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## Offshore Technology

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**Lynn Wagoner**  
**President TOGA**

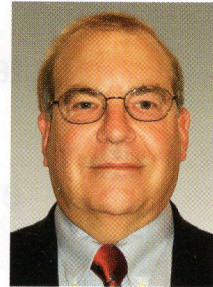
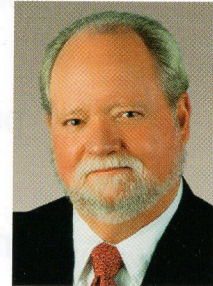
"Many wells that don't currently have a market for production can be brought back on line when the situation changes."

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**Carl Carlson**  
**President IOGA Pa**

"The Marcellus Shale presents Pennsylvania a tremendous opportunity for high paying jobs, capital influx, royalties to landowners, and income tax revenue."

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## Good Operators Get All There Is To Get From Each Well

This month's column focuses on a "nitty gritty" issue: getting the most from one's wells. This applies to new and mature wells, and to gas, oil and injection wells. It spans drilling and completion, stimulation, and operations. It is inspired by a March workshop in California on production enhancement techniques. Mason Medizade with Petrolects LLC and a professor of mechanical engineering at Cal Poly laid the groundwork, focusing on sources of damage and subsequent production enhancement. Representatives from Baker Petrolite, Halliburton and Schlumberger shared insights from their individual and corporate perspectives.

Skin is a term used to measure well bore damage. Positive skin indicates damage; negative skin indicates stimulation. Among the many potential causes for skin are damage to the formation itself, partial completion and slant wells, perforations, and pseudo skins caused by phase change or high flow rates.

Along the height of the producing interval, especially if multiple zones are producing, different formation properties and pressures lead to uneven skin effects. Uneven skin effects also can be present in horizontal wells. Uneven skin effects can be counteracted using diversion techniques during stimulation.

Skin caused by partial completion and slant wells is addressed through better completion engineering. Skin will be positive if less than 70 percent of the pay zone is perforated. Skin is negative for slant wells, and the larger the angle, the larger the negative skin will be. Perforating underbalanced minimizes perforation skin.

Damage to the formation itself may result from particles plugging pore spaces, fines migration, chemical precipitation, fluid damage, emulsions, relative permeability and wettability effects, mechanical damage, and biological damage. When naturally present fines bridge pore throats, local permeability is essentially zero. For bridging to occur, particle sizes must be on the order of 0.33-0.14 the size of the pore throat or larger. Most formation fines are water-wet, so the presence of a mobile water phase can cause fines migration and subsequent formation damage.

Fluids (drilling fluid filtrate, completion fluids, stimulation fluids and injection brine) should have a nondamaging ionic composition. The higher the formation brine pH, the more sensitive the porous media will be to salinity changes. To minimize damage, brines should contain at least 2 percent by weight KCl with 0.1 percent of the cations being divalent. Water sensitivity is greatest for NaCl brines, and decreases in the order Na, K and NH<sub>4</sub>. Inorganic precipitates usually result from divalent cations (Ca, Ba) combining with CO<sub>3</sub> or SO<sub>4</sub> sulfate ions.

Precipitates can result from injecting fluids containing CaCl<sub>2</sub> or from liberated CO<sub>2</sub> near the well bore as a result of pressure drop. Completion fluids should be filtered and should contain no more than two parts per million solids of a size less than two microns. Injected fluids also should be filtered so no particles larger than two microns are present.

Paraffin can precipitate when temperature is reduced or the oil composition changes with gas liberation as pressure is reduced.

*“Is the formation delivering all it is capable of?”*

There are a variety of paraffin management tools: operating practices, mechanical control (scrapers), and chemical (both prevention and removal). Certain polymers inhibit crystal growth. Properly chosen surfactants render paraffin particles water-wet so that they will flow with produced water.

Asphaltene, which is naturally dispersed in crude oil, precipitates as a result of pressure drop, shear (turbulent flow), acids, CO<sub>2</sub>-injected condensate, or mixing of incompatible crudes. In matrix acidizing, iron ions in solution can promote asphaltene precipitation. Asphaltene flocculation can result in a severe loss in productivity. Aromatic solvents normally are used to remove asphaltene from near the well bore. Asphaltene dispersants are used before applying acids or heat to the reservoir.

Emulsions, which have higher viscosity than the oils they are formed from, typically are formed chemically through the introduction of surfactants or fines. Water block, an increase in water saturation around the well bore, and wettability change from water-wet to oil-wet can reduce oil movement. Properly designed kill fluids can break emulsion or water blocks.

Regarding drilling damage, studies indicate that mud particles may invade up to one foot, while mud filtrate can invade up to six feet. Damage is more serious in horizontals, especially near the heel where the formation is exposed longer. There is inevitably some damage around perforations. Both drilling- and perforating-induced damage can be minimized with underbalanced operations.

For further information, contact Mason Medizade at [mm@petrolects.com](mailto:mm@petrolects.com). For those really interested in the topic, SPE Monograph No. 19, "Completion and Workover Fluids," can be ordered at [www.spe.org](http://www.spe.org). Dewey Sparlin at International Completion Consultants Inc. (phone 281-444-1014) occasionally delivers an SPE short course titled, "Formation Damage Prevention." John Campanella at Norwest Questa Engineering is delivering a Rocky Mountain workshop on successfully awakening mature oil fields on May 20 in Golden, Co. ([www.eventbrite.com/event/94763440](http://www.eventbrite.com/event/94763440)). A portion of the agenda undoubtedly will address damage/enhancement. □



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