Air heated solar collector usage for room heating

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Topics of Discussion

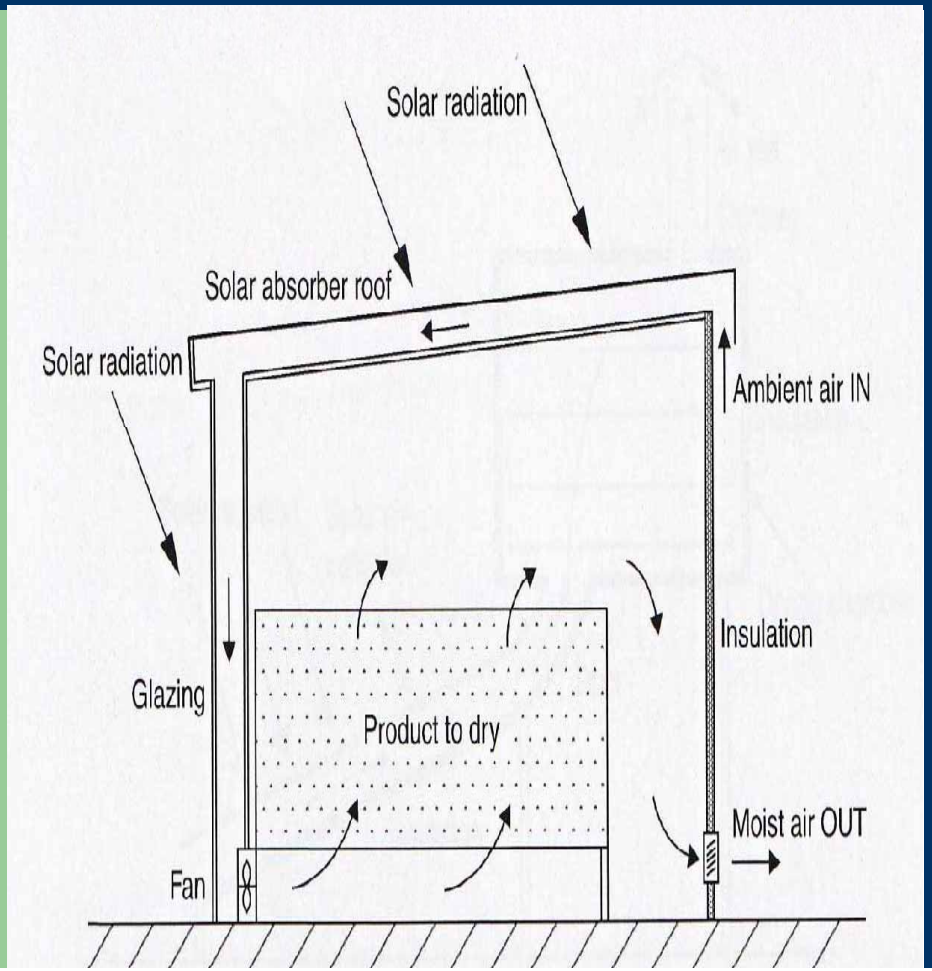
- Why solar air heating collector is necessary?
- Materials and methods
- Discussion and results
- Conclusion

Why solar air heating collector is necessary?

- The principles of energy resources are increasing
- The ways how to use alternative energy more widely are being explored
- The air heated this way is not toxic and electrically neutral
- Solar air heating collector efficiency is not high but it has simple construction and is cheap to make and operate (hand made)
- Solar air heating collector is good as extra heating device

