



Design and Development of New, Small Footprint Cuttings Dryers for Land Rigs in the Mid Continent Region

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Abstract

The use of large cuttings dryers has migrated from offshore operations to limited use on land rigs. Offshore, these units are designed to recover oil-based or synthetic-based fluid from cuttings prior to discharge overboard to meet environmental standards and regulations, but on-shore use has a different objective. Typically the goal of these land operations is to reduce operating costs associated with drilling waste management such as disposal costs of cuttings and excess mud at the end of the well. Incidental benefits include potential liability reductions resulting from spills during transport, and a site that can more easily be returned to its pre-existing condition. In addition, the recovered fluid can be reused, thereby reducing fluids costs for the operator. Case histories in this paper will show that in certain situations cuttings dryers can be very cost effective for the operator.

It was noted that the rate of penetration on most land rigs was far lower than the unit was designed to handle. Rig ups on the large cuttings dryers could be time consuming and expensive. A smaller unit, with reduced capital costs and footprint designed specifically for the slower drilling rates in land operations, could be more cost effective and perform as well or better than the larger offshore units. This paper will describe the use of conventional cuttings dryers on land rigs and the design and testing of a new cuttings dryer developed specifically for the land rig market.

Introduction

Chesapeake Energy was drilling on a location within the city limits of Marlow, Oklahoma. With several high profile wells on the drilling schedule, some in Marlow and others in similarly sensitive locations, the operator's challenge was to reduce the amount of waste generated in the oil based mud intervals, to reduce the transportation required through the town to the eventual disposal site and look for ways to make the oil-based drilling waste easier to handle to reduce likelihood or impact of spills during transport.

Based on similar projects in Latin America⁽¹⁾, Chesapeake proposed the use of vertical cuttings dryers. Halliburton mobilized and installed a system,

which included augers to collect the cuttings and feed the dryer, prior to switching to oil-based mud. The dryer uses centrifugal force to dry the cuttings, recovering the excess fluid so that it can be re-used in the drilling process. This also reduces the volume of cuttings to be collected and disposed of. The cuttings are also much drier making them easier to handle and transport, reducing likelihood of spills during transportation.

Offshore Cuttings Dryers

Primarily developed for offshore use, cuttings dryers are used to reduce the oil retained on cuttings (ROC) prior to discharge. This is usually to ensure compliance with local regulations for discharge of oil or synthetic oil contaminated cuttings overboard. For example in the Gulf of Mexico EPA Region 6, the maximum allowed ROC limit is 6.9% by weight. These levels can not usually be achieved with conventional solids control equipment and so additional equipment is required to dry the cuttings.

These drying units have been widely used and developed for offshore drilling where due to large costs associated with drilling, drilling rates are usually very high and formations are often a lot softer than found on-shore. The result of these much larger rigs and softer formations is that drilling rates on offshore rigs are often much higher than found on smaller land rigs. The solids control and drying equipment used on these rigs has to be capable of handling these much higher drill rates in order to ensure that the operator remains compliant and can discharge cuttings

While there are several types of cuttings dryers in use, the vast majority are basket centrifuges. These were developed for the oil and gas industry from a very similar application in the mineral processing industry and have been in use for over 40 years⁽²⁾. The baskets can be arranged horizontally or vertically, each type having different advantages or disadvantages, but the vertical basket centrifuges are the most commonly used. Information on the use of vertical basket centrifuges, also commonly known as vertical cuttings dryers (VCD) has been published previously⁽²⁾.

The sizes of these units are fairly standard, they

have a foot print of approximately 12 feet by 11 feet and weigh over 7,500 lbs. Table 1 shows the other physical properties of these types of units. The cuttings feed point at the top of dryer is usually at least 9 to 10 feet above the ground. A photograph of the standard vertical cuttings dryer (VCD) rigged up on location in Oklahoma is included in this paper as photograph 1.

