Department of Physics and Process Control

INSTITUTE FOR ENVIRONMENTAL ENGINEERING SYSTEMS

FACULTY OF MECHANICAL ENGINEERING

SZENT ISTVÁN UNIVERSITY

Gödöllő, Páter K. u. 1. H-2103
Hungary

Tel: +36 28 522055
Fax: +36 28 410804
Fizika.Tanszek@gek.szie.hu
http://fft.szie.hu

COMPARISON OF USEFUL SURFACE OF DIFFERENT TYPE OF SOLAR COLLECTORS

CIOSTA 29 June - 1 July 2011, Vienna

Ivett Kocsány

E-mail: Kocsany.Ivett@gek.szie.hu

CONTENTS

- Introduction
- Objectives
- Geometrical model scheme of flat plate and vacuum tube collectors
- Results
- Conclusion

BACKGROUND

Due to a different of geometry, under the same incoming radiation and the same incidence angle the two solar collectors showed many differences, like:

- different efficiency,
- useful area,
- reflected radiation.

Several reasons e.g. shape (active surface), convective heat loss and spectral sensitivity are different.

OBJECTIVES

- Analyze the developed geometrical model.

- Determine the active surface for separately flat plate and vacuum tube collector under different incoming radiation.

- To get a know-how about the differences of each type of collector operation.

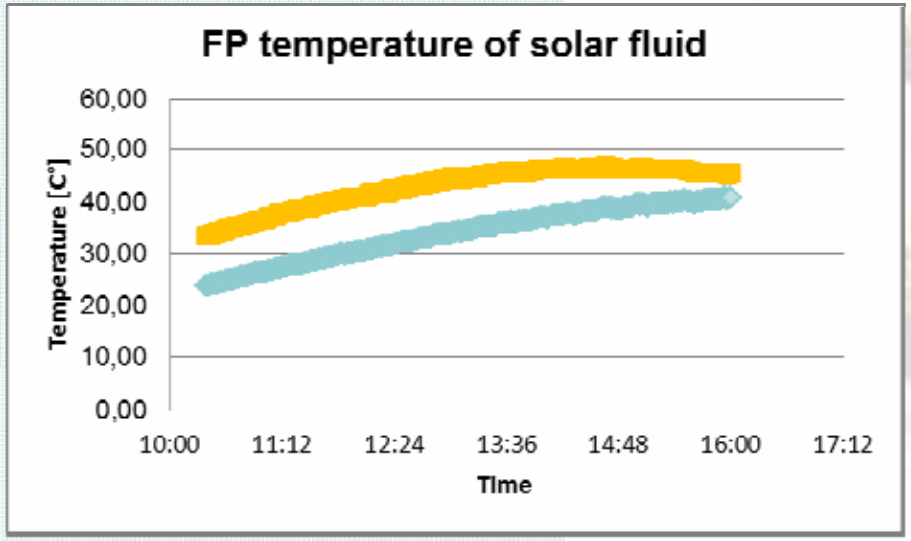
The equipment

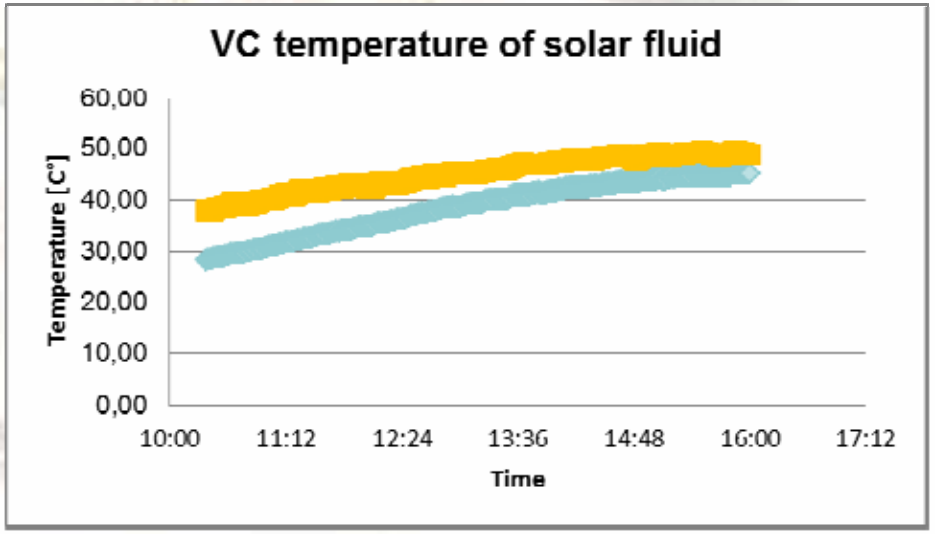
Measured parameters:

- temperature of inlet and outlet solar fluid,
- solar liquid volume flow rate,
- solar radiation,
- environmental temperature.

