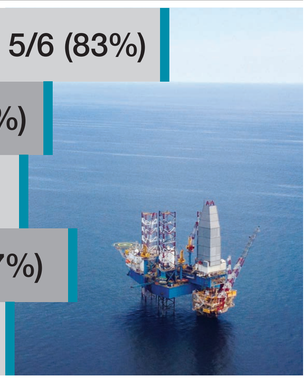
CEMENTING PRODUCTS

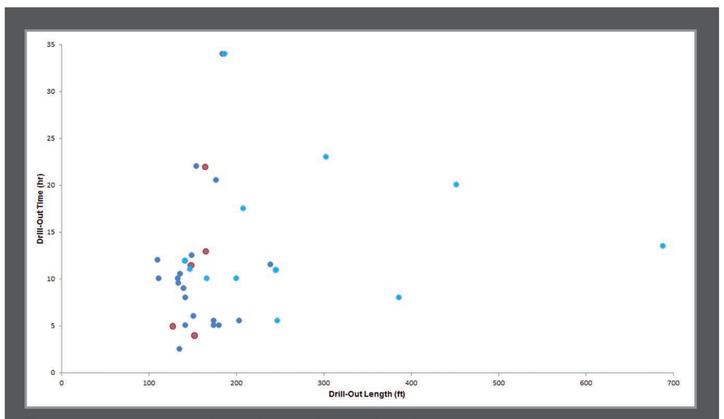
RECOMMENDATIONS FOR TESTING, EVALUATION, AND PERFORMANCE REQUIREMENTS FOR CEMENT WIPER PLUGS IN DEEPWATER

Five Deepwater Rigs for Shell Monitored in the Gulf of Mexico

Size inch	Bump Ratio
18	5/6 (83%)
16	3/5 (60%)
14	4/7 (57%)
11-3/4	6/9 (67%)
9-3/8	3/6 (50%)



Issues and Challenges



Fin measurement configuration and associated wear percentages

	Drill-Out Length (ft)	Drill-Out Time (hr)
Bumped	157.8	8.3
Non Bumped	243.8	13.6

Rig Hourly Rate:
$50,000

Average Additional Cost:
$263,000

Cost of Wet Shoe:
1-4 DAYS
$1,200,000 to $4,800,000

Contributing Factors to Underdisplacement

- Pump efficiency
- Cementing procedures
- Fluid Compressibility
- Displacement calculation error
- Cement plug degradation

Factors Affecting Displacement Calculations

- Fluid compressibility, especially with synthetic oil-based mud
- Wide variation of surface-line volumes from pump to cement head
- Downhole expansion of the casing due to differential pressure between the casing and the annulus while pumping
- Degradation of the cementing plug due to wear
- Cementing procedures in general
- Pump efficiency, whether of the cementing unit or the rig pumps

Cementing Procedures A

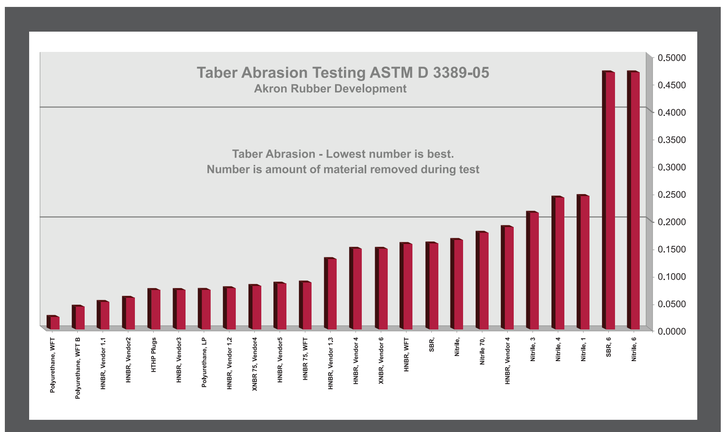
Displacement calculations
Hydrostatic compressibility not taken into account
Bump compressibility calculated
Compressibility = 0.0000032 * Displacement Volume * (Pumping + Bump Pressure)
= 0.0000032 * 927 * (1000 + 500) = 4.4 bbl
Shoe Track
Large-diameter casing (e.g., 14 in.) – No shoe volume pumped
Small-diameter casing (e.g., 9-3/8 in.) – Pump 1/2 shoe volume
Displaces with rig pumps
Triplex pumps: 6 1/2-in. plunger, 0.119 bbl/stroke (97% efficiency)
Efficiency not calibrated within last 1.5 years

Cementing Procedures B

Rig pump displacement
- Does not calculate compressibility volume for displacement; 95% pump efficiency takes care of compressible volume
- If displacement is late with indications, pump calculated volume