Usage of solar air heating collector

Usage of solar air heating collector in drying

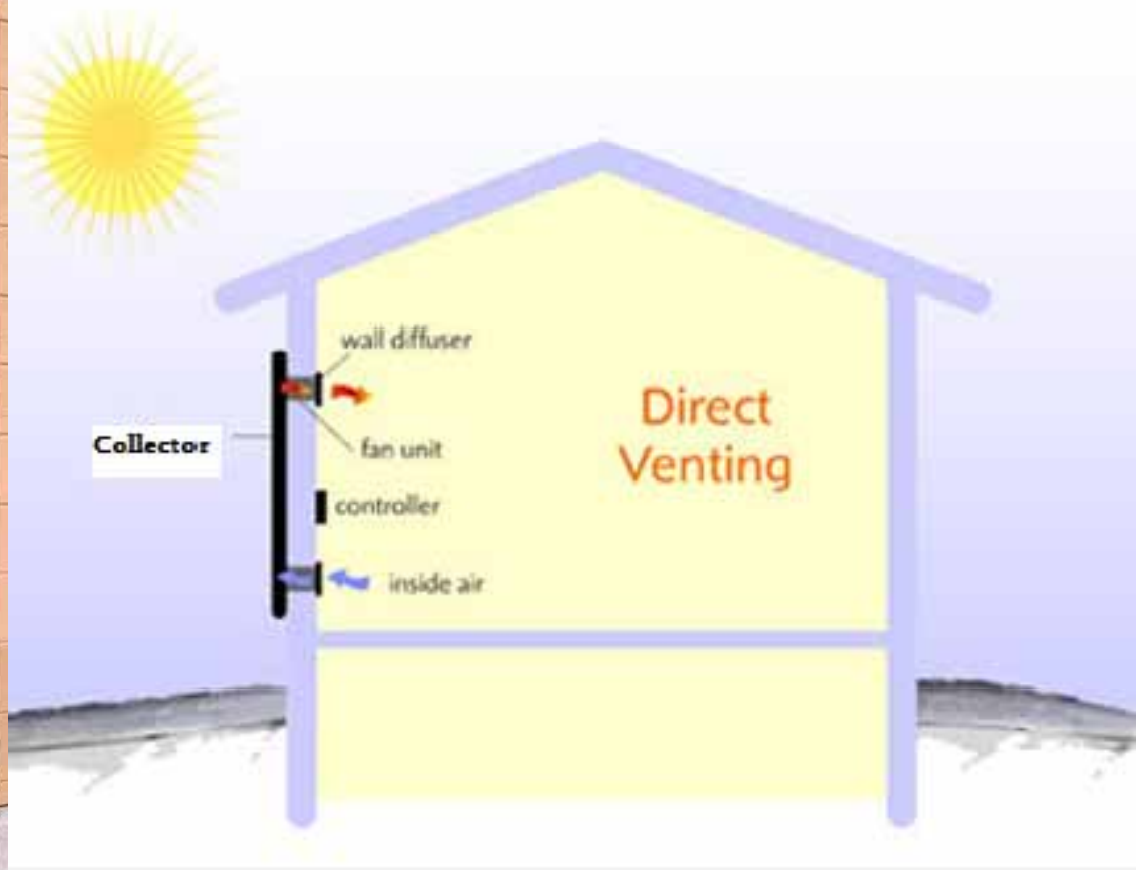


Usage of solar wall panel

For room ventilation with heated air

For agricultural applications

Schema of air heated solar collector usage for room heating



The aim of the research

The aim of our investigations was to compare three different absorber material uses and to make out their usability in sun air heating collectors for room heating.

We determined influence of sun radiation and sun’ s rays angle to air heating degree for those types of absorbers.

Materials and methods

- Solar radiation measuring instrument was the pyranometer
- In the laboratory a 0.1x0.5x1.0 meters long experimental solar collector was constructed for research
- In collector we used fan with power 100 $m^3 \cdot h^{-1}$. Air velocity at the experiments was v=0.9 $m \cdot s^{-1}$ and room space was approximately 80 m^3. Air is changing in room two times per hour.
- The experimental data were measured and recorded in the electronic equipment REG
- The experiments were carried out in September 2010 at the different weather conditions at different ambient air temperatures
- Our investigations devoted to the flat-plate collectors situated at wall in southward direction. Covered material of collectors was polystyrol plate. Covered material - polystyrol plate reduces sun radiation by 12-15 %

We compare different absorber materials:

