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TESTING OF THE SOLAR THERMAL COOKING PERFORMA OF THE ENERGY CONVERSION TECHNOLOGY CENTER AGENCY OF TECHNOLOGY ASSESSMENT AND APPLICATION

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ABSTRACT

Performance testing of solar thermal cooking. At the large institute of energy conversion technology, the body's assessment and application of technology. Practical Work. Serang: Mechanical Engineering Education, Faculty of Teacher Training and Education, Sultan Ageng Tirtayasa University, 2019. Solar thermal cooking is a technology that works by utilizing solar energy. This test uses observational methods, interviews, documentation and experiments, to determine the performance of solar cooking that is being developed by the Center for Energy Conversion Technology as a cooking aid to reduce or can replace firewood, LPG gas and electric stoves. The purpose of testing is the use of alternative energy that can be developed and possibly can be produced as a renewable technology. Conclusions testing for solar thermal cooking performance obtained data such as the highest radiation 930,211 W / m ^ 3 for the temperature 166^{0}C these data as a result of the performance of solar cooking performance and the results of the temperature test produced on cooking reached> 80^{0}C the temperature can pass the cooking conditions starting from boiling water, boiling eggs and so on.

Keywords: testing, performance, solar, thermal, cooking

INTRODUCTION

Renewable energy sources that are very abundant, especially in Indonesia is a gift that we have. becomes an opportunity to make all kinds of equipment to support the process of human activities such as cooking which has been using fuel that comes from nature and is not renewable because basically it will run out.

In this era the rapidly growing use of renewable energy such as the use of wind, solar, geothermal energy and all of that becomes an opportunity to create tools that aim to replace the use of non-renewable energy. On this occasion I took a test activity related to the use of tools for cooking such as stoves that use sunlight energy to produce heat quickly and improve the quality of understanding in the field of testing and work done in the world of institutions engaged in testing and research as improving technology utilization of solar thermal energy in Indonesia

This solar cooking testing process with 3 types of evacuated tube size tubes, this test is carried out starting from February 8 to February 13, 2019 using the SWH (Solar Water Heater) lab and using manual tools such as digital thermometers to determine the temperature in the performance testing process such as use for cooking and data from the swh lab processed digitally using a datalogger such as solar cooking surface temperature data as well as other factors such as radiation data and environmental temperature data which are read by pyranometer sensors and ambient sensors that send data to the data logger for processing and then entering to the computer unit to unite with other data.

Evacuatedtube

Evacuated tube collector is one of the most important ingredients to be used in solar cooking because as a means of receiving solar energy or an absorber material that is able to receive solar heat well and increase solar heat higher in the evacuated tube there are two more main components namely heat insulation and heat pipes as heat transfer component of the sun's absorption process. And the heat absorption section is made of borosilicate glass material which has high strength and is resistant to chemistry and heat. The air inside the gap between the outer layer glass tube and inside makes the part become vacuum,

The function of the vacuum as an insulator that prevents the loss of heat signi fi cantly into the atmosphere or into the air freely because the reduction factor is very drastic influences the temperature drop on the heat absorbed. On the inside of the glass coated with a selective layer (Al-N / AI or AIN / AIN-SS / Cu) which is useful for increasing radiation absorption and minimizing reflection of radiation energy. Inside the glass tube is a flat, curved aluminum plate or copper fins attached to the heat pipe inside the inner glass tube. The fins function as a heat capture sun to heat the heat pipe and the

liquid evaporator process occurs in the heat pipe and the design of the tube-shaped evaquatedtube collector has advantages because it can absorb heat more perfectly from various sides unlike a flat face which only has one surface only in the collector.

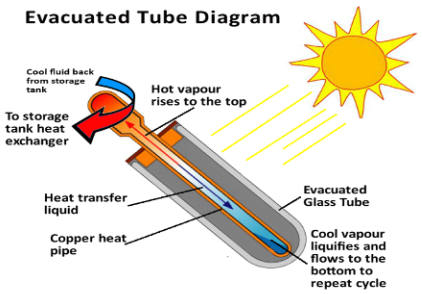

Figure 1 Evacuated tube circulation

(Source: Google)

In the working process of solar cooking is where the mathari radiation is directed towards or evacuatated tube with the vaporaizing process in the evacuated tube, which is a copper heat pipe filled with liquid vapor liquefies, producing temperatures ranging from 40^0 to 250^0 if the radiation obtained is of good quality in the 900 to 1100 radiation range.

