Abstract

Radon is a colorless, odorless, radioactive gas naturally occurs in the Earth's crust. It can accumulate in closed spaces and therefore may become a dangerous environmental factor affecting human health. Exposure to radon is the second cause, after smoking which leads to the lung cancer [155].

The type of technology used to build a building has an impact on the level of indoor radon concentration [61, 105]. A significant increase in the concentration of this gas could be connected with applying energy-saving technology based on the presence of air-tightening rooms and reduction of ventilation inside the buildings. This kind of technology solutions are used in passive houses, designed to minimize energy consumption, and which are characterized by very good insulation parameters and a range of solutions, such as mechanical ventilation and ground heat exchangers.

The aim of the study is to estimate the effective dose of inhaled radon that the inhabitants of energy-efficient, low-energy and passive buildings receive and to investigate the impact of the various structural solutions used in this buildings on radon concentration inside. The study group contains 27 buildings from five voivodships of Poland. In this buildings improvements to reduce the energy demand of the building are used (GOZE). Additionally objects from the GOZE group were divided into three subgroups: energy-saving houses, low-energy houses, and passive houses. The control group (CG) consists of 45 buildings made using traditional methods located in the vicinity of the examined facilities.

For measurement of indoor radon concentration the diffusion chambers with CR-39 trace detectors was used.

The average annual radon concentration in the energy-saving, low-energy, and passive houses is higher by 58% compared to those built using traditional methods. The mean values are equal to 56,1 $Bq \cdot m^{-3}$ for the houses belonging to the GOZE group and 35,6 $Bq \cdot m^{-3}$ for the buildings from CG. The lowest radon concentration value is observed in the passive houses (51.3 $Bq\text{-}m^{-3}$). The effective doses of inhaled radon are 1.58 mSv per inhabitant of passive houses, 2.1 mSv per inhabitant of low energy houses and 1.83 mSv per inhabitant energy saving houses.

A correlation was found between the concentration of radon inside apartments and the way of ventilation of rooms. Average annual radon concentration in the group of houses using mechanical ventilation is higher than in houses with gravity ventilation and the values are respectively 55.2 Bq-m-3 and 37.6 Bq-m-3.

Limited ventilation lead to an increase the radon concentration inside the buildings and in consequence raise the level of human exposure for radon. The penetration of radon-rich soil gas into the building is caused by the use of an underground heat exchanger in the form of a gravel bed causes. This method of recuperation applied in three buildings from GOZE group leads to the significant increase of indoor radon concentration compared to the other buildings.