DEEP SOUTH CHEMICAL, INC.
Just The Right Chemistry

COMMITTED TO ADVANCING THE SCIENCE OF WELLBORE CLEANING TECHNOLOGY…

DEEP SOUTH CHEMICAL, INC.
SPECIALTY CLEANING TOOL DIVISION

UTILIZING MECHANICAL CLEANING TOOLS ON WELLBORES: INDUSTRY BENEFITS VS. SIDE EFFECTS

Cleaning wellbores with combination scrapers and brushes has become more than a familiar catch-phrase for the wellbore cleaning industry even as the industry begins to put more emphasis on more effective displacements and surface cleaning quality. But where do specialty scrapers and brushes fit in a low-tech oilfield tool world?

By David G. Hines and Glenn P. Ray, Deep South Chemical, Inc.

Cleaning wellbores with combination scrapers and brushes (Combo Tools) has become more than a familiar catch-phrase for the wellbore cleaning industry even as it puts an increased emphasis on more effective displacements and surface cleaning quality.

While industry professionals offer differing views, most agree that Combo Tools benefit the wellbore cleaning industry. But where does that leave the wellbore cleaning professional? Do wellbore cleaning professionals clean for more effective displacements or emphasize surface cleaning quality?

Cleaning for Effective Displacements

Cleaning for effective displacements is the removal of a thin, low-permeable filter cake, consisting of lost circulation materials, emulsions, and unwanted elements that may have an adverse effect on the complete recovery of the drilling and completion fluids without compromising the integrity of the wellbore and the environment. Sometimes these elements are found in WBM, SOBM and OBM explains Dr. SK Baijal, Director of the Surface Cleaning Laboratory and Environmental Compliance, Deep South Chemical, Inc., Broussard, Louisiana.

According to Dr. Baijal, “what a responsible wellbore cleaning professional does through the process of wellbore cleaning is to create a sense of cleaning assurance and peace of mind that in turn creates a positive economic advantage to the operator”.

“Wellbore cleaning is facing a definite revolution. Drastic changes in the industry are being driven by two competing goals: highly cleaned wellbores with complete drilling fluid recovery and increasingly stringent environmental regulations including limitations on dumping overboard and waste disposal”.

Aqueous Cleaning

The theory of aqueous cleaning is based on the ability of water and water based formulations to remove water soluble and insoluble contaminants.

Most aqueous cleaning agents consist of water and one or more of the following components: builders, surfactants, corrosion inhibitors, dispersants, sequestering/chelating agents, defoamers and inorganic additives to promote better wellbore cleaning. In some cases, aqueous cleaning without additions has been found to provide adequate cleaning.

Aqueous wellbore cleaning systems in general have been effective for the removal of a wide of a range of contaminants.

Aqueous cleaning is a mature technology widely accepted for WBM wellbore cleaning. An estimated 65 percent of all wellbore cleaning applications and 90 percent of all WBM wellbore cleaning applications
utilize some type of aqueous cleaning system.

Among the many approaches to wellbore cleaning, aqueous solutions should always be considered first, on the basis of two key advantages: the solvent (i.e., water) is inherently safe (not flammable, combustible or toxic) and does not contribute to ozone depletion or smog. In general, aqueous cleaning solutions cost less than organic solvent systems.

Solvent-Based: A Viable Alternative for Wellbore Cleaning

Organic solvents have historically dominated the OBM and SOBM cleaning industry. Although advances have been made in aqueous cleaning, there are numerous cases in which using an organic solvent is the most cost-effective method to obtain casing and tubulars that meet rigid specifications for wellbore cleanliness. The environmental and health hazards associated with aromatic and aliphatic hydrocarbon solvents as well as the limitations associated with aqueous and semi-aqueous based cleaning warrant a review of hydrocarbon solvents, many of which were previously discarded when CFCs became the industrial standards. A wide range of aliphatic hydrocarbons can be used in cleaning, including mineral spirits and kerosene. Ketones, alcohols, terpenes, esters and other solvents are also employed for wellbore cleaning. New solvents, specifically for wellbore cleaning, are continually being developed.

Solvent selection depends on a number of factors including environmental acceptability, favorable toxicity, performance characteristics and availability. The cleaning abilities of various solvents are closely tied to a number of physicochemical properties, such as surface tension, solubility and solvency. The primary task of solvent wellbore cleaning systems is removing hydrocarbons and other oil wet solids. Extensive on going research has been and is being done by **DSC's Surface Testing Laboratory** for tailor-made solutions for optimizing cleaning performance and providing sustained effectiveness of using solvent technology in wellbore cleaning.