●black coloured steal tinplate in a middle of collector

●black coloured energy drink cans on steal tinplate

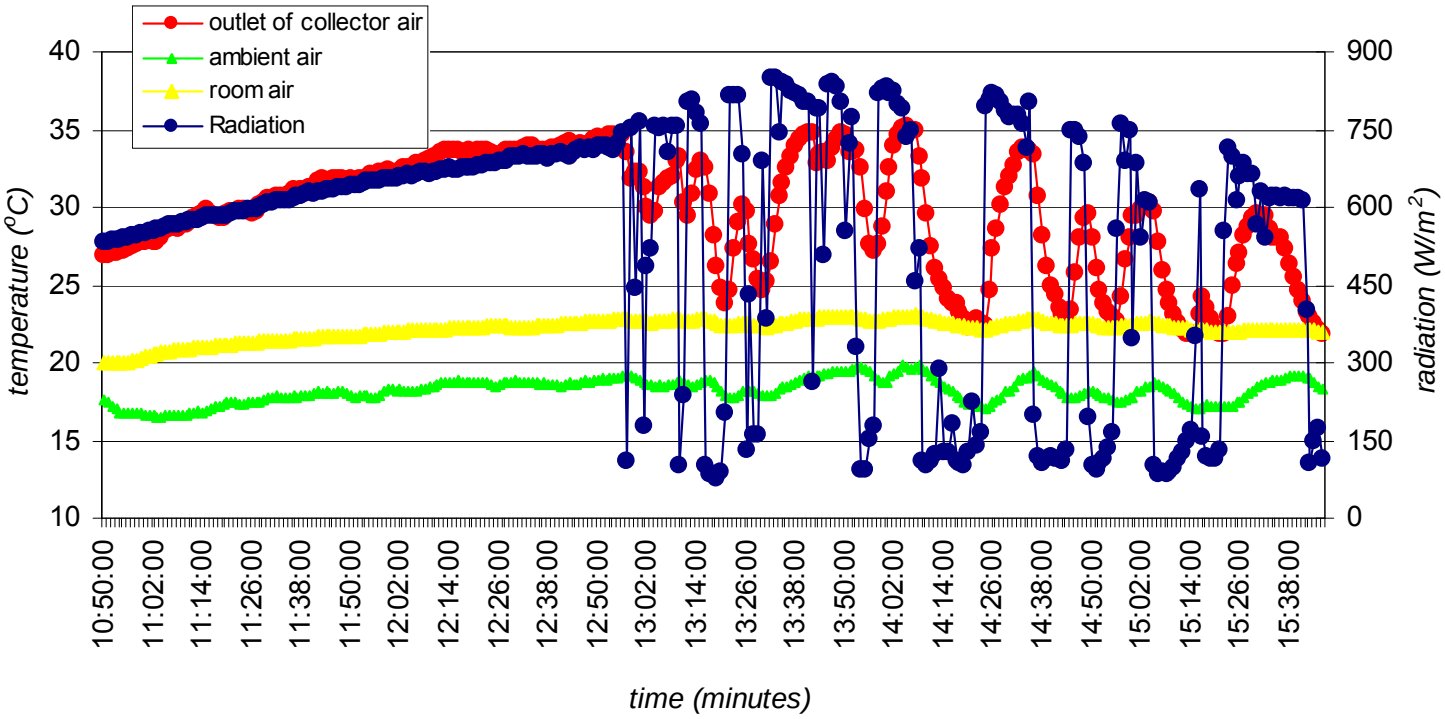
●7 seed boxes in line

Metering and recording equipment REG

Experimental data is recorded by means of an electronic metering and recording equipment of temperature, radiation and lighting REG. It is equipped with 16 temperature transducers and metering sensors of solar radiation and lighting.

