BACKGROUND

Greenhouse gases, in particular CO$_2$, are the main cause of climate change. This project was motivated by finding an alternative way of using natural gas to produce heat for industrial facilities with reduced CO$_2$ production. The main purpose of this project was to investigate pyrolysis of natural gas with a medium-scale set-up (8 kW). Natural gas can be decomposed into hydrogen and carbon black at high temperatures. Hydrogen can be used as a clean fuel and carbon black is a valuable raw material for many industries such as tire, rubber, ink and pigments.

PROJECT OVERVIEW

Experimental set-up and results:

A burner was designed to provide an inverted laminar premixed flame within a cylindrical quartz tube of 68 cm length and 20 cm diameter that is closed at both ends other than for inflows for the flame and the methane to be decomposed, and an outflow for the products formed. The quartz chamber is filled with circular blocks made of alumina silicate ceramic as insulators, these blocks have OD of 19.8 cm and ID of 4 cm. Propane fuel with a flow rate of 1.370 slpm and air with flow rate of 35.0 slpm were mixed in a static mixer to form the premixed flame, and methane co-flow of various flow rates from 0 to 5 slpm was introduced after the flame to be decarbonized.

The concentration of each component at the exhaust was measured by a gas chromatography analyzer (Agilent GC 7890b model). For stoichiometric flame, different methane flow rate (0 to 5 lpm) was introduced into the system and results are shown in Fig. 3. Carbon particulates are sampled with a preheated nitrogen dilution system, and the size distribution of particles formed by pyrolysis is measured by a scanning mobility particle sizer (SMPS). Dilution ratio is calculated using simultaneously measured CO$_2$ concentrations in exhaust products and diluted samples. Particle size distribution of generated particles are shown in Fig. 4.

The temperature inside the quartz chamber was measured by a K type thermocouple for different points, result shows temperatures over 1100 °C.

THEME OVERVIEW

Carbon Capture, Utilization & Storage

Hydrocarbons will continue to serve as an essential energy source while the world transitions to a lower-carbon energy economy, but can we prevent the use of those fuels from contributing to the accumulation of CO$_2$ in the atmosphere? Existing technologies can capture carbon, but these methods can be costly and energy-intensive. Extracting energy without burning fuels, improving CO$_2$ capture efficiencies if they are burned, and finding effective ways to store or reuse captured carbon may be essential to ensuring it does not enter the atmosphere.