REDUCING DOWNHOLE PUMP PROBLEMS RELATED TO SOLIDS IN PRODUCTION FLUIDS

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Abstract

This paper describes a new tool and method for removing solids; such as sand, scale, and iron sulfide; from production fluids before the fluid's entry and passage thru a downhole pump. A downhole pump's life and efficiency may be significantly increased. Erosive wear and sticking of pump parts is greatly reduced. This new device, the **"Sandtrap" Downhole Desander,** is run on the production string below any type of downhole pump. Centrifugal action within the device separates solids prevalent in well fluids and collects the separated solids in extended intervals of mud anchor joints or the rathole. It is most applicable in wells that produce small volumes of solids continuously or large volumes (slugs) intermittently.

Introduction

Solids contained in production fluids have long been a problem to operators of oil and gas wells. Many wells have been plugged and abandoned solely because a producer could not alleviate frequent pump failures and workover costs attributed to sand production.

Screen and filter devices are available, but they often plug or restrict a well's production rate. The selection of the optimum size of openings in a screen or filter is often made more difficult when a well produces solid particles of various sizes. More expensive sand control methods, such as gravel packing, are often cost prohibitive to the producer of marginal wells.

The "Sandtrap" Downhole Desander is a simple and inexpensive tool designed to protect all downhole pumps from wear and sticking caused by produced solids. Unlike a screen or filter, this new tool does not plug or restrict production. It removes both large and small solids from produced fluid by creating a vortex flow within the device. It will continue to separate solids until the mud anchor or rathole is completely filled with solids.

The "Sandtrap" Downhole Desander has been effectively used in conjunction with beam-type rod pumps, progressive-cavity pumps, and electrical-submergible pumps. Its utilization often allows the operator to select the most suitable and economical downhole pump for a well.

Downhole Desander Sub

The Downhole Desander Sub (DDS) is run below a downhole pump. It makes up directly to the production tubing (Fig. 1). Solids-laden production fluids enter the tubing thru the inlet ports of the DDS. The fluid flows downward thru a spiral device that spins the fluid. The vortex flow that is created forces the solids against the inner wall of the DDS where they fall by gravity into mud-anchor joints or the rathole.

The DDS is all steel constructed and has no moving parts. The standard DDS is three feet long. It has one foot of 1/4-in. or 3/8-in. inlet ports or slots. The size of the orifice tube and the opening thru the spiral is determined by the flow rate of the well in which it is to be installed. When properly sized, the pressure drop within the DDS is 4 to 7 psi, regardless of a well's flow rate. Erosive damage within the DDS is prevented by maintaining a low pressure drop.

Beam-Type Rod Pump Operation

For rod pump applications, the DDS is run below the seating nipple. As many joints of bull-plugged mud anchor as possible should be run below the DDS. Separated solids are collected in these joints. Solids will build up until they completely fill the mud anchor. At such time, the DDS will no longer prevent the flow of solids into the pump. Loss of pump efficiency or sticking may then occur. If a wells's characteristics allow setting the lower end of the mud anchor slightly below the perforations, a dump-valve device may be substituted for the bull plug in order to dump solids into the well's rathole. The dump valve closes during the upstroke of the pump to divert all produced fluids into the inlet ports of the DDS. It opens upon each downstroke of the pump to allow solids within the mud anchor to settle into the rathole. The storage capacity of solids is increased when solids may be collected in both the mud anchor joints and the rathole.

Since each DDS model (Fig. 2) is designed for a specific flow range based upon a 24-hr interval, the following calculation is required to determine the correct DDS model if a pump is operating on a timer clock.

$$\frac{24}{\text{NO. HOURS PUMP OPERATES/DAY}} \times \text{BBLS/DAY PRODUCED} = \text{DDS FLOW RATE}$$

Gas Anchor Designs For Rod Pump Operations

The DDS has a standard length of three feet. By elongating the DDS, it also may serve as a "Poor Boy" gas anchor (Fig. 3). The most common lengths of combination gas anchor and desander models are 15 ft, 20 ft, and 30 ft. The DDS is available in various diameters to easily duplicate the design of previous gas anchors utilized in a particular well. The size of the orifice tube and the body of the DDS is recommended to be similar or identical to the dip-tube and gas-anchor barrel dimensions that have proven effective for a well in the past.

