Vapor Intrusion Study of Landfill Gas Containing Elevated Levels of Carbon Dioxide

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Background/Objectives. From 1954-1959 and again around 1974, the southern part of a pond near Copenhagen was used as a landfill of primarily household waste. In 1975-1978 houses were constructed on top of the filling using pile foundation. Cavities were formed under the houses situated on the landfill due to the degradation of the organic matter in the landfill. The filling layer was up to 5 meters of depth and topped with approximately 1 meter of soil. From January 2016 to March 2017, NIRAS, on behalf of the Capital Region, carried out investigations of the landfill gas and its impact on the indoor climate in 15 houses built on top and in the vicinity of the landfill. There is no mechanical ventilation in the houses. The main objective was to reassess the existing outside landfill gas mitigation installations, in the form of passive ventilation systems from 1997, on seven properties. The mitigation systems were originally performed to prevent methane gas intrusion.

Approach/Activities. A vapor intrusion study was performed, including tracer gas injection into the void beneath the house and indoor leakage detection using a handheld detector. This technology pointed out several rooms in most houses with significant vapor intrusion pathways. In two centrally located houses, the level of carbon dioxide was measured continuously in the void under the houses, inside the house and in the return air from the mitigation installation in periods of up to 14 days. The placements of the measuring device in the houses were selected based on general vapor intrusion study performed.

The soil gas concentration of carbon dioxide and methane was measured by field measurements 10 times over approximately a year in up to 100 different permanent 1.5 m deep probes distributed over the landfill area and in the air the void below the houses. During the investigation period, the survey was expanded with soil and groundwater studies due to findings of chlorinated solvents and oil products.

Results/Lessons Learned. In particular, measurements in a closed room without occupancy for 14 days during the summer are very interesting, as relatively high carbon dioxide content at night is measured in the room, see Figure 1. The carbon dioxide originates from the void beneath the house and thus from the landfill and not human activity as the room was empty and windows and doors were closed. In November, we repeated part of the study again, with a meter with higher upper measuring limit, and found content of carbon dioxide in the same room up to 0.85%. In both studies, we saw a clear correlation between the content of carbon dioxide in the room and the variations in the relative temperature difference of the house relative to the outside temperatures. This results in the highest carbon dioxide levels during the night from midnight to around 6 p.m. The

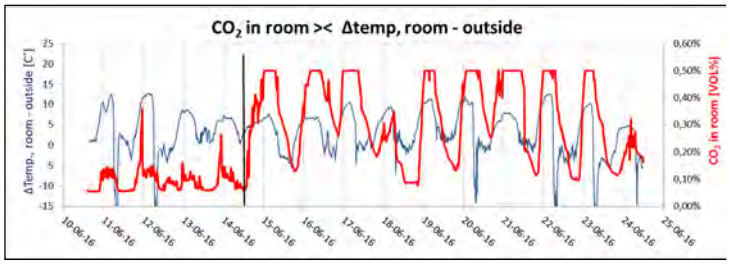

Figure 1: Content of carbon dioxide in a room which was closed and without occupancy after 14-06-2016 (black line). The red graph indicates the amount of carbon dioxide in the room (the meter's upper limit of measurement was 0.5%), while the blue graph shows the difference in temperature in the room compared to the outside.

temperature seems to be the main controlling factor for the vapor intrusion process (likely due to the thermal lift of the indoor air).

We found that measuring the level of carbon dioxide provides a very good impression of the dynamics of air flow from the landfill into the houses, especially if the respiratory influence can be emitted, as it is easy to measure the level of carbon dioxide and longer periods of continuous measurements can be obtained.