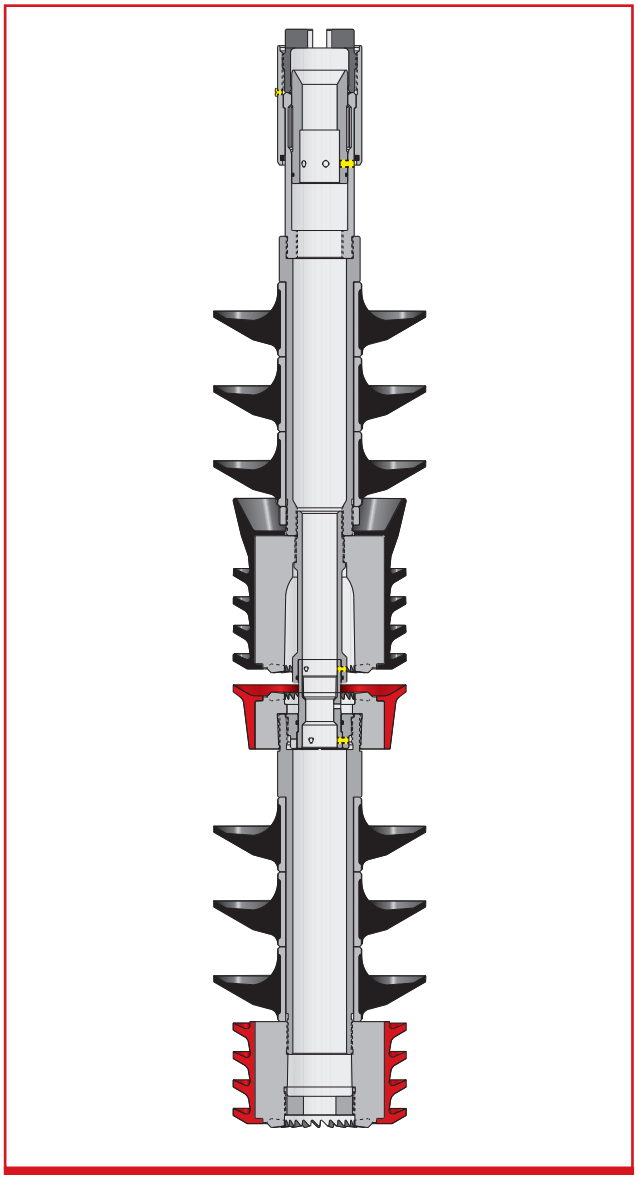
Five Wiper Cementing Plugs for Combination Casing Strings

Building on more than 85 years of designing mechanical cementing plugs for the oil and gas industry, Halliburton has designed a suite of combination cementing plugs. These plugs are used to cement multiple casing string sizes and weights in single casing string well designs. Use of combination cementing plugs allows the cementing of tapered casing strings while helping ensure efficient cement removal from the various casing IDs in the same casing string.

Like the standard version, the combination plugs feature rubber coated aluminum or plastic inserts available in 4 1/2-in. to 20-in. casing sizes as well as red rubber bottom plug and black colored top plug. The bottom plug rupture diaphragm has a 600 to 1500 psi differential.

Features

- Compatible with oil-based mud, synthetic mud, and water-based mud systems
- Available in a variety of size combinations and several design types, such as:
  - Combination string standard top and bottom five wiper plugs and HWE® wiper plugs
  - Combination string standard non rotating top and bottom five wiper plugs
  - Combination string standard top and bottom five wiper plugs for use with SSR® subsurface release plug systems
  - Combination string standard non rotating top and bottom five wiper plugs for use with SSR subsurface release plug systems
- Surface release combination plugs are PDC drillable whereas the additional aluminum material content used in the fabrication of SSR style assemblies increase the difficulty. However, proper drilling procedures have proven that even SSR style combination plug assemblies can be drilled successfully with PDC bits.



Combo String Standard Five Wiper SSR® NR Top and Bottom Plugs

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Case History 1

A customer needed Halliburton to provide a solution for wiping a tapered production string. The tapered production string was composed of three casing sizes: 10 3/4 × 9 5/8 × 7 in. (273 × 244.5 × 177.8 mm). Halliburton's challenge was to avoid leaving the 674 m of 7-in. (177.8-mm) liner full of cement. They had to design and run a combination plug that could fit within and wipe all three casing sizes. Contamination of the shoe track cement, which can result in a wet shoe, also had to be avoided.