Progressive Cavity Pump Operations

The DDS is normally attached to the lower end of a progressive cavity pump (PCP) and serves as the pump's intake. Bull plugged mud-anchor joints are run below the DDS to store separated solids. The continuous flow created by the PCP is most conducive for maximizing the separation effectiveness of the DDS.

Solids may also be collected in the rathole below a PCP by extending the mud anchor slightly below the perforations and substituting a rubber cup-type casing seal for the bull plug (Fig. 5). By setting the casing seal below the perforations, all production fluids are diverted thru the inlet ports of the DDS. Separated solids settle into the rathole thru the mud anchor's open end. Should the casing seal become stuck in the hole by solids, upward pull on the tubing will shear pins attaching the casing seal to the mud anchor. The casing seal is designed so that it will not interfere with washing or bailing sand from the rathole. It can be chased to bottom or recovered during the clean-out operation.

Electrical Submergible Pump Operations

For Electrical Submergible Pump (ESP) applications, a low-pressure casing seal is required. The ported casing seal mandrel attaches to the lower end of the ESP (Fig. 6). The DDS is attached to the lower end of the casing-seal mandrel. As many joints of mud anchor are run below the DDS as a well's profile will permit. The mud-anchor joints are usually bull plugged on the lower end. The casing seal diverts all production fluids into the inlet ports of the DDS. After the fluid enters the DDS, it must flow down thru the spiral before entering the orifice tube. Solids within the fluid passing thru the spiral are centrifugally separated and settle into the mud anchor joints. The solids-free fluid flows upward thru the orifice tube, reenters the casing thru the ports above the casing seal, flows past the motor for needed cooling, and into the ESP's intake.

Prior to running the ESP and "Sandtrap" Downhole Desander, a trip with a casing scraper is advisable to insure the integrity and condition of the casing. It is also necessary to run the ESP into the well at a slower rate so as not to damage the casing seal. A pressure actuated valve is available that may be substituted for the bull plug on the lower end of the mud anchor to bypass fluid when the ESP is run in the hole. The pressure actuated valve allows fluid to flow thru the lower end of the mud anchor as well as the inlet ports of the DDS when running the ESP in the hole. It will remain closed during production operations. It is only recommended for deeper wells when running the ESP and "Sandtrap" Downhole Desander slowly would be too time consuming and inconvenient.

It is also possible to dump separated solids into the rathole below an ESP. A second casing seal, like the one discussed above for PCP operations (Fig. 5), is required. The second or lower casing seal would be substituted for the bull plug on the bottom of the mud anchor.

Field Experiences

The "Sandtrap" Downhole Desander was first run in a well in East Texas below an ESP on March 13, 1992. The well had a history of producing sand and the longest previous life of an ESP had been eight days. The well produced approximately 1350 bbls/day water and 30 bbls/day oil. Only three joints of mud anchor were run below the DDS. The well was pulled twenty-nine months later on August 17, 1994 due to ESP sand related failure. All three joints of mud anchor were full of sand. The DDS was inspected for erosive damage and none was detected. The casing seal was replaced and a new ESP was run back in the well. The well has not required to be pulled again. Well and field data indicates most of the sand production probably occurred in the first few days of production and tapered off in succeeding months. The operator has since installed five other "Sandtrap" Downhole Desander assemblies below ESP's in the same field and all are performing satisfactorily.

A Permian Basin operator tracked the performance of Desander installations in 1992-93 and reported the following experiences:

Well # 310: 7/92 Well fraced
10/92 Pulled for pump failure, pump barrel & plunger cut
10/92 Pulled for pump failure, pump barrel cut, installed desander.
No sand related failures thru 8/1/93.

Well #416: 6/92 Well Fraced
1/93 Pulled for pump failure, standing valve & seat cut.
4/93 Pulled for pump failure, standing valve ball & seat cut. Installed desander.
No sand related failures thru 8/1/93.

Well #003: 6/92 Well Fraced
8/92 Pulled for Pump failure, barrel & plunger cut.
4/93 Pulled for Pump failure, pump stuck, installed desander.
No sand related failures thru 8/1/93.

Well #002: 10/92 Well Fraced, installed desander.
No sand related failures thru 8/1/93.

