Homepage Journal http://jurnal.polsri.ac.id/index.php/austenit

AUSTENIT VOL. 15 NO.1, APRIL 2023 ISSN : 2085-1286 E-ISSN : 2622-7649

COMPARISON OF THERMAL INSULATION OF GLASS WOOL AND SUPERBTEX TO THE DRYING RATE OF FISH DRYING EQUIPMENT

A Firdaus[1)]*, Gunawan[1)], M A A Saputra[1)], N Haryani[2)]

[1)]Mechanical Engineering, Sriwijaya University,
Jl. Raya Palembang-Prabumulih KM. 32 Indralaya Ogan Ilir OI South Sumatra
[2)]Chemical Engineering, Sriwijaya University,
Jl. Raya Palembang-Prabumulih KM. 32 Indralaya Ogan Ilir OI South Sumatra
*Corresponding email: anekafirdaus@unsri.ac.id

ARTICLE INFORMATION

Revised
10/04/2023

Accepted
28/04/2023

Online Publication:
05/05/2023

doi:

10.53893/austenit.v15i1.6546

ABSTRACT

The use of glasswool or Superbtek insulation material in a fish dryer is one way to reduce the heat coming out of the fish dryer, so that the heat temperature utilized for the fish drying process will be maximized. These two insulation materials will be compared which one is better able to reduce heat. This fish dryer will be made with certain dimensions as needed, this tool design measures: 100 cm long, 50 cm wide, and 50 cm high for the outer wall, and 90 cm long, 40 cm wide, 40 cm high for the inner side wall. The height of the tool frame legs is 70 cm. Glasswool and Superbtex materials are affixed to the outside wall. The two insulation materials will be analyzed how much they affect the heat on the wall of the dryer, aiming to get the best insulation material between the two for the drying rate. With the experimental method, it was found that using Superbtex insulation material; the temperature inside the dryer was 94.20^{0}C and the temperature of the outer wall was 45.68^{0}C, the average drying rate was 4.306 gr/min, with the use of Glassswool insulation, the temperature of the inside wall of the dryer was 83.5^{0}C and the temperature of the outside wall of the dryer was 47.58^{0}C, the average drying rate was 3.489 gr/min. So superbtex insulation material is better to use than glasswool insulation material.

***Keywords**: Dryer, Glasswool, Superbtex, wood charcoal*

1. INTRODUCTION

The development of the people's economy sector remains a mainstay in sustaining the economic growth of the Indonesian nation. The same as what is felt in South Sumatra, especially in the city of Palembang, a part of the community makes efforts to cultivate freshwater fish such as: Tilapia, Gourami, Catfish. This fish farming business is scattered in several places, in the Lemabang, Celentang and Pasir Putih areas. So that when the harvest time is simultaneous, a lot of these fish accumulate in the market, the impact is that fish prices fall/cheap. This became the idea to make preparations from fish that can be stored for a long time, one of which is drying and smoking fish.

(Bintang et al., 2013) designed a fish dryer with a disassembly system made of aluminum so that it is easy to clean and easy to store. Solar energy as the main energy source. With a light tool weight, length and width dimensions of only 80 cm x 80 cm x 188.2 cm, this tool does not require a large space when stored.

(Darianto, 2019), conducted a study entitled Analysis of the effect of time and smoke turbulence on catfish drying machines. The method used is that the fish to be smoked is first soaked in salt water, then smoked 3 times using the help of turbulence so that it is evenly distributed. It's just that the results of this fish product are not good because the dried fish absorbs smoke from burning.

(Firdaus et al., 2014), in the research has come to a conclusion:

1. The thermal conductivity value of the insulator made of glass wool is 17 (W/m°C).
2. The value of thermal resistance insulator made of glass wool is 0.00380 (ºC/W).
3. When the dryer has not been installed insulator, the surface temperature of the wall of the fish dryer is 76 ºC, and when installed glass wool insulator wall surface temperature fish dryer becomes 64.33ºC.

