



The Application of Waste Management Vertical Cuttings Dryers as an Integral Element of a Successful Solids Control System



2023 – Revision D

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10050 Cash Road • Stafford, Texas 77477 • +1 281-261-5778
www.elginseparationsolutions.com



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In Elgin's White Paper, "Common Challenges Relative to the Use of Decanter Centrifuges for Barite Recovery in the Oil & Gas Industry," a detailed discussion was offered about the complexities involved in achieving effective solids control when deploying a dual-centrifuge "barite recovery" system. As noted in that report, when centrifuges are properly used, centrifuges enhance the drilling fluid properties, thereby improving rig performance. By maintaining the target properties of the drilling fluid, centrifuges also lower the volume of waste drilling fluid and reduce raw material additive costs.



Figure 1 – Elgin's VCD Discharges 3% OOC Cuttings

Despite these achievements, the evolution of the drilling industry has resulted in the rapid deployment of centrifuge-based solids control systems that are unable to reach their full potential. This has been predominantly driven by the fact that the first line of defense, the shale shakers, tend to allow far too many fine solids into the active mud system and the second line of defense, solids control centrifuges, tend to process just 15% to 25% of the total mud system circulation rate. A concept that is later explored in greater detail.

Modern drilling rigs are continuing to set new standards by drilling deeper, faster, and longer. As such, the oil & gas industry has seen a substantial increase in the volume of waste solids and liquids being generated from the solids control system. There has never been a more critical time to manage drilling fluid and the associated wastes as an integral and inherently inseparable element of an effective solids

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control system. This is especially the case when a properly deployed Vertical Cuttings Dryer ("VCD") can significantly reduce waste disposal costs, dramatically lower whole mud losses within those wastes, and improve the overall quality of the drilling fluid by allowing the flow-line shakers and centrifuges to be used at their full operating potential. All of this can be done for about the same investment as a typical small-bowl decanter centrifuge system.

Section 1.0 – Application of VCD's

Common flow-line shaker cuttings can maintain an Oil-On-Cuttings (“OOC”) or Water-On-Cuttings (“WOC”) moisture content as high as 25%. As such, and on a conservative basis, an average well will lose approximately 5 gallons a minute of drilling fluid with the discarded flow-line shaker cuttings. Over a 10-hour day, this would equate to 3,000 gallons (11,356 liters or 71 barrels).

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VCD's are designed to recover the drilling fluids that are found on the drill cuttings discarded from the flow-line shakers. The intent is to have the VCD's installed in a manner that the flow-line shaker cuttings are immediately injected to a VCD to recover the lost drilling fluids. The lower the cuttings “age” (i.e. the amount of time by which the formation solids have been exposed to drilling fluid), the higher the performance that can be achieved by the VCD. **Figure 1** provides a general process flow diagram associated with the integrated application of VCD's within a drilling fluid solids control system using decanter centrifuges.