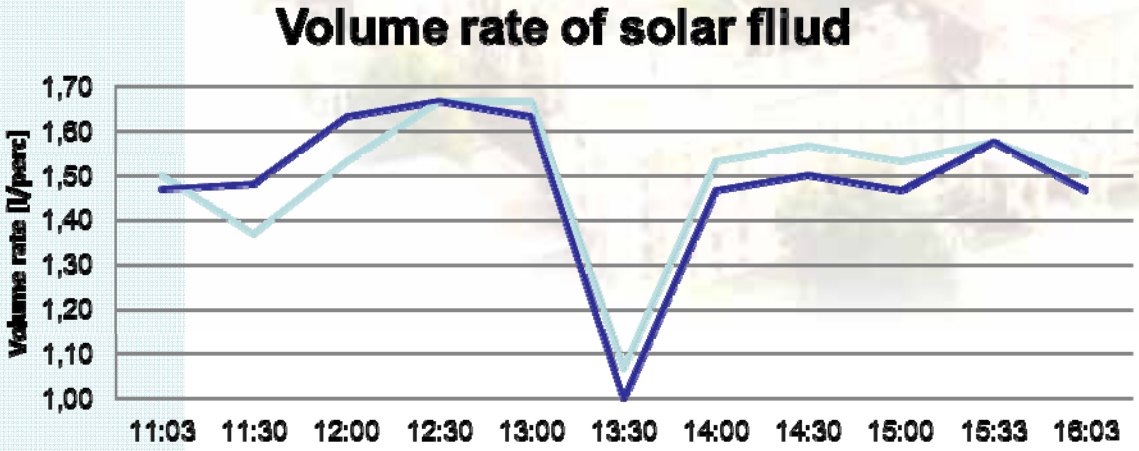
Measuring system

- Temperature of outlet and inlet solar fluid (Pt1000 platinum ohm temperature sensor)





- Volume rate of solar fluid (Zenner Zelsius)



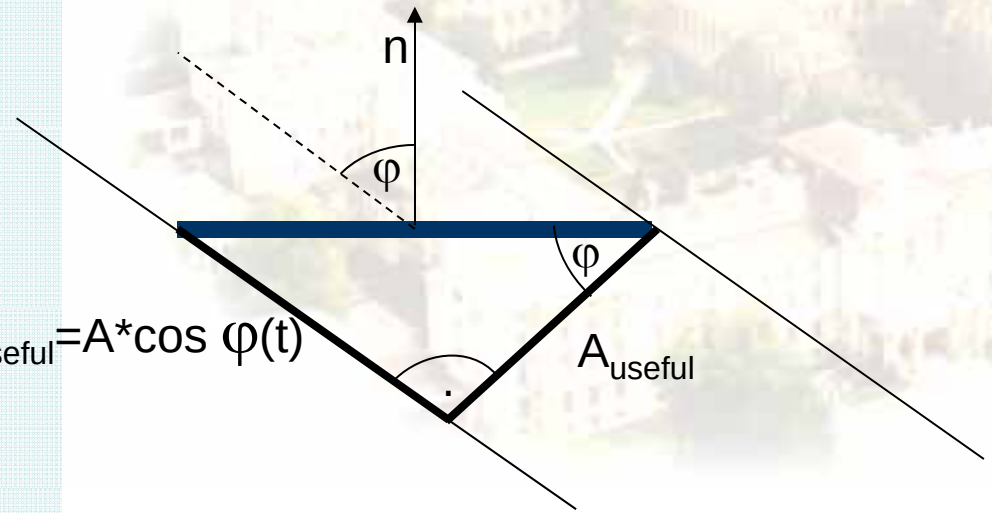
- Incoming radiation (Kypp & Zonen piranometer)

Geometrical model

Based on results of spectral measurement the geometrical model was improved with the angle dependence of the absorption at the different parts of the active surface to determine the daily incoming radiation.

