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Advanced Water Treatment for Hydraulic Fracking Water

One of the energy sources widely available in the United States is natural gas. According to the U.S. Energy Information Administration (EIA), between 2005 and 2013 the total natural gas production in the U.S. has increased by 35%. This has been due largely to developments in production of natural gas from shale formations. In the last decade, the use of hydraulic fracturing or fracking process to extract natural gas from shale formations has skyrocketed.

The laboratory set-up of individual components used in the Advanced Water Treatment skid. The hydrodynamic cavitation unit is at the forefront, the UV-ozone generator is mounted on the wall, and two storage containers for testing the real produced water. The electrochemical cell along with hydrodynamic cavitation unit and UV-ozone generator form the Advanced Water Treatment skid.

Hydraulic fracking (HF) is a development process of injecting water, containing sand and chemicals, in wells under extremely high pressure to fracture or crack open pores in the shale formation to release the oil and gas. Hydraulic fracking process injects large quantity of water (~ 100 million gallons) per well. Ground water and surface water resources are withdrawn to account for the large volume of water needed for the hydraulic fracking process, which directly influences the availability of ground and surface water for other consumptions. The flow-back water and produced water obtained during the hydraulic fracking process contains organic chemicals, dissolved metal ions, total dissolved solids, and chemical additives. If the flow-back and produced waters are not sufficiently treated and discharged to bodies of water, then contamination of ground and surface water could have serious health issues to humans and animals. Therefore, water management and wastewater treatment presents major technical and economical challenge to the hydraulic fracking technology.

The focus of this breakthrough work is to combine different methods such as, mechanical, photochemical, and electrochemical, to treat the wastewater generated by the oil and gas industry, especially that produced water from hydraulic fracking process. A skid was developed by De Nora Tech, by combining three technologies - hydrodynamic cavitation system (mechanical), UV-ozone generator (photochemical), and electrochemical cell (electrochemical oxidation) to treat flow-back of fracking water. The skid unit was designed to treat 5 gallons of wastewater per minute (gpm) with capability to scale up to 400 gpm. The objectives for this investigation was to: evaluate the functioning of the skid in treating the real produced water from hydraulic fracking process; abate the primary constituents of the produced water to meet the National Primary Drinking Water Regulations, and; provide recommendations to improve and optimize the skid.

The skid was subjected to real produced water from a gas well to evaluate treatment efficiency for its primary constituents. The produced water had volatile organic compounds including benzene, toluene, ethylbenzene, and xylene commonly referred as BTEX, nitrogen-containing compounds, and dissolved metal ions such as iron and manganese. The key findings are that the combination of three technologies has completely broken down the volatile organic compounds (BTEX) found in the produced water, the concentration of iron was reduced by 83.3%, the manganese concentration was lowered by 87.5%. The concentration of nitrogen-containing compounds expressed in terms of total kjeldhal nitrogen (TKN) was reduced by 95%. The concentrations of BTEX, nitrogen-containing compounds (TKN), and manganese in the treated water was compliant with the National Primary Drinking Water Regulations.

Conventional methods of treating wastewater containing volatile organic compounds involves the use of expensive UV-ozone irradiation method. In the case of dissolved metal ions, chemicals are added to the wastewater resulting in formation of precipitates, which needs further treatment.

The advantage that this breakthrough Advance Water Treatment Unit has over the conventional methods is portability, economical, and ease of operation for this robust system. The Advanced Water Treatment Unit completely removed the volatile organic compounds, especially BTEX (known carcinogens).

The Advanced Water Treatment Unit is a simple and effective way of combining three proven technologies (hydrodynamic cavitation, UV-ozone, and electrochemical cell) for treatment of produced water to meet the National Primary Drinking Water Regulations. For the oil and gas industry, better treatment of wastewater should increase its reuse and reduce the demand for fresh water for the hydraulic fracking process. It is projected that an average of 2.4 billion gallons of produced water are extracted every day. This Advanced Water Treatment skid is portable. It can operate on-site and can handle 400 gpm of wastewater. The treated water at least has the potential to be reused for the hydraulic fracking process.

Economic impact: The three technologies included in the Advanced Water Treatment skid was arranged in a Plug -n-Play model, meaning multiple units of these technologies can be added or removed depending on the water quality of produced water and treated water. The largest waste stream in oil and gas production is the produced water with an average of 2.4 billion gallons extracted per day. In the hydraulic fracking process, the cost for transportation, includes bring water on-site for well development and transferring produced water for treatment or disposal, is estimated at $0.50 to $8 per barrel. The mobility and small footprint of Advanced Water Treatment Skids should make it easier to treat produced water on-site thereby saving some of the transportation costs. Current estimated cost for treating the produced water varies from $0.20 to $8.50 per barrel based on the technology, location (on-site or off-site), and end use. The ability to remove key constituents (BTEX, manganese) from produced water to meet the Water Regulations using the current configuration of the Advanced Water Treatment is a strong indicator for efficient treatment technology. One of the goals of this research it to bring the cost for treating the produced water between $2 and $4 per barrel using the Advanced Water Treatment Skid.

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