Application possibilities of solar air systems in context with growing importance of geo tourism

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Abstract
Contribution deals with innovative using of solar collectors, working with heating medium of air for application that present part of the subject of still increasing interest of publicity – tourism and all its branches – agro tourism, ecotourism, etc. Since society still more intensively perceives consequences of intensive penetration of man to the country and nature, subject technology of interior spaces heating can make yet more attractive tourism in country environment, as well as in protected areas. Goal of the contribution is to show not traditional forms of heat energy obtaining from air collectors according recycled materials.

Key words: solar air collectors, solar generator, solar energy, tourism, geo tourism, eco tourism

INTRODUCTION

In present, high energetically demanded period heating in households or in any other subject presents significant financial costs, therefore attention is given today to the development of such equipments with aim to minimize expenses for heating.

Solar air collectors that serve for heating of brought external air through solar energy should be proper solution not only for costs decreasing of energy consumption, but also for effectiveness increasing. Important task is also our country that exists in area with moderate climate, which still increases reliability of solar air collector effectiveness.

Main equipment in solar air systems, using solar energy through change on heat is solar air collector with heating medium – air. Except of others it is characterized by broad scale of service temperatures, simplicity of installation and low respectively null service costs and costs per maintenance. Therefore it can be used in area of heating, pre-heating of brought external air or drying of agricultural products. Due to its low costs it presents economically effective form of solar energy using, thanks to which it can be propagated mainly in country areas, where many of them are subject of the interest due to their character also in area of development of specific forms of tourism, as for example agro tourism, geo tourism, or eco tourism (Compľová, 2010; Čulková et al., 2012, Štrba & Kurtová, 2013).

CHARACTERISTICS OF AIR COLLECTORS

Heating medium of solar air collector systems means the air. Their main part

presents absorber, through which the air is flowing, intake by ventilator. Air collectors are very simple equipments that use solar energy for heating of brought fresh external air to the building. As for their volume they present small compact modular units. During their installation there are not necessary special spaces and distribution of the air do not demand any sized pipelines, which would be necessary to lead through common building construction.

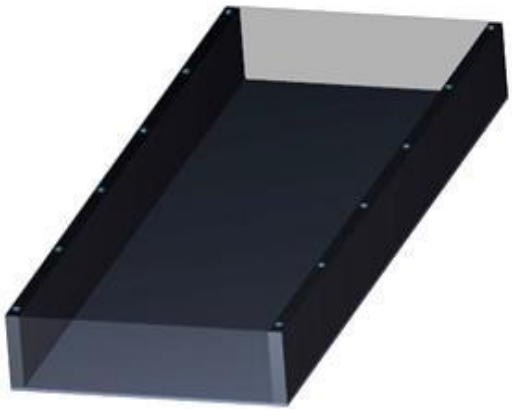

Fig. 1 3D visualization of collector model with transparent covering (Kristófová)

Main advantages of such equipments can be considered first of all quality control of the air, which means providing of hygienic demands. There is still provided flowing of the air and during proper suggested and sufficiently isolated housed as for the heat, collectors can fully replace warm-water heating system. Heating of brought external air by solar energy presents technology that removes and significantly simplify work of common heating system, and it saves finances and energy as well (Filleux & Guermann, 2006)

Air collectors can be divided according type of construction as follows (SolarWall, 2013):

- flat collectors with transparent covering
- flat collectors without transparent covering

and according way of production:

- standard, industrially produced collectors
- collectors constructed at the building

PRINCIPLE OF COLLECTOR´S ACTIVITY

Not covered broadcast air collectors work according principle of solar front, where one of the possible installations presents variant with smoothly perforated, covering, presenting at the same time external coat from structured absorption metallic plate.

Principle of front collector activity means heating of absorber consisted either from dark painted aluminum metallic plate through solar radiance. By managed suction through ventilator there is rising negative pressure in the air cavity between absorber and wall of the building and such pressure causes suction of external air, heated during transition through perforation. Consequently heated ascending air from air cavity is suctioned and connected to the ventilation´s equipment of the building. By the way of small technical changes additional hole can be produced in upper part of back ventilation, providing suction of overheated air during summer months. Functional scheme of collector Solarwall is illustrated at Fig. 2.