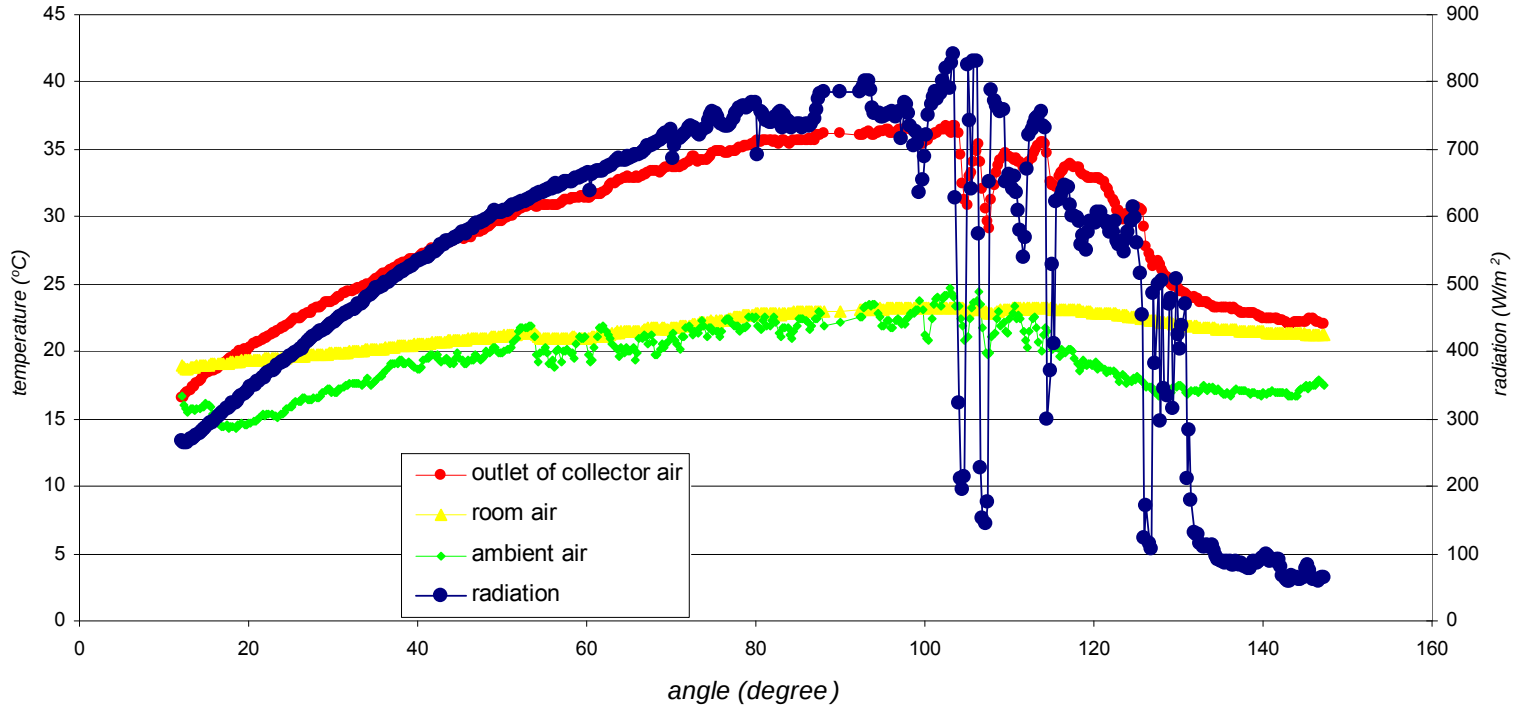
Discussion and results

Room air, ambient air and collector outlet air temperatures (absorber material - black coloured steel tinplate) comparing with sun radiation in time o'clock.



Experimental data show that, near little sun radiation are not visible constitutive air heating, but increasing sun radiation is growing air heating level. When radiation is smaller than 300 W/m² collector is not heating room air, because absorbent can not compensate heat loses in atmospheric temperature influence.

Room air, ambient air and collector outlet air temperatures (absorber material - black polypropylene seed boxes) comparing with sun radiation and horizontal irradiance angle of sun to collector surface.