The calculation is presented on all-glass evacuated tube solar collector and also on flat plate solar collector.

a.) Flat plate collector

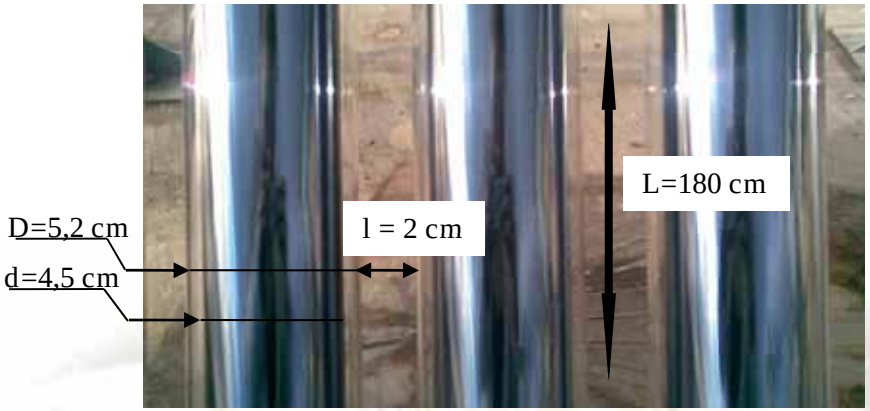


φ : the angle between the beam radiation on a surface and the normal to the surface

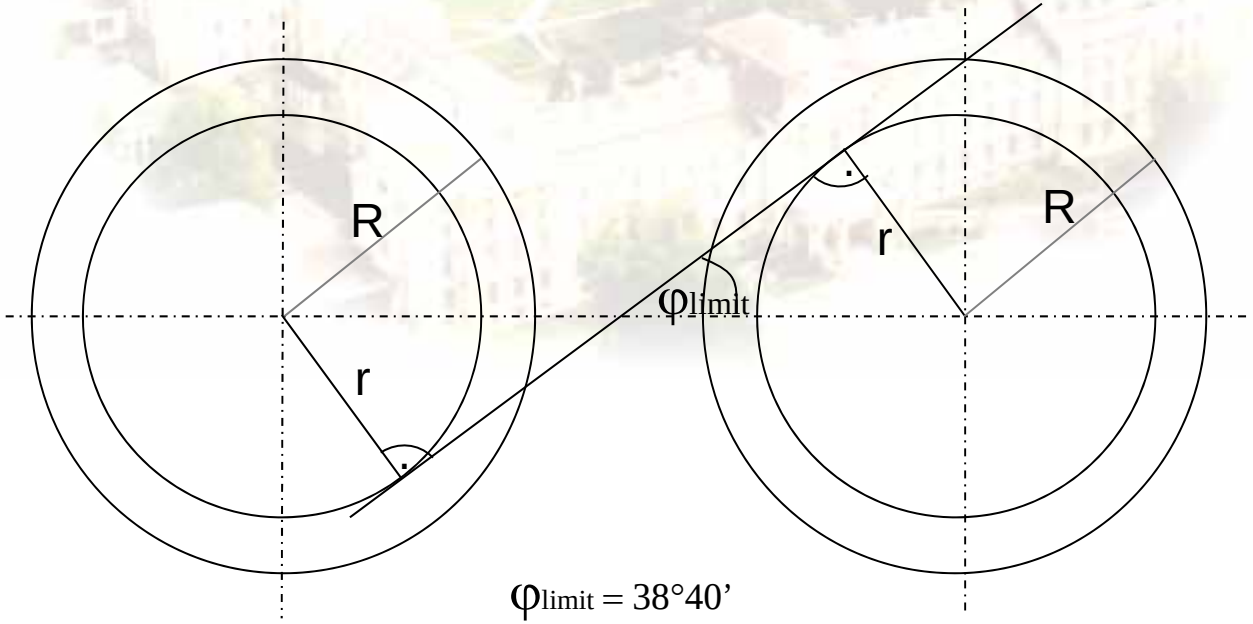
The rate of absorbed radiation is principally depends on the angle of incident radiation.