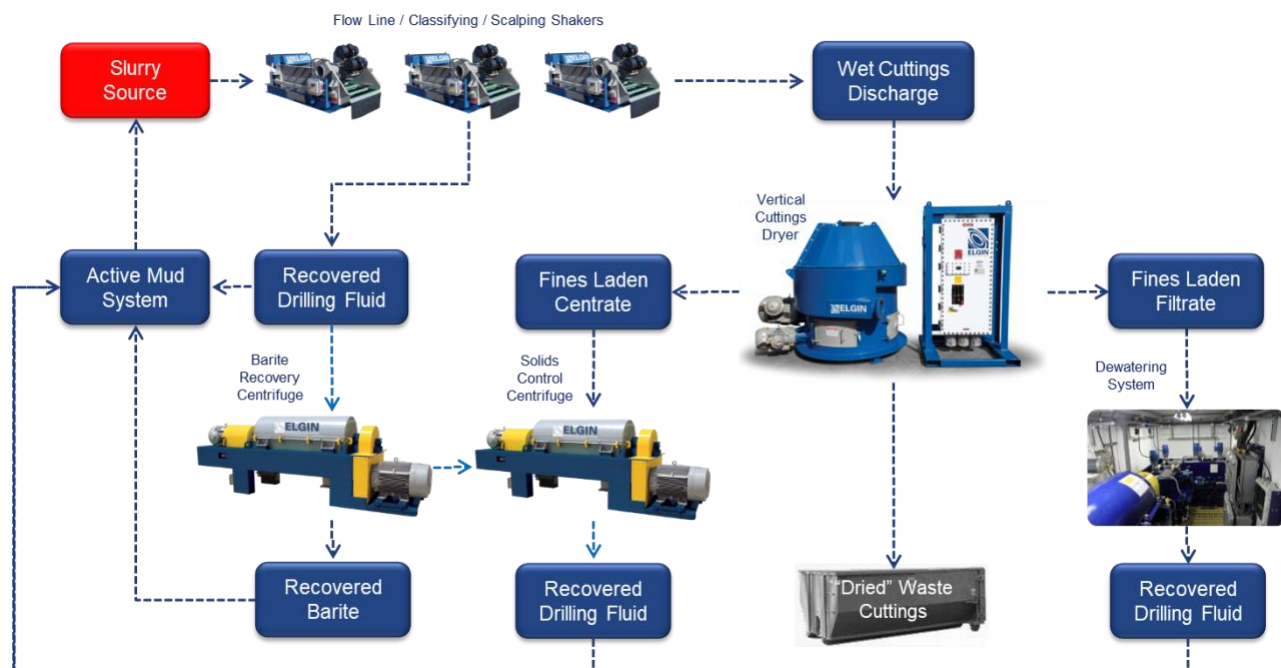


Figure 2 – Integrated solids control and waste management system process flow diagram utilizing Elgin's Hyper-G™ Flow-line Shakers, APEX™ Barite Recovery and Solids Control Centrifuges, CSI-D4™ Waste Management VCD, and ClearWater™ Water-Based Dewatering System

Decanter centrifuges and VCD's share a number of similarities. However, their objectives are quite different. Centrifuges are deployed in order to "cut" waste solids from the liquid stream. We typically consider the cut to be the "underflow" (a.k.a. "solids discharge" or "cake") and the cleaned liquid stream (a.k.a. "centrate") to be the "overflow". Centrifuge performance is a direct function of the drilling fluid inhibition, formation solids reactivity (defined as the combined measure of the potential for a material to cause a negative impact to the drilling activities by material hydration and/or dispersion), centrifuge design parameters, and centrifuge operating parameters.



Figure 3 – Elgin's APEX 19™ Centrifuge.

Conversely, VCD's are deployed to "cut" (i.e. recover) the valuable drilling fluid from the waste solids. For VCD's, the cut drilling fluids are considered the valuable centrate (a.k.a. "filtrate") and the waste solids are considered the underflow (a.k.a. "solids discharge"). Similar to decanter centrifuges, the centrate will contain most of the liquid and the finer solids. The solids discharge will contain limited liquid and the coarser solids. Like decanter centrifuges, the goal of a VCD is to have the solids discharge as dry as possible. Ultimately, the dryer the solids, the more effective the drilling fluid recovery. The ability to achieve this goal is a direct function of the drilling fluid inhibition, formation solids reactivity, cuttings age, VCD design parameters (i.e. screen surface area, screen angle, and solids residence time), and VCD operating parameters (i.e. G-force applied, feed rate, and screen selection).

As noted in our White Paper, "Common Challenges Relative to the Use of Decanter Centrifuges for Barite Recovery in the Oil & Gas Industry," common flow-line shakers will achieve a 115 micron cut (API 140 screens). Conversely, given the fact that the cuttings discharge from the flow-line shakers are surface wetted, it will

When cuttings are subjected to a VCD, approximately 90% of the surface wetting drilling fluid can be recovered from the cuttings.

maintain the full range of solids, from colloidal to coarse. As such, when the cuttings are



Figure 4 – Recovered Drilling Fluid from an Elgin VCD.

subjected to the VCD, approximately 90% of the surface wetting drilling fluid will be recovered from the cuttings via centrifugal force. It is not uncommon for VCD's to be able to reduce the OOC / WOC content from 25% by weight to 2.5% by weight. In doing so, the centrate slurry will maintain a high volume of "fines" that must be further treated by either a dedicated high-speed

decanter centrifuge or through the rig's existing dual centrifuge "barite recovery" system, prior to reintroduction to the active mud system.

It is important to keep in mind that the American Petroleum Institute's ("API") standard for barite ranges approximately from 1 micron to 100 microns (See **Figure 5**). Given that VCD screen technology maintains an opening size greater than 200 microns (typically 500 to 1,000 microns, see **Figure 6** below), loss of barite is a negligible concern. Only if the VCD centrate is subjected directly to the high-speed solids control centrifuge, without prior processing through the "barite-recovery" centrifuge, will a VCD system extract barite from the active mud system.

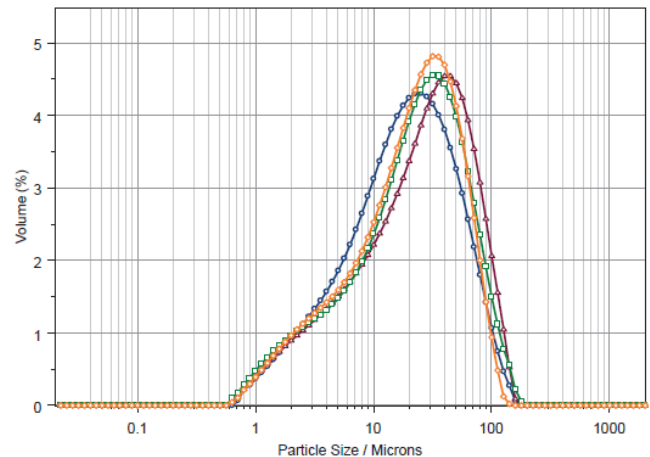


Figure 5 – Various API Barite Suppliers' PSD Analysis.