(Firdaus, 2017), has researched fish drying equipment using coal briquette energy, the process is very simple by placing fish products in a dryer and coal briquettes function as a heat source to dry fish products. From his research, the average drying rate was 1.9235 gram/minute, the water content was reduced to 70% and the average drying efficiency was 1.3255%.

(Santoso et al., 2020), Conducted research with two stages, namely the tool making stage and the dryer testing stage. The designed tool is made of iron frame, aluminum wall, and stainless steel rack and has better performance compared to traditional fish smoking tools. The time needed to smoke 3.4 kg of cork fish in the designed device only takes 5-5.3 hours with 11.5 kg of fuel for coconut shell and 5.75 kg for redwood, while in the traditional smoking device it takes 10-12 hours with 21 kg of fuel for coconut shell and 15.5 kg for redwood. The designed device also exhibits a higher smoking temperature profile and lower humidity, thus accelerating the drying process and reducing the water content in the fish more quickly compared to traditional fish smoking devices. Thus, the cabinet system fish smoker modified and tested in this study has the potential to improve the efficiency and quality of fish smoking. So the researchers are trying to make a fish dryer by designing a dryer with 2 walls that use an alternative fuel, namely wood charcoal which is expected to help pioneering household businesses in overcoming the problem of drying fish that is not disturbed by weather and time conditions, moreover hygienic because there is no smoke content from burning.

(Hatta et al., 2019), they examined the drying system with a hybrid solar and gas method. The temperature in the drying room is 43^0C using a solar collector and the highest light intensity is 915 W/m2, after the hybrid temperature in the drying room reaches 67^0C and the light intensity is 908 W/m2, with a duration of drying time of 8.5-13 hours, while ordinary drying (drying in the sun) takes 3 days, and even then the weather must be sunny.

(Pradana & Puja, 2009), examined the Characteristic of Solar Energy Drier Using Thick Absorber 9 cm, with the results;

1. Solar energy dryers using porous absorber can be used to dry agricultural products.
2. Variations in the opening angle of the air entering the collector and the slope of the tool can affect the characteristics of solar energy dryers using porous absorber.
3. The maximum air temperature value that occurs at the exit of the collector is 70.9 °C, which shows the ability of solar energy dryers using porous absorbers to produce temperatures that are high enough to dry agricultural products.
4. The highest collector efficiency is 0.00206, which indicates that the use of solar energy dryers using porous absorbers is quite effective in collecting energy from the sun and using it to dry agricultural products.
5. The lowest relative humidity of the air entering the collector is 23%, the lowest relative humidity of the air after the collector is 11%, and the lowest relative humidity of the air after the load is 30%, which indicates that the solar energy dryer using a porous absorber is quite effective in reducing the humidity of the air used to dry agricultural products.

In the use of this fish dryer, a heat transfer process will occur from the high temperature fluid to the low temperature fluid, as well as heat transfer from or to the environment. To reduce the occurrence of heat transfer that occurs from or to the environment, insulation made from glasswool and Superbtex is used. This research aims to (1). Knowing the effect of glasswool and superbtek thermal insulation on the drying rate in a fish dryer Also (2). Getting thermal insulation between glasswool and superbtek which is ideal with ideal air hole openings in the fish dryer studied.