Size	Maximum Capacity	Motor HP	Type	Screen Area
Standard	60 MT / hr	75 hp	Vertical	13.3 sq ft

Table 1. Standard Offshore Vertical Dryers Specs

Results from First Well

The first rig up was begun in April of 2005 and the first well utilized the VCD for a total of 33 days. During drilling the well the amount of fluid recovered daily and the volumes of cuttings hauled off location were monitored as well as the daily ROC values. At the end of drilling the well the results were analyzed and compared to previous wells. The financial benefits of using the dryer are summarized in Table 2.

VCD Technology Value – First Well	
Increased Cost Associated with Dryers + People	+ \$ 45,000
Value of OBM Drilling Fluid Recovered	- \$ 65,000
Savings in Haul Off Costs	- \$ 20,000
Net Savings to Chesapeake	- \$ 40,000

Table 2. Financial data from first well using VCD technology

It should be noted that in this particular case while the cost of the dryer was offset by the recovery of fluid alone, this is not usually the case and it is rare that dryers would be justifiable economically on land rigs based purely on mud recovery as mud costs are relatively low on land compared to the synthetic fluids used offshore.

It was also noted in this first well that actual values for ROC were slightly higher than expected based on experience with offshore use of dryers, see Table 3.

Days on Well	Maximum ROC	Minimum ROC	Well Average	Volume of Fluid Recovered
33	7.2%	6.9%	7.1%	866

Table 3. Performance data from first well using VCD technology

These values would normally be expected around 3 - 4% ROC on a typical offshore well using VCD technology. Upon review, changing the screen basket opening size improved these results slightly but in general ROC values remain higher than seen

offshore with the same dryers. One reason for this appears to be the particle size distribution of the cuttings. The cuttings generated in this well were very fine, due to formations types and slow drilling rates. Small cuttings have higher surface areas and therefore a higher proportion of fluid associated with them⁽³⁾ even after drying. This high surface area compared with typical offshore drill cuttings results in higher ROC values than typically seen.

Following the success of this well further dryers were mobilized and at the time of writing four dryer packages are being used in conjunction with land rig operations for Chesapeake Energy in the Mid Continent region. Chesapeake is now using the VCD in the Fayetteville shale play in Arkansas with even greater success, resulting in net savings of approximately \$80,000 per well. The dryer is very critical in this area because there is nowhere to dispose of oil based cuttings locally and cuttings have to be transported by truck long distances to disposal sites.

Re-use of Dried Cuttings

In addition to the commercial advantages identified by the use of the VCDs, Chesapeake was able to mix the dried cuttings with screen gravel and crusher run and use this material to make lease roads within the same field in Oklahoma. Upon thorough laboratory analysis the dried cuttings were approved by the Oklahoma Corporation Commission (OCC) to be disposed of on location and lease roads. A photograph showing the lease road is included in this paper as photograph 3.

Not only did this provide the operator with needed construction material but by finding alternative uses for the dried cuttings within the same field, additional transport and disposal costs could be avoided.

Limitations of Offshore Dryers on Land Projects

Following the success of the project it was decided to move forward with Halliburton providing additional units in support of Chesapeake's operations in the Mid Continent region. However it was noted that these units were in many ways oversized for this application, which resulted in higher costs both in terms of capital costs of equipment and rigging up and down and transport of the units. In addition the unit capacity was significantly higher than needed. It was also believed that the higher ROC values seen than usually seen on offshore rigs was due at least in part to the fact that the unit was operating at very low end of its capacity and therefore was probably was not operating very efficiently. For example the rig would need to drill at 150 feet / hr in 12 ¼" hole to generate 15 MT / hr of cuttings and over 550 feet / hr in 12 ¼" hole is needed to reach the maximum capacity of the dryer at 60 MT / hr. Considering that the typical well profile (see Table 4)

and the capability of the drilling rigs being used, these rates were rarely if ever going to be seen in this drilling program. Typical drilling rates are 10 to 20 feet per hour and sometimes lower during the oil based mud intervals as they are so deep.