USING OF SOLAR COLLECTORS

Solar air collectors have numbers of possible using and applications. It can be solar process of drying of produces, as for example tobacco and nuts, through solar heating and ventilation of fresh air for industrial, commercial, institutional and residential buildings (Matuška, 2013)

It means mainly following applications:

- **ventilation** – it presents preheating of fresh ventilated air, brought to the internal spaces. During summer period solar ventilation systems have limited using. Ventilation is important mainly due to the hygienic. Basic principle of ventilation is change of used and fresh brought air in the rooms.
- **heating** – it means heating of circulated heated air, brought directly to the space, or the air, imparting the

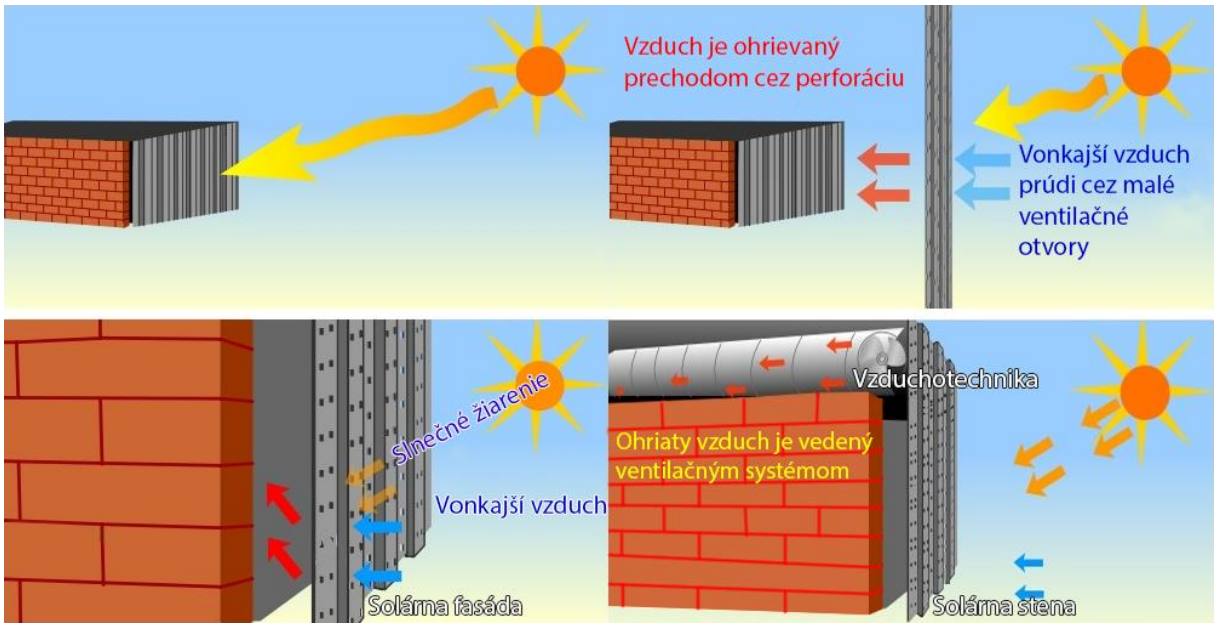

Fig. 2 Functional scheme of collector (SolarWall, 2013)

heat to the accumulated material of building construction (hypo caustic systems). Heating can provide heating of the room to the demanded level. It presents closed heating system and therefore ventilation of the room must be separated.

- **drying** – heating of the external air due to the increasing of intensity of density draft from dried material, for example drying of wood, produces, etc.
- **summer cooling** – during summer months tendency is growing of heat till hot days appearance. Solar / summer cooling presents technology with number of variants that are existing due to the existence of various elements, which can be used during interception of solar heat, heating managed process of cooling and its supplementation to the system (Teplická & Taušová, 2012)

MULTI RESIDENTIAL BUILDINGS AND HOTELS

Greatest attention is demanded for spaces in residential and accommodation units (hotels, pensions, centers for seniors, etc.) that must be permanently ventilated during providing of heat comfort. Heating of the air by convention tools is very expensive that is reason why those objects are proper of heating and cooling by solar air panels in new or reconstructed buildings. Except of others solar panels can act also as anti rain screen.

