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by Tawalujan, D I E Sundah, And D R S Maramis

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Environmentally friendly tool for smoking skipjack fish

L Tawalujan[1], D I E Sundah[2], and D R S Maramis[3]

[1]Mechanical Engineering Department, Manado State of Polytechnic, Jl Raya Politeknik, Kelurahan Buha, Kec. Mapanget, Manado, 95252, North Sulawesi Province, Indonesia.
[2,3] Business Administration Department, Manado State of Polytechnic, Jl Raya Politeknik, Kelurahan Buha, Kec. Mapanget, Manado, 95252, North Sulawesi Province, Indonesia.

Corresponding author's e-mail address: dvogessundah@yahoo.com, leotawalujan58@gmail.com, dianamaramis@ymail.com

Abstract

The purpose of this study is to promote the production of smoked fish in the use of green-technology process. This study has used a method of an experimental research in which to examine and to know the heat transfer occurs in the smoked-fish device from the outer space, therefore the oven and the amount of water is lost in the processed skipjack fish. Conduction Heat Transfer, Convection Heat Transfer, and Radiation have been used in analysing the technology process of this machine. The results highlighted the importance of green-technology in processing smoked fish products. This study found that a smoked fish machine has reduced air pollution and produced liquid smoke. There are 3 stages in processing smoked skipjack fish with clean technology, namely: (1) furnaces, (2) the application of the smoke stream, (3) the condenser tank. The evaporation process begins by placing fish onto shelves in the furnace. Then fuel is put into the furnace and burned. Once the fuel is burned, the supply of oxygen in the furnace is controlled, so that the smoke which usually causes air pollution can be converted into liquid smoke using a condenser.

Keywords:

Tool, smoked skipjack, fish, environmentally friendly, liquid smoke

Introduction

Heat energy is an energy that widely used or utilized in assisting various needs in households and the industry. Heat transfer can be defined as the transfer of energy from one region to another due to the different temperature between those regions. Moreover, drying is a process of reducing water or vaporize water in an ingredient so as to achieve the moisture of water content as we want. In the process of drying, it is required the heat energy vaporizes the content of water. The process of taking or decreasing water content into a certain extent aims to slow the damage of skipjack.

During this time the smoked-fish entrepreneurs do the smoking of skipjack regardless of its impact on the environment, whereas the resulting of smoke can make the air being polluted. All smoked skipjack entrepreneurs in North Sulawesi perform sjipjack-smoking activities in open areas and therefore the heat generated from the skipjack smoking process is much wasted (uncontrollable) and results in a large amount of fuel use (wasteful materials Fuel).

Based on the background of the problem, the purpose of this research is: (1) to analyze the heat transfer that comes out of the skipjack tool; (2) to analyze the heat transfer on the tool wall. (3) to build environmentally friendly tool for smoking skipjack that produce liquid smoke. The benefits of this

research are: reducing air pollution and generating revenues through the business of smoked skipjack and liquid smoke.

2. Theoritical framework

2.1. Basic principle of heat transfer (Calor)

Heat transfer can be defined as the transfer of energy from one region to another due to the different temperature between the regions. The Heat transfer literature generally recognizes three different ways of heat transfer such as: (1) Conduction; (2) Convection; and (3) Radiation.

2.1.1. Conduction heat transfer

Conduction is a process where heat flows from a high-temperature area to a low-temperature area in a medium (solid, liquid, gas) or between different medias that intersect directly. In the conduction flow of heat transfer, energy transfer occurs due to considerable molecular connections. According to the kinetic theory, the temperature of the substance element is comparable to the average molecular kinetic energy that makes up that element. Energy that is possessed by an element of substance caused by speed and position relative molecular which is called inside energy. Thus, the faster the molecules move, the higher the temperature or energy in the element of the substance. The basic equation for conduction in stable state can be written as follows:

$$q_k = -kA\frac{\Delta t}{\Delta x}$$ (Holman, 1997)

Whereas:

q_k= conduction heat transfer (w)
k = thermal conductivity of materials (w/m.^{0}C)
A= broad cross-section traversed heat flow (m^2)
$\Delta t/\Delta x$=temperature gradients on that cross section.[1]

2.1.2. Convection heat transfer

If there is a fluid that moves against a surface, and both temperatures are not the same, it will be a convection heat transfer mechanism. The faster the fluid movement, the greater the rate of its convective heat transfer. If the fluid is not moving, the heat transfer mechanism will be the conduction transfer mechanism. Because convection occurs due to fluid movement, the term is known as natural convection and forced convection. Natural convection (free convection) occurs because the fluid moves naturally, where the fluid movement is more due to the time difference of fluid type due to the temperature variation in the fluid. Logically, if the temperature of the fluid is high, surely it will be lighter and start moving upwards.

