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Increasing Performance Efficiency by Investigating the Surface of the Solar Air Heater Collector

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Abstract (Annotation): This article discusses the issues of increasing the working surface of the device by giving a geometrically concave shape to the air ducts of the proposed solar air heater, designed to save energy and increase the possibility of efficient use of renewable energy sources, which is becoming increasingly important topical issue today. The influence of the concave shape on the air movement relative to the outer surface of the concave air duct is investigated.

Keywords: Solar air heater, absorber, duct, heat, energy, surface, corpus.

I. Introduction

Now a day at this stage of development of world civilization, the excessive growth of energy demand, the constant rise in energy prices show the urgency of the widespread introduction and use of renewable energy sources.[1]

Much attention is being paid to the development of fuel and energy resources and the deterioration of the environmental situation around the world, and in this regard the development of new generations of devices based on renewable energy sources with high efficiency and low economic costs. [2]

Therefore the implementation of comprehensive measures to address the problems of energy conservation and the development of non-traditional renewable energy sources is very important. In the harsh continental climate, 49.6% of total energy consumption per year falls on agricultural processing systems.[3] The development of devices based on renewable energy sources is of great importance in obtaining thermal energy, including the amount of energy consumed.

The proposed submersible air duct solar air heater is also highly efficient, which is achieved by studying the working surface of the air ducts in a new way. [4]

As a result of research on improving the thermal efficiency of solar air heaters, a new method of research and development of heating surfaces in the working chamber of solar collectors [5] (Fig. 1). accelerating the exchange process and not increasing the hydraulic resistance of the collector [6]. In addition, the indentation created in the air ducts of the device not only allows air to move, but also creates an additional working surface. [7]

A model of a flat solar air heater with a tubular winding was developed, the length of the device l = 800 mm, width a = 400 mm, height h = 62 mm. The working chamber of this solar heater has metal channels of a triangular shape. The length of each channel is l = 150 mm. The distance between the two bases of the duct l = 60 mm, the height of the base of the channel h = 60 mm. Two rows of internal convex geometric figures are given on each side of the base of the ducts, the depth of which is h = 2 mm and the width l = 15 mm. The geometric shape given to the air ducts of the collector is opposite to the inner surface of the duct in the case of an internal convex position relative to the outer surface of the duct. The solar air heater has inlet and outlet pipes with d = 15 mm when used by blowing air. The device works in two different ways.

1. Blowing air
2. Absorbing air

When blowing air according to the scheme of the device, inlet and outlet pipes are used.

When absorbing air, each channel is used in a separate order from the ducts.

The arrangement of the channels takes place in a checkerboard form, covering the collector until the complete return of the entire air flow passing through the common working surface of the chamber.

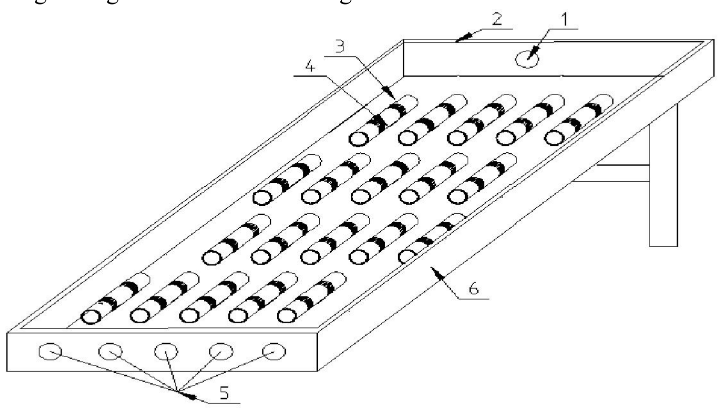

Figure 1: The scheme of the proposed flat solar air heater with a metal pipe

1-air outlet, 2-window, 3-darkened metal surface (absorber), 4-air duct, 5-air intake duct, 6-enclosur.[8]

Increasing the working surface of the air duct has a direct positive effect on the efficiency of the device. In the proposed solar air heater with sunken air tube, the geometry of the air tube is formed and its working surface is increased. [9] Determining the surface of the sunken air duct's submerged air duct (Figure 2) is determined as follows.

