MMS Safety Alert

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Minerals Management Service
Gulf of Mexico OCS Region

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Shallow Gas Flows While Cementing Surface Casing

A well recently blew out while waiting on cement after surface casing was set. After the wiper plug was bumped, the casing was pressure-tested and sugar water was spotted on top of the mud line hanger. The well was static for four hours, and the operator commenced to nipple down the diverter system. Two hours later, the well started flowing gas and cement out the open diverter. The diverter was closed, and the loosened bolts that attach the diverter to the conductor casinghead were reinstalled. Efforts were unsuccessful to stem the flow by pumping saltwater through the conductor casing valve while allowing the well to unload out both 10-inch diverter lines. Approximately one-half hour after the well started unloading, flow began coming from the annulus between the drive pipe and the conductor, and the rig was evacuated.

Several unsuccessful attempts were made to control the flow. Six days after the flow began, the flow rate decreased and the rig was able to move off location. Four days later, the drive pipe, conductor, and surface casings fell to the seafloor and the flow ceased. The next day, a subsea inspection by a remote operated vehicle (ROV) revealed a 25-foot crater at the base of the drive pipe with no bubbles or flow observed. Five months later, another rig moved on location and successfully completed abandonment of the well. There were no injuries or fatalities as a result of this blowout.

A similar incident occurred in July 1994 while spotting water mixed with lignosulfonate (ligno water) after washing the annulus through wash ports on the mud line hanger. After the 20-inch surface casing was cemented, the annulus was washed by circulating through ports on the mud line hanger, and ligno water was spotted. After a gyro survey was run, a diverter line was opened to check for flow. Flow was noticed on the annulus and the diverter line was closed. The annulus pressure was alternately bled off and allowed to build up during the next day. During the next two days, unsuccessful attempts were made to place heavy mud into the annulus by injection and by circulating through the mud line hanger. The well was finally killed by placing 3/4-inch tubing into the annulus and circulating heavy mud. Operations were resumed some three days after the flow began. There were no injuries or fatalities associated with this incident.

In another, less serious incident, a shallow gas flow also occurred after the surface casing was cemented. Nippling down of the diverter was begun seven hours after the plug was bumped and the float valves were checked. The diverter and diverter lines were rapidly reinstalled when flow first began. The well was shut in with a surface pressure of 50 psi, and was killed by lubricating mud into the annulus between the conductor and the surface casings. The annulus was then successfully grouted, and normal drilling operations were resumed 5 3/4 days after the flow first began. There were no injuries or fatalities as a result of this incident.

In still another incident, nipple down of the diverter system and installation of the casing slips were completed two hours after the plug on the surface casing was bumped. A slight gas flow was ignited by a welder making a rough cut on the surface casing one-half hour later. The gas was flowing from a casing valve that was open so that the annulus could be monitored. The flame was extinguished with no damage or injuries when the casing valve was closed. However, when the valve was later reopened, mud and gas flowed from the well. The valve was closed and the diverter was reinstalled on the wellhead. At this point, the seal on the casing slips failed, and 15-20 bbls of mud and gas were discharged through the diverter line. When fluid slowed to a very small stream, a line was connected to the casing valve, and 3 3/4 bbls of mud was pumped between the 13 3/8-inch and 20-inch casings. The well was monitored for 16 hours and 6.9 bbls of mud were recovered. Final flow rate was 2 1/2 gallons per hour, and at this point, the crew prepared to resume normal operations. The lead cement had

thixotropic properties typical of slurries used for this application.

All four cases were caused by formation fluids migrating into the annulus as the cement went through a transition before compressive strength was developed. Sixteen similar well-control incidents have been reported since 1973.

The best way to avoid these problems is to select, on the basis of the shallow hazards survey, a surface location that is not directly above a seismically visible shallow gas accumulation. However, if well objectives require drilling from a location in a shallow gas area, or if it is likely that gas sands will be penetrated in the surface hole, appropriate consideration as to how to handle any shallow gas related problem that might arise should be developed when the well is planned. This consideration is particularly important where the hydrostatic head is to be reduced by activities such as washing mud or cement from the upper annulus with water to facilitate future abandonment.

Items to be considered in shallow gas areas may include the following:

1. Improving cement properties to minimize chances of shallow gas flow, including density, fluid loss, transition time, compressibility, etc.

2. Planning for optimum cement column length (within guidelines established in **30 CFR 250.54**).

3. It may be desirable to hold slight back pressure on the annulus after cement is in place, and to consider shut-in of the well rather than diverting the well. In these cases, leakoff testing of the conductor casing shoe is recommended to better predict the surface pressures that could later be withstood without fracturing. Based on results of the leakoff test, the amount of back pressure that could safely be applied until cement has achieved compressive strength should be calculated. Any applied back pressure should not be enough to cause the formation at the conductor shoe to break down, and the annulus should be bled as required to avoid breakdown.

The considerations made regarding shallow gas should also seriously address whether or not the parameters associated with a particular well suggest diversion after cement is in place as a viable option. These parameters include leakoff test data and various depths at which gas sands may be drilled in the surface hole. The mindset that "diversion is the best option because a diverter system is in place" may need to be reexamined. In many cases, the planned shut in of a well may provide for a safer means of well control than diverting the well, especially after cement is in place.

Current regulations require waiting on cement for 12 hours before drilling out all casing strings other than the conductor casing, and that cement have a minimum of 500-psi compressive strength in the bottom 500 feet. This waiting time does not specifically apply to the nippling down of the diverters. In 3 of the above 4 cases, diverters had been partly nippled down in substantially less time than 12 hours after the plug was bumped. It was fortunate for the rig crews that the diverters were able to be reconnected before the flow became prohibitive. The proper amount of time to leave the diverter system in place is dependent upon the time required for the cement to develop adequate strength to prevent gas flow. (Flows began in an average time of 4.5 hours and a maximum time of 10.5 hours after the plug was bumped in 13 of the incidents for which information was available.)

A better determination of the time required for waiting on cement would be based on lab tests of the cement properties rather than time alone. The Minerals Management Service plans to investigate the issue of waiting on cement. The goal is to better understand well bore cement properties, particularly compressive strength, and how they can be used to establish an acceptable criterion for waiting on cement. This could lead to a regulatory change that better recognizes cement performance criteria and the importance of when well control equipment is nippled down in lieu of the rigid waiting on cement time prior to drilling out of casing in our current regulations.

A Regional Offshore Technology Assessment Committee workshop has been planned for May 23, 1995, at the Lod Cook Alumni Center at Louisiana State University, in Baton Rouge, Louisiana. The forum will provide industry and MMS with the opportunity to discuss issues, concerns, and potential remedies regarding waiting on cement. This effort is a first step at better understanding cement properties and improving the ability to prevent shallow gas flows while waiting on cement.

The enclosed agenda for the workshop should be viewed as a guide to focus the discussions. Any recommendations for additional agenda items and participation by your company would be appreciated.

Enclosure