Smart control of HVAC based on measurements of indoor radon concentration

M. Fromreide[a] and I. Henne[b]
[a]NORCE Norwegian Research Centre AS. E-mail: mafr@norceresearch.no
[b]NORCE Norwegian Research Centre AS. E-mail: inhe@norceresearch.no

Sufficient ventilation is important for creating a healthy indoor environment in both households and larger buildings (schools, offices, shops, warehouses). As the cost of heating and ventilation in large buildings is very large, modern ventilation systems apply smart control for optimizing the energy consumption. The control is typically based on temperature and/or CO_2 levels, whereas other pollutants such as particulate microparticles and radon are not accounted for. Exposure to indoor radon is the second most important reason for lung cancer, with more than 200 000 cases estimated worldwide every year. The indoor radon concentration depends on many factors, from local geological conditions and weather, to building materials and natural and mechanical ventilation.

Together with the Norwegian company OBEO AS, NORCE has completed a study of the indoor radon concentration at a Norwegian primary school prone to high radon levels. The study includes continuous measurements of radon, CO_2 and temperature for multiple rooms for different use as well as data for the ventilation system. The aim for the project was to build knowledge for a larger research project, where the goal is to develop a control algorithm for HVAC systems which also takes radon levels into account.

An important challenge is to make accurate sensors for measuring radon continuously at an affordable price for implementation in complex buildings. Generally, sensors that can measure at high frequency with good accuracy is very expensive. Thus, developing algorithms and mathematical models to treat the data from low-cost sensors can be an adequate tool for large systems/buildings. One must also account for the positioning of the sensor. For instance, it is known that the radon concentration is better distributed in a room with mechanical ventilation than in a room without, making the position of the sensor important for better interpretation of measurement data. In the pre-project we have studied how the radon levels show large variations that are related to the ventilation operation and daily/weekly variations. The large variations show the need for a high sampling rate (minutes to hours) to capture the peaks in the concentration. We have also studied the rate of change in radon concentrations over time and have amongst discovered a noticeable delay from the start of ventilation until radon is effectively removed from the air. The rate of change is an important parameter for planning ahead and securing fresh air during the full period of presence whilst optimizing the energy cost.

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