b.) Vacuum tube collector

Parameters:
D: glass tube diameter, cm
d: absorber tube diameter, cm
l: distance between tubes, cm
L: length of tube, cm



Scheme of vacuum tubes

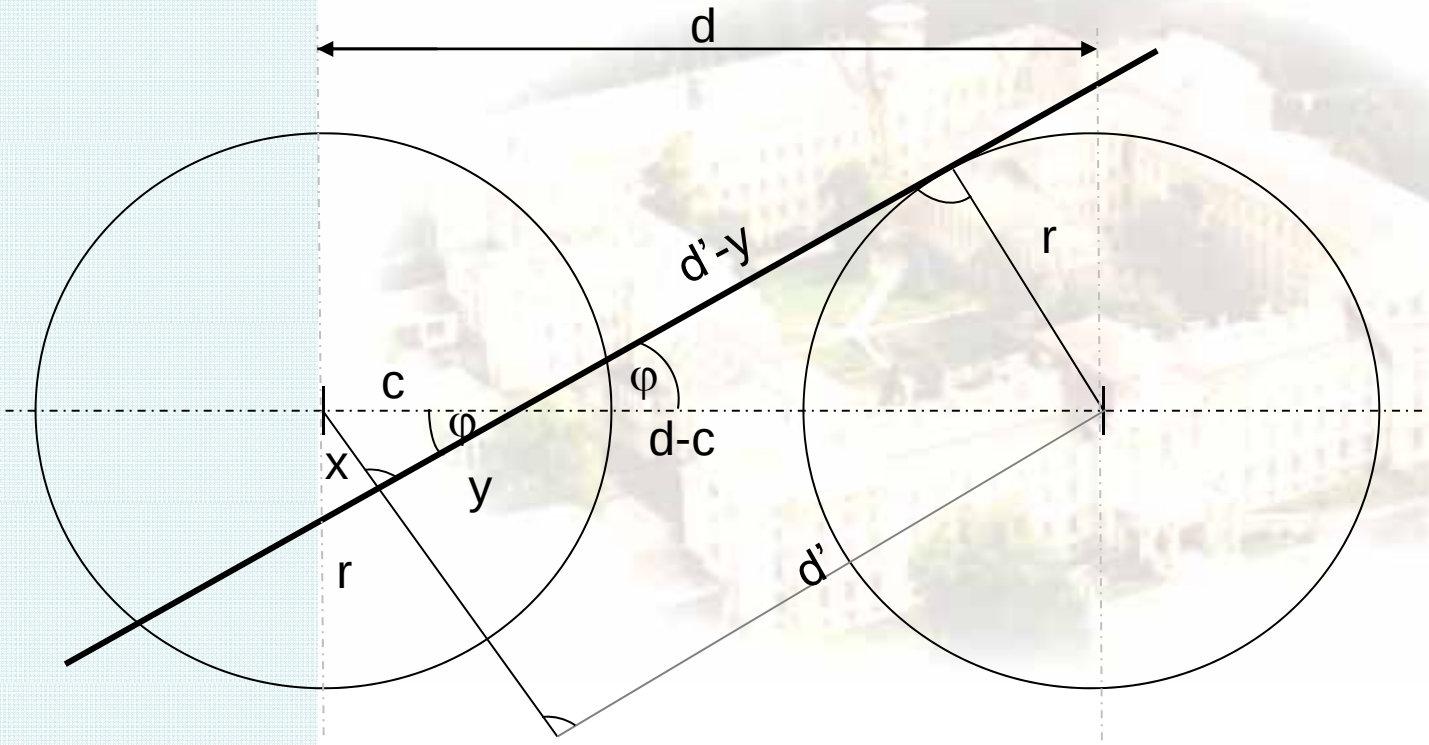


Determine **limit angle (φ)** of the incoming light which passes between two tubes

$\varphi_{limit} = 38°40'$

Shading effect

When the incoming radiation angle is lower than limit angle ($\varphi < \varphi_o$) there will be appear an overshadow from one tube to the neighbor.

