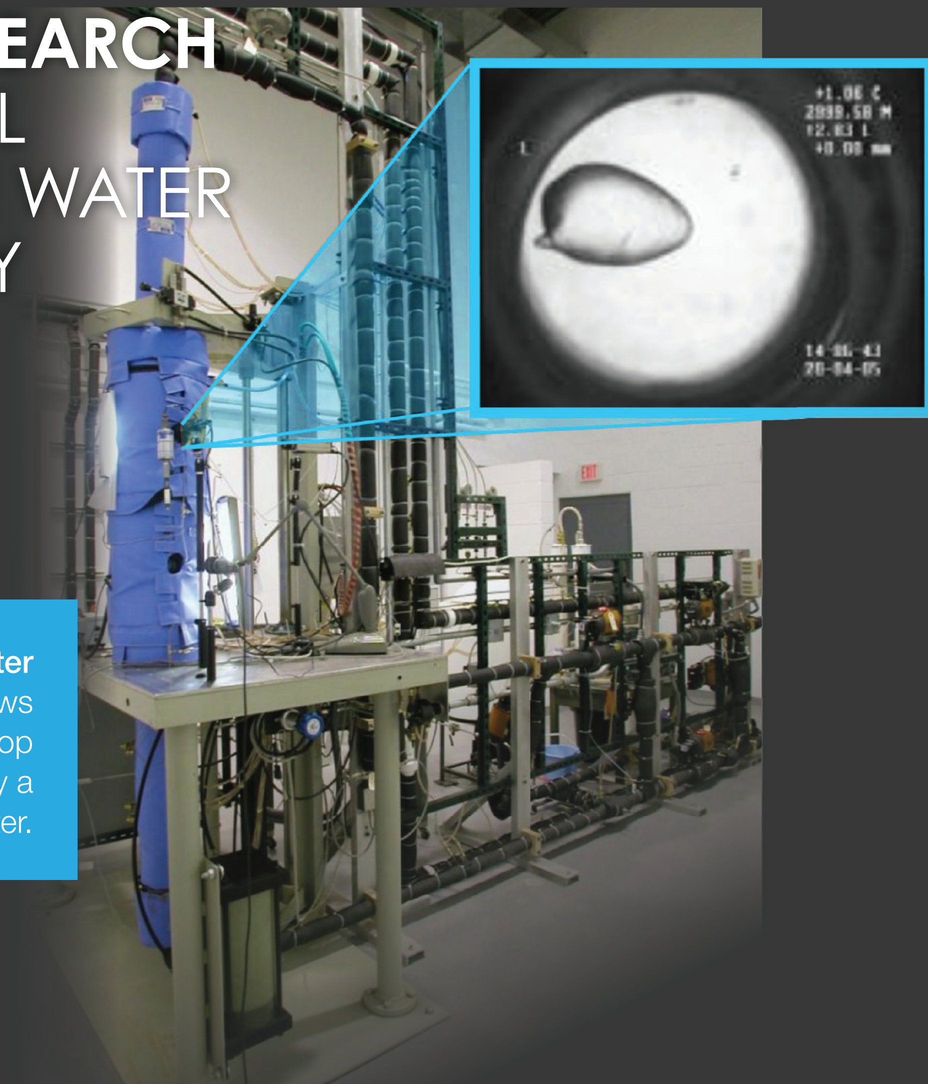
DEEPWATER RESEARCH IN THE DOE NETL HIGH-PRESSURE WATER TUNNEL FACILITY



NETL's High-Pressure Water Tunnel Facility. Inset shows a hydrate-covered CO_2 drop that was stabilized by a countercurrent flow of seawater.