CSI-04™ / CSI-E4™ / CSI-D4™ Vertical Cuttings Dryer Screen and Flite Selection Guide

Elgin Vertical Cuttings Dryer Screen Features					
 <p>Enhanced abrasion resistance via proprietary chrome hardening process.</p>	 <p>Full penetration TIG welded structure for maximum durability.</p>	 <p>Dynamically balanced screen for even surface wear and mitigated system vibration.</p>	 <p>Full stainless-steel construction for maximum corrosion resistance.</p>	<p>Revitalize your CSI-03™ & CSI-04™ VCD by eliminating lubrication system failures with Elgin's oil-sealed gearbox retrofit solution.</p> <p>Elgin's CSI Cyclone Pro™ direct, dual-drive VCD's are capable of processing water-based and oil-based waste without the need for a conversion kit.</p> <p>Need a complete turn-key waste cuttings management system? Elgin has the perfect solution for today's operational needs.</p>	
<p>0.010" (250 micron) Profile Wire Screen Part #325-2-010</p>	<p>0.015" (400 micron) Profile Wire Screen Part #325-2-015</p>	<p>0.020" (500 micron) Profile Wire Screen Part #325-2-020</p>	<p>Individual Hard Chrome Flites (Set of 8) Part #330-5C</p>	<p>Tungsten Carbide Flites (Set of 8) Part #330-10</p>	<p>Ceramic Single-Piece Conical Flite Set (Only for water-based Conversion Kits)</p>
 <p>Universal Drilling Fluids Cuttings Treatment Minimizes Centrate Fines, But Lowers Solids Discharge Dryness. Best Utilized for Fine Cuttings.</p>	 <p>Universal Drilling Fluids Cuttings Treatment Balances Centrate Fines and Discharge Dryness. Good Starter Screen for Average to Large Cuttings.</p>	 <p>Universal Drilling Fluids Cuttings Treatment Balances Centrate Fines and Discharge Dryness. Best Starter Screen for Average to Large Cuttings.</p>	 <p>Universal Drilling Fluid Cuttings Treatment Hard-Chrome is Applied to Increase the Time Required Between Changes and Ensures a Precision Fit Each Time.</p>	 <p>Universal Drilling Fluid Cuttings Treatment Tungsten Carbide Tiles Dramatically Increases the Time Required Between Changes. Will Provide the Longest Life.</p>	 <p>Universal Drilling Fluid Cuttings Treatment Dramatically Reduces the Time Required to Change Scrapers & Ensures a Precision Fit. 12-24 Month Life.</p>

2021 – Revision I

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Figure 6 – Elgin's VCD Screen Selection Guide Summary

Section 2.0 – VCD Deployment Challenges

At present, only one out of every four drilling rigs take advantage of VCD technology. Given the immediate return on investment achieved through the successful deployment of VCD's, the fact that VCD technology has not become a standard practice on all drilling rigs, is the direct result of four factors:

1. **The WBM Challenge** - Up until 2014, VCD technology was not well adapted for water-based drilling fluids. However, new patented VCD technologies (i.e. Elgin's D-Series VCD's) have been developed that allow VCD's to operate in both WBM and OBM environments. Elgin maintains an entire line of patented VCD's designed to specifically manage both WBM and OBM cuttings. These new VCD technologies operate through the entire well, regardless of the make-up of the drilling fluid.



Figure 7 - Elgin's Proprietary and Patented CSI-D4™ Cyclone Pro VCD

2. **The Myth of The Colloidal Solids Monster** - A great deal of unfounded historical stigma had been perpetuated relative to the development of colloidal solids via the use of VCD technology. Historically, there was potential foundation for this theory, as older VCD systems operated with a "cake-wall" in which a multitude of flites would carve away at the solids as they accumulated on the interior screen surface. However, the modern systems designed by Elgin, do not operate through the use of a sustained cake-wall. Instead, the flites maintain a tight tolerance to the screen interface which sweeps the solids from the screen with each pass. Further, it is easy to overlook the fact that all modern decanter centrifuges utilize a cake-wall in which a conveyor auger scrapes the interior cake wall, pushing the solids to the solids discharge zone. Typical solids can maintain a 3 to 4 second residence time within an average decanter centrifuge. In contrast, solids within a VCD have an average residence time of less than one-quarter that of a decanter centrifuge (under 1 second). If solids degradation impacts were material, relative to the development of colloidal solids as a result of the scraping action imparted by a flite or auger, this concern would have already been well documented by the thousands of applications utilizing decanter centrifuges. However, this is not been the case.