2. MATERIALS AND METHODS

2.1. Equipment Assembly

To conduct this research, we designed and manufactured a fish dryer as a place for fish to be dried. In the dryer there is a door that serves to enter the fish. This dryer has two walls; the outer wall and the inner wall, the gaps in the two walls serve to channel the heat generated by burning wood charcoal. This fish dryer has dimensions of 100 cm in length, 50 cm in width and 90 cm in height which has 1 cm diameter holes with a total of 6 pieces which function to drain the remaining heat and evaporate water as a result of the drying process that occurs in the drying chamber. In this fish dryer there is an inner space dimension with a smaller size than the outer wall which functions as a place to place the product, namely the fish to be dried. To get the value of conduction heat transfer rate, is to use the formula (Incropera, 2006):

$$Q = \frac{T_{\infty 1} - T_{\infty 2}}{R_{plat}} \quad (1)$$

(Incropera, Frank P and Dewitt, David P. 1985, page.131

Where:
Q = heat transfer rate
$T_{\infty 1}$= initial temperature
$T_{\infty 2}$= final temperature
R_{total} = resistance thermal

To calculate the drying rate using the following formula:

$$И_a = \frac{m_0 - m_1}{t_p} \quad (2)$$

where:

W_a= drying rate (gr/min)
m_0 = mass of water in material (grams)
m_1 = mass of product material in dry (grams)
t_p = drying time (minutes)

2.2. Researched Variables

The thickness of the glass-wool insulation material, Superbtex is taken with the same size, temperature and efficiency of the fish dryer. Determination of the thickness of the insulator material based on previous literature studies and from the manufacturer of the insulator material.

2.2 Methods

The method used in this study is an experimental method by directly observing the dryer, followed by collecting data during the drying process and then comparing it with existing data before drying. This was done using glasswool or superbtex. Supporting equipment used are: Charcoal, Thermocouples, Scales and Stopwatch.

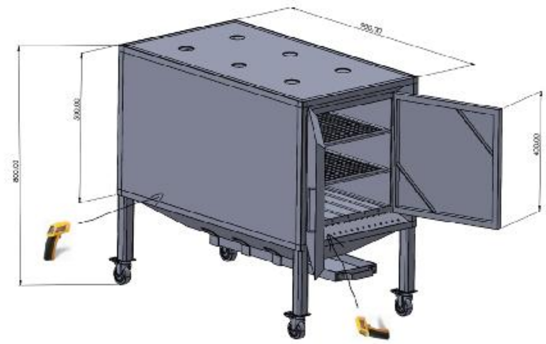

Figure 1. Dryer Equipment Design

Glasswool or superbtex insulation material will be attached to the wall of the dryer.

The procedure for this research involves the following steps:

a) Preparing the fish to be dried and weighing them to determine their initial weight.
b) Starting the fire with charcoal in the burner and allowing it to burn until it reaches a consistent temperature.
c) Placing the fish in the inner chamber of the dryer and closing the door.
d) Before data collection, the insulating material, namely glasswool, is installed on the dryer. after obtaining temperature data, in the same way using superbtex insulators.
e) Monitoring the temperature of the dryer using thermocouples placed in various locations inside and outside the dryer.
f) Recording the weight of the fish at regular intervals during the drying process using a scale.
g) Calculating the drying rate of the fish by comparing its weight before and after drying.
h) Collecting data on the drying time, energy consumption, and drying efficiency of the dryer with both glass wool and superbtex insulation material.

Figure 2. Dryer with Glasswool insulation

Figure 3. Dryer with Superbtex insulation

3. RESULTS

Table 1. Temperature data using Glasswool with a thickness of 25 mm

Time (min)	Inside Wall Temperature (ºC)	Outside Wall Temperature (ºC)	Mass (gr)	Drying rate (gr/min)
0	30	30	800	0
30	87	54	720	2.667
60	105	68	590	3.500
90	100	64	430	4.111
120	95	60	340	3.833
150	84	57	300	3.333
$T_{average}$	83.5	47,58		**3.489**

Hence the conduction Heat Transfer Rate

$$Q = \frac{T_{\infty 1} - T_{\infty 2}}{R\ plat} = \frac{83{,}5°C - 47{,}58°C}{0{,}00456°C/W.} = \frac{35{,}92\ °C}{0{,}00456°C/W} = 7877.19W$$

