A culture of successful cementing operations requires diligent support from a number of different processes. Engineering, slurry performance and execution can each contribute to failed cementing objectives. Permian Basin operators are facing a growing frequency of cementing failures and have partnered with third-party cement laboratories like CSI Technologies to find a solution to these cementing failures.

The intention is to mitigate failure trends by incorporating the benefits of third-party laboratory testing at the critical stage between cement blending and prior to execution. Though the process cannot inherently eliminate all process failure contributors, utilization of third-party laboratory evaluation of final blended components has proven to offer low-cost failure prevention benefits.

**Testing procedures**

Globally accepted, the API RP 10B-2: Recommended Practice for Testing Well Cements outlines the specific details for laboratory equipment and procedures used to understand the fluid and set mechanical nature of a given cement system. When coupled with sound well diagnostics and dynamic flow computation, the downhole conditions (namely temperature and pressure) needed to utilize these laboratory techniques are made available. Slurry evaluation gives insight into the fluid properties such as pumpability, flow characteristics, liquid stability and safe handling time of the slurry. Set mechanical properties are commonly limited to compressive strength of the post-cured slurry and give evidence of a set cement’s ability to provide structural support and maintain hydraulic isolation.

Empirical data are gathered on each slurry to ensure the fluid and set mechanical properties...
are sufficient using the described laboratory tests. These properties are optimized by incorporating countless variations and concentrations of cementing components and additives.

**Testing caveats**

It is likely that this ever-widening variation of slurry composition drove the industry to generally use the laboratory results (acceptable result threshold), rather than that of composition, for the proper fluid and set properties of a well-designed cement system. Although this process of slurry evaluation may sound straightforward, there are two significant caveats.

The first caveat, or potential discrepancy, lies within the accuracy of the collected data. Actual downhole conditions for which a cement system is designed can and often change significantly from the planning stage (pre-drill) to the execution stage (post-drill). The planning and original design of a cement system can take place days and sometimes weeks before the actual operation commences, and this implies that even if acceptable laboratory results are achieved early or prior to the drilling process, they may have been conducted under non-representative downhole conditions. This potential discrepancy creates a logistical and operational inconvenience on all involved parties. Communication to the cement service provider (responsible for final slurry design) is often done late in the well section drilling phase. The service provider has very little time to evaluate the significance of the downhole condition changes to make necessary modifications to the slurry performance under these new circumstances. Unfortunately, this often results in slurries designed for different downhole environments to be pumped either without knowledge of the discrepancy or without sufficient time or due diligence to make the necessary modifications.

The second caveat is improperly blended components/additives. This discrepancy exists when a “properly” designed cement slurry was planned for use, but blending the dry materials was mismanaged. As previously described, the acceptable results of a slurry are a function of the components and their associated concentrations.

If these concentrations are inconsistent with the finalized design (as confirmed by laboratory testing), significant differences in downhole performance should be expected. Common blending and sampling techniques too often are not designed to implement a quality check at this point. As would be expected, this behavior also frequently results in cementing operational failures.

**Third-party testing**

For more than 20 years, third-party cement laboratories like CSI Technologies have been aiding operators by conducting post-failure investigations intended to shed light onto the nature of the failure and, in many cases, provide compelling root cause analysis. To prevent failures before they happen, CSI has developed a customized partnership that includes an engineering downhole condition comparison, independent bulk plant sample collection, localized laboratory facilities, limited testing protocol and trending monthly performance metrics. These components were selected for the direct transparency they offer to known major failure contributors. A successful cementing operation is a culmination of a variety of diligent efforts. These efforts all exist as sub-components of the following cement operational processes: dynamic placement engineering, slurry component/additive attributes and care of execution.

In a relatively short period of implementation, the process suggests that consistent, noninvasive, third-party evaluation of a slurry field blend appears to have all but eliminated the failure mechanisms. A third-party evaluation has improved communication and overall cement success and has increased general confidence in cementing operations.