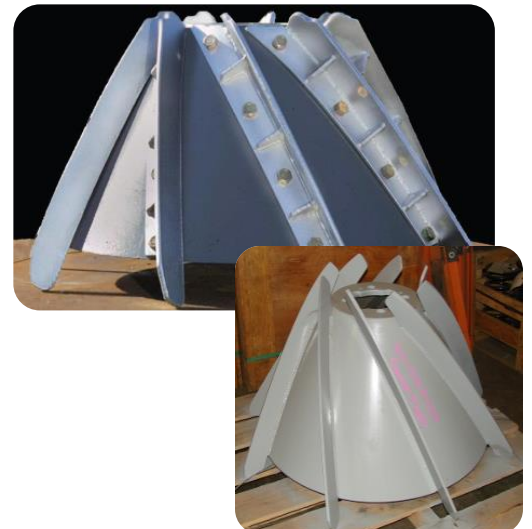
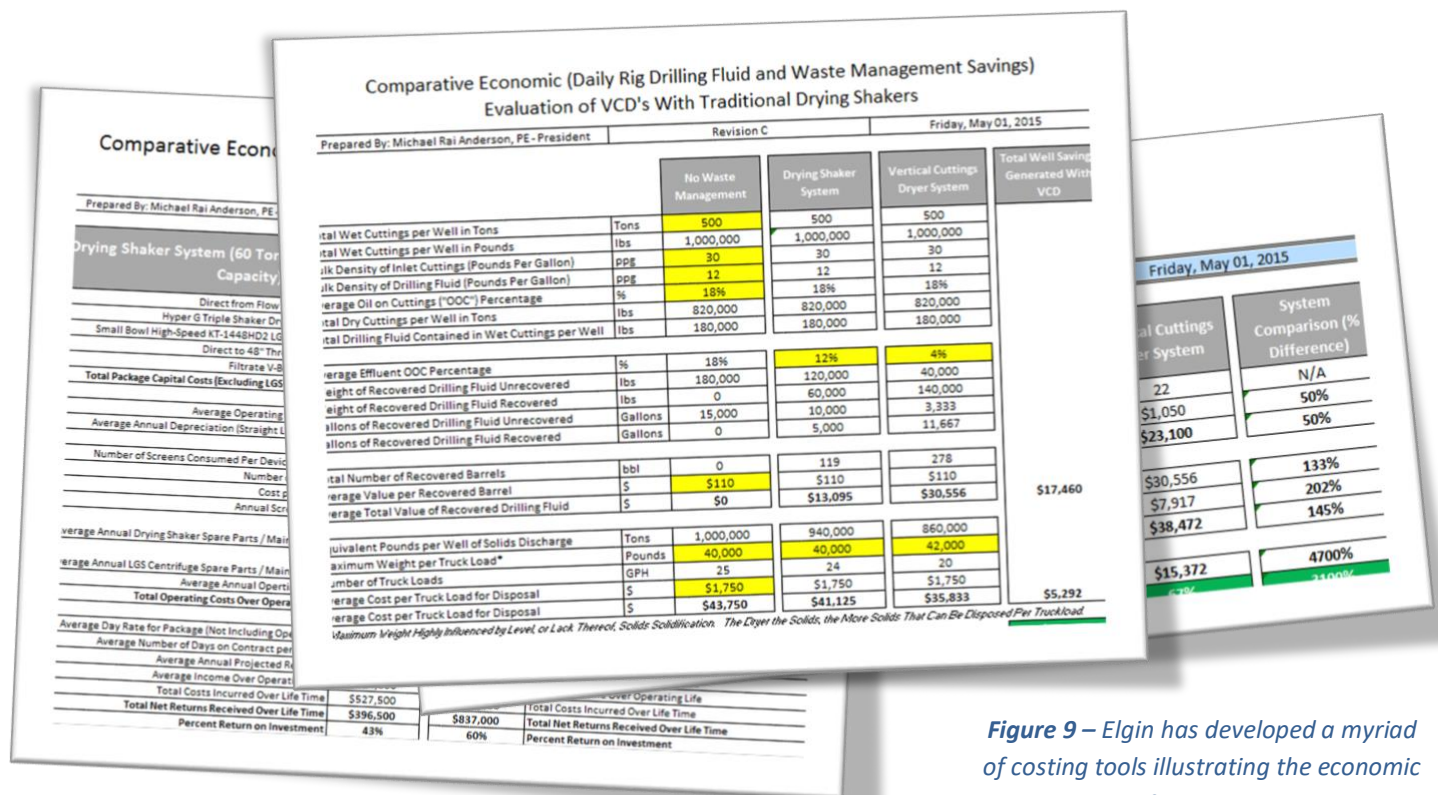


Figure 8 - Elgin's Proprietary Cast Flites and Single-Piece Conical Flite Sets.