Halliburton designed top and bottom triple-casing combination plugs that could be run on this cementing job. Some of the job details follow:

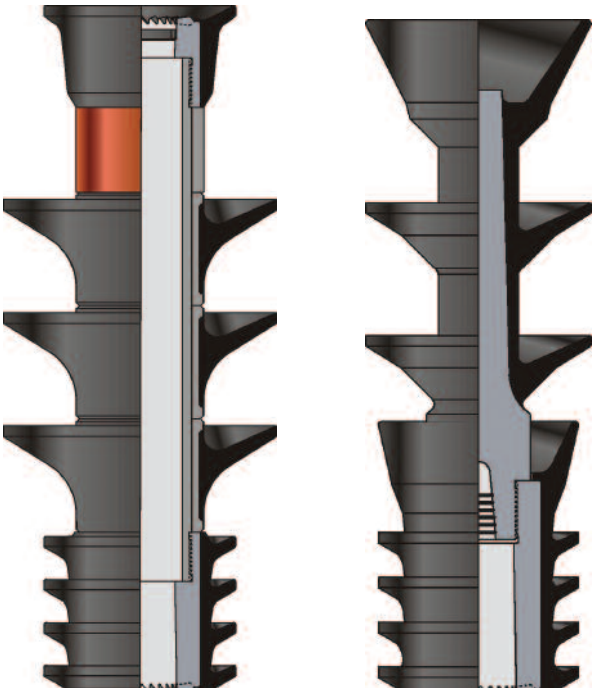
- Well depth at 3805 mMD
- Casing run according to program and well conditioned for cementing job
- Triple-casing combination plug, bottom and top
- 273.1-mm, 75.9-kg/m, L80 casing: 0 to 488.7 mRT
- 244.5-mm, 69.9-kg/m, L80 casing: 488.7 to 3125.8 mRT
- 177.8-mm, 56.6-kg/m, 13Cr liner: 3125.8 to 3799 mRT
- Shoe at 3799 mRT
- Float collar at 3728 mRT

The job was executed as planned. The bottom plug was dropped after base-oil preflush and dual spacer were pumped. The lead and tail slurry were pumped, and the top plug was dropped on-the-fly. The cement was displaced with seawater. The plug was not bumped, and half the calculated shoe-track volume was displaced. (The displacement volume was calculated with API nominal ID values.)

While tripping in-hole to drill out the plugs and shoe track, personnel encountered cement at 3477 mRT. This level was 20 m higher/shallower than expected, confirming that the top plug had not bypassed the displacement fluid. In 4 hours, the plug was drilled out with seawater and viscous pills from 3477 to 3664 m at an average ROP of 46.8 m/h.

The top and bottom plugs, with cement in between, were drilled out at an average ROP of 7 m/h. Drilling the cement in between plugs took 8 hours. The shoe track was drilled out from 3730 to 3793 m at an average of 31.5 m/h.

With the average ROP of 31.5 m/h, running the triple-casing combination plug and avoiding leaving the 7-in. (177.8-mm) liner full of cement saved 7 hours of rig time. These hours translate into $78,750 worth of savings.



Case History 2

In Angola, a customer needed to cement a tapered string with conventional cementing methods. They wanted to drill a 12 1/4- × 8 1/2-in. tapered hole and run a tapered 9 5/8- × 4 1/2-in. casing production string. Halliburton needed to supply cementing plugs that would effectively wipe the casing IDs and pump through the restricted IDs. Halliburton Malongo contacted Tools Systems in Duncan to help design a plug that would meet the following restrictions:

- 9 5/8-in. casing
- 15° transition from 9 5/8- to 5-in. ID polished bore section (PBS)
- Three 8-ft sections of 5-in. ID PBS
- Transition from 5-in. ID to 4 1/2-in., 12.6-lb/ft casing
- Average well angle of 30 to 35°, with some up to 55°

Halliburton provided the customer new design drawings from Tool Systems and a cost estimate from Duncan manufacturing. To verify that the plugs could safely pass through the unusual restrictions of the Angola well, Halliburton simulated the casing requirements with actual transition pieces. The plugs were successfully pumped through the setup several times.

Based on the successful testing, the customer ordered four sets of plugs. During the first job, the plugs did not bump on the float collar. During drillout, the plugs became hung up in a nipple placed in the string.

One problem encountered was that the longer-than-normal plugs required a longer extended pin so that the top plug would stay in the cement head. The pin extension did not arrive on location in time for the first job, but it was used successfully on the remaining jobs.

Additionally, special steps were taken to help minimize air entrainment in the system. Knocking the cap off to load the top plug could allow air to fill the space in the casing. The compressed volume of the trapped air when the plug was bumped was calculated.

Air could push the shoe-track cement out of the casing. Halliburton worked with a professor and his class to devise a solution. Based on the volume calculated, an extra shoe joint was run in the shoe track to ensure some shoe joint slurry.

The second and third jobs exhibited some discrepancies. The displacement volumes indicated underdisplacement of the fluids, which caused concerns that the plugs were hanging up and causing a wet shoe that needed a possible squeeze job. However, allowances for pump efficiency and fluid compressibility placed the actual displacement volumes in line with calculated volumes. As a result, these jobs were performed as planned.

By solving the problems encountered during the first jobs, the fourth job was performed as designed with no problems.

Running a tapered casing string instead of a liner hanger assembly can reduce costs by an estimated $850,000 per well. The customer envisions 45 to 50 more jobs with the new setup.

This project shows how Team Halliburton recognizes a customer's need, pulls together the resources to tackle the need, and supplies an effective solution for the customer.

For additional information about Halliburton Five Wiper Combination Cementing Plugs, please contact your local Halliburton representative.

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