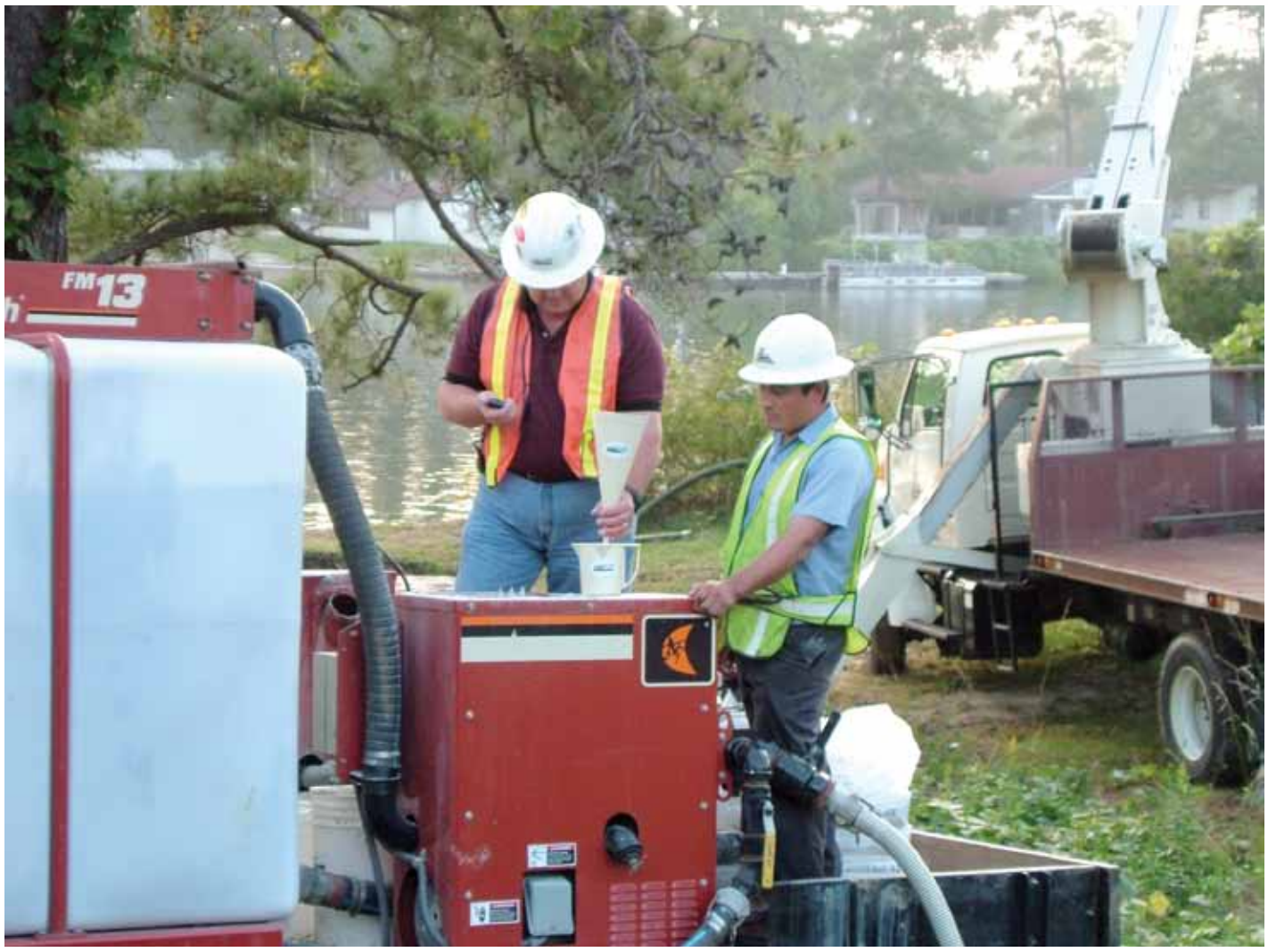
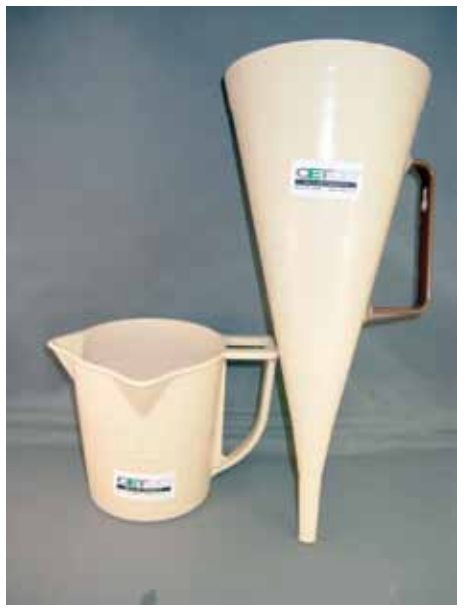
GEORGE DUGAN