Utilization of Solar Thermal Energy Utilization

Food Quality IPB utilization of solar thermal energy can be seen in table 1.1 Regulations for use.

Table 1.1 Regulation of Temperature of use

Sector	Processes	Temp (^{0}C)
Brewing and Malting	Wort boiling	100
	Bottle washing	60
	Drying	90
	Cooling	60
Milk	Pasteurization	60 – 85
	sterilization	130 - 150
Food preservation	Pasteurization	110 – 125
	Sterilization	< 80
	Cooking	70 – 100
	Scalding	95 – 100
	Bleaching	<90
Meat	Washing, Sterilization,cleaning	<90
Wine and beverage	Bottle washing	60 – 90
	Cooling (single effect absorption cooling)	85
Textile	washing,bleaching,dyeing	<90
	cooking	140 – 200
Automotif	Paint drying	160 – 220
	degreasing	35 – 55
Paper	Paper pulp:cooking	170 – 180
Tanning	Water heating for damp	165 – 180
Cork	Drying, cork baking	40 – 155

Source:: Observatoire Médi-terranéen de l'Energie (OME)

Table 1.2 Regulations of the pathogenic bacterial sterilization process.

No	Types of cooked food	Temperature (^{0}C)	(F^0)	The duration of the process of sterilization of pathogenic bacteria
1	Eggs, poultry, meat, fish	74^0	165^0F	15 Second
2	various mixed dishes	74^0	165^0F	
3	Stuffed meat	74^0	165^0F	
4	Animal Meat	$68,3^0$	155^0F	
5	Processed Meat	$68,3^0$	155^0F	
6	Fish	63^0	145^0F	
7	Steak / Minced Meat	63^0	145^0F	
8	Roasts	63^0	145^0F	
9	Eggs (Boil, Fry)	63^0	145^0F	
10	Vegetables	57^0	135^0F	
11	Food Ready to Eat	57^0	135^0F	

Source: Banu Lesmana Bagaskara Supervisor of IPB Food Quality Assurance

Solar energy is energy that is clean, cheap, safe, unlimited and able to be renewable (renewable) and economic potential that is extraordinary for example in Indonesia. Utilization of solar energy can be in the form of photon energy and thermal energy. Photon energy can be converted into electrical energy in the presence of solar cells while solar thermal energy can be used for the process of cookers, dryers, water heaters, power plants, distillation of sea water, etc. Based on the Observatoire Médi-terranéen de l'Energie (OME) report), and the results of the Banu Lesmana Bagaskara Guarantee Supervisor

Research methodology

Observation

The process of introducing the environment starts from what is done at the institution and what services are available at the institution that is being run so as to understand and adjust to the workplace environment of the practice as well as at Interview This process is carried out for the collection of some data in order to understand how it works and what kind of rules must be applied to the practical work process so that it does not experience problems in the process of this practical work. documenting the initial preparation of tools such as sensors used by tools and materials and the condition of objects tested to determine the initial conditions of the process and the final process to determine the condition of the equipment has changed or not.

ExperimentsThe process carried out in an experiment is to test a cooking experiment with regard to temperature and radiation as it tries to use a test to find out whether the conditions of solar cooking are the same as a stove that uses LPG, electricity or other such cooking experiments.

Results and Discussion

1) Data from performance test results without load or cooking test

A. Ambient graph, calmp surface temperature, Radiation on February 8, 2019

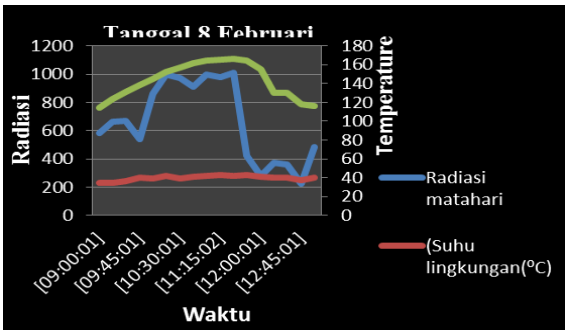

Figure 2. Radiation Graph, Ambient Clamp surface temperature on February 9, 2019

In Figure 2, the graph above can be an increase graph between the radiation graph and the temperature on the clamp or surface at (09:00) to (13:00) the highest temperature to above 160^{0}C with the highest radiation reaching 1007 (and the graph shows the amount of decrease between radiation with the clamp temperature at 11:00 to nail (13.00) with the amount of radiation ranging from 996 to 481 with a decrease in temperature on the clamp at 165 ° C to 116 ° C because of the rain in the process of the experiment.