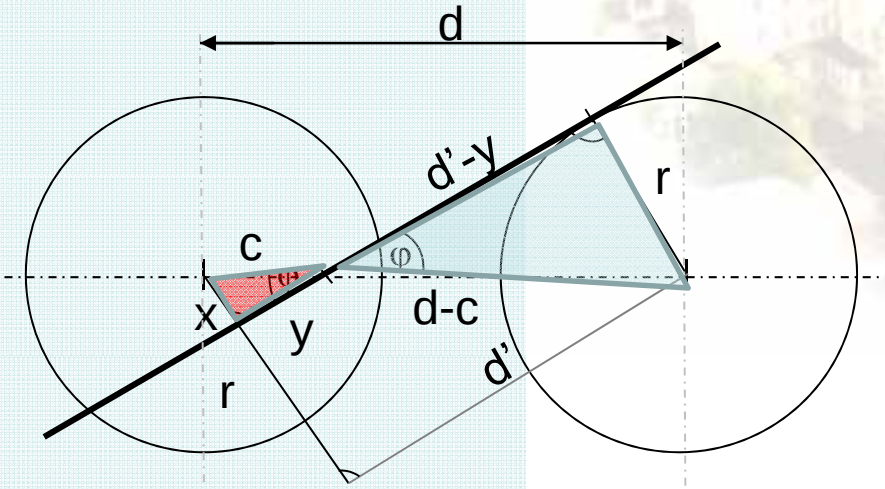


Sets of equations:

I. $$tg\,\varphi = \frac{x}{y}$$

II. $$\cos\,\varphi = \frac{d'-y}{d-c}$$

III. $$tg\,\varphi = \frac{r}{d-c}$$



$$y = d - \frac{r}{tg\varphi}$$

$$x = tg\varphi \cdot y$$

Measurment analysis

Used equations:

$$Q_{be} = I \cdot A_h \cdot t \; [J]$$

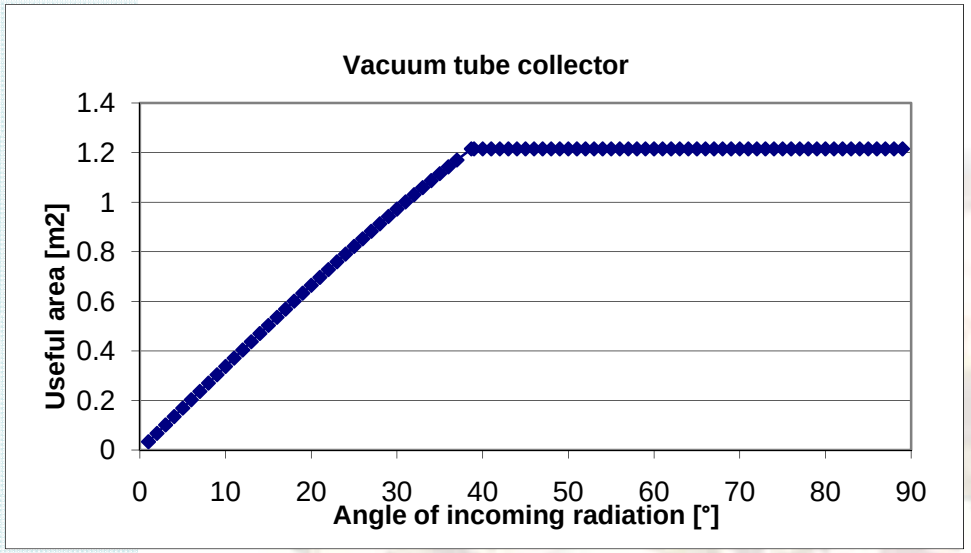
$$m_{szolár\ folyadék} = \rho \cdot \mathrm{V} = \rho \cdot \mathrm{q} \cdot \mathrm{t} \; [\mathrm{kg}]$$