Low Surface Tension

Allows the solvent to readily penetrate blind holes, crevices and porous surfaces.

Solubility and Solvency

The Hildebrand solubility parameter indicates how miscible liquids are with one another, as well as solubility of a solid in the solvent. For solutions that approach regular behavior, plots of the log of the mole fraction of the solute vs. the square of difference between the solubility parameter of the solvent and the solute should be approximately linear. Thus, this parameter can estimate how well a specific solvent might dissolve a specific contaminant. Additional criterion, such as polarity, must be considered when using solubility parameters. These parameters only provide semi-quantitative results and are most reliable for non-polar components.

The Kauri-butanol (KB) number (ASTM D1133) is an empirical representation of the solvency power of a solvent. KB is the volume (in mls) of solvent at 25° C. required to produce a specified degree of turbidity when added to 20g of a standard Kauri resin and n-butanol solution. In general, the higher the KB number, the better the solvent. Depending on the substrate to be cleaned, an intermediate KB value (around 30 to 35) is advantageous, since solvents with high KB values can be more likely to attack substrates, especially emulsifier packages inherent to Oil Base Mud and Synthetic Oil Base Muds .

The solvent power of "chemical" or oxygenated solvents such as ketones, alcohols, esters and glycol esters is much greater than that of hydrocarbons and techniques to determine solvency such as the KB value are not applicable.

There is a linear relationship between the KB number and the Hildebrand solubility parameter for KB numbers greater than 35. For aliphatic hydrocarbons with KB values less than 35, another relationship includes a correction for molecular size.

Safety issues should also be addressed.

Safety Considerations

Solvents having higher flash points can be heated if necessary for increased cleaning power, but solvent temperature should be well controlled to at least 15° C. below the flash point unless explosion-proof equipment is being used. Safe and efficient use of these solvents demands that they be used in a closed system, engineered so that no sparks can get near the solvent. Additionally, the equipment must minimize all solvent loss for environmental, toxicological and economic concerns.

Protection of the environment must not compromise employee safety. A compound's toxicity and carcinogenicity must also be considered. The threshold limit value (TLV) is the recommended occupational value proposed by the American Conference of Governmental Industrial Hygienists (ACGIH) to express the airborne concentration of a material that nearly all workers can be exposed to day after day without adverse effects. OSHA has similar guidelines on many compounds; OSHA's values are enforced.

Wellbore Cleaning

For all displacements and wellbore cleanup, a clean water wet metal surface is essential. The cleaning process must remove mineral oils, organic oils and thread compounds as well as

chemical residues left on the metal surfaces. The wellbore cleaning system must remove all drilling fluids and its components which might interfere with packer settings, water wetting for corrosion inhibition and cement placement. Effective wellbore cleaning may be accomplished by using mechanical (abrasive) and/or chemical (solvents, surfactants) means. After cleaning, the metal surface should be free of solids and oils and completely water wet.

While Oil Base Mud and Synthetic Oil Base Mud's aim is a suspension of solids, i.e., emulsifiers, LCM, barite, colloidal clays, thinners, surfactants, cellulosic and acrylic polymers and many other chemical additives required to modify mud properties, it has been found to contain many questionable elements. These include known carcinogens, small formation cuttings, salts, drilled solid residues and many types of diesel, crude and synthetic oils, including mineral, esters and olefins.

Contaminants, such as formation fines and emulsions from particles in the drilling mud, have been linked to formation damage. Studies have shown these elements as possible causative factors for potential damage in the production of hydrocarbons from an oil and gas bearing formations.

A Surface Cleaning Issue

According to D. Jeff Harrison, Vice President - Sales of Deep South Chemical, Inc.'s Wellbore Cleaning Division, sharp burrs and metal splinters can turn up in casing from continual metal to metal contact from drill bits etc. "As far as utilizing the DSC Combo Scraper/Brush to perform machinelike downhole metalworking, such as deburring, surface finishing, edge bending, roughening and cleaning there is no problem. And there never has been, despite popular misconceptions."