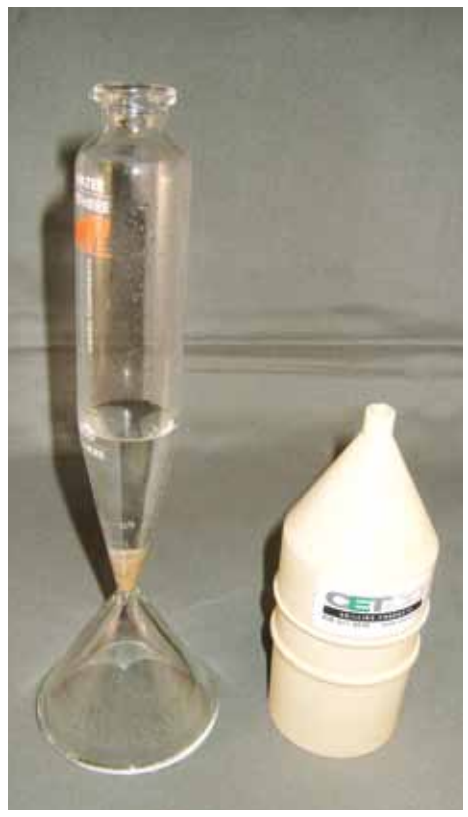
Funnel Viscosity Not the Whole Story



George Dugan (L) loves nothing better than being out in the field playing with mud.



Funnel viscosity reports the thickness of a drilling fluid.



A sand content test.

It is ironic that of all the different types of tests that can be performed on drilling fluids, the one test most commonly performed provides us with the least amount of information. The marsh funnel viscosity test undoubtedly is the hands-down favorite among drilling contractors from any drilling industry that utilizes either mineral (bentonite) or polymer-based drilling fluids or slurry, but funnel viscosity only tells us the thickness of a drilling fluid. Determining the funnel viscosity of a drilling fluid does not accurately tell us how well the fluid will keep a hole open, convey cuttings to the surface, or perform any other function expected of a drilling fluid. It is important to understand the limitations of the funnel viscosity test, and know when to delve deeper into drilling fluids testing and rheology in order to determine whether a drilling fluid is capable of performing the functions required to complete a drilling project effectively.

Looking up the word "viscosity" in *Webster's New World Dictionary*, you will find that viscosity is "the internal friction of a fluid which makes it resist flowing past a solid surface or other layers of the fluid." This definition should get the attention of anyone using drilling fluids for rotary mud drilling, because this statement indicates that viscosity can work against us in our efforts to perform the functions expected of a drilling fluid. Higher-viscosity (thicker) drilling fluids will require more pressure at the drill bit or reamer to move the column of drilling fluid out of the hole, especially when drill cuttings are thrown into the mix, further increasing the viscosity of the returns. Additional pressure at the drilling head or reamer increases the chances of compromising the structural integrity of the hole, which can result in formation damage, loss circulation and/or frac-outs (especially in horizontal directional drilling applications). Higher-viscosity drilling fluids are more difficult to keep clean, regardless of whether one is utilizing mechanical solids-removal equipment or relying on gravity to settle drill cuttings, resulting in higher drill solids and poor-quality drilling fluids.

Bentonite drilling fluid is non-Newtonian, which means that the viscosity changes with shear. Viscosity in Newtonian fluids, such as water and oil, changes with temperature (the hotter the fluid, the thinner it gets), whereas non-Newtonian bentonite drilling fluids get thinner with shear and should pump easily, yet transform into a gel-like substance at rest and suspend drill cuttings. Bentonite drilling fluid also can be described as thyrotrophic, according to *Principles of Drilling Fluid Control*, because of its "ability to build up a rigid or semi-rigid gel structure if allowed to stand at rest, yet can be returned to a fluid state by mechanical agitation." The most effective and efficient drilling fluid is one that can perform all of the functions of a drilling fluid (gel strength, suspend drill cuttings, stabilize the borehole, etc.) at the lowest possible viscosity.

The routine of checking funnel viscosity gives us a relative indication of how much bentonite or polymer is in a drilling fluid, and is a first step in matching drilling fluids to soil conditions. When recycling/re-circulating drilling fluid, it is important to test the funnel viscosity frequently in order to maintain the drilling fluid properties needed to complete a drilling project. As drilling fluid is re-circulated along with an increasing amount of retained of drill cuttings, these drill cuttings continually get ground down until they are close to the particle size of clay (0 to 2 microns). A drilling fluid contaminated with ultra-fine drill cuttings, or contaminants such as lime, can exhibit a high funnel viscosity, yet have poor fluid-loss properties that hamper the ability to maintain an open hole; low gel strength, which can lead to hole plugging and/or stuck drill pipe; and high densities that increase the chances of formation damage and loss circulation. A sand-content test will indicate the amount of drill cuttings 74 microns and larger in a drilling fluid, but a mud balance is needed in order to identify high concentrations of ultra-fine solids in a drilling fluid.

Mud weights above nine pounds per gallon indicate high levels of ultra-fine solids, and the only remedy is to discard and replace partial volumes of the solids-laden fluid with new (clean) drilling fluid to lower the solids concentration/density.

Although testing the funnel viscosity of a drilling fluid yields little information on the performance or quality of the fluid, it is a vital step in matching a drilling fluid to soil conditions, as well as maintaining a drilling fluid throughout the drilling process. It is important to understand that additional testing is needed to develop a complete picture of what is happening with a drilling fluid, and determine what is needed to make the necessary corrections to get the job done. ND

George Dugan is a regional manager for CETCO.