Another Permian Basin operator reported the following data:

"Since August of 1993, Desanders have been installed in 14 well within the field. The initial installation was in the #1570. This was a newly drilled well that had an average pump run life of 2 months. A Desander was installed 8/9/93 and the well is still running 16 months later. Following installation, the rod stroke became smoother and the pump valves no longer became stuck closed. This eliminated the need for repeated lowering of the pump spacing to tag the pump and jar the valves open. Following this success , a Desander was installed in #1512. This well had pump run life for 1992-1993 of about 4 months. The Desander was installed 9/2/93 and the pump ran for 9 months. This well also experienced a smoother rod pump action and no longer required repeated tags. In summary, the Desander tool provides a cost effective method to improve the operation of rod pump wells with sand production problems."

An operator in the Methane Coal Bed region of Alabama reported the following findings:

"There have been three wells that the Desander has been used successfully. The first being the #3600. This well had 4 workovers due to sanded up pumps in a 30 day period from 10/13/93 to 11/13/93. A Desander was installed and the well went to 1/20/94 before requiring a pump repair. During this period average gas production increased from 49 MCFD to over 80 MCFD. Also due to the continuous pumping, stabilized gas, water, and fluid levels were attained that allowed for analysis and recommendations.

Another Desander was installed in #3608. This well had 4 workovers performed between 11/4/93 to 11/29/93. The Desander was installed 11/29/93. The well produced for 29 days before another workover was performed. Before the Desander was installed, gas production was 115 MCFD. After the Desander installation the production increased to over 1,000 MCFD.

Well #3511 had a Desander installed below a tubing pump 7/20/94. This well has had pump efficiency reductions due to sand production. Fluid production had decreased only 6% after the Desander's installation. Previously, fluid production decreased 19% between pump repairs.

In conclusion, the Desander has been successfully used on selective wells to reduce workovers, extend pump life, and increase gas production."

Since February of 1994, several producers in California's "heavy oil" steamflood projects have reported positive results in extending the run life of rod-type pumps. They indicate they have been able to increase their pump life 2-3 times their previous experiences. The Desander's all steel construction is not affected by downhole temperatures.

This new product has proven especially effective in wells following frac jobs. After frac jobs, high fluid levels often permit raising a pump well above the perforations and running several hundred feet of mud anchor joints below the DDS for sand storage. After fracs heal and sand production decreases, the pump is often lowered and a dump valve is substituted for the bull plug on the lower end of the mud-anchor joints. The rathole is then used for the storage of solids. The Downhole Desander insures the pump's operation until the mud anchor or rathole is filled with sand.

Summary

The "Sandtrap" Downhole Desander fulfills a need for a simple, durable, and inexpensive device for protecting downhole pumps from solids in production fluids. It uses time proven centrifugal action and gravitational force to separate solids within production fluids before they enter the pump. It separates both large and small particles and does not plug or restrict production. It is compatible with all types of downhole pumps.

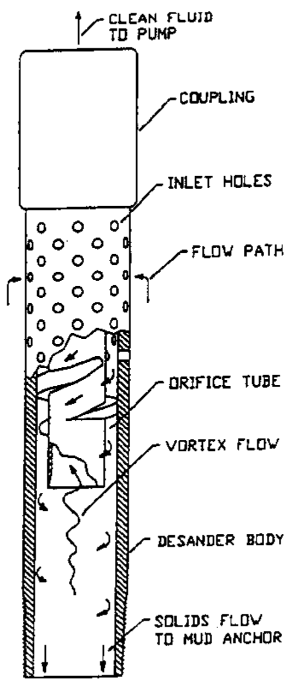

Figure 1 Illustrates the flow path of produced fluids thru the desander sub. Fluid enters the tubing thru the inlet holes. The fluid must flow down thru a spiral to enter the orifice tube and flow upward to the pump. Centrifugal action created by the fluids flow thru the spiral push solids away from the vortex flow of the orifice tube. Solids settle into the mud anchor or rathole. The clean fluid flows upward thru the orifice tube to the pump.