3. **Potentially Counterintuitive Business for Major Service Provider Incumbents** - The recovery of drilling fluids by VCD's will indubitably reduce the volume of lost drilling fluid. As such, the deployment of such technology will lower "mud bills". It is not practical to expect the same service companies that are selling drilling fluids to recommend a technology that lowers their revenue base by as much as 5%. Ultimately, it is up to the operators to specify that drilling fluid recovery technologies are installed on all drilling contracts to lower unnecessary waste disposal costs and to reduce the volume of make-up drilling fluid needed during the course of the well. In due time, VCD technology may become a foundational element of the flow-line shaker system owned and operated by the Drilling Contractor, not the third-party service providers.
4. **Lack of Education** – Despite a deployment history that dates back more than 20 years and the fact that more than 1/4 of the world's rigs are already successfully utilizing VCD technology, there has not been a great deal of formal education presented to the market. It is Elgin's hope that documentation, such as this, will help dispel many of the common myths, as well as provide a clear context to the value proposition that VCD's provide. Further, Elgin has developed a number of financial cost/benefit analysis tools to help customers make informed decisions about the selection and application of VCD technology.



Section 3.0 – Overcoming Common Solids Control Failures Using VCD's

Drilling fluid conditions will inevitably degrade over the course of the well. Theoretically, there are means to keep this from happening. However, many of today's solids control techniques make this hard to avoid. As highlighted in the introduction, this is driven by two common solids control errors:

1. **Coarse Flow-Line Shaker Screens** - Most drilling rigs operate their primary flow-line shakers with screens too coarse (Screens rated at API 140 or lower) to achieve meaningful solids control. In order to cut costs, drilling rig operators use coarse screens that last longer. Further, coarse screens minimize the risks of whole mud losses when drilling fluid circulation rates are high. However, the risk of whole mud losses would be significantly reduced, if a sufficient number of shakers (i.e. sufficient surface area) were installed or if there was VCD system that actively recovered such losses.
2. **25% Centrifuge Slip Stream Treatment** - Despite the fact that most rig drilling fluid circulation rates will operate between 800 and 1,200 gallons per minute, the largest centrifuge applications treat 100 to 300 gallons per minute. As highlighted by **Figure 10**, most centrifuge applications treat only one out of four parts of the drilling fluid during each pass. The challenge is that modern drilling techniques constantly generate colloidal and ultrafine solids, through the natural degradation cycle, faster than can be removed by the solids control system. The more solids that are allowed to pass through coarse shaker screens, the faster the degradation cycle. Ultimately, those three out of four parts, not treated by the centrifuges, will simply further degrade and be joined by more colloidal and ultrafine solids from the drilling process. This is the fundamental reason that mud weights rise over the course of the well, despite the application of traditional solids control technologies.



The combination of these factors results in drilling rigs operating with primary flow-line shakers that are too coarse to sufficiently support the goals of the solids control program and utilizing insufficient centrifuge capacity to make up for the poor performance of the shaker systems. Despite the fact that drilling fluid operations have become significantly more advanced in the last 20 years, most drilling rig operations continue to use 14" or 16" solids control centrifuges. Though these centrifuges may have been well sized for systems a decade or two ago, this is no longer the case.



Since a "Barite Recovery" system operates more like dialysis system, than a full-flow treatment system, the only way to maximize drilling performance and long-term drilling fluid quality is to ensure that the

drilling fluid entering the system is as clean as possible. If there was no concern relative to whole mud losses, due to the deployment of VCD technology, and rigs were therefore able to increase the API rating of their screens from API 140 to API 170, the average cut point would be improved by 20%, dropping from 115 microns to 90 microns. Since the “Barite Recovery” system will manage approximately 25% of the active mud system circulation rate, this means that the remaining 75% of the flow, will no longer be able to further degrade those 90 to 115 micron solids. If the shakers are truly the first line of defense, then the finest screens that can be practically applied should be utilized. Without doing so, the first line of defense will never operate at its full potential.

When properly deployed, VCD technology can help improve the average cut point achieved by the flow-line shakers by as much as 20%.