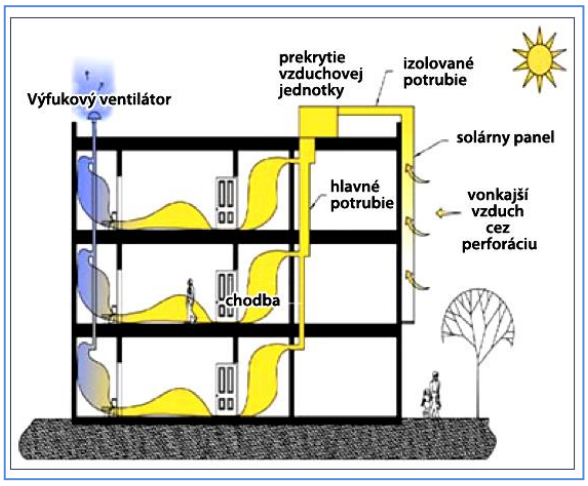

Fig. 3 Application of solar air panel for multi residential building

External air is coming to the air collector through perforation, where it is heated and flowing through isolated and main pipeline to main part of any flat. Not used or

"redundant" air is led away by exhaust ventilator. Many times low quality of the air in working space presents main underestimated reason of sicknesses rising. One of the possible solving can be solar air collectors that decrease also negative impact during not controlled entrance of external air to the building. Mainly such entrance of the air causes increasing of heating costs. This problem is solved by solar air collectors that use solar energy for preheating of brought fresh air. Schematic process of heating of brought cool air during winter is illustrated at Fig. 4.

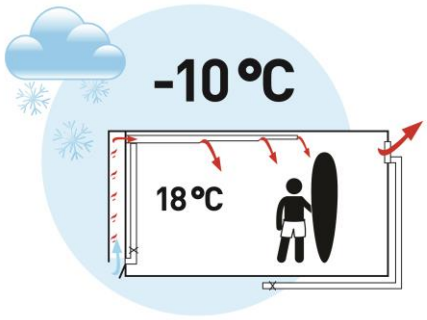

Fig. 4 Winter service of not transparent air collector

During summer cooling is made in preventive draft of redundant solar radiance from such side of building that is orientated to the south. Warm air is drawing by ventilation drafting from the space between collector and roof of the building and by this way there is raising vacuum that enables automatic suction of fresh and cooled air from northern side through proper pipeline (Fig. 5).

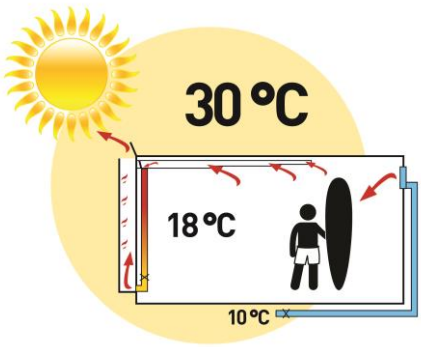

Fig. 5 Summer service of not transparent air collector

DEVELOPMENT OF SOLAR AIR COLLECTOR ACCORDING RECYCLED PLASTIC MATERIALS

In present time there is running research at the Laboratory of renewable energy sources, Faculty BERG, TU Košice, connected with project, orientated to the development of low costly solar air collector. Prototype of collector must fill demands of material specification, which means collector must consists from recycled plastic material. According observance of this demand also next demand is filled, mainly demand of low cost, since it presents material that is commonly available in present time for considerably lower costs.

Fig. 6 Connection of collectors to the air-conditioning unit (Hovorka)

Constructed suggestions of solar air collector´s prototypes are welded and screwed and they are presently tested. They are connected to the air technique unit (Fig. 6).

