

Design and Fabrication of Ohmic Heating Equipment

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Abstract

Ohmic heating is an advanced, alternative and innovative thermal processing method in food processing, particularly in aseptic processing. Ohmic heating is also called electrical resistance heating, joule heating or electro resistive heating. With proper formulation, electrical energy can be converted to heat uniformly in food matrices; thereby runaway heating can be avoided even for non-homogenous food products. In Ohmic heating the food materials, serves as an electrical resistor and is heated by passing electricity through it. Electrical energy is dissipated into heat, which results in rapid and uniform heating. The paper deals with the design and fabrication of ohmic heating equipment. The ohmic heating equipment consists of a tank, sets of electrodes, stand, DC power supply and temperature controller. The tank is made of glass. The electrodes are made with stainless steel (SS 316). The stand and temperature controller is made of mild steel and the DC power supply has a maximum voltage rating of 30 V and current rating of 10 A

Key words: ohmic heating, electrical energy ,electrodes.

1. Introduction

Ohmic heating is an advanced thermal processing method wherein the food material, which serves as an electrical resistor, is heated by passing electricity through it. Electrical energy is dissipated into heat, which results in rapid and uniform heating of the food material. The technology is useful for the treatment of proteinaceous foods, which tend to denature and coagulate when thermally processed.

Thermal processing is the most widely used method for destroying microorganisms and impart foods with a lasting shelf-life. As an alternative thermal method, Ohmic heating ensures the benefits of conventional thermal processing while offering the potential for improvements in the retention of vitamins and nutrients.

2. MATERIAL AND METHODS

Ohmic heating occurs when electric current is passed through food materials to be heated. This electro resistive heating is volumetric by nature, therefore has potential to significantly reduce over processing. Ohmic heating is also called Joule heating, electrical resistive heating, direct electrical resistance heating, electro heating, or electro resistive heating. Ohmic heating from other electrical heating methods by,The presence of electrodes contacting the foods (if microwave and inductive heating electrodes are absent).The frequency applied (unrestricted, except for the specially assigned radio or microwave frequency range).Waveform (also unrestricted, although typically sinusoidal)

The fundamental requirements for ohmic heating equipment for food processing are a pair of electrodes, a container for the food to be processed, and an alternating power supply.

2.1DESIGN OF STATIC OHMIC HEATING EQUIPMENT

The ohmic heating equipment primarily consists of an ohmic heating chamber, varying power source, volt-amp meter, stand and control panel.

2.1.1 Ohmic Heating Chamber

Ohmic heating chamber is a rectangular tank with two electrodes, which are closely fixed on the length sides of the chamber. The material to be heated is filled in the tank in between the electrodes and when current is applied, heating takes place.

2.1.2 Construction of the Chamber

The main criteria used for the construction of the ohmic heating chamber are as follows:

It should be electrically non-conductive.It should be able to withstand process temperature.It should not impart off-flavour to the product.Based on the above criteria for the construction of ohmic heating chamber, glass sheet of 5 mm thickness was selected.

2.2 METHODS

The parameters considered in our project are

- The distance between the electrodes
- Optimization of time taken for reaching the desired temperature.

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2.2.1Electrode

The material used as an electrode inside the ohmic heating chamber must have the following features:It should be of food grade and non-corrosive.It should be workable and provide smooth finish.To meet out the above said minimum requirement the food grade stainless steel 316 (120 mm) was selected as an electrode material. (Raghavan, et al., 1994).

2.3 DESIGN AND CONSTRUCTION OF OHMIC HEATING CHAMBER

The ohmic heating rate depends on spacing between the electrodes or the voltage gradient applied. Initially for the trial experiment run, the length and breadth of the electrode were arbitrarily fixed as (200 mm and 50 mm), (140 mm and 50 mm) and (70 mm and 50 mm). With these dimensions the ohmic heating chamber were constructed with the spacing between the electrodes as 30 mm, 45 mm, 77.5 mm and 100 mm.