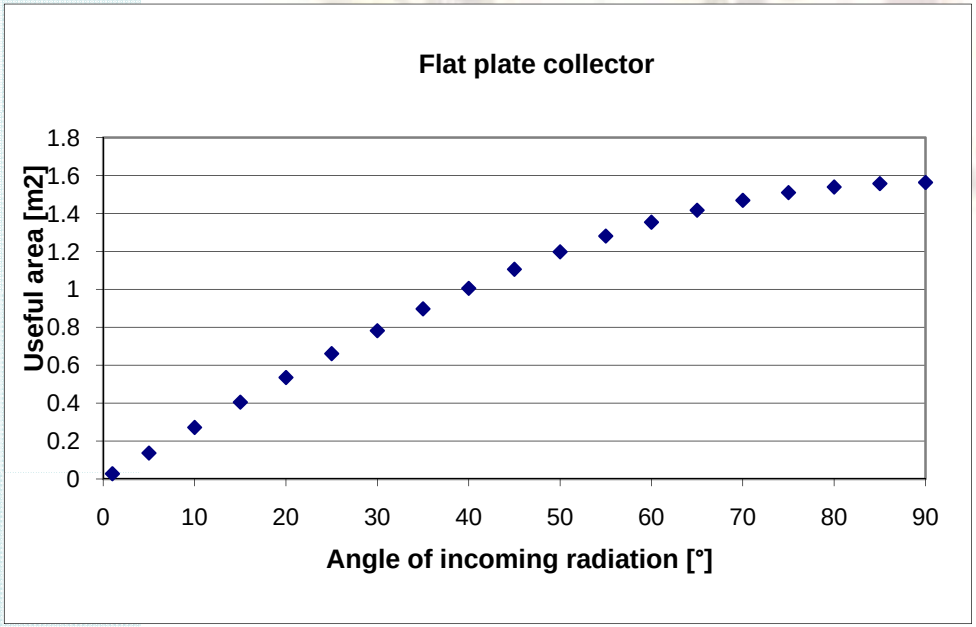
$$Q_{ki} = c_{szolár\ folyadék} \cdot m_{szolár\ folyadék} \cdot (t_{ki} - t_{be}) \; [\mathrm{J}]$$

