

A Study of Solar Reflector Efficiency of Parabolic Dual Trough

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Abstract: Problem statement: The receiver of parabolic dual trough had been designed and built in order to increase efficiency of solar radiation accumulation by using iron-aluminum sheet as an intermediate in receiving heat and it is the study into how to benefit from solar radiation energy. This research proposed the principle of changing solar radiation to be heating energy by using aluminum sheet made into dual parabolic curve tilted with iron-aluminum sheet which was receiver of radiation reflection. **Approach:** This dual parabolic curve could be adjusted so that heat obtained from the solar radiation accumulation, which was the focus, could spread around iron-aluminum sheet. In testing of heating by solar energy, the unit would be tilted at 16° to the North-South in order to receive solar radiation and the unit was arranged horizontally. The test was classified into 4 conditions including (1) laying the unit horizontally and un-drive the motor, iron-aluminum sheet would be put in place unmoved in vertical line; (2) laying the unit horizontally and drive motor so that iron-aluminum sheet could be moved upwards and downwards along the vertical line; (3) laying the unit to be tilted at 16° with plane level and un-drive motor and (4) laying the unit to be tilted at 16° with the plane level and drive motor so that iron-aluminum sheet could be moved upwards and downwards along the vertical line. **Results:** It was found from the test of temperature of iron-aluminum sheet that on the first condition, the highest temperature of iron sheet was 75.2°C and the highest temperature of aluminum was 84.7°C ; on the second condition, the highest temperature of iron sheet was 90.6°C and the highest temperature of aluminum was 97.2°C ; on the third condition, the highest temperature of iron sheet was 87.4°C and the highest temperature of aluminum was 93.4°C ; on the fourth condition, the highest temperature of iron sheet was 94.5°C and the highest temperature of aluminum was 89.4°C . Therefore, the test of laying the unit to be tilted at 16° with the plane level and driving motor led to the high temperature since the perpendicular of light and the spreading of sunlight from dual parabolic curve could cover all area. **Conclusion:** These results indicate dual parabolic curve could be increased efficiency of solar radiation accumulation by using iron-aluminum sheet as an intermediate in receiving heat.

Key words: Solar radiation, dual parabolic trough, iron-aluminum sheet

INTRODUCTION

The sun is an object that is vital to human life. It is the center of our solar system; it is the powerful source of energy. Energy is essential to daily life of all life. Men, through various ages, have been developing the use of energy; energy from firewood, wind energy, hydro energy, coal, petroleum, natural gas, as well as nuclear energy. The use of energy tends to increase rapidly. It is expected that there will be no more petroleum left on earth within around 50 years and there will be no more coal left on earth in around 100 years (Energy Research Institute, 2009). Furthermore,

the use of energy causes pollution to environment including acid rain, green house effect, increased dust and increased toxic gas in the air (Craxford, 1983; Gao and Chen, 2008).

Solar energy is renewable energy; consequently, there is unlimited amount of it to be used. The users can directly use it comprehensively. It is the source of clean energy and does not pollute environment. Normally, men already use solar energy in daily life. The solar radiation intensity in Thailand is about $18 \text{ MJ m}^{-2} \text{ day}$ almost all year (Ministry of Energy, 2008); therefore, the potential to use solar energy is very high.

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Therefore, in this research, receiver of parabolic dual trough had been designed and built in order to increase efficiency of solar radiation accumulation by using iron-aluminum sheet as an intermediate in receiving heat and it is the study into how to benefit from solar radiation energy.

MATERIALS AND METHODS

The tool used in receiving solar energy consists of structure of receiver of solar energy, parabolic dual trough which could be adjusted and was made of aluminum sheet with reflection coefficient of about 0.8 and was easily burnished without rust and with high flexibility; so, it could be easily assembled, receiver of reflection radiation (iron and aluminum sheet with the size of 38.5×29.5 cm) from parabolic dual trough and the kit controlling the moving of radiation reflection receiver (Fig. 1). The sunlight provides heating energy to dual parabolic curve and leads to light accumulation at the focus then reflects to the existing unit in vertical line and could move upwards and downwards.