While forced convection occurs due to fluid, not because of the natural factor, the fluid moves because of the tools used to tinroot the fluid such as fans, pumps, blowers and so on.

Heat transfer rate by convection between one surface and a fluid can be calculated with the equation:

$$\boldsymbol{q_h = h.A\,\Delta T}$$ (Holman, 1997)

Where:

q_h= rate of convection heat transfer (w)
h = convection heat transfer coefficient (W/m^2 ^{o}C)
A= surface area of solid objects (m^2)
ΔT= different temperature between surface temperature and fluid temperature.

Conduction heat transfer and convection can be calculated with the following equation:

Q=U.A.ΔT (Heat Exchanger performance)

$$U = \frac{1}{\frac{1}{ht}+\frac{x1}{k1}+\frac{1}{ho}}$$ (Heat Exchanger performance)

Where:

Q= the heat released or received (W)
U= comprehensive heat transfer coefficient (W/m^2 ^{o}C)
A= widespread heat transfer (m^2)

Δt= defferent temperature (°C)
ht=Convection coefficient (W/m^2.°C)
K1=Thermal conductivity (W/m.°C)
X1=different distance (m)
Δt =Average temperature difference (°C)

2.2. Effect of air temperature on drying process

The evaporation rate of the water-drying material is determined by the temperature rise. When the drying temperature is adjusted then the heat needed for the evaporation of the water material becomes reduced.

In the process of drying is required the presence of air heat transfer in mechanically drying heat drive can be assisted by using heat conducter pipes. The air drying process serves to:

(1) Take the steam around the evaporation
(2) As a heat transfer into the material that is dry
(3) As a burning substance
(4) As a place to dispose of steam that has been taken from the drying place.

In the drying process should be considered air dryer temperature. The greater the difference between the media temperature of the heater with dried material, the greater the speed of heat transfer into the material so that the evaporation of water in the material will be more and faster. Because water removed from the material in the form of water vapor must be moved and kept away from the material. Otherwise, the moisture will saturate the atmosphere on the surface of the material, slowing down the evaporation of subsequent water. Drying process that uses high temperature in a short time is less likely to damage the material from the low temperature drying process for a long time.

The amount of water content that should be eliminated from the material can be calculated using the following formula:

$m = m_a - m_b$ (Suparman, 2017)

Where:

m = amount of moisture to be removed (kg)
m_a = moisture content before drying (kg)
m_b = moisture content after drying (kg)

The results of previous research resulted in a method of making smoke fish using an oven made of galvanized plates and equipped with a chimney and wind-driven ventilator turbine (Martuti, Rosidah, and Saputro (2013). The Oven is made in a multilevel system (3 levels) where each level is able to hold fish as much as 2-2.5 kg of fish.

The result of this research has been equipped with a furnace located at the bottom of the oven and a 5-metre high chimney and ventilators. The turbine ventilator serves to pull the smoke upwards so that the smoke does not pollute the environment. The process of smoked skipjack by using this tool has been able to increase the production capacity of smoked skipjack. Moreover, the speed of the production process of smoked skipjack is increasing (fish are faster cooked), attractive colors, fuel-efficient, hygienic and environmentally friendly products.

3.Research Method

3.1. Location of Research

The location and time of the research are conducted at the workshop on mechanical Engineering of Manado State Polytechnic.

3.2. Research operational activities

The implementation of this research was compiled stages as follows:

3.2.1. The observation phase, which is the stage that is done by directly plunging the space to obtain the required data, this stage consists of:
The preparation phase:

-Preparing Skipjack
-Preparing fuel (coconut coir)
-Prepare a furnace burn, and oven.

3.2.2. The Data retrieval phase is to measure the weight of fish before and after the fuming and observe the temperature changes occurring in the furnace, in the oven and temperature around (temperature outside of the furnace) during the fuming process.

Figure 1. Adjusting the position of Skipjact

Figure 2. Blame for fire

3.3. Types of research

The type of research used to solve the problem is the type of experimental research in which the authors want to examine and know the heat transfer that occurs in the fish-roasting device from the outer space, the fuel to the oven and the amount Water content that is lost in fish.

3.4. Operational definitions

A variable operational definition is the understanding of variables (which are disclosed in the concept definitions) operationally, in a practical, tangible scope of research objects/objects studied. The variables used in this study are free variables and bound variables.