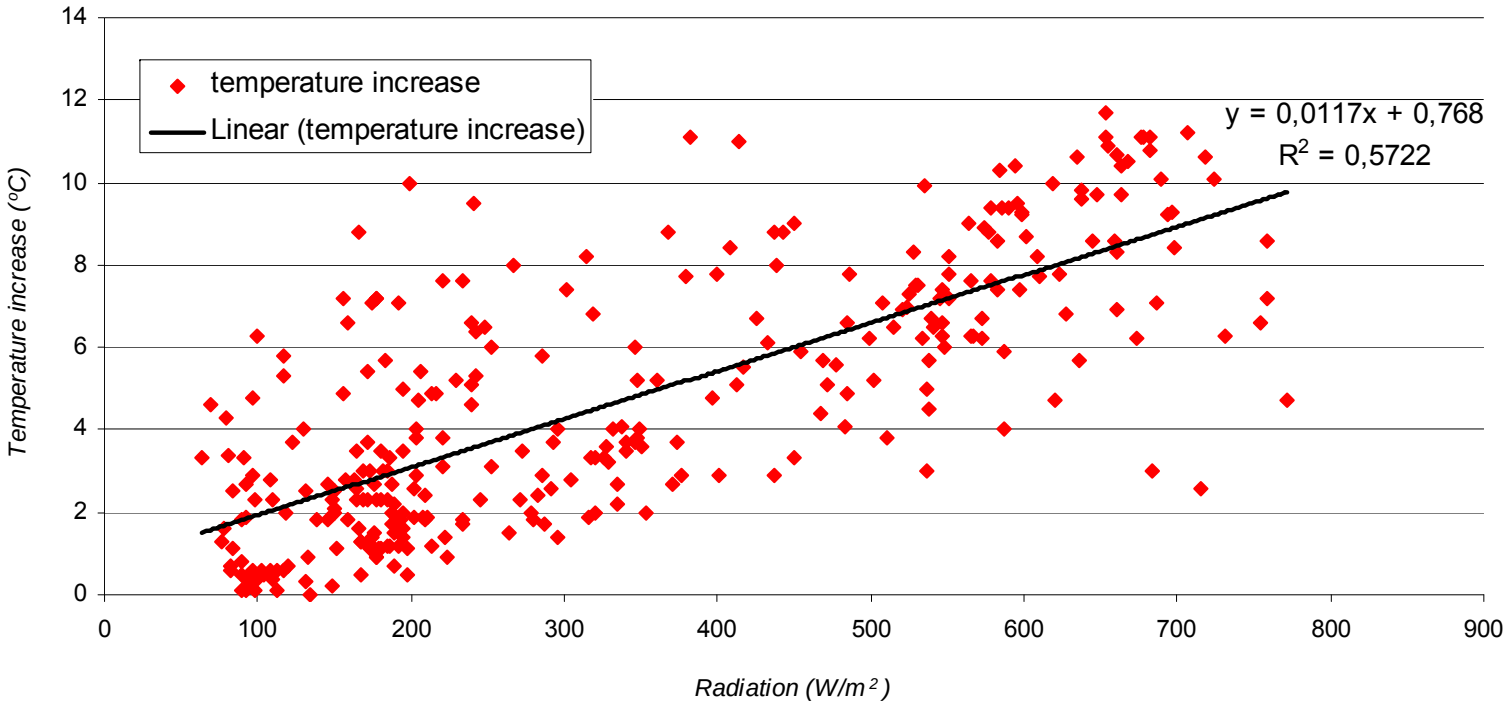


As you can see near little sun radiation are not visible constitutive air heating, but increasing sun radiation is growing air heating level and you can see that collector is heating air up to 12ºC.

We are interested...

We would like to know how sun radiation influence air heating level for stacionar collector. Radiation and air temperature increasing dependence is shown in next chart.

Temperature increase in outlet of collector (absorber steel-tinplate with cylinders of black coloured cans) comparing with sun radiation.

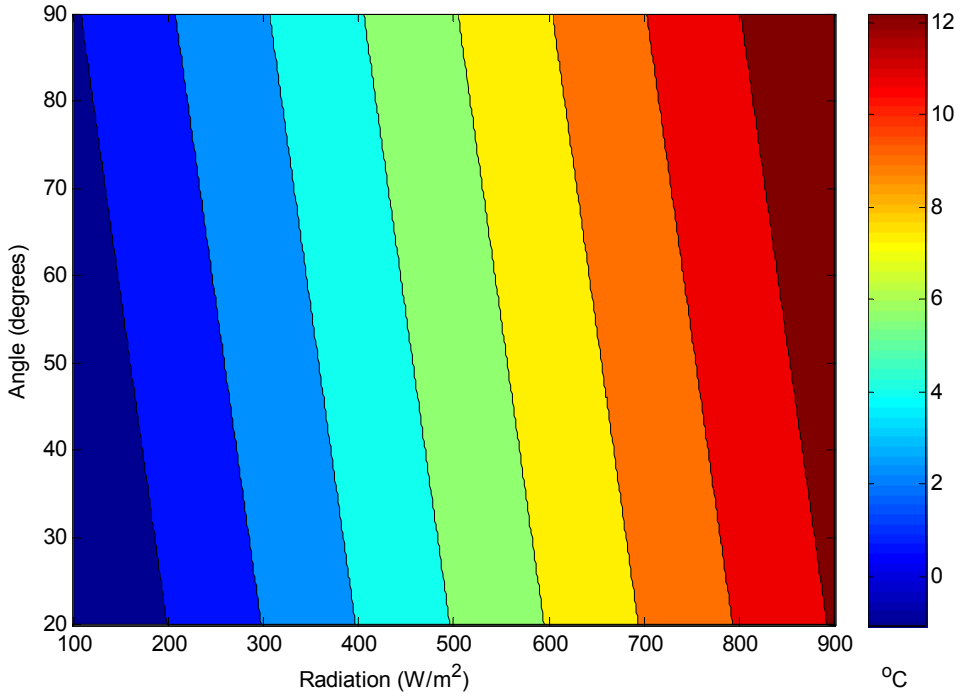


Large data dispersion shows that horizontal irradiance angle of sun to collector surface is giving influence to temperature increasing wich we ignored.