Figure 1 - Desander sub

SANDTRAP DESANDER MODEL NUMBERS										
FLOW RATE (BBL/DAY)				STANDARD			WITH BUILTIN POORBOY GAS ANCHOR		
ESP		ROD PUMP		EUE TUBE SIZE			EUE TUBE SIZE		
MAX	MIN	MAX	MIN	2-3/8	2-7/8	3-1/2	2-3/8	2-7/8	3-1/2
150	75	75	35	D2301	D2701		D2301G	D2701G	
200	100	100	50	D2302	D2702		D2302G	D2702G	D3402G
350	175	175	85	D2303	D2703	D3403		D2703G	D3403G
500	250	250	125	D2305	D2705	D3405			
750	375	375	185	D2307	D2707	D3407			
1100	550	550	275	D2311	D2711	D3411			
1600	800	800	400	D2316	D2716	D3416			
2400	1200	1200	600		D2724	D3424			
3600	1800	1800	900			D3436			

PERFORATED PACKER SUB MODEL NUMBERS			
	EUE TUBE SIZE		
CASING SIZE	2-3/8	2-7/8	3-1/2
4-1/2	CP2344		
5-1/2	CP2354	CP2754	
7		CP2770	CP3470

Figure 2 - Model and flow range chart

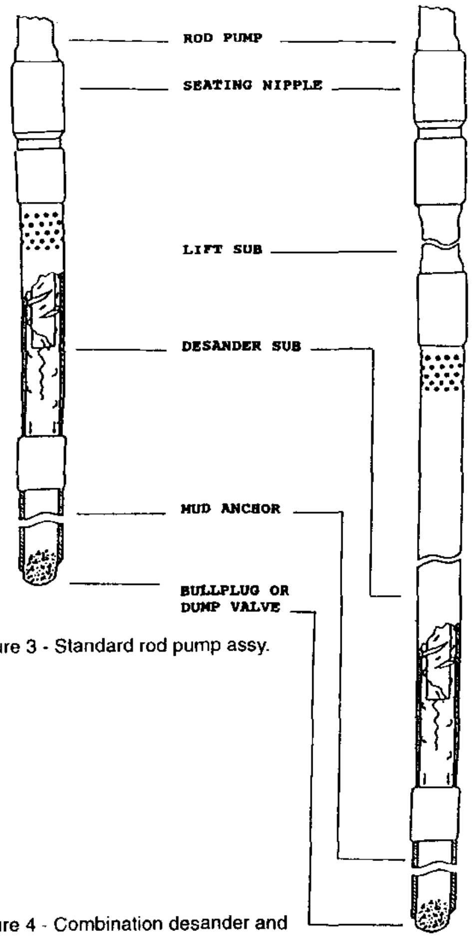

Figure 3 - Standard rod pump assy.

Figure 4 - Combination desander and "poor boy" gas anchor assy.

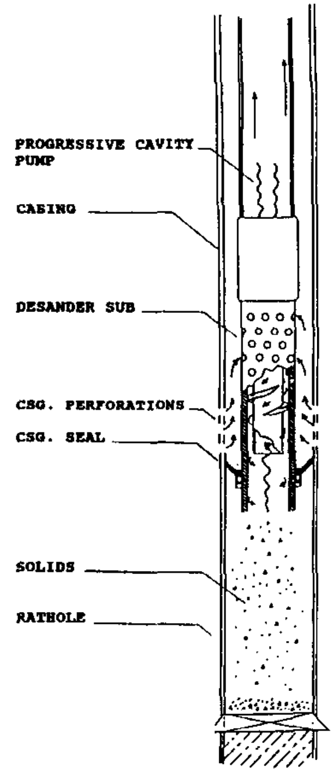

Figure 5 - Progressive cavity pump assy. with csg. seal for collecting solids in the rathole.

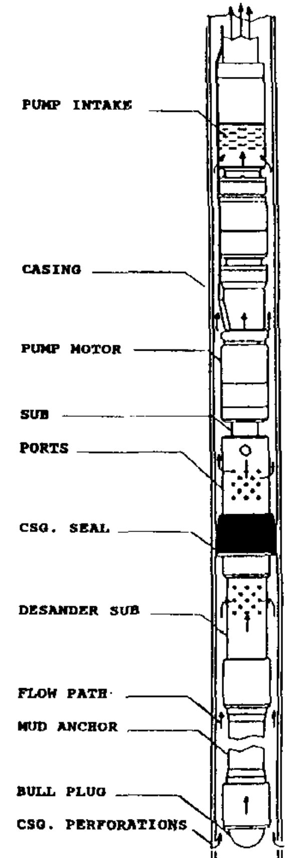

Figure 6 - Electric submergible pump assy. with csg. seal and desander sub.