He says, "the risks from using downhole cleaning tools will save hours of circulating downtime, completion fluid filtration and fishing problems."
"The DSC Combo Scraper/Brush serves as an excellent cylindrical tool for radial cleaning. The method of construction combines the best features of tool stabilization and centralization with a high quality non-pressured brush design. Using the latest CNC controlled brush filling machines, DSC utilizes the *Chevron* brush design that is very effective for running in the hole at slow or fast speeds and to entirely remove fine or bulky solids and debris. The crimped filament brush material is permanently secured with an anchoring centering wire. This metal construction is very sturdy and is highly dependable", Harrison says.

"When you talk about the issue of brush wear and tear especially losing bristles in the hole", says Harrison, "the perspective is that the more brush bristles you fill the brush pad with, coupled with the amount of constant pressure that is exerted on the bristles, is necessary for surface cleaning. That philosophy is contrary to modern brush technology. Proper surface cleaning is not determined by the number of bristles in a brush and/or how much constant pressure that is used. But proper surface cleaning can be accomplished using mechanical (high quality, effective brush design ideally suited for wellbore cleaning and the correct amount of pressure to clean) and chemical (solvents and surfactants) means. And for that reason we do not use pressured pads that force the bristle against the metal surface. Our DSC Combo Scraper/Brush has a much higher bristle life expectancy and our client will not be left with the task of wondering if the

brushes wore out going in the hole or coming out of the hole. Much less, wondering if the wire filaments, that used to be in the brush pads when the tool went in the hole, have mysteriously wound up in the formation".

"Just about every other brush company in the marketplace advocates brushing too hard. Mistakenly believing that the harder they brush the cleaner the wellbore surface will be...most likely not!" says Harrison.

After a certain amount of pressure you don't get the metal surface cleaner but you do damage the metal surface and cause the bristles to lay flat and leave tool joints untouched and still filled with formation damaging debris.
The DSC Combo Scraper/Brush solves that problem by exerting the proper amount of pressure, so the bristles can clean the intimacies of the metal surfaces and reach into the tool joint crevices to effectively remove all debris.

"It is vitally important to the operators overall success that we show how proper wellbore cleaning is achieved and not perceived" Harrison concluded.

Tool Optimization

To enhance complete solids removal, most all of the time, a 'short trip' of the tools is made. Running one tool to total depth and then bringing that tool back to the surface for a 'short trip' would normally not be economical. Multiple tools, spaced out properly in the wellbore, would present the most cost savings. Deep South Chemical, Inc. has developed a software program to "optimize" the number of tools necessary to be utilized for the most cost-effective short trip. The DSC "optimization" software takes into consideration the size of the casing, the casing depth, trip speed in feet per hour, trip time in hours, rig cost per day and the tool cost. The program calculates the number of tools; short trip distance in feet and total cost that is optimum for all of the wellbore, rig and tool parameters.

Advantages of Stationary Brushes

Rugged Construction – The only surface cleaning brush pad that is tough enough to stand up under prolonged, heavy use.

Easy on Pipe Surfaces – Brushes are dynamically balanced and non-abrasive, resulting in a cleaner surface and longer brush life.

Surface Conditioning – Non-pressured brushing action produces uniform radial cleaning action that thoroughly cleans the casing surface without creating additional metal fatigue and stress**.**
DSC Casing Scrapers are designed to remove burrs created by other operations. **DSC Casing**

Scrapers will remove the burr without creating secondary burrs or leaving two sharp edges.

True Selective Cleaning – Stationary brushes are distinctly suited for removal of surface contamination and allows the wet cleaning operations to chemically clean the metal surface. And by utilizing flexible long trim bristles the brush can best contact irregular surfaces such as pipe joints and well profiles.

Brushes Are Non-Loading – Unlike pressured brush pads, brushes will not load when brushing highly solids laden area.

Disadvantage's Of Using A Pressurized Brush Pad

Depth of Engagement – *is the position of the casing surface relative to the free position of the brush.* Increasing the amount of pressure or penetration produces more heat, which shortens brush life and causes deterioration on the casing surface. Increased pressure causes greater filament deflection, which accelerates fatigue-related breakdown of the brush.

Trim Length – *is the radial length of the filament exposed beyond the brush pad. It is the amount of fill material that can flex and do work.* Reducing the trim length by mechanically pressing the brush filaments against the casing surface impairs the brush's ability to follow the casing contour. A brush with reduced trim length is more aggressive to the casing surface and may cause stress cracks and metal fatigue.