We determined influence of sun radiation and sun’ s rays angle to air heating degree for those types of absorbers.

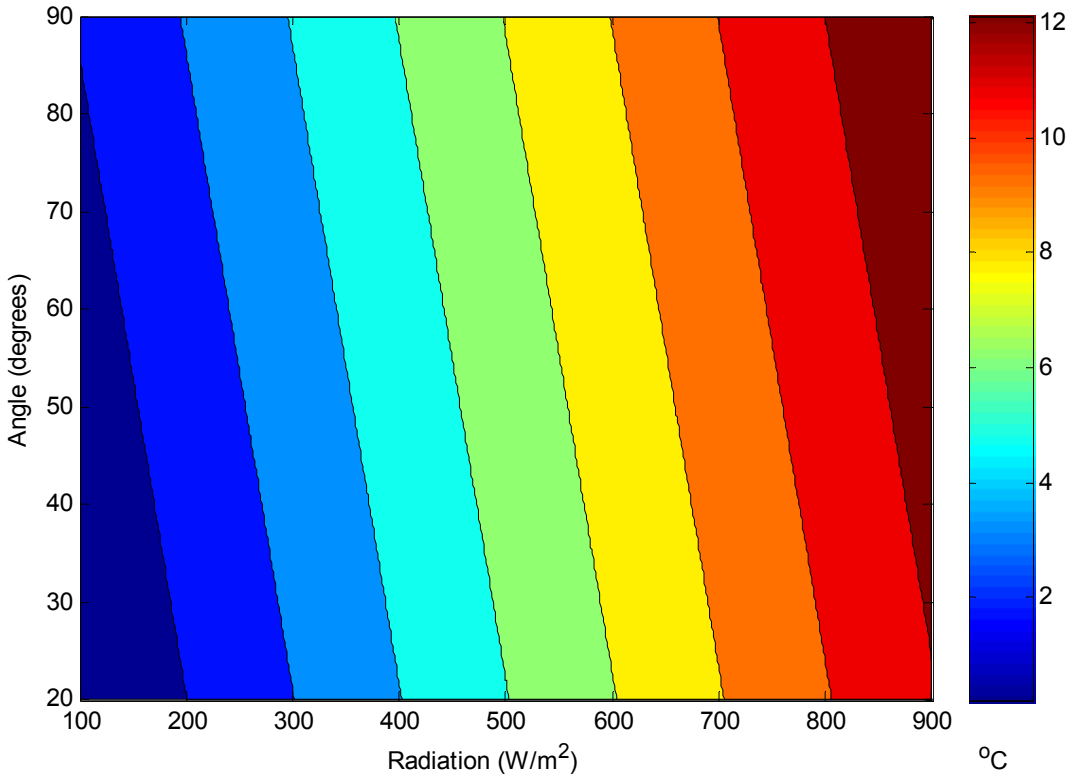
We want to find correlations that join sun radiation, horizontal irradiance angle of sun to collector surface and air heating degree. Using experimental results and statistical processing data we received connectedness between sun radiation, horizontal irradiance angle of sun to collector surface and air temperature exchange in outlet of collector. We determined these relations for 3 types of absorbers, with determination coefficient $\eta^2>0,7$ in 6 hour non-stop experimental time.

*Contour plot of air temperature increase ΔT depending on angle of sun and radiation of sun for collector with **black coloured steel tinplate as an absorber.***



