Extended abstract

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Title of the presentation

Radon measurements for the assessment of the IAQ

Introduction

Nowadays, we are more concern about indoor air quality and its impact that this could have on our health. In many cases most people are aware that outdoor air pollution can impact their health but when it comes to indoor air pollution they are not conscious that can have important and risky effects on their health. The people inside the buildings are responsible for large amounts of carbon dioxide emission (CO2), moisture, odours and dust. Moreover, the buildings materials, interior finishes, furniture and other indoor equipment's contribute to the emission of hazardous substances into the indoor air, such as volatile organic compounds (VOCs), airborne biological contaminants (germs, viruses and bacteria) and formaldehyde (HCHO). One of the most dangerous indoor pollutants is radon. The news IAEA's Basic Safety Standards put radon issue in a leading position concerning the identification and controlling of population risks derived from exposure to radon. In many studies it was shown the carcinogenic impact of radon. It was found that the risk of developing lung cancer due to radon increases by 16% per 100 Bq/m^3. Moreover, in Europe there is a percentage of 8-15% of lung cancer cases which are attributable to radon in homes. Despite these alarming data and negative effects of radon on the human's health the population is not entirely concern – probably because they are not informed correctly. A range of techniques are available to reduce high indoor concentration and to minimize the risk. The next table presents a comparison of the main remediation methods developed experimentally and the results on the reduction efficiency (%) of the initial radon concentration achieved in a previous national Romanian research program called IRART. The remediation methods were applied for 21 houses with high risk of radon from the Baita-Stei uranium mining area. The implemented methods are based on active and passive pressurization and depressurization of indoor spaces.

No.	Remediation technique	Short description
1	Soil depressurization	It works by reversing the pressure difference between the space under the floor and the room above. The air containing radon is expelled through a ventilator, thus preventing its infiltration indoors. The method

	(active and passive methods)	of coupling the radon collector with a fan is known as the **active collector.** Efficiency: 68-95%
2	Improving natural ventilation	Determines mixing of radon-rich indoor air with the outdoor air, thus decreasing the indoor radon concentration but also slightly increasing the pressure inside the house which helps reduces the tendency of radon to be sucked indoors. 30-59
3	Improving mechanical ventilation	It involves introducing air inside the house through a fan, thus creating a slight positive pressure relative to the outside air. This reduces radon entry and forces the air out through cracks, windows and other openings. 65-78
4	Ventilation methods combined with soil depressurisation	It requires installation of additional under-floor ventilation paths to force evacuate radon using an active fan. These ventilation paths are crossed by longitudinal slotted PVC pipes. 88-95
5	Insulation of floors and walls. Anti-radon barrier	It prevents radon entering the ground floor from the soil underneath by isolating all entry points. The insulation material must be durable and flexible enough to accommodate future movements of construction materials. The radon barrier is based on flexible polymer membrane applied onto the internal surfaces of the floor, under flooring. 60-65

Results

Since September 2016 we have started a research project entitled SMART-RAD-EN focused on the indoor air quality and radon concentration in energy efficient houses. From our first results, it was noticed that in thermally rehabilitated buildings due to high airtightness of the houses the indoor air quality is poor. It is clear that insulation methods and materials must be coordinated with indoor air quality. Minimum legislative requirements recommend avoiding deterioration of indoor air quality, i.e. increasing the levels of radon and other household air pollutants after applying energy-saving technologies. For example, in a case study conducted in the Czech Republic on a building constructed in 1975 the indoor radon concentration increased about three times after its thermal rehabilitation (envelope insulation and windows replacements). With the SMART-RAD-EN project we planned to measure the indoor radon levels in 1000 dwellings. The first 100 housed with the highest levels will be monitored in detail and at the end we will choose 20 buildings and remediate the problem. The remediation will consist from simple ventilation systems to more advanced and energy efficient solutions.

Conclusions

A well-insulated house, with tight air permeability is the most exposed to have high radon levels. This would not have been a problem if the dwellings were equipped with mechanical ventilation systems. Unfortunately, in Romania, 99.5% of the newly built houses are well insulated and air tight but don’t have any ventilation system to provide the needed fresh air. Moreover, based on approximately 5000 indoor radon measurements during IRART project it was found that 23 % of the investigated dwellings exceed the threshold of 200 Bq/m^3. The Romanian research team is not working on another important research programmed in order to have a national radon map and to introduce new regulations when it comes to radon thresholds, especially focused on the energy efficient houses.

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