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ECO-QUALITY APPROACHE TO THE MOST COMMON MATERIALS BUILT IN THE SOLAR HOUSES

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Abstract. *In this paper the influence of some building materials which are most commonly built in the monolitisation of the solar house heat storages is treated from the Eco-quality aspect. The ambiental air Eco-quality of the solar house directly depends on the building materials built in the heat storage. The special accent is given to the indoor environment Eco-quality from the radiation aspect. From this point of the view, the main influence on the indoor environment air quality has the gas radon (^{222}Rn).*
In the design of the solar houses heat storages the most common building materials are: concrete, stone, sand and brick. These materials were specially observed in this paper. The contents of the natural radionuclides and the total equivalent radioactivity in these materials. The knowledge of contents of the natural radionuclides and total equivalent radioactivity in these building materials are not of meritore factors for architect by decision to choice the ″health″ materials. According the ICRP and UNSCEAR recommendations, the Eco-quality of the solar house indoor air is defined.

Key words: *Solar house, heat storage, building materials, Eco-quality, natural radiation, gas radon.*

LOW TEMPERATURE SOLAR ENERGY HEAT STORAGES

Solar energy is a time dependant energy source. The success of its application is reflected trough the efficiency factor of its useful accumulation and its adequate conversion. The designers decision on the location of the heat storage, which may be placed on the house, in the house or out of it, is dependant on the season sun rays amount, heat demands of the house as well as applied system. In the passive made architecture, the attempt should be

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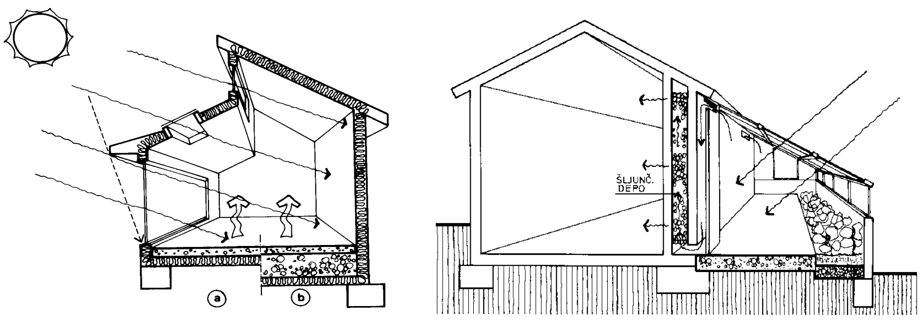
made to store solar energy by the massive elements of the house, such as facade wall panels, floor and inter floor construction, water containers, stone storage etc.

The thermoaccumulative mass should be directly exposed to the sunrays so that it can maximally accumulate incoming heat and in the some time present overheating of the indoor environment. In the design phase the attempt should be made to make the accumulative elements which are not too massive (in thickness) but have the maximal absorptive surfaces. The thermoaccumulativity of indoor environment will depend on the tone of the inner surfaces color. Schematic review of the basically principle of the solar energy holding from building is represented on the figures 1a and 1b). The principe of the solar energy holding by ″floor accumulate″ and heat energy (heated air) keeping by thermoreflective glass membranes using are shown on the figure 1a. The principe of the indirect accumulation of the solar heat by the heat air passing through the adequate thermoaccumulative medium (granulated pebbles) is given on the figure 1b.



(a) (b)

Fig. 1 . The variant of the hold and accumulation of the solar energy from object.

THE CHOICE OF THE BUILDING MATERIALS AS HEATING MEDIUMS FROM THE RADIATION ASPECT

The stone aggregate, concrete, bricks and even sands are the solid materials which are usually used as the medium of the accumulation in the heat storage they must be correctly situated in the space which should be heated and it must be protected from all possible polluters which could destroy its designed capacity and Eco-quality so that the heat storage could coexist with all other elements of the solar house. Figure 2. represents shematical two solutions of the space architecture design organization and indoor air circulation system.

From this point of the view, it is very important to determine indoor air Eco-quality from the radiation aspect. Namely, to the long live of the physical and chemical parameters, that determine the indoor air quality, one important aspect - the radiation was associated in the last ten years. The ionizing radiation level, that comes from radon and its short-lived daughters, is in the indoor air even 10 times higher than outdoors. On the other hand, from the point of the statistic, the modern man spends more than 75% of his lifetime indoors (Moschandreus, 1981).

There are different ways in which radon enters indoor spaces, but the most common are: the convection from the soil under the buildings and diffusion from the building materials. The main radon source in the houses in the USA is the soil under the house, while in European houses that is the incorporated building materials.

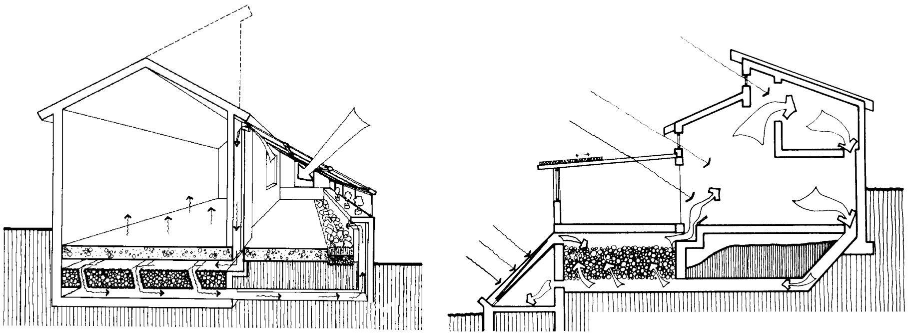


Fig. 2. Integral connection between thermoacumulative medium, heat storage and indoor air spaces.

