Analysis of Dish Collector Focal Shape in Vertical and Horizontal Direction of Concentrating Solar Power System

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***Abstract* – A CSP (Concentrating Solar Power) system must have a receiver to receive solar ray reflection from parabolic dish collector. Based on the receiver installation to the collector, there are two type installation such as parallel to collector (horizontal direction) and perpendicular to collector (vertical direction). In this research not only we compared the receiver orientation but also we varied geometry concentration ratio. The experiment results show that the focal shape diameter elongates 2 mm and surface temperature increases 5-10°C for vertical orientation with greater concentration ratio. However, there is no significant effect to receiver with horizontal orientation. Thermal efficiency was affected by radiation and convection heat loss but for geometry concentration ratio above 100, radiation and convection heat loss gived small impact.**

***Index Terms* – CSP dish, receiver, horizontal orientation, vertical orientation**

INTRODUCTION

A secondary concentrator provides more efficiency in the two stage concentrator concept. It gives greater geometry concentration ratio and greater effective intercept factor [1]. Therefore, a receiver that consists arrangement of capilary tubes is placed into the secondary concentrator. Most fabricants placed this receiver in cross section with concentrator but often placed it in edge of concentrator cavity [2]. To keep higher efficiency of a receiver it's not enough just greater geometry concentration ratio, we need to absorb the solar radiation with a selective absorber. Thermal efficiency of a receiver is a function of the geometry concentration ratio and the temperature of receiver [3].

STUDY LITERATURE

Heat input to collector

$$Q_{in} = I_{sun} \times A_c \qquad (1)$$

where:

I_{sun} = Sun radiation intensity measured by pyranometer = 840 Wm^{-2}
A_c = Collector area = 4.3 m^2

Heat loss calculation

$$Q_{loss} = Q_{rad} + Q_{conv} = U_L \times A_r \qquad (2)$$

where:
U_L = overall heat transfer coefficient
A_r = receiver area = $\frac{\pi}{4} \times (\emptyset_i + t)^2 + \pi \times (\emptyset_i + t) \times p$
t = pipe thickness = 1.8 mm

Receiver efficiency

$$\eta_2 = \frac{Q_{use}}{Q_r} = 1 - \frac{Q_{loss}}{Q_r} \qquad (3)$$

Overall efficiency

$$\eta_{th} = \eta_c \times \eta_r = \frac{Q_{loss}}{Q_{in}} \qquad (4)$$

EXPERIMENT DESIGN

The receiver diameter varied from 0.25 inch until 1.5 inch with increasing value of 0.25 inch. After receiver diameter have been choosen, pipe length was measured by measuring focal range through surface thermometer. Table 1 shows information about relationship between receiver diameter and focal spot.

TABLE 1. MEASURED FOCAL SHAPE FOR EACH GEOMETRY CONCENTRATION RATIO

Pipe diameter	Focal range	Focal spot
1.50 in	84.5-100.0 cm	92.3 cm
1.25 in	84.7-100.4 cm	92.5 cm
1.00 in	85.0-100.7 cm	92.9 cm
0.75 in	85.2-100.9 cm	93.1 cm
0.50 in	85.3-101.2 cm	93.3 cm
0.25 in	85.5-101.7 cm	93.6 cm

From Table 1 we could conclude that the actual collector focal spot was 93.6 cm. The smallest receiver diameter gived the smallest focal range. From this information (to be reference) we put the horizontal receiver.

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GRAPHICS AND DISCUSSION

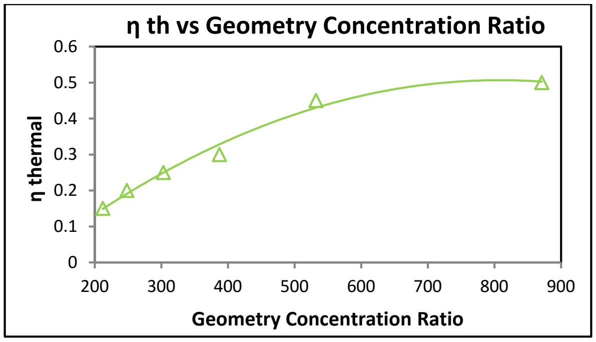

Figure 1. Thermal efficiency graphic.

As shown in Fig. 1 we could conclude thermal efficiency was higher as well as geometry concentration ratio. Fig. 2 shows the effect of heat loss to efficiency.

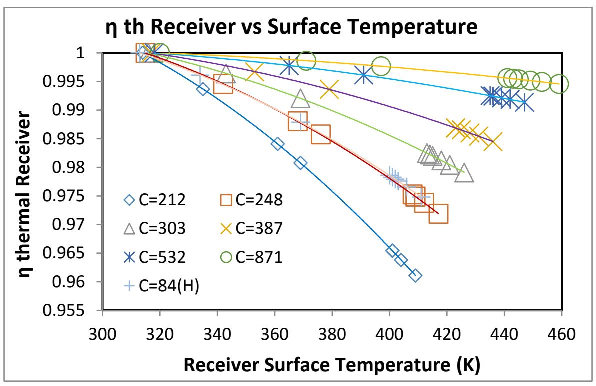

Figure 2. Receiver efficiency graphics.

Described phenomenon from Fig. 2 was the effect by temperature distribution along the surface receiver. We needed to study deeply to know the caracterize of this ditribution in next research by numerical investigation using CFD software.

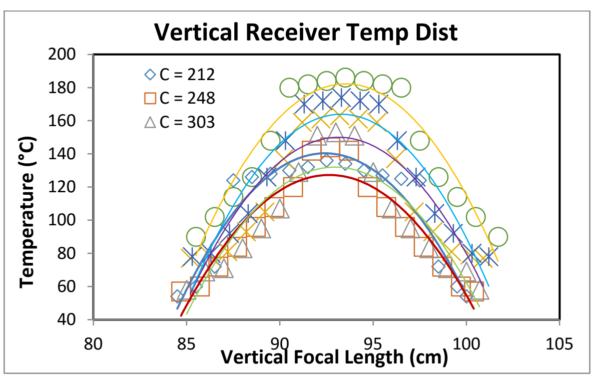

Figure 3. Temperature distribution on vertical receiver.

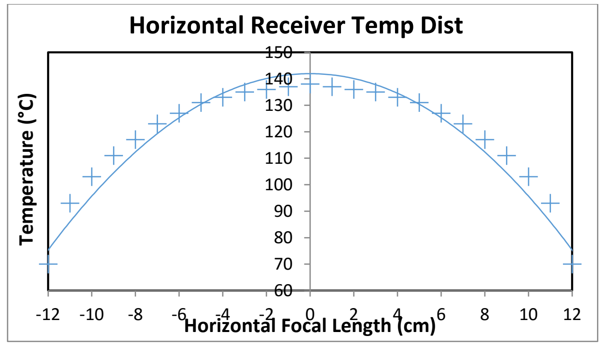

Figure 4. Temperature distribution on horizontal receiver.

CONCLUSIONS

From discussions above we can conclude that:

1) Horizontal receiver has better temperature distribution than vertical receiver.
2) Greater geometry concentration ratio gives greater thermal efficiency.

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