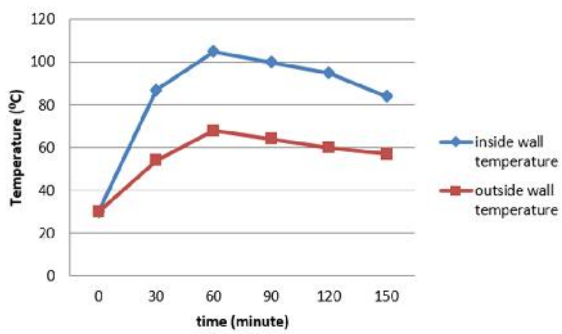

Figure 4. Graph of dryer temperature with glasswool insulator material

Table 2. Temperature data using Superbtex with a thickness of 25 mm

Time (min)	Inside Wall Temperature (ºC)	Outside Wall Temperature (ºC)	Mass (gr)	Drying rate (gr/min)
0	30	30	800	0
30	88.2	44.5	680	4.000
60	91.2	51.5	480	5.333
90	112.2	49.1	395	4.500
120	131.5	49.5	300	4.167
150	112.5	49.5	270	3.533
$T_{average}$	94.2	45.6		**4.306**

Hence the conduction Heat Transfer Rate

$$Q = \frac{T_{\infty 1} - T_{\infty 2}}{R\ plat} = \frac{94{,}2°C - 45{,}6°C}{0{,}00456°C/W} = \frac{48{,}6\ °C}{0{,}00456°C/W.} = 1067.89W$$

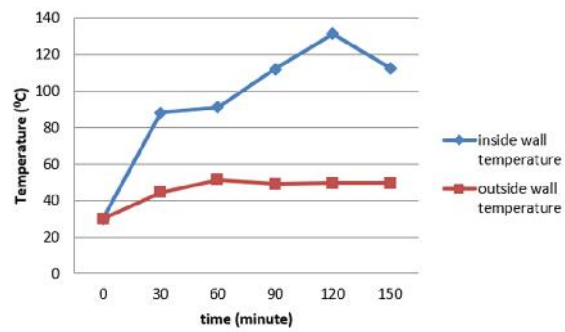

Figure 5. Graph of dryer temperature with superbtex insulator material

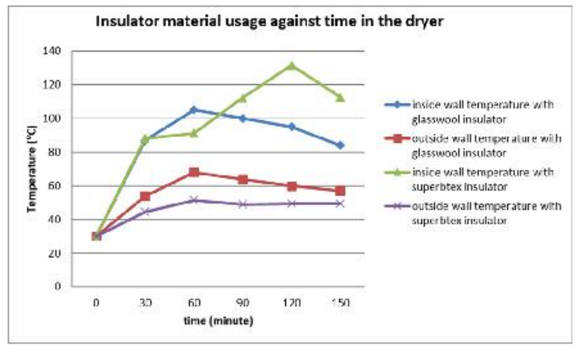

Figure 6. Graph of insulator material usage against time in the dryer

It can be inferred that Superbtex insulation has a higher thermal conductivity compared to Glass wool insulation, as it is better at dissipating heat. This implies that Superbtex insulation offers less thermal resistance, allowing for more efficient heat transfer from the dryer to the outer wall. Consequently, the temperature difference between the two surfaces is reduced.

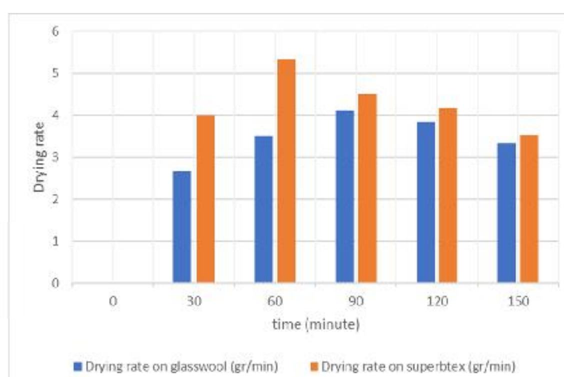

Figure 7. Combine Graph of Effect of Glasswool and Superbtex thickness of 25 mm on Drying Rate

In this case, since Superbtex insulation can dissipate heat better than Glass wool insulation, it means that Superbtex has a lower thermal resistance, implying that it is a better conductor of heat than Glass wool. Therefore, it is more effective in transferring heat from the dryer to the outer wall, resulting in a smaller temperature difference between the two surfaces.