Surface to 11,000 feet	Water Based Mud
11,001 to 17,000 feet	Oil Based Mud

Table 4. Mud Types for Typical Well

Other concerns include the power requirement on land rigs. In some cases additional generators had to be hired as the rig did not have enough power to run the dryer package.

First Generation Small Dryer

In 2005 Halliburton approached a manufacturer of basket centrifuges to supply a much smaller model for testing on land rigs. The unit specifications were based on the much lower drilling rates seen on the rigs to date and a horizontal unit with a maximum estimated capacity of 15 MT / hour was selected. This unit had several of the features Halliburton was seeking:

- Lower capital cost per unit than large VCD
- Manufacturer had experience building larger dryers for the mineral processing and oilfield application and understood challenges
- Manufacturer had built smaller capacity units for other industrial applications
- The horizontal design meant that no elevation of cuttings was required and unit should be easier to feed and install on location
- Lower power requirement
- Significantly smaller footprint, 5 feet by 4 feet, was only 4 feet high and a much lower weight at 2000 lbs, making rig up, rig down and transport much easier

Size	Maximum Capacity	Motor HP	Type	Screen Area
Standard	60 MT / hr	75 hp	Vertical	13.3 sq ft
Small	15 MT / hr	30 hp	Horizontal	3.5 sq ft

Table 5 - Small Horizontal Dryers Specs

This first generation trial unit was delivered to the field and rigged up. See photograph 4. Installation was simple and easily performed. The relatively small size of the unit allowed significant flexibility in placement. The rig up was simple and quick.

At the time of testing, the rig was using an insert bit drilling at 8 feet per hour resulting in very fine, crushed drilled solids entrained in a viscous emulsion mud. Almost immediately problems with this unit were encountered. The low feed rates coupled with the consistency of the cuttings resulted in immediate

blinding of the internal screen. There were not enough cuttings coming to the unit to move solids down the screen. The cuttings layer was below the height of the internal conveyor and the resultant solids were smeared across the screen. Changes in screen were unsuccessful. The unit was released and is currently undergoing significant modifications incorporating a steeper screen angle and scroll coupled with a backwash feature to deal with periodic blinding. The second generation mini-dryer will undergo trials toward the end of Q1 2006.

Second Generation Small Dryer

Based on the lessons learned from this test, especially around capacity and the need for the dryer to effectively handle the fine cuttings, Halliburton decided to try another vertical dryer. Similar in design to the original VCDs, this unit had a smaller foot print than the standard VCD at approximately 10 feet by 10.5 feet, lower power requirement and lower maximum capacity, therefore it would be operating at a higher efficiency at the lower drill rates seen on these wells. It also weighed approximately 4400 lbs less at; making transport and rigging easier. The feed point is also lower at under 8 feet high than the standard VCDs, making installation easier. While there is a slight capital cost saving, this however is not a significant advantage of this design. This unit was installed in late 2005 on another City of Marlow and performed very well. See Photograph 5. As shown in Table 6. this is basically an "intermediate" unit between the standard offshore VCD and the first small dryer tested and is more suited to land operations than the larger units.

Size	Maximum Capacity*	Motor HP	Type	Screen Area
Standard	60 MT / hr	75 hp	Vertical	13.3 sq ft
Small	15 MT / hr	30 hp	Horizontal	3.5 sq ft
Intermed.	40 MT / hr	30 hp	Vertical	7.1 sq ft

Table 6. Vertical Dryer Specifications

**Note all Maximum Capacity values are provided by OEM as guideline only and actual field values will vary depending on feed material composition.*

The data in Table 7 shows the performance of this unit on the first well since installation and in general it performed well, even slightly better than the standard VCD units did on similar wells suggesting that smaller units are indeed the better option for land rig drilling. The average ROC on this dryer over 32 days was 6.4% compared to an average ROC of 7.1% over 33 days for the standard VCD.

Days on Well	Maximum ROC	Minimum ROC	Well Average	Volume of Fluid Recovered
32	7.5	5.3	6.4	680bbl

Table 7. Performance data from first well using smaller footprint VCD technology

Conclusions

The use of cuttings dryers on land rig operations in the Mid Continent region has shown considerable value to the operator and it would appear that this technology has applications in many land drilling operations especially as the industry enters more and more environmentally sensitive areas.