In the experiment of heating receiver of dual parabolic curve, the period of 9.00 am. -3.00 pm. when the sunlight was of the highest level of intensity was selected. The sunlight intensity was recorded with Pyranometer, EKO brand, MS-64 model, accuracy of ±50 mV testing period. Lay the unit horizontally and tilted at 16 Degree with the plane level. Record temperature every 15 minutes by type-K thermocouple and data logger with Yokogawa brand and MX100 model at the iron and aluminum sheet, internal temperature of solar receiver and ambient temperature.

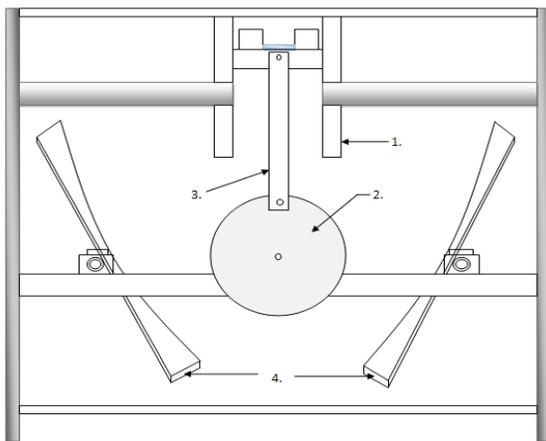


Fig. 1: Experimental equipment set up (1) iron-aluminum sheet; (2) reflection receiver; (3) unit moving vertical line; (4) parabolic trough

The measurement of such temperature was classified into 4 conditions including (1) laying the unit horizontally and un-drive the motor, iron-aluminum sheet would be put in place unmoved in vertical line; (2) laying the unit horizontally and drive motor so that iron-aluminum sheet could be moved upwards and downwards along the vertical line; (3) laying the unit to be tilted at 16° with plane level and un-drive motor and (4) laying the unit to be tilted at 16° with the plane level and drive motor so that iron-aluminum sheet could be moved upwards and downwards along the vertical line.

Take temperature value plotted in graph and time to calculate heating value of iron and aluminum sheet from Equation:

$$Q = mC_p(T_2 - T_1)$$

Where:

- Q = Heating value (kJ)
- m = Mass of materials (kg)
- C_p = Specific heat capacity (kJ kg⁻¹°C)
- T₂ = Temperature of material (°C)
- T₁ = Temperature of environment (°C)

RESULTS

Temperature of the unit moving upwards and downwards in vertical line and laying test kit horizontally: Fig. 2 shows solar energy intensity on the condition of laying the testing tool horizontally and the unit moving upwards and downwards in vertical line; the sunlight intensity tends to increase from 9.00 am. and with the highest level of intensity of 974 W m⁻² at 12.15 pm. And after that, it tends to decrease that looks like an inverted parabola. From such graph, it shows that the sunlight intensity is high during 12.00-1.00 pm when the light is perpendicular with testing area. Temperature of testing kit on such condition is shown in Fig. 3.

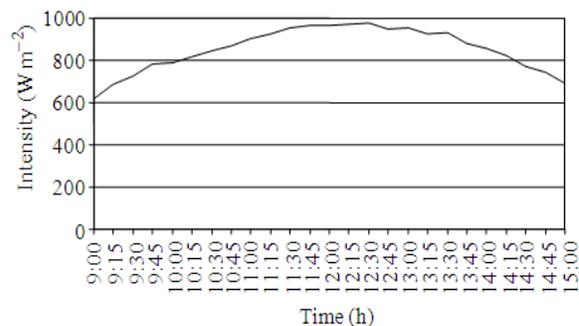


Fig. 2: Solar energy intensity

Table 1: Result of temperature and heating value of iron sheet

Testing condition		Temperature (°C)		Heating value (kJ)	Ambient temperature (°C)
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		Min	Max		
Horizontal	Un-drive motor	55.3	75.2	24.90	33.39
Horizontal	Un-drive motor	75.5	90.6	19.58	36.94
16°	Un-drive motor	57.2	87.4	8.70	34.04
16°	Drive motor	54.2	94.5	20.68	33.86

