NavApp: Greenhouse Gas

Learning Objectives

- determine the electron pair geometry and molecular geometry of greenhouse gases
- determine the formal charge on any atom
- determine if a molecule is polar or nonpolar
- determine the amount of sigma or pi bonds in a molecule

1. Introduction

The Department of Defense (DoD) is the largest consumer institutional user of petroleum and the single largest producer of greenhouse gases in the world according to the Environmental Protection Agency. With the United States engaged in the Global War of Terrorism in more than 80 countries, the use of fossil fuel energy has increased since 2001.

2. Chemistry in the Operating Forces

Recent estimates of DOD emissions from 2001 to 2014 are approximately 766 million metric tons of CO_2-equivilant (CO_2e), with more than 400 million metric tons of CO_2e in the Middle East major war zones. The majority of the DoD's energy consumption is from vehicles and equipment, including jet and diesel fuels. Another major source of energy consumption is in facilities for electricity and natural gas.

In 2014, it was estimated that operational force energy consumption was dominated by air assets, including airlift and fighter aircraft. The sea forces, including combatant and supply ships made up another 14% of DoD energy consumption. In FY2017 alone, 85 million barrels of operation fuel was used to power ships, aircraft, vehicles, and contingency bases. The cost of this usage was nearly $8.2 billion. These 85 million barrels are down from the average of 120 million barrels of fuel averaged between 2010-2015.

3. Scientific Practices

Major byproducts of burning fuels are greenhouse gases, including $H_2O(g)$, CO_2, CH_4, O_3, N_2O and chlorofluorocarbons.

Compound Name	Chemical Formula
Water (vapor)	$H_2O(g)$
Carbon Dioxide	CO_2
Methane	CH_4
Ozone	O_3
Nitrous Oxide	N_2O
Chlorofluorocarbons (CFCs)	CFC_{11} & CFC_{12} CCl_3F & CCl_2F_2

Many of these gases are naturally produced in the environment and manmade production can harm disrupt the ecosystem. Water forms in the clouds, causing a cooling effect, carbon dioxide comes from living and decaying organisms, methane is released from wetlands and cattle, ozone helps protect us from the sun's harmful radiation, and nitrous oxide is a natural part of the nitrogen cycle. CFCs are NOT naturally produced but come from manmade products, like Freon used to cool a refrigerator.

If you are interested in researching fuels and environmental chemistry, please talk to your instructor about research happening here at USNA

4. Questions

a. What is the electron pair geometry of water? What is its molecular geometry?
b. What is the formal charge on the oxygen in water?
c. How many sigma bonds are in methane?
d. What is the electron pair geometry of ozone?
e. What is the molecular geometry of CFC_{11}? What is the formal charge on F?
f. Is CO_2 polar or nonpolar? N_2O? $CFC_{11}(CCl_3F)$

References and Additional Readings

References are given in the figure captions, where available/applicable. Additional readings can be found on the Chemistry Department's website: https://intranet.usna.edu/ChemDept/plebeChem/navapps.php

https://watson.brown.edu/costsofwar/files/cow/imce/papers/2019/Pentagon%20Fuel%20Use,%20Climate%20Change%20and%20the%20Costs%20of%20War%20Final.pdf

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