4. CONCLUSION

In summary, Superbtex insulation's lower thermal resistance enables it to facilitate better heat transfer, which leads to a reduced temperature difference between the two surfaces and follows are:

1. The temperature inside the fish dryer using Glasswool insulation is 83.5^{0}C and the outside wall temperature is 47.58^{0}C.
2. The temperature inside the fish dryer using Superbtex insulation is 94.10^{0}C and the outside wall temperature is 45.68^{0}C
3. The heat transfer rate using superbtex insulator is 10657.89 W wich is greater than that of glasswool insulator of 7877.19 W.
4. The use of superbtex insulation material produces a drying rate of 4.306 gr/min, while glasswool insulation material produces a drying rate of 3.489 gr/min.
5. Maximum drying time is 2.5 hours.

5. ACKNOWLEDGMENT

Thanks are extended to the Chancellor of Sriwijaya University who has funded the publication of this article with: Budget of the DIPA Public Service Board of Sriwijaya University for Fiscal Year 2021. SP DIPA-023.17.2.677515 /2022, December 13, 2021. In accordance with Chancellor's Decree 0005/UN9/SK .LP2M.PM / 2022 dated 15 June 2022.

REFERENCES

Bintang, Y. M., Pongoh, J., & Onibala, H. (2013). KONSTRUKSI DAN KAPASITAS ALAT PENGERING IKAN TENAGA SURYA SISTEM BONGKAR-PASANG. In *Jurnal Media Teknologi Hasil Perikanan* (Vol. 1, Issue 2).

Darianto, D. (2019). Analisa Pengaruh Waktu Dan Turbulensi Asap Pada Mesin Pengering Ikan Lele. *Journal of Mechanical Engineering Manufactures Materials and Energy*, *3*(2), 130. https://doi.org/10.31289/jmemme.v3i2.3029

Firdaus, A. (2017). Perancangan Dan Analisa Alat Pengering Ikan Dengan Memanfaatkan Energi Briket Batubara. *Jurnal Teknik Mesin*, *5*(4), 1. https://doi.org/10.22441/jtm.v5i4.1216

Firdaus, A., Ferdinand, D., Mesin, T., Sriwijaya, U., & Pustaka, S. (2014). *Pengaruh Tebal Isolasi Termal Bahan Glass Wool Terhadap Laju Pengeringan Ikan Pada Alat Pengering Ikan*. 1–6.

Hatta, M., Syuhada, A., & Fuadi, Z. (2019). Sistim pengeringan ikan dengan metode hybrid. *Jurnal Polimesin*, *17*(1), 9–18.

Incropera, F. P. (2006). *Fundamentals of Heat and Mass Transfer*. John Wiley & Sons, Inc.

Pradana, A. J., & Puja, I. G. K. (2009). Karakteristik Pengering Energi Surya Menggunakan Absorber Porus Dengan Ketebalan 12 cm. *Seminar Nasional -VIII Rekayasa Dan Aplikasi Teknik Mesin Di Industri Kampus ITENAS - BAndung*, *November*, 14–20.

Santoso, M. H., Hutabarat, K. I., Wuri, D. E., & Lubis, J. H. (2020). Smart Industry Inkubator Otomatis Produk Pengering Ikan Asin Berbasis Arduino. *JURNAL MAHAJANA INFORMASI*, *5*(2 SE-), 45–53. https://doi.org/10.51544/jurnalmi.v5i2.1643