RESEARCH THERMOTECHNIC ANALYSIS OF CRADLE-CONVEYOR DRYER

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Abstract. *In the given work, results numerical modeling for research and an estimation of thermal productivity of drying chamber combined solar-fuel drying installation which is based with cradle-conveyor, heated up by direct receipt of sunlight and an additional source of heat are presented. All calculations have been spent in cases of an “empty” condition drying chamber and “non-working” mode of infrared lamps.*

Into a database of the given program are entered all thermophysical and physical properties of materials and the substances used in solar dry kiln. Absorbing ability and factor of radiation of a surface of a wall solar dry kiln make chambers (case) 0.90 and 1.0 accordingly where it is made of the processed stainless steel having following properties: the density of 7900 kg/m^3, a specific thermal capacity of 500 J/(kg·˚C), factor of heat conductivity of 16.3 W/(m ˚C), and as the entry condition its temperature has been chosen, equal ambient temperature. In quality translucent coverings have been used polycarbonate sheets having following properties: density of 1200.00 kg/m^3, a specific thermal capacity of 1200 J/(kg·˚C), it has been specified that in them heat conductivity is homogeneous also their factor of heat conductivity of 0.20 W/(m ˚C). For a thermal protection of a ground part drying chambers the polystyrene having following properties has been used: Density of 1075.0 kg/m^3, a thermal capacity of 350 J/(kg ˚C), factor of heat conductivity of 0.082 W/(m ˚C). The heat-carrier in given solar dry kiln is air having the following physical and thermophysical property: relations of specific thermal capacities (Cp/Cv) 1.399, and molar weight of 0.0290 kg/mol.

Keywords: *thermotechnic, drying, cradle-conveyor, infrared*

The most effective way of transfer of thermal energy to a drying product - a way of drying with thermoradiation or drying by infrared beams. The theory of drying of foodstuff infrared ray is described in works [1-2]. In particular, A.S.Ginzburg [1], studying drying with infrared beams, has established that the maximum depth of penetration of beams makes 6÷7 mm, though for fruits and vegetables speed of drying on 25÷95 % above, than in convective drying. At this the high specific power consumption making 27.072 kJ on 1 kg of a final dry product is observed. However non-uniformity of drying limits their application. Investigating radiating drying of apples, E.N.Meleh [3] has achieved reduction of duration of process to 1.5 hour, and for drying of vegetables and fruit has established a range of infrared beams 1.2÷2.2 µm.

The combination of a way solar and infrared drying, as one of the main tasks drying manufactures minimization of expenses of energy on unit of received production is expedient at the maximum preservation of biological indicators of initial raw materials.

The combined solar dryers unite advantages of solar energy with a usual or any auxiliary energy source, and can work either in a combination, or in a single mode from any energy source. These dryers, as a rule, are the average or large installations, 50-60 % working in a range, and to compensate the temperature fluctuations caused by environmental conditions [4]. Ben and Fuller have described direct solar drying installation with natural convection in a combination to a simple torch of a biomass, suitable for drying of fruit and vegetables in regions without an electricity [5]. Air an input through the heat exchanger where it heats up to the set temperature, by means of combustible gas. A part of the used air, leaving northern wall of a dryer, and the rest return through a returnable pipe, and the cooled gas leaves through a flue with surrounding (Kondor, etc., 2001) [6]. Recently developed the combined solar hair dryer for drying a banana consisting of the heat exchanger and the accumulator it is warm [7]. Analyzing the works set forth above, it is necessary to notice that the combination of a way solar and infrared drying, as one of the main tasks drying manufactures minimization of expenses of energy on unit of received production is expedient at the maximum preservation of biological indicators of initial raw materials. And also, the cradle-conveyor system for loading-unloading technological processes of dried up products is offered.

The scientists of the Tashkent state technical university carried out a study of agricultural drying [8-10].

Into a database of the given program are entered all thermophysical and physical properties of materials and the substances used in solar dry kiln [8]. Absorbing ability and factor of radiation of a surface of a wall solar dry kiln make chambers (case) 0.90 and 1.0 accordingly where it is made of the processed stainless steel having following properties: the density of 7900 kg/m^3, a specific thermal capacity of 500 J/(kg·˚C), factor of heat conductivity of 16.3 W/(m ˚C), and as the entry condition its temperature has been chosen, equal ambient temperature. In quality translucent coverings have been used polycarbonate sheets having following properties: density of 1200.00 kg/m^3, a specific thermal capacity of 1200 J/(kg·˚C), it has been specified that in them heat conductivity is homogeneous also their factor of heat conductivity of 0.20 W/(m ˚C). For a thermal protection of a ground part drying chambers the polystyrene having following properties has been used: Density of 1075.0 kg/m^3, a thermal capacity of 350 J/(kg ˚C), factor of heat conductivity of 0.082 W/(m ˚C). The heat-carrier in given solar dry kiln is air having the following physical and thermophysical property: relations of specific thermal capacities (Cp/Cv) 1.399, and molar weight of 0.0290 kg/mol.

