 2110.4g)

Time interval (min)	T_1 (°C)	T_2 (°C)	T_3 (°C)	T_4 (°C)	T_5 (°C)	T_6 (°C)	γ (%)	m_{evp} (g)
-	17.5	17.6	18.7	19.2	18.4	17.4	59.2	-
10	35.0	36.8	21.8	19.6	34.2	19.8	73.6	1.5
10	50.6	53.0	25.9	19.8	46.8	21.1	86.5	4.7
10	63.2	66.7	29.0	20.1	54.2	23.9	90.8	12.0
10	73.8	76.6	31.8	20.2	59.2	25.2	91.3	13.3
10	81.6	84.5	33.8	20.4	65.6	25.8	91.6	23.9
10	86.6	90.8	35.5	20.4	68.8	26.7	93.5	26.3

Table A4 Observations for internal heating of sugarcane juice in a stainless steel pot (Heat input = 320 watts; w_1 = 2200g; w_2 = 2110.4g)

Time interval (min)	T_1 (°C)	T_2 (°C)	T_3 (°C)	T_4 (°C)	T_5 (°C)	T_6 (°C)	γ (%)	m_{evp} (g)
-	16.7	16.8	17.9	18.3	17.8	16.5	67.0	-
10	37.1	38.5	24.3	18.8	35.2	19.7	85.0	1.7
10	55.1	57.5	31.9	19.0	49.8	22.0	90.8	7.5
10	69.5	72.7	38.1	19.3	55.6	23.6	91.1	13.6
10	81.2	84.0	43.8	19.8	63.4	24.7	92.2	28.7
10	88.8	93.2	47.2	20.2	71.3	27.7	93.9	32.8

Table A5 Observations for internal heating of sugarcane juice in a stainless steel pot (Heat input = 360 watts; w_1 = 2200g; w_2 = 2110.4g)

Time interval (min)	T_1 (°C)	T_2 (°C)	T_3 (°C)	T_4 (°C)	T_5 (°C)	T_6 (°C)	γ (%)	m_{evp} (g)
-	16.9	17.1	17.9	18.1	16.8	16.3	66.5	-
10	39.3	41.6	23.0	18.5	35.8	19.9	84.2	2.5
10	58.9	61.6	30.4	18.9	52.8	21.9	91.0	11.8
10	74.1	79.6	35.4	19.1	58.6	21.2	88.6	15.7
10	86.2	90.8	39.4	19.4	72.8	29.9	94.4	35.0

Table A6 Observations for internal heating of water in a stainless steel pot (Heat input = 200 watts; w_1 = 2200g; w_2 = 2110.4g)

Time interval (min)	T_1 (°C)	T_2 (°C)	T_3 (°C)	T_4 (°C)	T_5 (°C)	T_6 (°C)	γ (%)	m_{evp} (g)
-	17.0	17.1	17.6	17.8	17.8	16.5	69.5	-
10	28.1	29.0	20.8	18.2	27.4	18.7	76.2	0.3
10	38.8	40.0	24.9	18.6	36.4	19.3	80.2	0.5
10	47.8	49.2	28.2	18.7	44.8	20.3	85.9	3.4
10	55.2	56.7	31.0	19.0	50.6	23.8	91.5	9.4
10	60.4	61.9	33.1	19.2	56.4	24.3	92.8	13.8
10	64.3	65.8	34.2	19.2	59.8	24.2	91.2	19.1
10	67.0	68.2	35.2	19.2	62.6	24.7	91.6	22.5
10	68.8	70.3	36.2	19.3	64.4	26.2	92.4	25.6
10	69.9	71.4	36.6	19.3	65.6	26.2	93.0	28.0
10	70.7	72.0	37.2	19.4	65.8	27.3	93.1	29.2
10	71.2	72.8	37.1	19.4	66.4	27.2	93.1	37.9
10	71.3	73.0	37.6	19.4	66.6	27.0	93.2	25.1
10	71.3	73.1	37.0	19.4	66.6	30.4	93.6	32.7
10	71.3	73.0	37.2	19.4	67.2	27.2	93.5	33.4
10	71.2	72.8	37.0	19.4	67.4	29.4	94.7	32.2
10	71.2	73.2	36.8	19.4	67.4	25.0	92.2	36.6
10	71.1	73.1	35.8	19.5	67.8	25.5	92.6	30.9

UTICAJ UNUTRAŠNJEG GREJANJA NA RAZUMNO PONAŠANJE SOKA ŠEĆERNE TRSKE U LONCU OD NERĐAJUĆEG ČELIKA

U ovom istraživačkom radu razmatra se prirodno prenosno ponašanje tokom unutrašnjeg zagrevanja soka šećerne trske u loncu od nerđajućeg čelika za pravljenje nerafinisanog šećera. Sprovedeni su različiti eksperimenti sa unutrašnjim zagrevanjem soka šećerne trske u loncu od nerđajućeg čelika i to sa različitim unosom toplote od 200 do 360 vati. Korišćeni su eksperimentalni podaci za određenje vrednosti konstanti u izrazu Nuseltovog broja prostom metodom linerane regresije a onda su određene vrednosti koeficijenta prenosa toplote. Uočeno je da se ovi koeficijenti uvećavaju sa povećanjem stope unosa toplote kao i radne temperature. Takođe su procenjene eksperimentalne greške u smislu procenta neizvesnosti.

Ključne reči: *unutrašnje zagrevanje soka šećerne trske; pravljenje nerafiniranog šećera; razumno zagrevanje, koeficijent prenosa toplote*