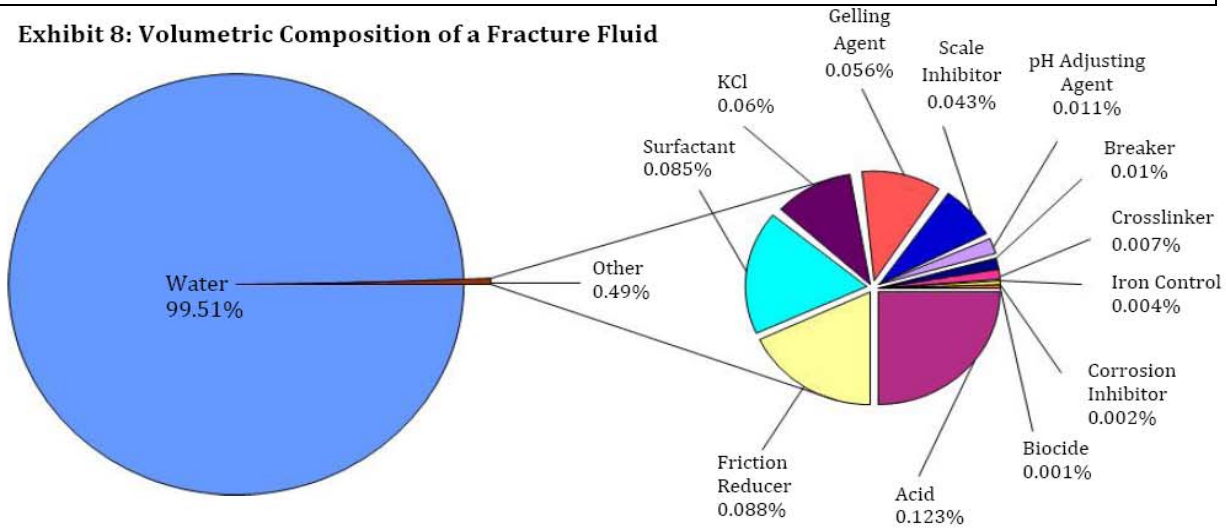
**See complete report on fracture stimulation technology "Fracture Stimulation Info" under the Fayetteville Shale Information tab on the AOGC web page**

**Exhibit 8: Volumetric Composition of a Fracture Fluid**




*Source: Compiled from Data collected at a Fayetteville Shale Fracture Stimulations by ALL Consulting 2008.*

**EXHIBIT 9: FRACTURING FLUID ADDITIVES, MAIN COMPOUNDS AND COMMON USES.**

| Additive Type | Main Compound | Use in Hydraulic Fracturing Fluids | Common Use of Main Compound |
|---|---|---|---|
| Acid | Hydrochloric acid or muriatic acid | For the fracturing of shale formations, acids are used to clean cement from casing perforations and drilling mud clogging natural formation porosity, if any prior to fracturing fluid injection (dilute acids concentrations are typically about 15% acid) | Swimming pool chemical and cleaner |
| Biocide | Glutaralde-hyde | Fracture fluids typically contain gels which are organic and can therefore provide a medium for bacterial growth. Bacteria can break down the gelling agent reducing its viscosity and ability to carry proppant. Biocides are added to the mixing tanks with the gelling agents to kill these bacteria. | Cold sterilant in health care industry |
| Breaker | Sodium Chloride | Chemicals that are typically introduced toward the later sequences of a frac job to "break down" the viscosity of the gelling agent to better release the proppant from the fluid as well as enhance the recovery or "flowback" of the fracturing fluid, | Sodium chloride is also used as a food preservative. |
| Corrosion inhibitor | N,n-dimethyl formamide | Used in fracture fluids that contain acids; inhibits the corrosion of steel tubing, well casings, tools, and tanks. | Used as a crystallization medium in Pharmaceutical Industry |
| Crosslinker | Borate Salts | There are two basic types of gels that are used in fracturing fluids; linear and cross-linked gels. Cross-linked gels have the advantage of higher viscosities that do not break down quickly. | Non-CCA wood preservatives and fungicides |
| Friction Reducer | Petroleum distillate or Mineral oil | Minimizes friction allowing fracture fluids to be injected at optimum rates and pressures | Cosmetics including hair, make-up, nail and skin products |
| Gel | Guar gum or hydroxyethyl cellulose | Gels are used in fracturing fluids to increase fluid viscosity allowing it to carry more proppant than a straight water solution. In general, gelling agents are biodegradable. | Guar gum is a food-grade product used to increase the viscosity and elasticity of foods such as ice cream, and |

| | | | |
|---|---|---|---|
| | | | salad dressings |
| Iron Control | Citric acid | Sequestering agent that prevents precipitation of metal oxides. | Citric Acid it is used to remove lime deposits. Lemon Juice is approximately 7% Citric Acid |
| KCl | Potassium Chloride | Added to water to create a brine carrier fluid. | Low sodium table salt substitute |
| Oxygen scavenger | Ammonium bisulfite | Oxygen present in fracturing fluids through dissolution of air causes the premature degradation of the fracturing fluid, oxygen scavengers are commonly used bind the oxygen. | Used in cosmetics |
| Proppant | Silica, quartz sand | Proppants consist of granular material, such as sand, which is mixed with the fracture fluid and is used to hold open the hydraulic fractures allowing the gas or oil to flow to the production well. | Play box sand, concrete or mortar sand |
| Scale inhibitor | Ethylene glycol | Additive to prevent precipitation of scale (calcium carbonate precipitate). | Automotive antifreeze and de-icing agent |
| Surfactant | Naphthalene | Used to increase the viscosity of the fracture fluid. | Household fumigant (found in mothballs) |