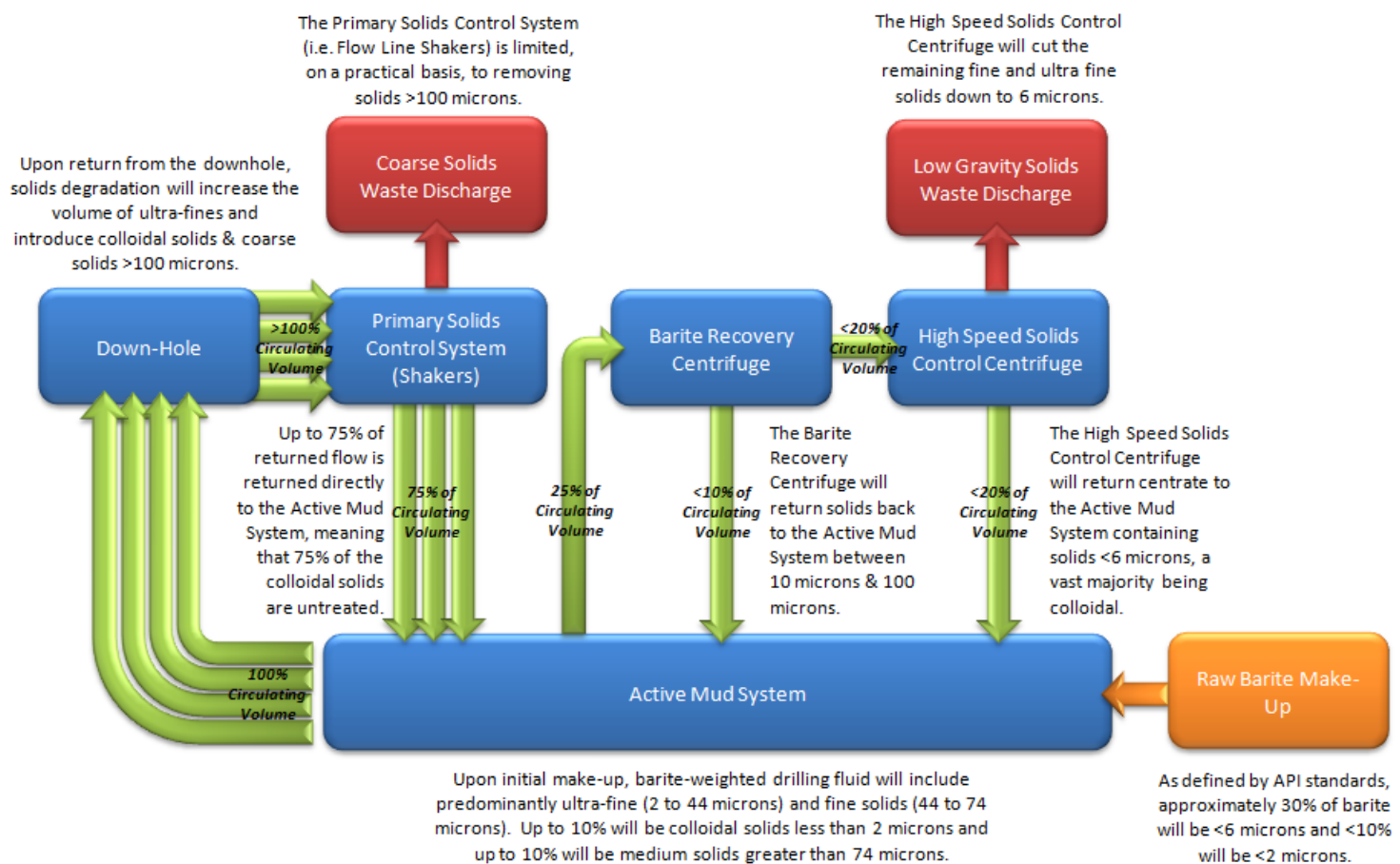


Figure 10 – Prototypical Barite Recovery Solids Control System

Section 4.0 – Conclusion

The most cost effective, field-proven and efficient means of deploying highly effective waste management at the rig site is through the deployment of a VCD. It is important to keep in mind that the common flow-line shaker cuttings discharge may maintain an Oil-On-Cuttings (“OOC”) or Water-On-Cuttings (“WOC”) moisture content as high as 25%. As such, the average well will lose

An average well will lose approximately 5 gallons a minute of drilling fluid with the discarded flow-line shaker cuttings. Over a 10-hour day, this would equate to 3,000 gallons (71 barrels).

approximately 5 gallons a minute of drilling fluid with the discarded flow-line shaker cuttings. Over a 10-hour day, this would equate to 3,000 gallons (71 barrels). If the make-up cost of this drilling fluid were just \$50 per barrel, more than \$3,500 of drilling fluid are lost per day. A VCD operating at a 90% recovery rate will return \$3,200 (64 barrels) worth of this drilling fluid back to the active mud system every day. If there were only 10 drilling days per month, a drilling contractor could pay for an entire VCD system (i.e. Dryer package, telescoping stand, control panel, cuttings feed system, and cuttings collection system) in less than one year.



