THE SCIENCE AND TECHNOLOGY OF HYDRAULIC FRACTURING

Hydraulic fracturing is a method to enhance oil and natural gas extraction from underground geological formations involving injection of a fluid under high pressure in order to crack the rock containing the hydrocarbon. While the method is not new, its use has surged since being combined with horizontal drilling technology in the late 20th century. The broadened scale and geographical scope of hydraulic fracturing have both led to significant economic and energy security benefits and raised public concern about the technology's environmental impact.

Hydraulic fracturing is now widely practiced in the US for both natural gas and oil production and has dramatically increased the US-developed supply of both, contributing to a decrease in US oil imports, the cessation of US natural gas importation, a global reduction in energy prices, and a larger and cheaper pipeline of feedstocks for the chemicals production, with an impact on the U.S. economy of hundreds of billions of dollars. ACS recognizes the significance of hydraulic fracturing for the U.S. economy, energy landscape, and chemicals industry.

The availability of cheaper natural gas (methane) has also spurred its replacement of coal in most new and many existing power plants, decreasing their CO2 emissions to levels not seen since the mid-1990s. Burning methane instead of coal releases roughly half the CO2, less SOx and NOx, and eliminates mercury releases. However, atmospheric release of just a few percent of the methane produced would entirely offset these benefits, as methane is a substantially stronger greenhouse gas; ongoing studies suggest that methane releases associated with oil and gas production and transmission are environmentally significant.

Additional environmental concerns stem from the technology's implications for water resources. Hydraulic fracturing of a single horizontal well can involve injection of millions of gallons of a 98% water fluid, taken from valuable freshwater sources or, increasingly, recycled from previous operations. However, water released from geological features and the injected fluid -- which also includes a "proppant," such as sand, to hold fractures open, and typically around 1% of chemical additives – returns to the surface. This "flowback" may also contain naturally occurring radioactive materials (NORM) such as radium, and elevated concentrations of salts, minerals, and heavy metals. Flowback is either disposed of in deep injection wells or re-used for subsequent fractures.

In some locations where hydraulic fracturing has been conducted, organic and inorganic materials have been found in nearby groundwater, raising significant public concern. Studies on the cause of this contamination have not been definitive, but poor well construction has been implicated in some cases. Furthermore, recent increases in seismic activity have been linked to the deep well disposal. In short, the full environmental impact of hydraulic fracturing is not known.

Contemporary oil and gas development is subject to a host of regulations at the federal, state, and/or local level, from well construction to the disposal of waste water. Regulation of hydraulic fracturing has been delegated by the EPA to the states by statute; the Department of the Interior regulates hydraulic fracturing on tribal lands. Many states have developed their own regulations for specific

The American Chemical Society (ACS) Board of Directors Committee on Public Affairs and Public Relations adopted this statement on behalf of the Society at the recommendation of the Committees on Environmental Improvement, Science, Chemistry and Public Affairs, and Corporation Associates. ACS is a non-profit scientific and educational organization, chartered by Congress, with nearly 157,000 chemical scientists and engineers as members. The world's largest scientific society, ACS advances the chemical enterprise, increases public awareness of chemistry, and brings its expertise to state and national matters.

aspects of hydraulic fracturing, including to require disclosure of chemical identities, which is not required at the federal level.

Given public concerns and open questions about potential adverse impacts of hydraulic fracturing on the environment and human health, ACS recommends the following:

1. ***Governments should support rigorous and independent scientific research on the environmental impacts of hydraulic fracturing***, both directly due to the extraction process and indirectly due to all steps of oil and gas production through well end-of-life. Such analyses must account for regional variations in geology, hydrology, and seismic characteristics of the areas where drilling occurs. Key research topics include:
    - The extent and causes of ground and surface water contamination in the vicinity of hydraulic fracturing
    - Methods for evaluating the impact of leaking wells, including wells no longer in production.
    - The extent of atmospheric methane and other volatile emissions from hydrocarbon production and transmission sites, and new methods for minimizing such releases.
2. ***Governments should support science-based hydraulic fracturing-related policies to facilitate development of oil and gas resources while protecting human health and the environment, and should be proactive in their oversight of cases of adverse impacts on either.*** In particular, they should ensure:
    - Continual review, revision, adoption and enforcement of regulations requiring the safe disposal, treatment, recovery and recycling of water used in hydraulic fracturing.
    - Development and enforcement of fugitive emissions standards for all U.S. wells and throughout the distribution system.
    - Up-to-date requirements for safe well construction and end-of-life practices.
3. ***Policymakers and industry should advance and encourage compliance with best practices for hydraulic fracturing and related operations***. Such practices should aim to minimize adverse impacts, such as depletion of fresh water, truck traffic, site congestion, and exposure to harmful chemicals. Best practices include:
    - Recovery and recycling of produced water as appropriate to minimize the depletion of critical fresh water resources and to reduce the prevalence of disposal wells.
    - Ongoing characterization of the chemical constituents in produced water for the purpose of informing and establishing safe methods of treatment, reuse, or disposal.
    - Ongoing iterative evaluation of hydraulic fracturing fluids, and characterization of their chemical composition, toxicity, and use potential within a lifecycle framework.
4. ***Governments should facilitate transparent communication among stakeholders about hydraulic fracturing operations and related policies.***
    - Companies should be encouraged to work cooperatively with communities to address concerns, explain the hazards and risks, and jointly develop risk reduction and emergency response programs, and should continue to disclose the identities of chemicals used.

Guidelines or policies that hold industry accountable and government responsible should be formulated with input from all stakeholders, including the public, the scientific community, governments, and the oil and natural gas service and production industry.