Economic Disposal of Solid Oilfield Wastes

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Summary

A variety of solid oilfield wastes, including produced sand, tank bottoms, and crude contaminated soils, are generated during drilling, production, and storage processes. Crude oil and crude-contaminated sands or soils are generally designated as nonhazardous wastes. However, these materials still must be disposed of in an environmentally acceptable manner. The problems can become most pressing as oil fields in urban areas reach the end of their productive lives and the properties are redeveloped for residential use.

An economically and environmentally sound solution is to reinject the solid waste into sand formations through slurry fracture injection. Slurry injection has been used to dispose of drilling muds and cuttings in Alaska, the Gulf of Mexico, and the North Sea; naturally occurring radioactive materials in Alaska and the Gulf of Mexico; and large volumes of produced oily sand in the provinces of Alberta and Saskatchewan, Canada. The technique offers a number of economic and environmental advantages for disposal of solid oilfield wastes. When reinjecting into depleted oil sands, the crude waste is simply being returned to its place of origin. The long-term liability to the operator is eliminated, in marked contrast to surface storage or landfill disposal. Finally, fracture-injection costs are less than typical transport and landfill disposal costs for moderate to large quantities of solid waste.

Technical Design Considerations

Fig. 1[1] shows the basic components of a slurry-fracture-injection process. Solid wastes are screened, sometimes ground, and then mixed with fresh or produced water. The slurry is then injected downhole at high pressure. Slurry fracture injection is typically accomplished in periodic stages, each lasting from a few hours to several days. The solids concentration in the slurry can be as high as 30 to 40 vol% for fine grain materials ($< 150\ \mu$m) and on the order of 20 vol% for coarser materials. Injection should be carried out at relatively high rates (5 to 10 bbl/min) to maintain turbulent flow and avoid solids segregation in the wellbore.

The objective in large-scale solid-waste disposal is to pack as much solid material within the target formation as possible. This is best accomplished by packing the solids into short, thick, horizontally oriented fractures and allowing the carrying fluids to bleed off rapidly. The process is closely related to continuous "tip-screenout" fracturing and "frac-and-pack" operations used in high-permeability formations.

The ideal target formation should have relatively shallow to moderate depths (500 to 5,000 ft); flat-lying, laterally continuous strata; and alternating sand/shale stratigraphy, with target formations overlain by a thick, impermeable, ductile formation. The primary target intervals should be unconsolidated or weakly cemented, thick (>30 ft), porous ($>25\%$), and permeable (>1 darcy).

The injected solid material creates a complex process zone of combined tensile parting and shear dilation rather than a single, discrete fracture plane. As vertical-fracture zones are packed with solid-waste material, the minimum horizontal stress and the propagation pressure will increase. Eventually, the modification in stress can result in reorientation of the process zone into a horizontal direction, providing a more preferential geometry for vertical containment of large-scale waste injection.

Regulatory Issues

Wastes generated by oil and gas E&P activities, such as drilling fluids, produced waters, drill cuttings, and tank bottoms, generally are classified as "nonhazardous." Subtitle D of the Federal Resource Conservations & Recovery Act applies to management of such wastes and essentially delegates the regulatory responsibility to the states. In many areas, including California, such materials are classified as Class II fluids (because they are brought to the surface in conjunction with oil and gas operations) and are allowed to be disposed of into Class II injection wells on a case-by-case basis.

Regulatory agencies reviewing disposal of oilfield wastes through slurry fracture injection have several concerns. The materials to be injected must be tested properly and classified for the proposed type of injection well. The mechanical integrity of the injection well and nearby wells penetrating the injection interval must be confirmed. And finally, containment of the injected material must be clearly demonstrated and documented through design, analysis, and process monitoring.

Reference

1. Bruno, M.S. *et al.*: "Economic Disposal of Solid Oilfield Wastes Through Slurry Fracture Injection," paper SPE 29646 presented at the 1995 SPE Western Regional Meeting, Bakersfield, CA, March 8–10.

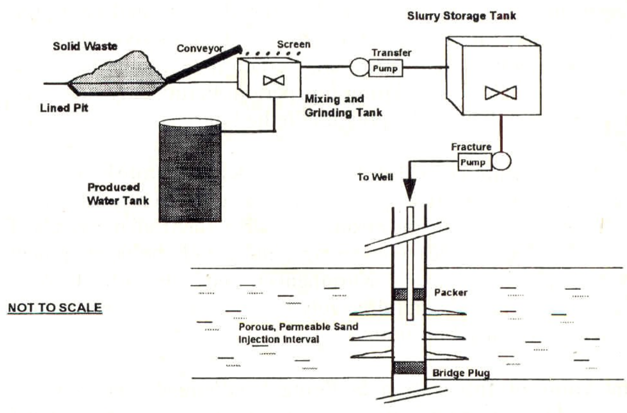

Fig. 1—Schematic of oilfield solid-waste slurry-fracture-injection process.

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bbl × 1.589 873	E − 01 = m^3
ft × 3.048*	E − 01 = m
md × 9.869 233	E − 04 = μm^2

*Conversion factor is exact.