Brush Construction Features – *can influence brush life. While many of these features are a function of the brush manufacturer selected, there are some guidelines, which should be considered.*

- The more rigid and structurally solid a brush is, the more brush life is increased.
- Brushes generate heat during operation. Pressured brushes have no way of dissipating the heat. Bending and breaking could become a very big problem.

In Conclusion

It is widely understood that chemical and mechanical means are best when it comes to complete wellbore cleaning. Chemicals alone have been used for many years with good results. With the introduction of mechanical cleaning utilizing a scraper and a brush, i.e., the **DSC Combo Scraper/Brush**, when used in conjunction with chemical cleaning, operators now have the peace of mind that their wellbore has been meticulously and scrupulously cleaned in less time, utilizing computer software for optimization which will all lead to a clean, 'solids free', timely and most productive completion.

SOME "KEY POINTS" YOU DEFINITELY SHOULD CAREFULLY CONSIDER:

- If the word "brushes" only reminds you of street sweepers and brooms.
- If your well cost is over budget because of a poor displacement and packer failures.
- If you want to reduce costly filtration time.
- If running conventional casing scrapers do not meet all your wellbore cleaning requirements.
- If intelligent product solutions are a "requirement" for you.

When it comes to high quality wellbore cleaning brushes, Deep South is your competent supplier in nearly every case.

IMPORTANT CASING BRUSHING TIPS:

- **Contact Pressure**

It is important to remember that the tips of wire filaments do the actual work. Where high brush pressures and speeds are required, it is recommended that a more aggressive brush be used. This may be done by increasing wire size, decreasing trim length, or in some instances changing to another brush type.

- **Brush Pressure**

Avoid excessive brush pressure against the casing wall. This reduces the efficiency of the brush and could cause premature failure during operation.
See Brush Down Pressure illustration below.

- **Fill Density**

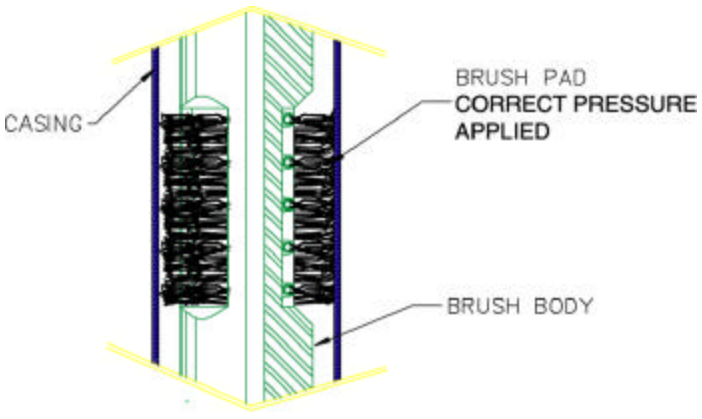
The number of wire filaments per square surface area determines fill density. High-density brushes are used to produce finer surface finishes and also where fast cutting action is required for example burr removing operations. Low-density brushes offer greater brush flexibility; the individual wires operate like a whip.

- **Flexibility**

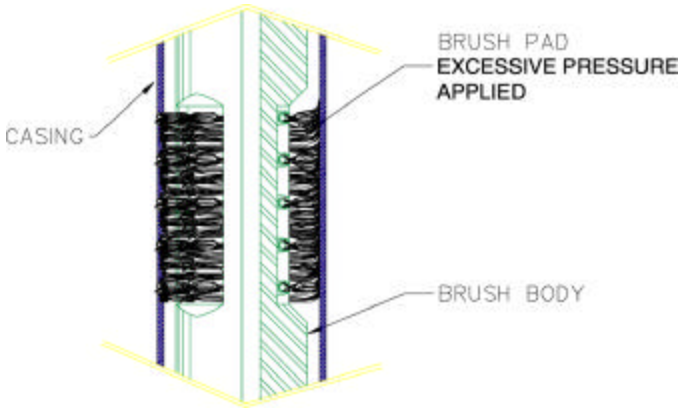
That quality of a brush, which determines resiliency and ability to reach into confined areas and conform to uneven or contoured surfaces.

BRUSH DOWN PRESSURE

SINCE THE **LATERAL FORCES** ON THE FILAMENT ARE TYPICALLY MUCH LESS THAN THE **TIP FORCES**, THE AMOUNT OF WORK DONE BY THIS "SIDE ACTION" IS TYPICALLY LESS THAN THAT DONE BY THE TIPS.



Correct Pressure



Excessive Pressure