B. *Ambient Graph, Clamp surface temperature, Solar radiation February 9, 2019*.

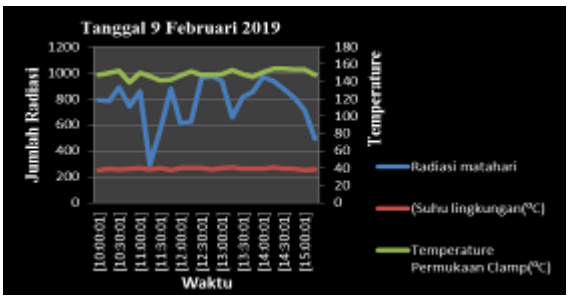

Figure 3. Radiation Graph, Ambient Clamp Temperature on February 9, 2019

In Figure 4 a graph of environmental temperature, radiation, and clamp temperature without load or non-cook test results can be obtained with observations of increases or decreases at (10:00) to (15:00) the data depicted on the graph at (10.00) with the amount of radiation 787 with a clamp surface temperature of 147 ^{0}C but a decrease at (11:15) with the amount of radiation 292 but the surface temperature of the clamp has increased before it reaches 157^{0}C the decrease in radiation is likely due to clouds covering the radiation sensor. On the graph the highest radiation value is at (13:00) with the number 936 and the temperature at the clamp 148 ^{0}C.

C. Ambient Graph, Clamp surface temperature, Solar radiation February 10, 2019

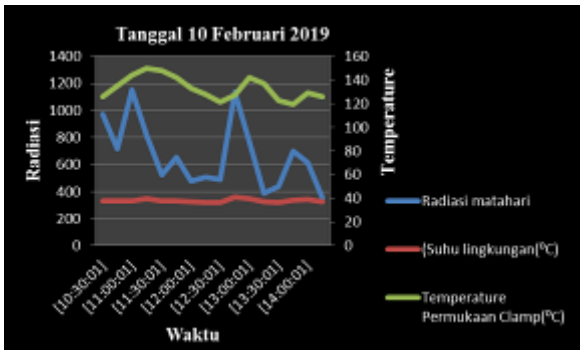

Figure 4. Radiation Graph, Clamp and Ambient Temperature on February 10, 2019

In Figure 4 above can be an increase between the radiation graph and the temperature on the clamp or surface at (10:30) to (14:00) illustrated graphs that rise and fall with the highest temperature up to 149^0 C with the highest radiation reaching 1152 (W /) at image at (11:00) and experiencing a purification at (12:30) with the amount of radiation 487 W / and the clamp surface temperature 121^0 C the decrease is due to weather conditions in the cloudy or cloudy experiment process which results in a decrease in the clamp surface temperature due to a decrease in the amount of radiation in received by the collector while the ambient temperature did not experience an increase and decrease with an average amount of 30^0 C.

2) Performance test data with load or cooking test

Radiation graph Ambient surface clamp temperature, and temperature on cuisine February 11 2019

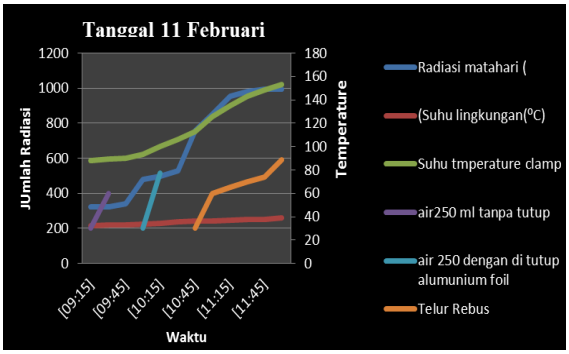

Figure 5. Radiation graph Ambient surface temperature of the clamp, and temperature on the cuisine Date February 11, 2019