The ohmic heating chambers are constructed using the glass sheets of 5 mm thick. The edges of the glass sheets are joined together using the cementing material (silicon paste) as reinforcement to form a leak proof chamber. The cementing material is applied on the outside edges of the tank.The surface of the stainless steel electrodes is polished to a smooth finish using fine emery sheet. The polished electrode plates of 120 mm thick were fixed closely.

2.3.1 CONSTRUCTION DETAILS

2.3.2 Tank

The tank is made of glass of 5 mm thickness. The height of the tank is 295 mm and the width of the tank is 20 mm. The hole at the bottom of the tank is of 25 mm diameter. The cementing material used for making the tank is silicon paste which can withstand temperature of about 600^0C. The silicon paste is a food grade paste.

2.3.3Electrodes

There are three sets of electrodes. It is made of food grade stainless steel (SS 316).The thickness of the electrode is 120 mm.Nuts and bolts made of SS 316 are used for attaching the wire with the electrodes. The three electrodes are of height 200 mm, 140 mm and 70 mm with a constant width of 50 mm.

2.3.4 Lid

The lid is made of Teflon which is a food grade material.It can withstand high temperatures of about 600^0C.The thickness of the lid is 6 mm, length is 253 mm and the width is 250 mm.The lid has four holes of 125 mm for connecting the electrodes with the power supply. The distances between the electrodes are adjusted using the knobs.

2.3.5 Temperature Controller

It consists of the PID controller for accurate measurement of the temperature in the equipment.The temperature sensor is the J type thermocouple which can withstand a temperature of 200^0C.The height of the controller is 110 mm and the width is 150 mm.

2.3.6 DC Power Supply

The maximum voltage rating is 30 V and the maximum current rating is 10 amps.

2.3.7 Stand

There are two stands and for the tank and the other for the controllers.The stand for the tank is of 2 ft and width ½ ft.The stand for the controller is of height 4 ft, length 2.5 ft and width 2 ft.The stand for the controller is given an upper layer of glass wool which acts as an insulator.

3.RESULTS AND DISCUSSION

Ohmic heating technology has gained interest recently because the products are of superior quality to those processed by conventional technologies. Moreover, the ohmic heater assembly could be incorporated into a complete product sterilization or cooking process. Among the advantages claimed for this technology are uniformity of heating and improvements in quality, with minimal structural, nutritional or organoleptic changes.

The fabrication of ohmic heating equipment was done using materials like mild steel for components that is not in direct contact with the food materials, stainless steel food grade 316 for components which are in direct contact with food materials and glass for the ohmic heating tank.The capacity of the ohmic heating equipment is tested for tender coconut water..

3.1CAPACITY

Capacity of the ohmic heating equipment refers to the weight of the sample fed in the given time

$$\text{Capacity} = \frac{\text{Weight of the sample}}{\text{Time taken}} \quad \text{kg/hr}$$

3.1.1Capacity Calculation for Tender Coconut Water

Weight of sample taken = 3000 g

Time taken = 2 min

$$\text{Capacity} = \frac{\text{Weight of the sample}}{\text{Time taken}} \quad \text{kg/hr}$$

= (3000 x 60) / (2 x 1000) = 90 kg/hr.

The capacity of the ohmic heating equipment is tested for tender coconut water was found to be 90 kg/hr **.**Thus it was decided that the ohmic heating equipment is well suited for tender coconut water treated with an electrode at varying distance. The shelf life was found best based two factors as

- pH
- Organoleptic tests

The shelf life of the tender coconut water was extended significantly.