3.4.1. Independent variable

Independent variable is a variable that causes the occurrence or change of dependent variables. The variables used in this study were temperature differences in a certain period of time during roasting the skipjack.

3.4.2. Dependent Variable

Dependent variables are variables that are influenced by independent variable. The dependent variables used in this study are to do the research and retrieval of data to solve the causes of the independent variables, namely by calculating the heat transfer occurring within a certain period of time.

3.5. Subject/object/sample/study population

Subject/object/sample/Population in this study is the temperature data taken during the test process on a fish-roasted device within a period of 3 – 4 hours to determine the heat transfer occurring in the tool.

3.6. Data Analysis

The type of data analysis used in this research is quantitatively, namely, data obtained through the process of collecting data is processed into graphs to determine temperature changes occurring within 210 minutes until 240 minutes in the research the author proposed.

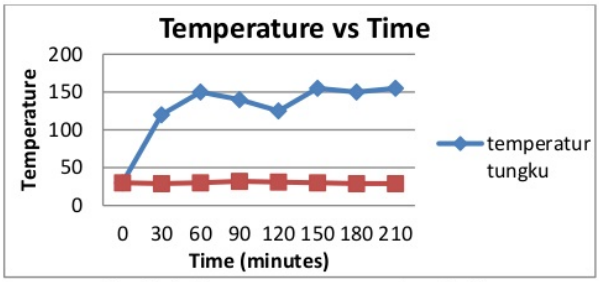
4. Research results and Discussion

4.1. Test Data

In the retrieval of the first test data use the fuel coconut fibers in the data obtained as follows:

-Heavy fish before in roast (2 fish): 2.1 Kg
-Weight after baked fish: 1.1 Kg
-Amount of fuel used: 23.1 Kg
-Roasting time: 210 minutes

The temperature ratio is obtained between the furnace and the outside temperature as follows:



Graph 1. Temperature comparison in furnace and temperature outside of furnace

At first experiment, with an observation every 30 minutes during 210 minutes shows the following results:

-At the first 30 minutes, the temperature in the furnace 130^{0}C
-At the second 30 minutes, the temperature in the furnace 160^{0}C
-At the third 30 minutes, the temperature in the furnace 150^{0}C
-At the second 30 minutes, the temperature in the furnace 130^{0}C
-At the second 30 minutes, the temperature in the furnace 170^{0}C
-At the second 30 minutes, the temperature in the furnace 160^{0}C
-At the second 30 minutes, the temperature in the furnace 150^{0}C

In the first 30 minutes, the temperature of 32^{0}C increased to 130^{0}C. This is because the coconut fiber fuel was almost burnt maximum. In the second 30 minutes, the temperature rises to a difference of 30^{0}C due to the maximum of combustion of coconut coir. In the third 30 minutes, the temperature was down to 150^{0}C. This is because the fuel has started to run out. In the fourth 30 minutes, the temperature was drops to 130^{0}C because of the added fuel. In the fifth 30 minutes, the temperature was increased to 170^{0}C due to the added fuel burn which reaching in the maximum conditions. In the sixt 30 minutes, the temperature becomes 160^0 C, because the fuel has begun to decrease. It also occurs in the seventh 30 minutes, the temperature becomes 150^{0}C (see Graph 1). The observation of smoked skipjack fish at 30 minutes to 3 fish conditions is seen in a half-baked state (see Figure 3). Furthermore, observations on the 7th 30 minutes are seen the smoked fish are already in a mature condition (see Figure 4)

In this process, coconut coir fuel is used as much as 23 kg within 210 minutes and the temperature often changes at a time interval of 30 minutes. Graph 1 shows the temperature change that occurs in the furnace, in the oven and temperature outside the furnace.

Figure 3. The Skipjack condition in 90 minutes

Figure 4. The Skipjack condition in 210 minutes

5. Conclusion:

Based on the results of the experiment, it can be concluded as follows:

1. The weight loss of fish before baking and after baking until cooked for 1 skipjack fish is 0.6 kg to 0.4 kg. The content of water in the skipjack fish has decreased by 33,33 %.
2. 19 smoked skipjack fish take approximately 210 minutes and the use of amount fuel is 23 kg of fiber coconut.

6. Recommendation:

6.1. Environmentally friendly tools for smoked fish should be coated with bricks to avoid the many lost heat. This is caused by bricks is a small conductivity.

6.2. The process of smoked skipjack should use dry coconut coir.

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