In given developed CAD models solar dry kiln non-stationary heat exchange cradle-conveyor based is considered. Numerical calculations were spent for 24 business hours chamber at constant solar radiation of 800 W/m^2 and ambient temperature 20˚C.

All calculations have been spent in cases of an “empty” condition drying chamber and “non-working” mode infrared lamps. In these cases, the quantity of heat received from sunlight (the stream of solar radiation was constant and equal 800 Vt/m^2) is investigated and established at various values of the volume expense drying agent (an air stream with constant entrance temperature 20˚C) beginning from 100 till 1200 m^3/hour.

All calculations spent in cases of an “empty” condition drying chamber and “non-working” mode infrared lamps, allow to estimate in details the quantity of heat received from sunlight at various values of the volume expense drying agent (an air stream with constant entrance temperature 20˚C) beginning from 100 till 1200 m^3/hour. Definition of the optimum volume expense drying agent minimization of expenses of energy on unit of received production allows to estimate optimum thermal productivity of a dryer, as one of the main tasks drying manufacture. Dependence of average temperature drying agent and the thermal capacity received from sunlight from time at various values of the volume expense drying agent shows that the optimum volume expense of the heat-carrier under the set entry conditions is necessary at 700 m^3/hour (fig.1).

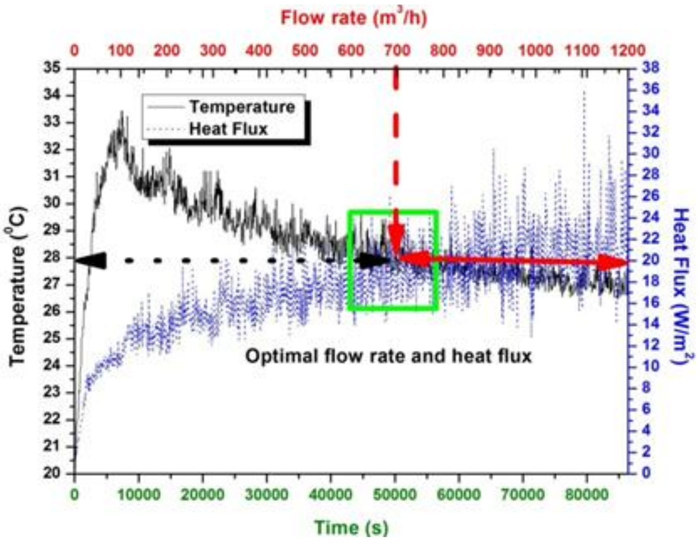

Fig.1. Dependence of a stream of thermal loss and temperature of the heat-carrier from various values of the volume expense of the heat-carrier.

Considering the data resulted in rice 2-4, the thermal capacity received from sunlight, increased in 5 times when the volume expense drying agent has increased in 12 times. According to the received data, the basic growth of increase in thermal productivity, i.e. optimum thermal productivity, it was observed in 700 and 800 m^3/hour intervals of the volume expense drying agent at the above-stated values of parameters of environment.

Conclusion. Therefore, it is necessary to notice that in the given work results numerical modeling for research and an estimation of thermal productivity drying chambers combined solar-fuel drying installation cradle-conveyor based, heated up by direct receipt of sunlight and an additional source of heat (infrared lamps) are presented. All calculations have been spent in cases of an "empty" condition drying agent and "non-working" mode infrared lamps. In these cases, the quantity of heat received from sunlight (the stream of solar radiation was constant and equal 800 W/m^2) is investigated and established at various values of the volume expense drying agent (an air stream with constant entrance temperature 20˚C) beginning from 100 till 1200 m^3/hour. Thermal productivity given solar-fuel drying installations at identical streams of solar radiation and ambient temperatures and on an input drying agent increased in 5 times when the volume expense drying agent has increased in 12 times. According to the received data, the basic growth of increase in thermal productivity, optimum thermal productivity it was observed in 700 and 800 m^3/hour intervals of the volume expense drying agent at the above-stated values of parameters of environment.

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