Review finds environmental impact and toxicity of biocides used in fracking still largely unknown

December 11 2014

A Colorado State University-led research team has completed the most comprehensive review to date of the environmental fate and toxicity of the biocides most commonly used in hydraulic fracturing fluids.

Researchers analyzed more than 200 research papers, studies, and other literature to critically evaluate the current knowledge on how these chemicals may enter the environment, whether they are likely to degrade or persist, and if they or their degradation products may pose a risk to human health and the environment. The team also pinpointed various areas in which more research is urgently needed and identified the pros and cons of potential biocide alternatives.

The critical review article, "Biocides in Hydraulic Fracturing Fluids: A Critical Review of Their Usage, Mobility, Degradation, and Toxicity," was recently published in the prestigious journal *Environmental Science &Technology*.

"We were trying to figure out if there is sufficient information available for an accurate environmental impact assessment of this important class of chemical compounds, and identify where the major knowledge gaps are" said Jens Blotevogel, a research assistant professor of environmental engineering and a lead author on the paper.

Biocides are common chemical compounds used in many industrial

processes and are found in bleach and other household products. They also are used in hydraulic fracturing, a process in which a mixture of water, sand and chemicals is forcefully injected into a well to break rock and enhance oil and gas extraction.

Biocides are added to fracking fluids to kill bacteria that can corrode well casings, limit efficacy of oil and gas extraction, and produce highly toxic hydrogen sulfide gas.

The CSU-led team also includes Thomas Borch, an associate professor of environmental chemistry and the principal investigator for the project; Genevieve Kahrilas, a doctoral student and also lead author on the paper; and Philip Stewart, a professor from Montana State University. The paper focused on biocides because this group of chemicals is known to be toxic and thus has received significant attention from regulators and concerned citizens.

Specifically, little is known about what happens to these biocides if they are accidentally spilled on agricultural soil, enter surface or groundwater, or are exposed to the high temperature and pressure conditions in well boreholes.

"There have been a lot of conflicting studies," Borch said. "We wanted to look at a variety of literature related to biocides and try to derive conclusions that can be used to serve as a guide for environmental risk assessment and identification of microbial control strategies to help develop a sustainable path for managing hydraulic fracturing fluids."

After spending nearly a year reviewing biocides-related research, the team drew several conclusions outlined in the journal article, including:

- None of the 16 major biocides used in hydraulic fracturing are

specific to the oil and natural gas industry. All of them are used in other industrial processes and/or commercial products.

- Of the 16 major biocides used in fracking, nine have been reported to have chronic toxicity effects (such as developmental, reproductive, mutagenic, carcinogenic, or neurological effects). Of the seven that have not shown any evidence of chronic toxicity, three may transform into intermediate products with toxic potential.
- Based on currently available data, surface spills appear to be the most likely cause for environmental contamination by fracking fluids. According to the Colorado Oil and Gas Conservation Commission, in 2013 in Colorado there were 591 reported spills, which released a total of 590,000 gallons, or 0.004% of all produced water.
- If inadvertently released into the environment, some biocides will primarily contaminate water and will thus be more mobile but also break down faster. Others will stick to soil and be less mobile and thus take longer to break down.
- Many biocides degrade naturally in the environment, but some may transform into more toxic or persistent compounds.
- Hardly anything is known about transformation, sorption and transport of fracking chemicals once injected into these deep formations, which have high temperature, pressure, salt and organic matter concentrations. Consequently, little is known about the type and toxicity of the compounds that return to the surface with produced/flowback water. More research is critically needed to understand these processes.
- Several biocide alternatives exist but are rarely used because of higher costs and high energy demands or potential formation of toxic disinfection byproducts such as chloroform.
- Environmental and human health risks associated with the use and disposal of hydraulic fracturing fluids are not well understood due to lack of research.

More information: "Biocides in Hydraulic Fracturing Fluids: A Critical Review of Their Usage, Mobility, Degradation, and Toxicity." *Environ. Sci. Technol.*, Article ASAP DOI: 10.1021/es503724k

Provided by Colorado State University