

## Economic Treatment of Frac Flow-Back Water to Recyclable Condition Using Physical Chemical Processes

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Economic treatment of frac flow-back water to a recyclable condition; that is, for reuse for in subsequent fracturing operations, has been developed and demonstrated in Southern Alberta. The treatment technology uses physical-chemical processes that were successfully demonstrated using a pilot plant capable of treating several four cubic meter samples of flow-back water at time. The frac flow-back water samples were contributed by several operators around Brooks, Alberta. The treated water was evaluated for use in subsequent fracturing operations. The treatment process is scalable to treat several thousand cubic metres of wastewater per day using fixed or movable treatment plants. The treatment technology promises to eliminate the need to dispose of flow-back water by deep well injection or to hold the wastewater in large storage ponds when deep wells disposal is not available.

The process to treat frac flow-back water to a recyclable condition involves complex reactions utilizing various chemicals at different stages followed by polishing treatment. The oil-water-mineral complex suspensions are knocked out during this process. The synthetic emulsifiers, de-emulsifiers, gellants and metallic cross linkers present in the frac water are suppressed at acidic and alkaline conditions in the presence of de-emulsifiers, coagulants and surfactants. The flocculated particles are removed in subsequent clarification process. Bacteria do not survive the treatment process. The sludge is dewatered to a stable dry cake for landfill disposal. Treated water may be economically reused in subsequent fracs.

The fluids used in hydraulic fracturing vary from pure water to gummy gels. Other frac treatments contain various substances to improve the fluid's flow characteristics and effectiveness in fracturing the rock formation. All fracture treatments are designed such that the fluids are limited to the hydrocarbon zone being treated. Fluid volumes introduced range from a few hundred to several hundred thousand litres. The amount of unrecovered fluid is typically 10 to 50 percent of what was introduced, usually less than 30%. The recovered fluid or flow-back water contains all of the additives originally put in to expedite the frac, (a variety of formation fluids and solids and gel breaking chemicals). The degraded

quality of the flow-back water limits its use, without treatment, in subsequent fracturing operations. It has proven very difficult to treat frac flow-back water to a condition where it may be safely disposed in natural surface water drainage systems.

The physical-chemical treatment process presented is able to treat frac flow-back water, of widely varying quality, from a variety of operators, to a condition where it could be economically reused in subsequent fracturing operations with or without dilution of 'new' fresh water supplies. Flow-back water resulting from the fracturing of newly developed gas wells could be treated and made available for subsequent fracturing operations (often two or more years after production has started). Water originally diverted and used for fracturing could be used to exhaustion. In so doing all disposal issues, except for solid wastes, can be minimized or avoided.

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Dr. Manz has more than thirty-five years of professional experience in water and wastewater management and treatment projects in Alberta oil sands projects, municipal water treatment, agricultural wastewater treatment, industrial water and wastewater treatment, irrigation and drainage engineering in Canada and internationally. He has significant business experience, including senior corporate and engineering management positions, in both privately and publicly owned water and wastewater treatment companies. He continues as a professor in various colleges and universities and nearly twenty years in humanitarian efforts to provide safe drinking water to disadvantaged communities worldwide. Dr. Manz has published numerous papers in journals and conference proceedings and is the author of several patents pertaining to water and wastewater treatment technologies.