Methane Hydrate Combustion

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Introduction

Methane Hydrates are molecules of methane (CH4) bounded within a crystal of ice (H2O) created under high pressure and low temperature. Methane Hydrates are important because

- They are currently being studied for extraction from the depths of the ocean to use as a source of energy.
- It is estimated the newfound resource could supply about 250 years worth of natural gas.
- One of the properties of methane is that it is extremely flammable and may form explosive mixtures with air.
- Methane Hydrate properties are not all known.
- The W.M. Keck Foundation Deep-Ocean Laboratory at UC Irvine is studying the combustion and burning characteristics.

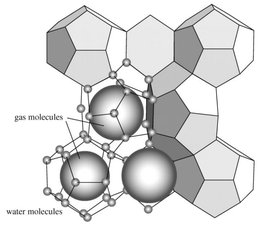

Figure 1: Clathrate Structure (Gas Hydrate)

Figure 1: Clathrate Structure
Methane Hydrate structure of methane bounded by crystal ice.

Figure 2: Existing Combustion Facility
This combustion facility was built by a previous team. We are using this facility for reference. Facility was deemed not fit for methane hydrate combustion testing by customer.

Figure 2: Existing Combustion Facility

Team

Faculty Advisor:
Derek Dunn-Rankin

PhD Candidate and Customer:
Navid Saeidi

Team Lead:
Michael Hu

Team Members:
Dania Alfeerawi
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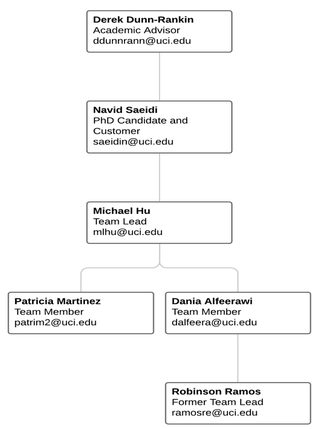
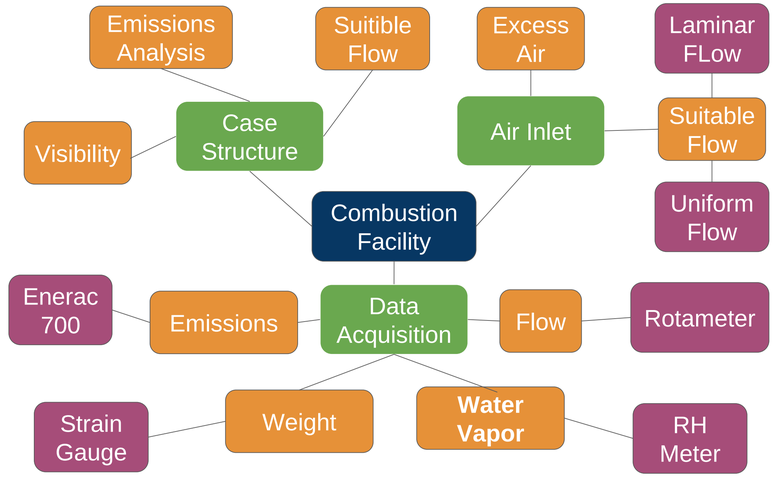
Resources:
W.M. Keck Foundation Deep-Ocean Laboratory
Robinson Ramos



Goal & Requirements

To redesign, construct, and test a Methane Hydrate combustion facility that permits emission monitoring from a 50 cc methane hydrate sample during combustion.

- Accurate Combustion Emission readings using Enerac 700 probe
- Laminar Airflow (Re <2100) and uniform airflow
- Ability to provide 0 to 10 times excess air into system
- Enable measurement of air inlet and exhaust outlet volumetric flowrate
- Enable measurement of water vapor emissions, methane hydrate weight loss, and liquid water during combustion
- Visual access to combustion process
- Ability to hold at least 50 grams of methane hydrate sample



Timeline

Fall

- Design specifications and parameters determined
- Simulations made
- Materials and equipment selected

Winter

- Facility manufactured and fabricated by the end of winter quarter

Spring

- Testing of facility through Methane Hydrate Combustion
- Prototype ready to present

Progress

Process of acquiring simulations in Figure 3 and Figure 4:

- Performed experiments with gel Ethanol (solid, hydrocarbon fuel substitute) combustion
- Determined gel Ethanol & Methane Hydrate mass loss rate and combustion emissions concentrations from experimental data
  - Methane Hydrate data provided by Navid
- Derived volumetric air flow rate and required excess air concentrations
- Evaluated alternative air inlet designs with SolidWorks Flow Simulation using air flow rate

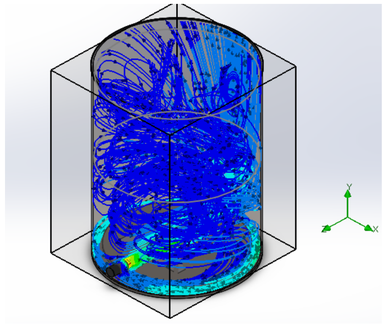


Figure 3: One inlet ⅝ inch diameter hole for airflow

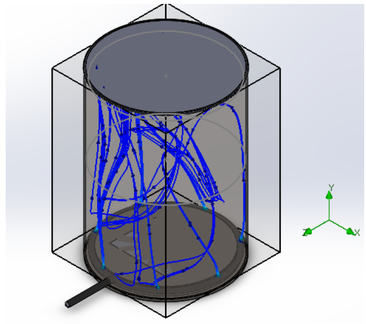


Figure 4: Seven hole ring of 1/16 inch diameter for airflow

Budget

Quantity	Description	Cost
1	Humidity & Temp Transmitter	$3,306
1	Hydro Halo Water Ring 6''	$7.95
1	Rotameter	$67.23
1	Flowmeter	$11.65
1	Strain Gauge	$4.58
	Total	$3,397

Acknowledgements

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