Table 2: Result of temperature and heating value of aluminum sheet

Testing condition		Temperature (°C)		Heating value (kJ)	Ambient temperature (°C)
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		Min	Max		
Horizontal	Un-drive motor	54.6	84.7	5.02	33.39
Horizontal	Un-drive motor	74.1	97.2	4.17	36.94
16°	Un-drive motor	58.2	93.4	1.65	34.04
16°	Drive motor	56.2	89.4	4.38	33.86

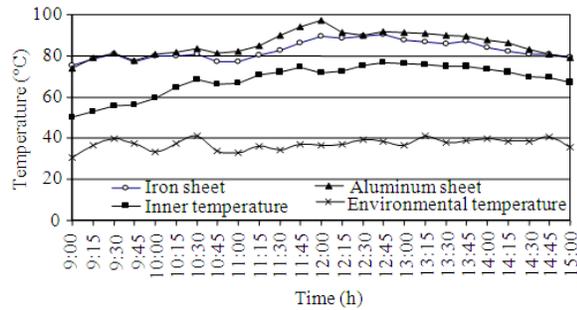


Fig. 3: Temperature of solar receivers in laying the unit horizontally

Figure 3 shows the inside of solar energy receiver, temperature of iron and aluminum sheet and ambient temperature. The temperature of iron and aluminum sheet tends to increase according to the temperature inside solar radiation receiver to the extent that it is at the highest level of 90.6 and 97.2 °C at 12.00-1.00 pm. whereas the ambient temperature is quite stable.

Temperature and heating of iron and aluminum sheet under various testing conditions: According to Table 1, the temperature and heating value of iron sheet put in place and moves upwards-downwards in vertical line, in laying the solar receiver horizontally and tilted at 16° with plane level were 54.2-94.5°C; the highest temperature of iron sheet was 94.5°C under the condition of driving motor so that iron sheet could move upwards-downwards in vertical line and put to be tilted at 16° with plane level; this shows that laying the unit to be tilted and the moving of result of the highest level of difference of average temperature of iron sheet and ambient temperature under equation whereas the second highest temperature of iron sheet is 90.6°C under the condition that the iron sheet moves upward-downwards in vertical line and lay the unit horizontally.

According to Table 2, the result of temperature and heating value of aluminum sheet when laying the unit horizontally and driving motor to move aluminum sheet upwards-downwards in vertical line in order to receive solar radiation from dual parabolic curve result to be 97.2°C; secondly it is the laying of the unit to be tilted at 16 Degree with plane level and un-drive motor, this makes the temperature of aluminum to be 93.4°C. It shows that driving motor or tilting solar radiation receiver at 16° with plane level results in the perpendicular of light and the spread of sunlight from parabolic dual trough to cover all area while in the calculation of heating value of aluminum, it was found that the condition of laying the unit horizontally and un-drive motor and tilting at 16° with plane level and drive motor provides heating value of 5.02 and 4.38 kJ, respectively; this may be because the ambient temperature of testing under such condition is lower to 33.39 and 33.86°C that makes the difference of temperature under Equation 1 become high under such testing condition and this increases the heating value of aluminum sheet.

CONCLUSION

According to the result of the experiment in laying the unit horizontally and driving motor leading to total temperature of the unit to be of the highest value, the highest temperature of iron sheet obtained was 90.6°C, the highest temperature of aluminum was 97.2°C; secondly it was the condition of laying the unit to be tilted at 16° with plane level and drive motor. The highest temperature of iron obtained was 94.5°C and the highest temperature of aluminum was 89.4°C; this reveals that the driving of motor and the tilting solar radiation receiver at 16° with plane level leads to the fact that the perpendicular of light and the spread of sunlight from parabolic dual trough cover all area.

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