Photocatalytic removal of atmospheric methane

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Background and motivation

- **Methane is a potent greenhouse gas (GHG). [1]**
- **Atmospheric concentration of methane is rising fast in recent years.**
- **Methane removal technologies are highly desirable to remove CH_4 from atmosphere to offset continued CH_4 release. [2]**
- **We are carrying out a H2020 funded project (https://cordis.europa.eu/project/id/871998; STEPforGGR) to develop a pioneering technology.**

A pioneering technology

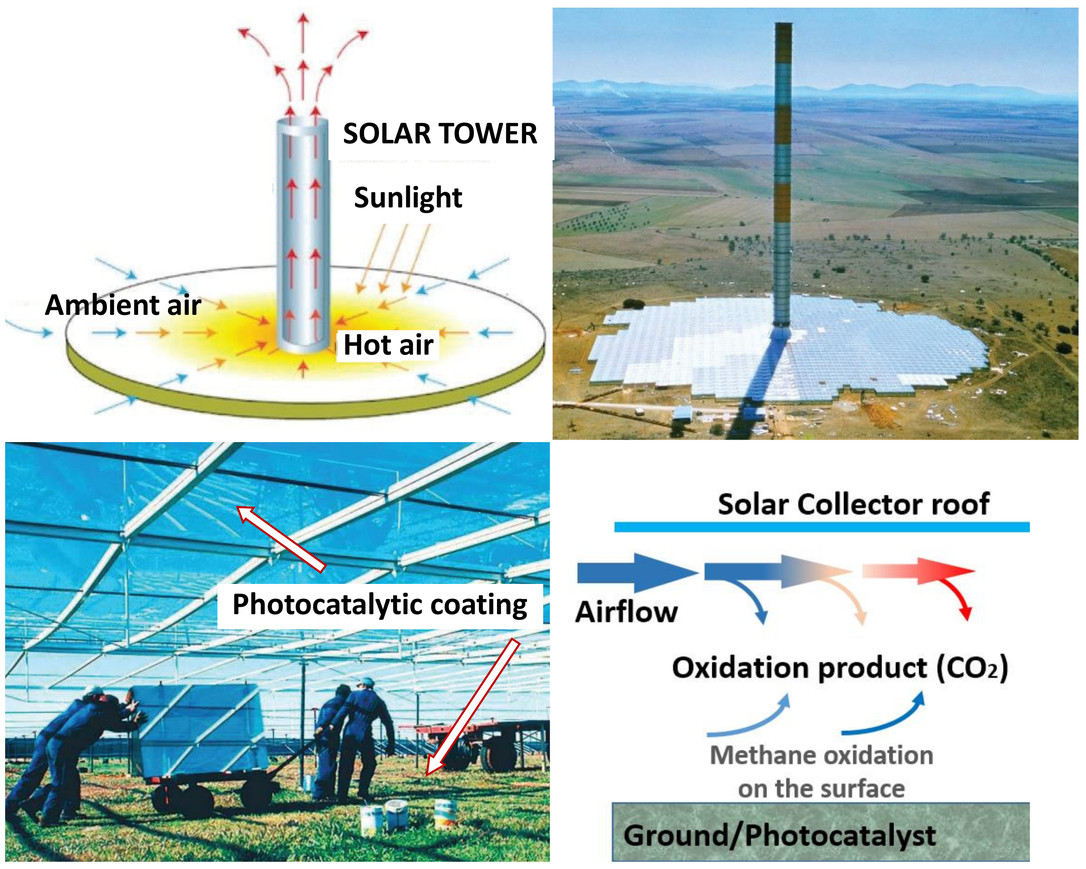

Figure 1. A Solar Up-draft Tower (SUT).
The Spanish Manzanares facility from 1982, a test facility for power generation

Our STEPforGGR project will carry out study to answer a question: is this SUT + Photocatalysis technology feasible for the purpose of global methane removal?

This proposed technology, proposed by de Richter et al. [3, 4], has been endorsed as an emerging technology for GHG removal in 3 different reports from the Intergovernmental Panel on Climate Change [1, 5] and the Royal Society [6].

Experimental set up

The first step is to test the idea in lab scale targeting directly the atmospheric methane, using the below continuous flow photocatalytic setup.

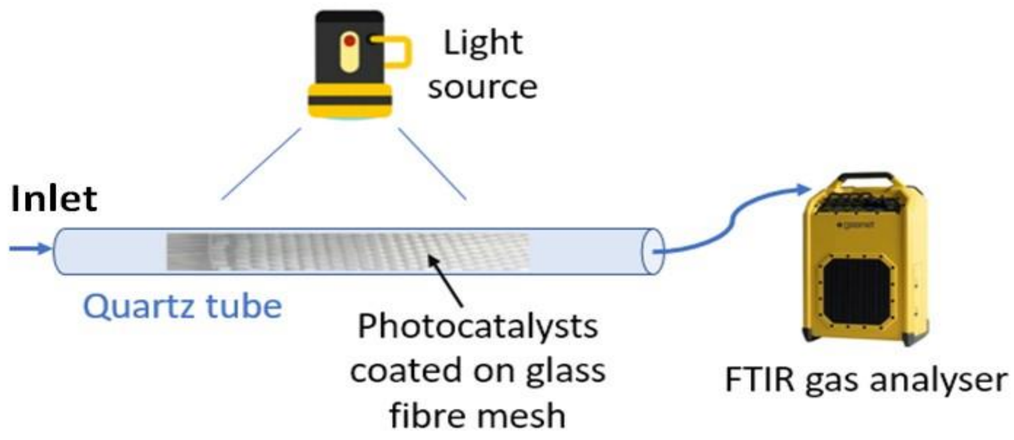

Figure 2. The experimental set up.