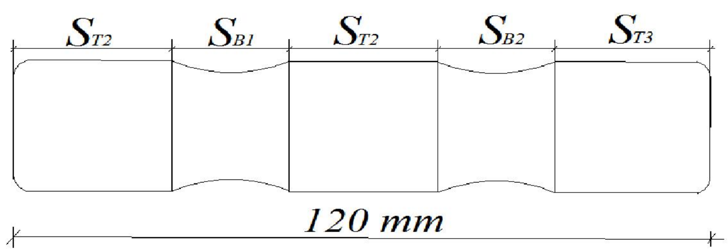

Figure 2: Schematic view of a concave air duct

Determining the outer surface of a dry air stream moving [10] is determined using the following formula. [11]

$$S_Q = \sum S_B + \sum S_T \quad (1)$$

$$S_Q = 3014.4 + 9040 = 12044.4 \cdot 10^{-6}\ \text{m}^2;$$

Here **S_b**– is the surface of the concave part of the air pipe,

S_t –is the surface of the flat part of the air pipe.

The air chamber in the working chamber of the solar air heater is equipped with a submerged air duct (Fig. 2), the total surface area of the submerged part of this air duct $\sum S_B$ is determined using the following formula. [12]

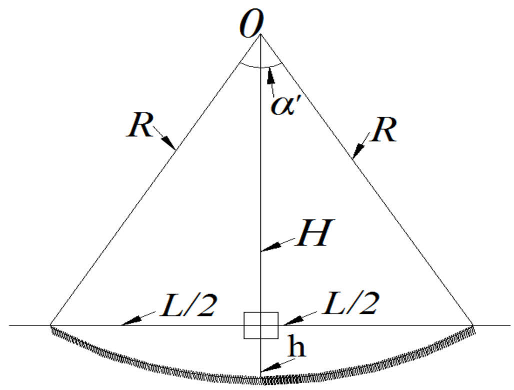

Figure 3: Schematic view of the air duct depression.

$$\sum S_B = S_{B1} + S_{B1} \dots . + S_{Bn} \quad (2)$$

The specific sinking surface of the air duct S_{Bn} is determined using the following formula:

$$S_{Bn} = \mathrm{PdL} \quad (3)$$

$$3.14 \cdot 32 \cdot 15.51 = 1559.28 \cdot 10^{-6}\mathrm{m}^2;$$

Where **d** is the pipe diameter, mm, **L** is the length, mm.

When determining the depth surface, the length **L** is determined as follows.

$$L = 2\mathrm{PR}\frac{\alpha}{360} \quad (4)$$

$$(2 \cdot 3.14 \cdot 15.062)\frac{59}{360} = 15.51 \cdot 10^{-6}\ \mathrm{m}^2;$$

From this we define R as follows:

$$R = \mathrm{h} + 2$$

or

$$\mathrm{R}^2 = (\tfrac{\mathrm{L}}{2})^2 + (\mathrm{R} - 2)^2 \quad (5)$$

$$\mathrm{R}^2 - 4\mathrm{R} + 456.25 = \mathrm{R}^2$$

$$4\mathrm{R} = 60.25$$

$$\mathrm{R} = 15.0625\ \mathrm{mm};$$

$$Sin\alpha = \frac{7.5}{15.0625} \approx 0.498$$

$$\alpha = 29.5\ ^\circ$$

$$\alpha' = 2\alpha$$

$$\sum S_B = 1559.285 \cdot 2 = 3014.4 \cdot 10^{-6}\mathrm{mm}^2;$$

The total surface area of the flat part of the air duct is determined using the following formula:

$$\sum S_T = S_{T1} + S_{T1} \dots . + S_{Tn} \quad (6)$$

$$\sum S_T = 3014.4 \cdot 3 = 9040\ \cdot 10^{-6}\mathrm{mm}^2;$$

Here S_{T1} is a separate flat surface of the air duct.

The separate flat surface of the air duct is determined using formula (6).

$$S_{T1} = 3.14 \cdot 32 \cdot 30 = 3014.4 \cdot 10^{-6}\ \mathrm{mm}$$

As a result of the above calculations, it can be seen that each 120 mm long air [12] allows to increase the total surface area of the pipe by up to 10%.

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