Heated air from collectors flows in galvanized pipelines, which area isolated by flexi tube with circle average Ø 20 and 25 cm. Managing unit works in two circle phases. At first phase warm air is intake to the spaces of RES laboratory in Košice and at second phase managing unit serves only for measurement of searching parameters, which means the air is launched to the exterior without its utilization. Through such phases we can compare measured and obtained parameters not only in air technique unit, but also in its individual parts.

Simulation program had been developed due to the orientation suggestion of solar air collector in the frame of VUKONZE project.

PROGRAM FOR SUGGESTION OF AIR COLLECTORS

Due to the simulation of service characteristics of solar air module collectors, such as overflow of the air, air buoyancy, temperature of the air and possibility of consequent analysis, we suggested variants of situations, from which unique dependences among input – output results. Suggested variants should to make easy for interested one, as well as for designer, modeling of solar air collector.

Type 1 presents situation, when interested person demands certain temperature of the air, ascending from solar system and at the same time he knows volume of the space, proper for installation. According mentioned data program would calculate mass overflow during various variants of solar system, meanwhile it would determine for any variant also dimensions of the individual solar air collector and their number. According such data investor can decide about the system that is proper for his demands.

Table processor MS Excel had been used for elaboration, simulation and presentation of input and output values, since it enables transparent calculations.

Following we will mention situation, when client demands resulting temperature of the air 30 °C during input temperature 10 °C and dimensions of space for installation are 5m height and 10m width.

Table 1 mentions calculation with emphasize of data, given by designer according input data from client and parameters of solar air collector prototypes.

From the table of resulting values we can see that client can decide according output overflow of the air, meanwhile during final decision he can consider for example maximal carrying capacity of front that would cause limitation of collector´s depth, or number of collectors for some variant of solar air collector.

CONCLUSION

Running measurement of prototype of solar air collector confirmed assumed great potential of subject technology during number of applications. High demands, given to the quality of ventilation air in accommodation and catering establishments give assumption for extending of such technology also at organizations, orientated to the tourism in Slovakia. Submitted values can be considered as important factor during suggestion of other prototypes and finally also for improving of construction elements and service characteristics. Due to the low investment costs of solar air collectors, consisted mainly from recycled materials, except transparent coverings, they can achieve comparable effectiveness with commercially available equipments.

Acknowledgement
"This publication is the result of the Project implementation: Research centre for efficient integration of the renewable energy sources, ITMS: 26220220064 supported by the Research & Development Operational Programme funded by the ERDF."

"We support research activities in Slovakia / Project is co-financed by the EU."

Tab. 1 Calculation of parameters for solar air systém

data entered with designer
data obtained customer

Description of the input parameters	Description	Unit	Value
input temerature	**T1**	°c	20
input temerature	**T1**	K	293,00
output temerature	**T2**	°c	30
output temerature	**T2**	K	303,00
Size of the area to install		m^2	21,00
Width of area		m	1,00
Height of the area		m	21,00
The flow area width			0,94
Installation width of the collector		m	1,06
flow width of the collector	**b**	m	1,00
lenght of the collector	**l**	m	20,00
collector thickness = height of an expansion column	**a**	m	0,10
Number of collectors		ks	0,94
Flow width of collector area		m	0,94
air density at Tťaž	**ρťaž**	$kg.m^{-3}$	1,23
acceleration due to gravity	**g**	$m.s^{-2}$	9,81
resistance coefficient for thickness expansion. columr	**Z**	-	2,00

results of calculations			
Description of calculation	**Description**	**Unit**	**Value**
effective buoyancy	**Δp**	Pa	2,02865
air velocity	**w**	$m.s^{-1}$	1,28656
flow rate per collector	**V**	$m^3.s^{-1}$	0,12137
mass flow rate per collector	**M**	$kg.s^{-1}$	0,14876
The total flow rate	**Vcelk**	$m^3.s^{-1}$	0,11
The total mass flow rate	**Mcelk**	$kg.s^{-1}$	0,14

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