In Figure 5, the results obtained from Observation graph are the amount of radiation increase, clamp temperature, boiling water temperature and boiled egg test. For radiation depicted on the blue colored graph the highest results are 996 and the lowest results are 321 temperature rises at the highest clamp starting at (09.12) to (12.00) with the result of an increase in temperature on the clamp with a green graphic image increase of 87° C to 153° C. During the process The load testing was done for cooking such as differences in cooking water with the lid and open data obtained as a table on open water for 15 minutes in the amount of initial radiation 325.108 and the initial temperature of the clamp 87.54^0 C the final temperature at the clamp 89,54^0 C. For the initial temperature at open water 30 ^{0} C and for the final temperature 60 ^{0} C with a

purple chart, for water that is covered for 15 minutes in the data with the amount of initial radiation 477,477 and initial clamp temperature 93.44^0 C and final temperature clamp 100.37^0 C at water temperature closed with an initial amount of 30° C and a final temperature obtained by 77° C as in the light blue graph, for experiments to cook eggs by boiling in 75 minutes with data obtained such as initial radiation amount of 759,1598 and clamp temperature 112, 84^0 C for egg temperature 30^0 C after 30 minutes afterwards it was obtained the amount of radiation 951.7898 for the temperature at the clamp 135.29 ^{0}C while the temperature in the egg was 65^0 C after processing for 75 minutes the experiment in the amount of radiation was 996.3252 for the clamp temperature 153.50^0 C whereas for the cooking temperature of 89^0 C on the orange graph. With the results as in the table (Table 3.7 Results of cooking performance test on February 11, 2019), while for the ambient temperature only slightly affects the increase or decrease that occurs in the clamp.

Radiation graph Ambient surface temperature of the clamp, and temperature on the 12 February 2019 cuisine.

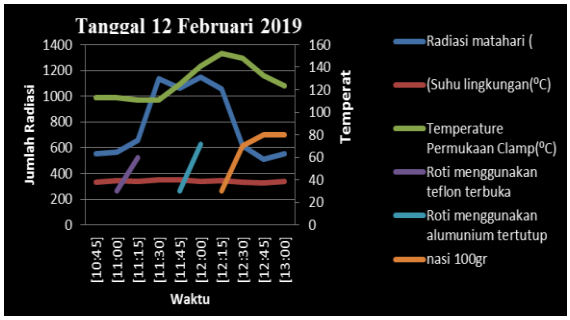

Figure 9. Radiation graph Ambient temperature of the clamp surface, and temperature on the cuisine on 12 February 2019.

In Figure 9: Observation results can be obtained with the amount of radiation, clamp temperature, ambient temperature, rice cooking temperature, temperature of bread cooking with Teflon and using aluminum foil, from some of the results obtained test results data as seen in the graphic image at 10:45 until 13.00 can be observed temperature observations on the initial clamp surface 113° C and the amount of radiation 553,166 to the highest temperature 152° C at 12:15 with the amount of radiation 1057.68 and as shown in the graph there is a decrease in the amount of radiation resulting in a decrease in the clamp temperature at 12:30:30 until 1:00 p.m. which is very fast with a total radiation of 510.69 and a clamp temperature of 123.68° C.

For the results of cooking trials with initial test data that is baking bread using Teflon at 11:00 with the initial clamp temperature of 113.12° C and initial food temperature of 30 ° C in accordance with the results of environmental temperature data and the results of the last test on the bread indeed at o'clock 11.15 with the amount of radiation at 660.10 and the number of clamp temperatures 110.63° C for food temperatures obtained at a result of 60 ° C. For data indeed using aluminum foil starts at 11:45 with the amount of radiation 1060.437 and the temperature temperature clamp

124.92 ° C while for food temperature at 30^{0}C after being tested for 15 at 12.00 in the result of the amount of radiation 1147.76 and for the temperature of the food reached 70 C. The last experiment was cooking rice weighing 100gr for 60 minutes starting at 12:15 to 13.15 with the results of the initial radiation data 1057 , 686 with the temperature at the clamp 152.12 ^{0} C and the initial temperature of the food 30 ^{0} C after doing for 15 minutes gradually doing the temperature on food after 80 ° C the food temperature remained until the last minute with a total radiation of 946.50, the result data are in the table (Table 1.4 Results of the cooking performance test on February 11, 2019).

Table 1.4 Results of cooking performance tests on 11 February 2019

No	Test Material	Duration	Test material temperature (^{0}C)
1	Bread using Teflon	30 Minute	68^0
2	Bread uses aluminum foil	15 Minute	72^0
3	100-gram rice becomes cooked rice	60 Minute	80^0

Radiation graph Ambient surface temperature of the clamp, and temperature on the 12 February 2019 cuisine

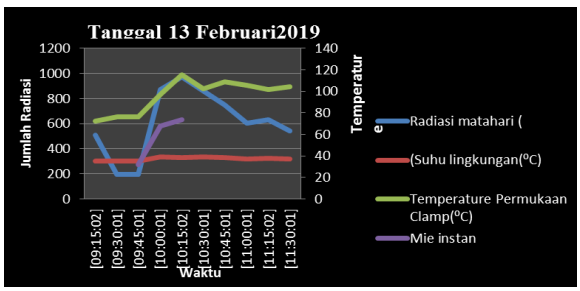

Figure 13 Radiation graph Ambient surface temperature of the clamp, and the temperature in cuisine February 13, 2019.