Figure 11 – Dried solids discharge from a CSI-03 VCD.

However, the recovered drilling fluid savings are just one element of the big picture. By recovering 64 barrels per day of drilling fluids, the waste disposal volumes are reduced by as much as 27,000 pounds (Assuming the drilling fluid maintains a weight of 10 ppg). In many cases, this means one less truck load and one less landfill disposal fee per day, further increasing the daily savings. Not to mention the fact that this presents a reduced carbon footprint. Even if the wastes are being submitted for further treatment (i.e. thermal desorption), the dryer material will dramatically lower the energy consumption and therefore the costs required for further processing.

More importantly, when properly integrated with a solids control system, VCD technology will allow flow-line shakers to be fitted with finer screens, therefore lowering the volume of drilled solids from entering the active mud system. This ultimately places less stress on the centrifuge system, improving their

VCD systems are not only cost-effective, but can lower drilling fluid make-up costs, lower disposal fees, improve drilling performance, and lower the carbon footprint.

performance. The combined effect of improved shaker and centrifuge performance ultimately results in higher drilling fluid quality. This improves the drilling rates of penetration and reduces the damaging effects of accelerated wear on drill tools, mud pumps, and related equipment. In essence, when properly used, VCD’s can help improve the performance of the solids control system, enhancing the drilling fluid properties, thereby improving rig performance (i.e. increased rates of penetration, improved cake wall stability, reduced bit torque and reduce pipe drag).

Section 5.0 – Not All VCD's Are Created Equal

Based on more than 60 years of experience and tens-of-thousands of deployment, Elgin now offers a host of specialized VCD technologies, as highlighted in **Table 1**. These systems are the result of decades of product development based on performance data collected from the field.

Model Name	CSI-E3 Cyclone™	CSI-D3 Cyclone Pro™	CSI-E4 Cyclone™	CSI-D4 Cyclone Pro™	CSI-D5 Cyclone Pro™
Equipment Image (Stand and Panel Not Shown):					
Feed Capacity: ¹	40 TPH (7.5 kg/s)	40 TPH (7.5 kg/s)	80 TPH (15 kg/s)	80 TPH (15 kg/s)	100TPH (22.5 kg/s)
G-Force (Sheave Size Denoted in Inches):	480V / 60Hz – 518 8" or 642 G's 9" 360V / 50Hz - 445 G's 9.0"	480V / 60Hz - 300 to 700 G's (VFD) 360V / 50Hz - 300 to 500 G's (VFD)	480V / 60Hz - 403 10.5" or 526 G's 12" 360V / 50Hz - 426 G's 13"	480V / 60Hz - 300 to 550 G's (VFD) 360V / 50Hz - 300 to 450 G's (VFD)	480V / 60Hz - 350 to 600 G's (VFD) 360V / 50Hz - 350 to 500 G's (VFD)
Screen Opening Sizes:	0.008" (0.2mm) to 0.040" (1.0 mm) with 0.020" (0.5mm) Standard	0.008" (0.2mm) to 0.040" (1.0 mm) with 0.020" (0.5mm) Standard	0.008" (0.2mm) to 0.040" (1.0 mm) with 0.020" (0.5mm) Standard	0.008" (0.2mm) to 0.040" (1.0 mm) with 0.020" (0.5mm) Standard	0.008" (0.2mm) to 0.040" (1.0 mm) with 0.020" (0.5mm) Standard
Gear Box Ratio:	Two Stage 74:1	Three Stage VFD Variable	Two Stage 71:1	Three Stage VFD Variable	Three Stage VFD Variable
Lubrication:	Oil Sealed	Oil Sealed	Oil Sealed	Oil Sealed	Oil Sealed
Weight (Without Stand):	4,400 lbs (1,995 kgs)	3,900 lbs (1,769 kgs)	7,700 lbs (3,492 kgs)	7,300 lbs (3,357 kgs)	8,800 lbs (3,990 kgs)
Screen Surface Area	7.11 sq. ft. (0.661 sq. m.)	7.11 sq. ft. (0.661 sq. m.)	13.3 sq. ft. (1.25 sq. m.)	13.3 sq. ft. (1.25 sq. m.)	16.0 sq. ft. (1.50 sq. m.)
Motor Horsepower:	30 HP (22.71 KW)	(1) 25 HP (18 KW) (1) 5 HP (4 KW)	75 HP (60 KW)	(1) 60 HP (44 KW) (1) 15 HP (11 KW)	(1) 75 HP (60 KW) (1) 20 HP (15 KW)
Voltage:	480V/60Hz or 360V/50Hz 3 Phase	480V/60Hz or 360V/50Hz 3 Phase	480V/60Hz or 360V/50Hz 3 Phase	480V/60Hz or 360V/50Hz 3 Phase	480V/60Hz or 360V/50Hz 3 Phase
Electrical Classification:	US C1 – D1, IECEx or ATEX Zone 1	US C1 – D1, IECEx or ATEX Zone 1	US C1 – D1, IECEx or ATEX Zone 1	US C1 – D1, IECEx or ATEX Zone 1	US C1 – D1, IECEx or ATEX Zone 1
Dimensions (Without Stand):	7' (2.1m) L x 6' (1.8m) W x 5' (1.5m) H	7' (2.1m) L x 5.2' (1.6m) W x 4.7' (1.4m) H	8.10' (2.5m) L x 7.3' (2.2m) W x 5.9' (1.8m) H	8.10' (2.5m) L x 7.3' (2.2m) W x 5.9' (1.8m) H	8.10' (2.5m) L x 7.3' (2.2m) W x 5.9' (1.8m) H