The dryers developed for offshore operations can be used effectively in land operations; however there are commercial and technical advantages to developing smaller units specifically for these types of operations. The dryer allows for more utilization of OBM for shale stability and improved drilling while reducing environmental liabilities for the operator.

The most recent developments in smaller footprint vertical dryers are beneficial to land operations and should expand use of cuttings dryers further but it seems likely that further improvements in technology should be possible.

The small footprint horizontal dryer developed by Halliburton will be tested in the field again in early 2006, after being adjusted based on lessons learned in 2005 tests.

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Nomenclature

<i>ROC</i>	=	<i>Retained Oil on Cuttings</i>
<i>VCD</i>	=	<i>Vertical Cuttings Dryer</i>
<i>OCC</i>	=	<i>Oklahoma Corporation Commission</i>
<i>ROP</i>	=	<i>Rate of Penetration</i>
<i>MT</i>	=	<i>Metric Tonne (1000 kg = 2205 lbs)</i>
<i>Hr</i>	=	<i>Hour</i>
<i>Hp</i>	=	<i>Horsepower</i>
<i>Sq ft</i>	=	<i>Square Feet</i>
<i>OEM</i>	=	<i>Original Equipment Manufacturer</i>

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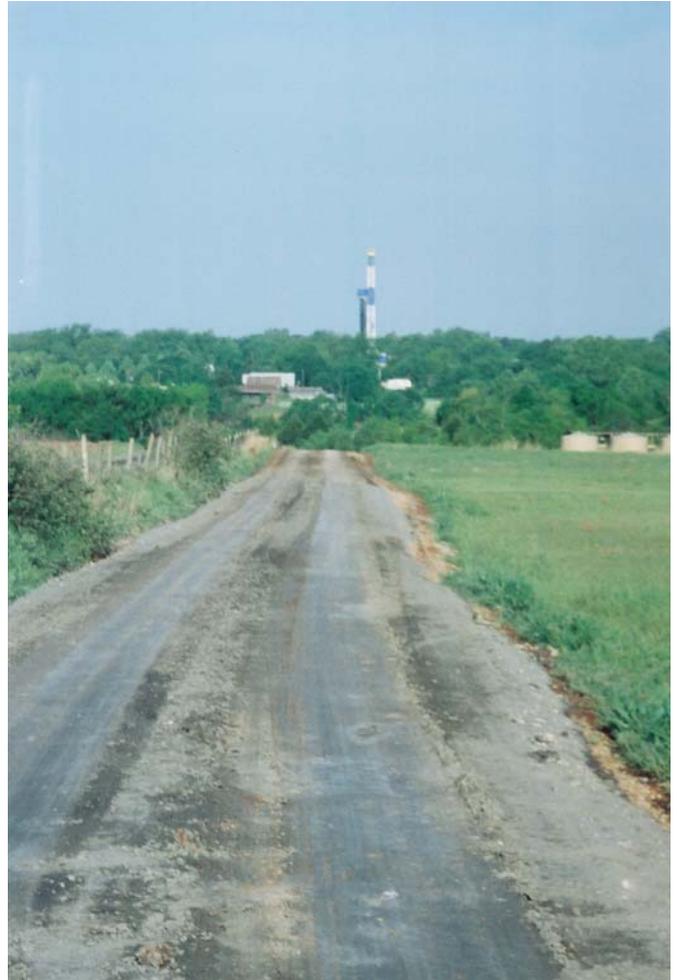
Photographs



Photograph 1. Standard Vertical Cuttings Dryer Installed on Chesapeake land rig in Oklahoma



Photograph 2. Dried Cuttings as collected from standard VCD



Photograph 3. Dried cuttings used as part of lease road



Photograph 4. 15 MT/hr Horizontal Dryer in workshop



Photograph 5. Small VCD and effluent tank installed on City of Marlow location