In the picture 13 graphs can be obtained from the graphs The data from the graph are the test of cooking instant noodles which at 09.45 to 10.15 can be the result of the amount of radiation seen in the blue graph with a starting point of 197.59 for the clamp temperature of 76.63C and the highest point at 975.36 with a clamp temperature of 115.48 at 10:15. For the process takes 30 minutes because the first thing to do is to taste the water that will be used to boil the instant noodles with a cooking temperature of 68^{0}C then insert instant noodles for 10 minutes with the final temperature reaching 74 ^{0}C with a clamp temperature of 115.48 ^{0}C the following results are described in the results of instant noodle cooking in the table (Table 3.11 Results of the cooking performance test on February 13-2019).

Table 1.5 Results of cooking performance tests on February 13, 2019.

No	Test Material	Duration	Test material temperature (^{0}C)
1	Instant boiled noodles	18 Minute	74^0

3) Thermal comparison data between Isolators using Glas Woll and Foam Polyuretane Insulators

Table 1.6 Table The heat efficiency achieved in insulating replacement

No	Material Name	Highest temperature reached (^{0}C)	Total radiation intensity
1	Glass Woll	147(^{0}C)	933.8276
2	Foam Polyuretane	166 (^{0}C)	930.211

The increase in clamp isolator is very significant in the type of insulator that uses polyurethane foam because this type has very few gaps in the clamp that can cause heat loses to the clam itself and also the spread of heat occurs in the heat pipe can be channeled directly towards the surface of the clamp which can increase the temperature maximally

4) Advantages and disadvantages of Solar coking with other types of solar cooking.

Table 1.7 Too much and lack of solar cooking

No	Types of Solar Cooking	Advantages	Deficiency
1	Solar thermal cooking Evacuated tube (Made in B2TKE)	• Having a solid shape • Having centralized heat without having to move the sun regularly • Can be changed by adjusting the number of evacuated tubes • Rapid heat increase	• Evacuated tube raw material is difficult • The price is quite expensive • Tools are not concise
2	Solar stove with a single reflector system (with glass Reflector) Sriwijaya Polytechnic	• Low cost • Concise form • Material is easy to obtain	• • The • cooking process takes a long time • Requires adjusting the angle of each cooking process

CONCLUSION

B2TKE is a large center of study and research in the field of energy conversion, work in B2TKE (Center for Energy Conversion Technology) such as air conditioning testing, household appliances and so on with the existence of this can help the quality of producers to know the goods they will market pass the standardization test or not. B2TKE is also a development body for a product such as solar cooking products which is a development stage and is a prototype that is still being developed to improve performance better and work optimally and can produce this product.

The results obtained from the testing process of solar cooking using Evacuatedtube are some results such as the process of selecting the insulator material used to replace glass woll insulators into polyurethane foam in the result of an increase with 166 (^{0}C) with 930,211 radiation which before was only 147 (^{0}C) 933.8276For the results of the cooking test, there are several results such as the test of cooking eggs and cooking rice as much as 100 grams can be processed within 60 minutes,

toast takes 15 minutes. Like using a conventional stove and to boil water in just 15 minutes with an amount of 250 ml temperature can be quite high compared to using solar cooking type of light reflector and one of the superior that has from solar cooking with the amount of radiation that is comparable to the type of reflector can produce higher temperatures because the surface of the type of solar cooking evacuated tube can receive solar radiation without having to reset the position if the position of the sun moves.

For the provisions of the temperature achieved has also fulfilled several requirements such as eggs for meat with temperatures> 90 ^{0} and for processed vegetables can be exceeded because the temperature generated from solar cooking is 166 ^{0} for clamps and the possibility of this product can be run by government programs in the type of energy renewable for the cooking process.

This tool also works more optimally for coastal areas and areas that have a high amount of radiation such as the area of West Nusa Tenggara and East Nusa Tenggara. This product may be a government program that can help people in remote areas replace conventional stove raw materials such as firewood into solar cooking.

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