Hydrocarbon gas emissions from oil and gas wells contribute significantly to anthropogenically emitted greenhouse gases, predominantly as methane [1, 2, 3]. Methane flux from oil and gas wells has reached 61 Tg yr$^{-1}$, which is the largest source of the total anthropogenic methane emission flux of 336 Tg yr$^{-1}$ [4]. It is essential to reduce methane emissions from oil/gas wells to mitigate global warming.

There are more than 80,000 active, inactive, temporarily abandoned and permanently plugged oil and gas wells in Indiana. The extent of fugitive hydrocarbon emissions from those wells into the atmosphere has not been quantitatively studied. This study is a first attempt to quantify those emissions. Methanotrophs are methane-oxidizing bacteria which can metabolize methane. Methane in natural gas can be partially consumed by methanotrophs in soil around seepages before it reaches the atmosphere [5]. Therefore, soils enriched in methanotrophs above hydrocarbon leakages have the potential to mitigate hydrocarbon emissions from leaks. We investigated a microbial mitigation strategy with mesocosm and artificial soil mound experiments.

Experiments

1. Research area

We investigated 20 active, temporarily deactivated or plugged-abandoned oil/gas wells across Monroe, Daviess and Sullivan counties in Indiana. Fugitive emissions on the order of liters per hour qualified an active gas well in Monroe County to serve as our research site.

2. Quantification of methane emission

We built a polyethylene tent to enclose fittings of a research well. The bottom of the polyethylene soil was ballasted by stones to seal against the ground. A DC-operated fan homogenized the methane in the tent. Air from within the tent was sampled by a SARAD RTM 2200 instrument and methane detector. The methane concentration in air was measured by a SARAD RTM 2200. We also tested if prolonged exposure of a soil mound from the leaky research well.

3. Methanotrophic activity

We collected topmost soils adjacent to and 20 m away from the research well. We imbibed those soils to remoistened by 16 wt. % and used them in artificial soil mound experiments.

Results

1. Methane emission rates

The measured methane concentrations in ambient air surrounding investigated oil/gas wells are listed in Table 1. We found that methane concentrations in the tent around the research well increased linearly with time. The average methane emission rate was calculated as 1.73 L/hour using k=1.93 E-3 L/hour m$^{-2}$. This is 1.42, 1.32, 1.36 mL m$^{-2}$. respectively for the three measurements; V=0.358 m$^3$.

Conclusions

The methane flux from the leaky research well is ca. 2 L/hour.

• Soils adjacent to leaky wells exhibit significant methanotrophic activity. Prolonged exposure of soil to elevated methane concentrations enhances their methanotrophic activity.

• Building a soil mound with high methanotrophic activity located above abandoned and leaking oil/gas wells can be a cost-effective strategy to microbially mitigate fugitive hydrocarbon emissions from wells.

References