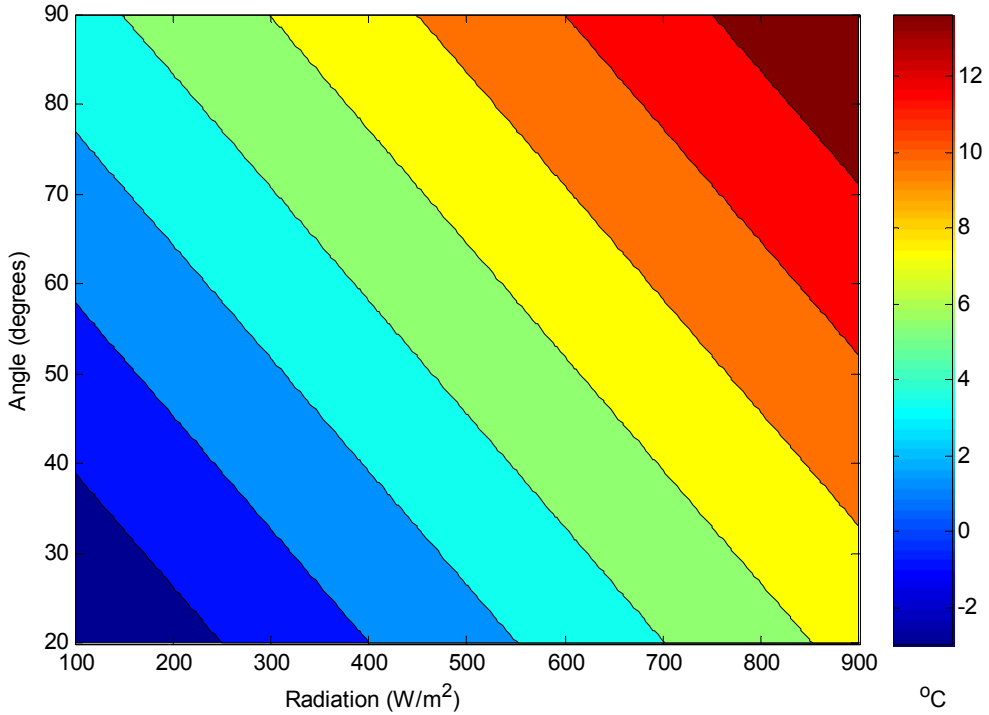
Contour plot of temperature growth of collector by average sun radiation 540 W/m^2, average room temperature 22,1ºC and average ambient air temperature 18,2 ºC during experimental time 6 hours.

Contour plot of air temperature increase ΔT depending on angle of sun and radiation of sun for collector with black steel tinplate with cylinders of black coloured cans as an absorber.



The average sun radiation 339 W/m^2, average room temperature 21ºC and average ambient air temperature 18 ºC during experiment.

Contour plot of air temperature increase ΔT depending on angle of sun and radiation of sun for collector with black polypropylene seed boxes as an absorber.



The average sun radiation was 523 W/m^2, average room temperature 21,6ºC and average ambient air temperature 19,4 ºC during experimental time 6 hours.

Some aspects and discussion

At experiments we can see that the solar radiation changes significantly affect the passing air temperature. This effect does not happen instantly, but with a delay of 3-5 minutes.

It should be noted that the un-insulated collector efficiency is highly influenced by wind speed, which cools the surface of the collector body.

Air heating level is not highly dependent on ambient temperature. Much more it is influenced by solar radiation and horizontal irradiance angle of sun to collector surface.

Because cans are placed side by side, the surface does not create shadow like with the black coloured steel tinplate, where the absorbent solar angle of incidence effect is small. Absorbent material (black polypropylene seed boxes) surface are with a deep relief and therefore part of the surface is shaded. It means that the solar angle of incidence affects the air heating level in collector.

Some aspects and discussion

Absorber material is one of the factors affecting the efficiency of the collector.

Our investigations showed that more effective FPC was collector with absorber black polypropylene seed boxes at middle of collector body. At favorable weather conditions the heating degree of the ambient air with absorber black polypropylene seed boxes reaches more than $\Delta T=13\ ^{o}C$ at the air velocity 0.9 m/sec.

We made correlation, with determination coefficient $\eta^2>0,7$ on average 6 hour non-stop experimental time for all types of absorbers.

Conclusions

- Sun's rays angle more affect collector effectiveness with absorber- black seed boxes, less when absorber was steel tinplate with cylinders of black colored energy drink cans.
- Admittedly, that useful such collectors use in room air heating is case, when sun radiation exceed 300 W/m^2 and sun's rays angle exceed 30°, otherwise ambient air temperature is cooling room air .
- Correlations have been obtained, which describes the sun angle of irradiance, solar radiation influence to the air heating level in a stationary solar collector. Coefficients at R and the sun flow angle of incidence α describe appropriate sorbent material and the relief effects on air warming.
- Seed boxes absorbent have a limited useful time for stationary collector - solar angle of incidence must be at least 50-55 degrees with a radiation more than 400W/m^2. Otherwise, collector work is not effective or it is cooling room air.
- Such absorbers can be used for air heating solar collectors in Latvia for room heating purposes at favorable weather conditions. Air heated solar collectors can be used as extra heating devices.

Thank you for your attention!