

Methane Bubbles *Performer's Version*

Safety Hazards

- Personal Protective Equipment
 - Safety glasses/goggles
 - Chemical & flame retardant lab coat
 - Fire extinguisher
- Physical Hazards
 - Utilizes open flame; may cause serious burns on skin
 - Methane is a highly flammable gas and may ignite gas in air.
- Chemical Hazards
 - Methane may cause serious skin and eye damage.

Materials

- 1 Plastic bin for tap water
- 1 Plastic bin for soapy water
- Dish soap
- Methane gas, compressed
- CGA 350 Regulator with plastic tubing
- Lighter

Safety Data Sheet(s)

- [Methane, compressed](#)

Procedure

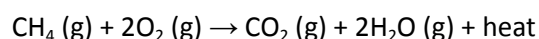
Someone from the Demonstrations team must be present in order for this demonstration to be performed.

1. Fill both plastic bins with water.
2. Add plenty of dish soap to one of the two plastic bins.
3. Submerge the tubing from the methane regulator directly into the soapy water plastic bin. Check to make sure the tubing is fully submerged. Manually keep the tubing submerged with your hand.
4. Open the methane tank and then slowly open the regulator to begin bubbling methane gas into the soapy water plastic bin. Continue to bubble methane into the soapy water plastic bin until you have the desired bubble height, about 8 to 12 inches above the water's surface.
5. Close the regulator, and then close the methane tank. Release the pressure from the regulator while the tubing is still submerged before removing it from the water.
6. **IMPORTANT:** Remove the gas cylinder a minimum of fifteen feet away from the soapy water plastic bin. Preferably, behind a closed door.
7. Make sure that you have no accessories or jewelry on and your lab coat is closed, with one sleeve secured above your elbow (secure with a clip or rubberband if needed). Fully submerge your non-dominant hand into the water bin. Be sure to coat your hand all the way to your elbow in water. Keep your arm submerged until you're ready to ignite – after the tank is safely put away.
8. Using your water-soaked hand, scoop the desired quantity of bubbles into your hand.
 - a. *Note: Make sure there are no bubbles on the back of your hand. If there are, wipe them off with a wet cotton or paper towel. Spread out your fingers and double check – having bubbles on the back of your hand ignite is an easy way to burn yourself!*
9. Fully extend the arm that contains the bubbles over the table. Do NOT hold your hand over the soapy water plastic bin.

10. Using your dominant hand, light the edge of the bubbles. Be sure to keep your face and hair away from the flame!

Pedagogy & Supplemental Information

The methane bubbles demonstration serves as a compelling illustration of core principles in chemistry and thermodynamics. In this experiment, soap bubbles are filled with methane gas, subsequently scooped up by a hand coated in water, and ignited with a lighter. The combustion of methane (CH₄) is a highly exothermic process, described by the stoichiometric reaction:



This reaction liberates a considerable amount of energy due to the highly exothermic nature of methane's oxidation, with a standard enthalpy change of combustion of approximately -890 kJ/mol. The energy released results from the breaking of C-H bonds in methane and O=O bonds in oxygen, and the subsequent formation of stronger C=O and O-H bonds in carbon dioxide and water, respectively. The exothermic nature of this reaction is indicative of the transition from high-energy reactants to lower-energy products, releasing the difference as heat.

The role of water in this demonstration is critical, attributed to its exceptionally high specific heat capacity. The specific heat capacity of water, approximately 4.184 J/g°C, enables it to absorb significant quantities of thermal energy with only a modest increase in temperature. This thermophysical property is pivotal in the context of the demonstration. When the methane bubbles ignite, the resultant combustion releases a surge of thermal energy. The water layer coating the hand effectively absorbs much of this heat, thereby mitigating the transfer of heat to the skin. This absorption capability is a direct consequence of water's extensive hydrogen bonding network, which requires substantial energy to disrupt.

The thermodynamics of the methane bubbles demonstration underscore the complex interplay between energy release during exothermic reactions and heat absorption by materials with high specific heat capacities. The substantial heat generated by methane combustion is managed through the heat-absorptive properties of water, preventing rapid heat transfer and consequent burns. This controlled heat management exemplifies how specific heat capacity is crucial in regulating thermal energy dissipation.

In broader applications, these principles are pivotal in diverse fields. Methane's high heat of combustion underpins its utility as a primary fuel in natural gas, driving energy production through efficient energy release. Conversely, the concept of specific heat capacity is integral to thermal management in electronic devices, where materials with high specific heat capacities are employed to dissipate heat and maintain device integrity. The methane bubbles demonstration thus encapsulates fundamental thermodynamic principles, showcasing their relevance in both educational contexts and practical technological applications.