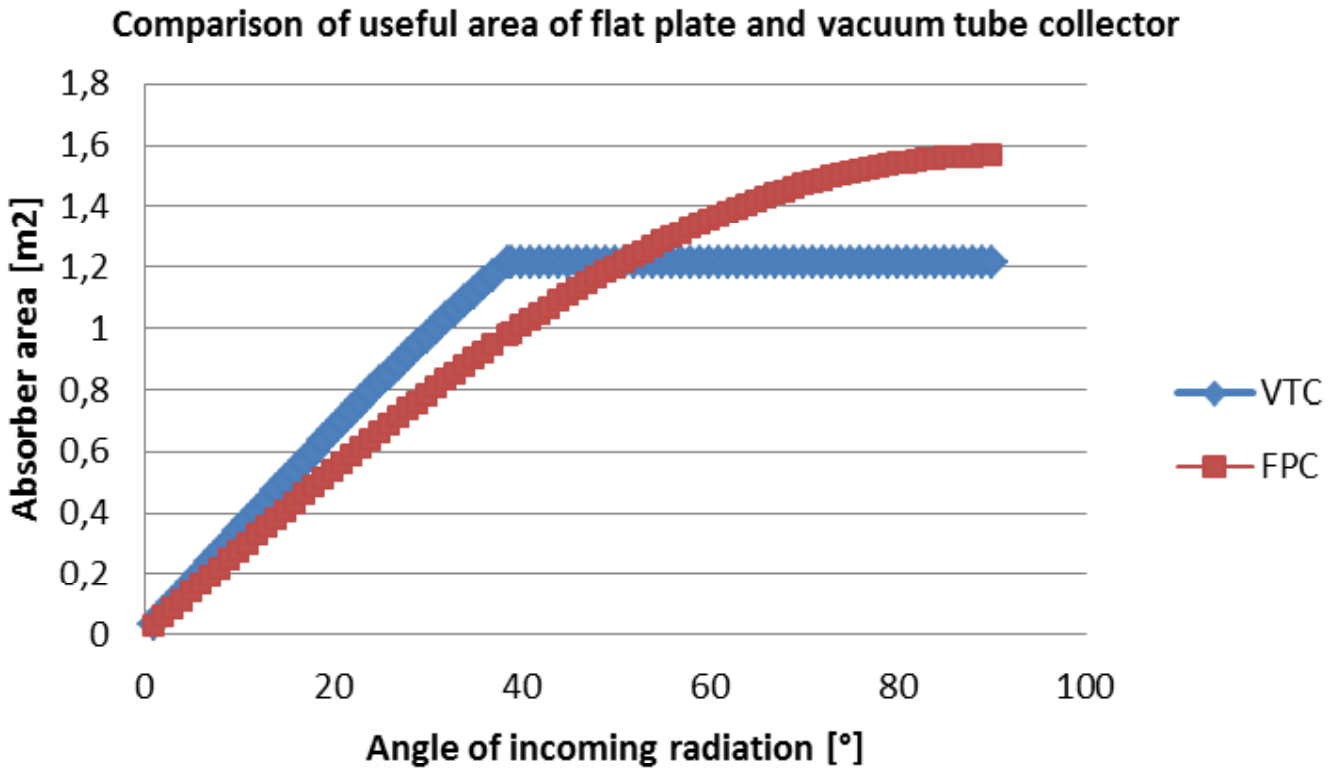
$$\eta = \frac{Q_{ki}}{Q_{be}}$$

Results

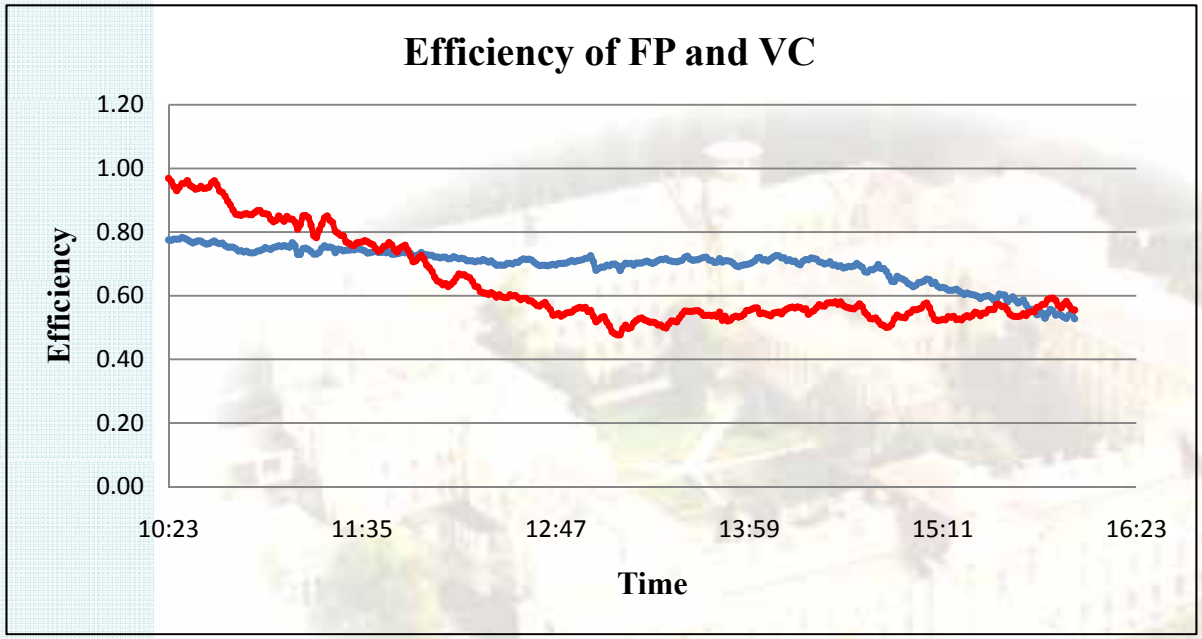
The useful area under different angle of incoming radiation on a horizontal plain surface






Comparison of useful area of flat plate and vacuum tube collector
Absorber area [m2]
1,8
1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
0
0
20
40
60
80
100
Angle of incoming radiation [°]
VTC
FPC

Result



Energy production (MJ/m2)		
	FP	VC
Time intervall (MJ)	21,014	14,944
Area (MJ/m^2)	13,470	12,351

CONCLUSION

•Based on such observation data analysis was elaborated for understanding the behavior of different technologies. Due to the discrepancy it can be concluded when the angle of incidence radiation is between 40-60° when ray of sunlight are lateral better used for vacuum tube collector then flat plate which active surface is bigger at near to the vertical rays (60-90°).

•In the future work it is planned to determine the rate of the reflected and absorbed power as a function of the incidnent angle.

Thank you for your attention!