4.SUMMARY AND CONCLUSION

Today ohmic heating is being used widely in the food industries. In India, ohmic heating is one of the fast growing technologies in food industries. The ohmic heating system allows for the production of new, high value, shelf stable products with a quality previously unattainable with alternate sterilization techniques, especially for particulate foods, proteinaceous foods, which tend to denature and coagulate when thermally processed. Its major advantages are:

1. Continuous production without heat transfer surfaces.
2. Rapid and uniform treatment of liquid and solid phases with minimal heat damage and nutrient loss (e.g., unlike microwave heating, which has finite penetration depth into solid materials).
3. Ideal process for shear-sensitive products because of low flow viscosity.
4. Reduced fouling when compared to conventional heating.

The tender coconut water is taken to calculate the capacity of the fabricated ohmic heating equipment. The optimized time is 2min and the temperature is 40^0C.

REFERENCES

1. Allen.K., V.Eidman and J.Kinsey, An economic engineering study of ohmic food processing, Food technology.
2. Assiry.A.M., S.K.Sastry and C.P.Samaranayake, Influence of temperature, electrical conductivity, power and pH on ascorbic acid degradation kinetics during ohmic heating using stainless steel electrodes, Bioelectrochemistry.
3. Ayadi.M.A., J.C.Leuliet, F.Chopard, M.Berthou and M.Lebouche, Continuous ohmic heating unit under whey protein fouling, Innovative food science and emerging technologies.
4. Chinan.M.S., R.P.Singh, L.D.Pederson, P.A.Carroad, W.W.Rose and N.L.Jacob, Analysis of energy utilisatio in Spanish processing, Trans of ASAE.
5. DeAlwis, A.A.P. and P.J.Fryer, Operatability of the ohmic heating: electrical conductivity effects, Journal of food engineering.
6. Eilot-Godereaux.S.C, F.Zuder and A.Goullieux, Processing and stabilization of cauliflower by ohmic heating technology, Innovative food science and emerging technologies.
7. Fryer.P., and Z.Li, Electrical resistance heating of foods, trends in food science and technology.
8. Halden.K., A.A.P. DeAlwis and P.J.Fryer, Changes in the electrical conductivity of foods during ohmic heating, International journal of Food science and technology.
9. Halleux.D.D., G.Piette, M.L.Buteau and M.Dostie, Ohmic cooking of processed meats: Energy evaluation and food safety considerations, Canadian biosystems engineering.
10. Icier.F and C.Ilicali, Temperature dependent electrical conductivities of fruit purees during ohmic heating, Food research international.

11. Icier.F, H.Yildiz and T.Baysal,Peroxidase inactivation and colour changes during ohmic blanching of pea puree, Journal of food engineering.
12. Imai.T, K.Uemura, N.Ishida, S.Yoshizaki and A.Noguchi, Ohmic heating of Japanese white radish, International journal of food science and technology.
13. Jun.S and S.K.Sastry, Modelling and optimization of ohmic heating of foods inside a flexible package, Journal of food processing engineering.
14. Khalaf.W.G and S.K.Sastry, Effect of fluid viscosity on the ohmic heating rate of solid liquid mixers, Journal of food engineering.
15. Kim.H.J, Y.M.Choi, A.P.P.Yang, I.A.Tab, J.Giles, C.Ditusa, S.Chall and P.Zoltai, Microbiological and chemical investigation of ohmic heating of particulate foods using s 5kW ohmic system, Journal of food processing and preservation.
16. Larson.D.L and L.A.D.Cortez, Energy analysis: Essential to effective energy management, Trans of ASAE.
17. Mizrahi.S, Leaching of soluble solids during blanching of vegetables by ohmic heating, Journal of food engineering.
18. Palaniappan.S and S.K.Sastry, Electrical conductivities of selected solid foods during ohmic heating, Journal of food process eengineering.
19. Palaniappan.S and S.K.Sastry, Electrical conductivity of selected juices: Influence of temperature, solid content, applied voltage and particle size, Journal of food process engineering.
20. Praporscic.I, N.I.Lebovka, S.Ghnimi and E.Vorobiev, Ohmically heated enhanced expression of juice from apple and potato tissues, Biosystems engineering.

Figure 1. *Ohmic Heating Equipment*

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