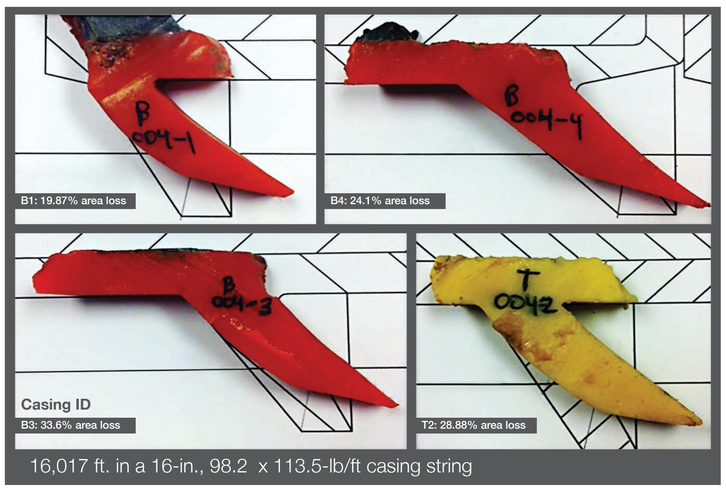
Cement unit displacement
- Displaces landing string volume; compressibility not calculated
- Switches over to rig pumps

Plug Wear and Reliability



Plug locator system

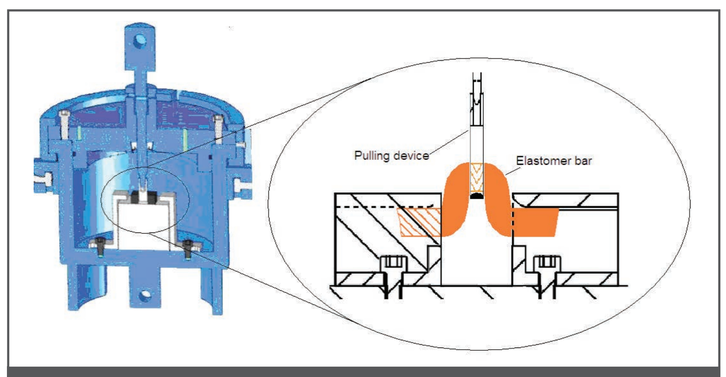
Plug Wear Resistance



16,017 ft. in a 16-in., 98.2 x 113.5-lb/ft casing string

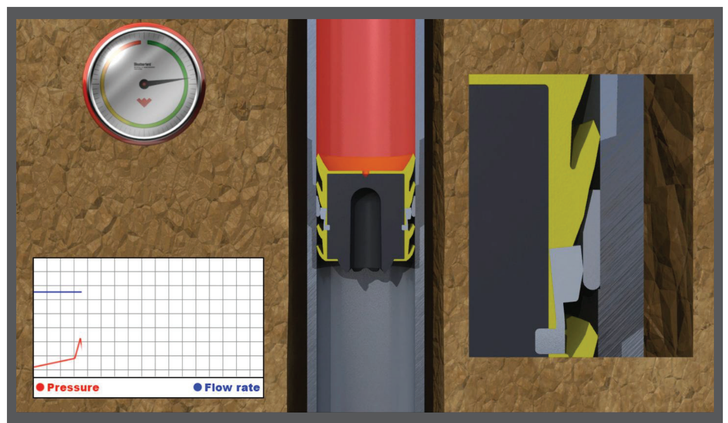
Wiping Efficiency

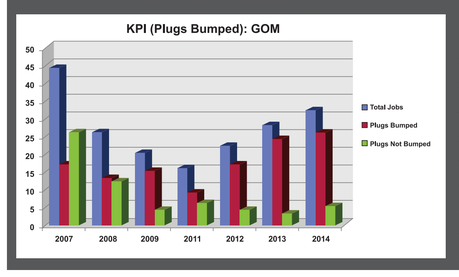
Attempts to Measure Wiping Efficiency
· Resistance to loading balanced
· Sample testing of retrieved pipe



All Fluid types
Various Temperatures
Applied Pressure = Penetration of Fluid into the Elastomer
Measure Stiffness = Wiping Efficiency

A New Approach: Plug Locator System





Plugs Bumped

Cementing Plugs	GOM Facts
2007	40% Bumped
2008	52% Bumped
2009	76% Bumped
2010	(Moratorium)
2011	59% Bumped
2012	78% Bumped
2013	86% Bumped
2014 (Q1-Q2)	82% Bumped

Conclusion

Cementing Procedures

Plug Locator Systems
- Re-zero pumps as plug passes through landing collar
- Refine volume and compressibility calculations based on data collection of known plug location

Develop Cementing Plug Standards

Progress with the API Mechanical Cementing Plug task force for the adoption into API standard RP 10F
- Develop minimum performance standards for material types
- Develop wear resistance testing standards
- Develop wiping efficiency Standards

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