Experimental result

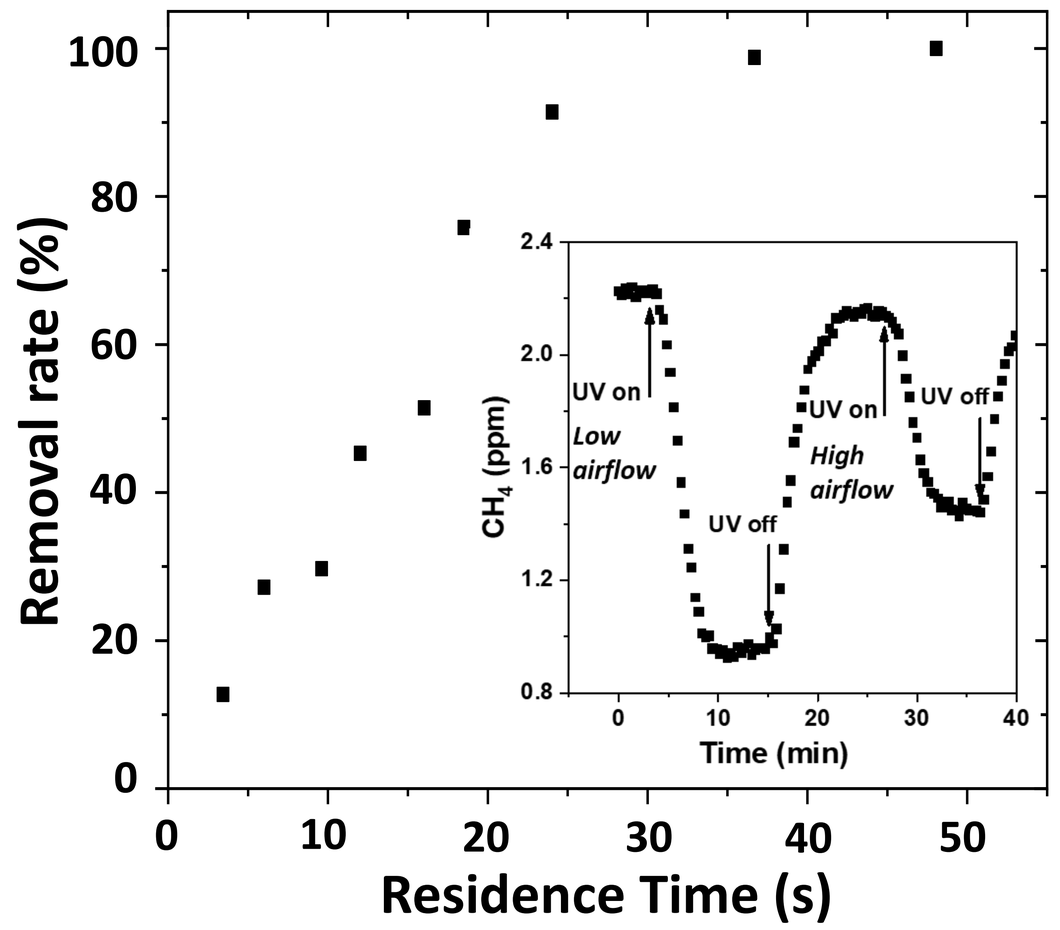

Figure 3. Photocatalytic removal of CH4 in a bench top continuous flow reaction system.

Discussion

- **Tests are based on simulated sunlight (UV + Vis) and P25 TiO_2.**
- **Airflow of 0.4 L/min (i.e. residence time of 12 seconds), the removal rates is 46%.**
- **Shorter residence time gives lower removal rates.**
- **Longer residence time provides higher removal rates, as high as 98% for half minute.**
- **The earlier mentioned SUT can provide residence time as long as ten minutes.**

Conclusion

- **We investigated photocatalytic removal of 2 ppm atmospheric CH_4 in a continuous flow reaction system using only commercial P25 TiO2.**
- **The results show that solar driven photocatalysis combining with solar updraft devices is feasible for atmospheric methane removal.**

References, Funders, and Collaborators

[1] Masson-Delmotte, V., et al., IPCC Technical Summary. In: Climate Change 2021, (IPCC, 2021).
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[4] Huang, Y. F., et al., Frontiers in Chemistry, 2021, 9, 745347.
[5] Masson-Delmotte, V., et al., IPCC Special Report: Global Warming of 1.5 ºC, (IPCC, 2018).
[6] The Royal Society, Greenhouse gas removal, (The Royal Society, 2018).

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