The parameter, that significantly determines radon level, is its activity concentration. Average indoor radon concentrations range over more than two orders of magnitude, largely because of variability in the rate at which radon enters from building materials or soil. Since it is impossible to influence the natural soil structure, the incorporated building materials remain the main factor, that determines future indoor air Eco-quality.

Table 1. The specific and total equivalent activity of the heat storage building materials.

N^o. Type of material	Specific activity [Bq/kg]				Ref.
	^{226}Ra	^{232}Th	^{40}K	Ra - eq	
1. Portland cement	61	25	263	117	[1]
2. Cement	49	17	238	92	[6]
3. Cement (Sweden)	55	47	241	137	[4]
4. Cement (Hong Kong)	36	20	205	80	[8]
5. Cement (Finland)	44	26	241	98	[4]
6. Brick (G. Britain)	52	44	703	170	[4]
7. Brick (Finland)	78	62	962	241	[4]
8. Slag concrete (Hungary)	111	30	185	166	[7]
9. Cement mortar	5	8	152	28	[1]
10. Sand (from Duane)	9	10	292	46	[1]
11. Quartz sand	6.1	3.7	87	18	[6]
12. Massive brick (Varadin)	30	43	670	143	[1]
13. Silicate brick	15	4	333	48	[4]
14. Red brick	42	54	770	179	[1]
15. Red brick (Hungary)	44	52	592	162	[7]
16. Red brick (Hong Kong)	78	100	624	269	[8]
17. Red brick (Norway)	63	74	1136	257	[5]
18. Block hollow brick	47	57	620	176	[1]

The building materials, that contain higher natural radionuclides concentration, unavoidable lead to the reduction of the Eco-quality of the monolitised heat storage. That is specially noticeable in the winter period, when the solar house owner, because of the accumulated heat energy keeping, does not make enough indoor air ventilation rates. The increasing of the ventilation loads to the exponential decrease of the radon concentration, what rises the indoor air Eco-quality.

The contents of natural radionuclides in the most common for heat storages building materials, as well as their total equivalent radioactivity are given in the Table 1.

On the ICRP (International Commission on Radiation Protection), recommendations the values for Ra-eq (the last column in the table 1) should not exceed 400 Bq/kg. In the building materials listed in Table 1, the most important are the concentrations of radium ^{226}Ra whose direct decay product is radon ^{222}Rn. The radon concentration in observed indoor environment is the main factor that defines the indoor air Eco-quality.

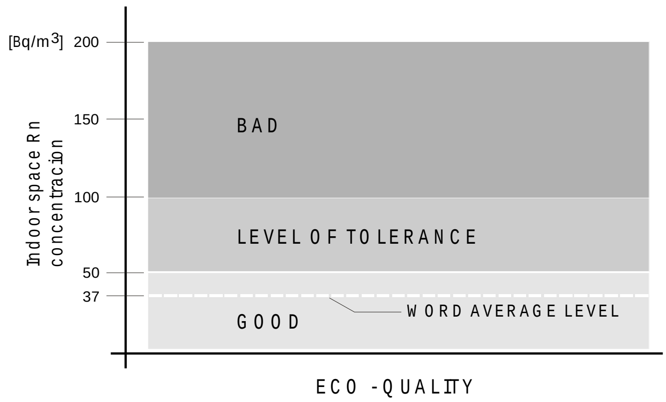


Fig. 3. Determination of the indoor Eco-quality in the function of the Rn concentration.

It should be noted that the average indoor radon concentration (for the whole world) is 37 Bq/m^3, (UNSCEAR, 1977) but the greatest part of the builded objects (above 90%) has the radon concentration up to 50 Bq/m^3. The Figure 3, can be used for quick approximate determination of the Eco-quality of the solar houses air in relation to radiation effect. The values on the ordinate are the recommendations on ICRP and UNSCEAR.

CONCLUSION

In order to preserve good Eco-quality of the solar houses, it is necessary to make ceartful choice of the building materials that incorporate in the heat storage, from the aspect of their specific radiation. Before a built-in, it is necessary to determine the contents of natural radionuclides in building materials and, if it is possible, incorporate only these that have good Eco-quality.

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EKO KVALITET TOPLOTNIH DEPOA U ZAVISNOSTI OD PRIMENE VRSTE GRAĐEVINSKIH MATERIJALA

Dragan J. Gavrilović, Dušica Vučić

U radu se tretira uticaj nekih najčešće ugradivih građevinskih materijala pri monolitizaciji toplotnih depoa solarnih objekata sa aspekta eko-kvaliteta. Eko-kvalitet ambijentalnog vazduha kod solarnog objekta direktno zavisi od materijala koji se ugrađuju u toplotni depo.

Poseban akcenat se daje na eko-kvalitet ambijentalnog vazduha sa radijativnog aspekta. Na kvakitet ambijentalnog vazduha glavnu ulogu sa tog aspekta ima gas radon ^{222}Rn.

Pri konstrukciji toplotnih depoa kod solarnih objekata, najčešće korišćeni građevinski materijali su: beton, kamen, pesak i opeka. Stoga je u ovom radu posebna pažnja posvećena upravo ovim materijalima. Poznavanje sadržaja prirodnih radionuklida u ovim građevinskim materijalima, kao i njihova ukupna ekvivalentna radioaktivnost jedan su od meritornih faktora arhitekti pri opredelenju kod izbora ″zdravih″ materijala. U skladu sa preporukama ICRP i UNSCEAR definisan je eko-kvalitet ambijentalnog vazduha kod solarne kuće.

Ključne reči: *Solarna kuća, toplotni depo, građevinski matrijali, eko-kvalitet, prirodna radijacija, gas radon.*