NATIONAL ENERGY TECHNOLOGY LABORATORY

BACKGROUND

The National Energy Technology Laboratory's (NETL) High-Pressure Water Tunnel Facility (HWTF) allows researchers to investigate the chemistry, physics, and hydrodynamics of gas bubbles, liquid drops, and solid particles in deepwater environments. Built to withstand conditions at simulated ocean depths in excess of 3,000 meters, the facility was originally used to study the fate of carbon dioxide (CO_2) in the deep ocean, released either intentionally or inadvertently during sequestration activities. Currently, researchers are using the facility to obtain crosscutting information on fluids that could accidently be released and transported from a deepwater hydrocarbon reservoir, in events such as the 2010 BP Deepwater Horizon oil spill (Macondo blowout) in the Gulf of Mexico.

The fate and role of gas hydrates (crystalline inclusion compounds composed of water and gas) have been major factors in both prior sequestration research and current deepwater hydrocarbon release research. The HWTF's high-speed, high-definition (HSHD) video capabilities provide detailed information on dissolution, hydrodynamic behavior, and hydrate formation and dissociation.

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The unique feature of the HWTF is that a vertical countercurrent flow of water or seawater can be used to stabilize a rising or sinking object of interest in one of its multiple observation windows for extended periods of time. Multiple cameras track and measure the object and provide control input for automated stabilization.

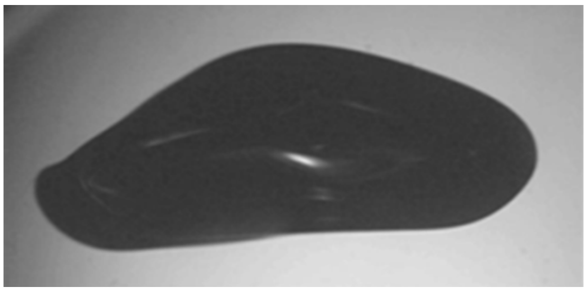

Figure 1. Methane bubble stabilized in the HWTF at deepwater conditions similar to those at the Macondo well blowout.

GOALS AND OBJECTIVES

The goal of this current research is to obtain fundamental chemical, physical, and hydrodynamic information on fluids from anthropogenic or natural releases from subsea hydrocarbon reservoirs into a deepwater environment.

The fundamental information obtained in the HWTF will be used in numerical, thermo-dynamic, and plume models to comprehensively describe potential roles and impacts of gas hydrates in a deepwater release scenario. This information will also be used to improve techniques to more accurately assess the nature and magnitude of the release.

PROJECT DESCRIPTION

Currently, the HWTF is being used to observe the formation and stability of gas hydrate on hydrocarbon bubbles and drops under conditions that simulate those of the Macondo well blowout. The Department of Energy (DOE) and the Department of Interior Bureau of Safety and Environmental Enforcement (DOI BSEE) are supporting this research.

BENEFITS

- Fundamental data on gas hydrates and their role in deepwater environments
- High-definition, high-speed video capabilities:
  - Detailed information on bubble hydrodynamics
  - Unprecedented resolution of hydrate surface morphology
- Data for deepwater plume modeling development, especially for gas behavior in the deepwater zone of hydrate stability
  - Regional impacts of natural or anthropogenic gas releases in deepwater environments
  - Global impacts of natural hydrocarbon gas seeps
- Capabilities include bubbles and rising or sinking drops or particles

ACCOMPLISHMENTS

NETL researchers used the HWTF in a multi-year effort to determine dissolution rates, impact of gas hydrates, and hydro-dynamics by studying over 500 individual CO_2 drops under deep ocean conditions down to 3,000 meters. Researchers also used the facility to successfully evaluate two novel deep-ocean injection technologies: (1) formation of sinking composite particles that consisted of a mixture of liquid CO_2 droplets, CO_2 hydrate, and seawater and (2) coating of CO_2 droplets with calcium carbonate powder that not only made the droplets sink but also buffered some of the acidity resulting from dissolution into seawater. Researchers are now conducting studies on the deepwater release of hydrocarbon gas bubbles, including mixtures containing methane, ethane, and propane.

Research Partner

Bureau of Safety and Environmental Enforcement (BSEE)

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