Identifying and Quantifying Hazardous Chemicals in Produced Water

Oil and natural gas exploration and production creates large volumes of water, called produced water. This water is from ancient sea beds, and therefore often has high levels of salts and other minerals leached from the ancient ocean sediments, as well as dissolved organic chemicals from contact for millions of years with oil and natural gas. Naturally occurring chemicals and minerals in produced water include:

- Salts - often Na, Cl, Ca, sulfate and carbonate, varying from brackish (10,000 ppm salts) to over 10 times sea water salt concentrations (> 300,000 ppm salts)
- Minerals - boron, barium, iron, barium, copper, lithium, manganese, and others
- Naturally occurring radioactive materials (NORM) - often uranium and radium
- Organics - mainly petroleum hydrocarbons - benzene, toluene, xylene, and others

Produced water can also include chemicals used for drilling, fracking, and completions such as:

- Friction reducers –0.025% polyacrylamide,
- Biocides – 0.005% to 0.05% glutaraldehyde or quaternary amine
- Surfactants - 0.5 to 2 ppm phosphate,
- Thickeners - guar gum & cellulose polymers,
- Scale and Corrosion inhibitors - synthetic organics
- Other trace chemicals and synthetic compounds including Per- and Polyfluoroalkyl Substances (PFAS)

As shown in the figure below, most waste waters and surface waters in agricultural and industrial areas also contain a significant number of minerals, biological, and synthetic chemical compounds - including salts, metals, pesticides, herbicides, pharmaceuticals, NORM, and bacteria and viruses.

This highlights that the reuse of any waste water, including produced water, needs to be appropriately monitored, analyzed, and treated to meet all state and federal regulatory requirements in order to be protective of human and ecological health and safety.

Therefore, it is imperative that raw produced water and treated produced water be sampled and analyzed on a routine basis to assure that treated produced water planned for a specific fit-for-purpose use can meet all state and federal water quality and health and safety requirements established by the New Mexico Environment Department and the US Environmental Protection Agency (EPA).

To accomplish this, the Consortium is using sophisticated, state-of-the-science chemical analysis methods to accurately identify and measure chemical constituents in both raw and treated produced water. The analytical approaches being used for different constituents include:

- Ion chromatography (IC)
- Inductively coupled plasma optical emission spectroscopy (ICP-OES)
- Inductively coupled plasma mass spectroscopy (ICP-MS)
- Gamma Spectroscopy
- Fluorescence excitation emission matrices (FEEM)
- Spectro-fluorescence
- Gas chromatography (GC) and GC mass spectroscopy (GCMS)
- Liquid chromatography tandem MS (LC/MS/MS)
- Scanning electron microscopy/energy dispersion x-ray spectroscopy (SEM/EDX)

The ultra-performance liquid chromatography system at New Mexico State University can identify unknown constituents in a water sample by comparing their molecular mass and composition to a library of over 400,000 compounds. The ability to identify all constituents in a treated produced water using these modern chemical spectroscopy analysis techniques, combined with Whole Effluent Toxicity (WET) testing, human cell line testing, and green house testing (See related Fact Sheets for these additional testing approaches) will allow the Consortium to assess the effectiveness of treatment technologies to meet the identified health and safety requirements for any fit-for-purpose use.

References and More Information

- New Mexico Produced Water Research Consortium: https://nmpwrc.nmsu.edu/
- "Comprehensive Characterization of Produced Water and Surrounding Surface Water in the Permian Basin, United States", New Mexico State University, submitted for publication, October 2021.
- Mass Spectrometry - What It Is and How It Works: https://www.thoughtco.com/definition-of-mass-spectroscopy-605331
- 22 Types of Spectroscopies with Definition, Principle, Steps, Uses - MicrobeNotes.com: https://microbenotes.com/types-of-spectroscopy/
- A Critical Review of Analytical Methods for Comprehensive Characterization of Produced Water - MPDI.com: https://www.mdpi.com/2073-4441/13/2/183

Questions

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