The design of the VCD's offered by Elgin provides a harmonic balance between G-force, surface area, screen opening size, and residence time. This must be done to maximize system performance. When considering Elgin's preeminent position within the VCD market, the following factors should be considered.

1. **Safety** - As noted in Elgin's white paper, "Understanding the Potential Class II – Division I Safety Hazards Present When Operating Vertical Cuttings Dryers," there are a growing number of new entrants into the market, especially those that are being imported from "low-cost country" sources. In many cases, these new entrants have poorly designed or completely exposed belt and sheave systems that provide no barrier between potentially combustible oil mist or dust and a static-electrical discharge or excessive heat source. Further, many of these same products lack any indication that their belts meet ISO 9563 certification requirements. This does not always generate from a poor design, but from the fact that the country of origin may not have defined safety standards and laws requiring such protections.
2. **Dated Design Philosophy** - Beyond the lacking safety standards, several competitor systems have not yet achieved the level of design tolerance needed between the flites and screens in order to maximize recovery. In many cases, their designs follow past design theory, in which an unmanaged cake wall is generated, therefore creating a potential avenue for further solids degradation.
3. **Experience** – Elgin's CSI™ dryers have been and continue to be the industry standard for VCD's. Elgin has developed a number of models over a 30-year history and has shipped more units to the industry than all competitors combined.
4. **Durability** - Given our extensive installed base, we have qualified evidence showing that Elgin's CSI™ Cyclone™ dryers have the longest life. When properly maintained and operated, CSI™ Cyclone™ dryers easily enjoy a useful life exceeding 10 years. Some key product enhancements that dramatically affect equipment life include:
 - a. **Abrasion Resistant Chrome Screens** - Elgin's exclusive chrome-coated screens provide the industry's long-lasting screen. Elgin's screens can enjoy double the screen life when compared to competitor products.

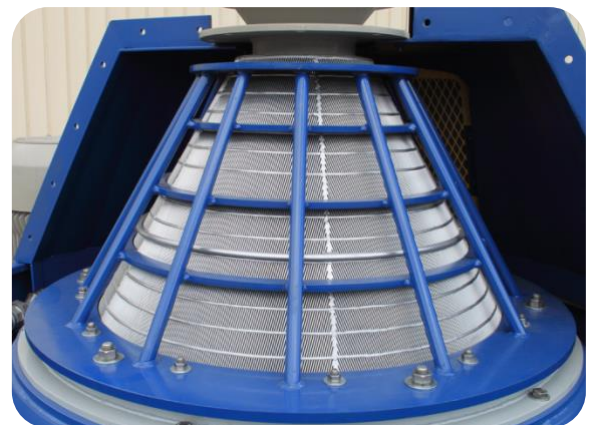


Figure 12 – Elgin's proprietary chrome-coated, TIG welded screen

- b. **Proprietary TIG Welded Screen Technology** - To further ensure screen durability, Elgin's profile wire screens are manufactured using an exclusive TIG welding process that fully bonds each individual profile wire strand. Competitor screens use a significantly less durable method called resistance welding. Resistance welded screens provide comparable initial performance, but wear quickly.
 - c. **High Tolerance Scraper Flites** - By using a formed and machined scraper flite, Elgin obtains optimum screen to blade clearance.
 - d. **Abrasion Resistant Scraper Flites** - To maximize scraper blade life, Elgin had develop a both a hard-chromed scraper flite and a tungsten-carbide scraper flite. Hard-chromed scraper flites can achieve double the life of a standard cast flite. Elgin's tungsten-carbide faced flites can achieve four times the life of a standard cast scraper flite.
 - e. **Industry Leading Gear Boxes** - Elgin's planetary gearbox is the heart of the VCD. With almost 30 years of experience, Elgin's gearbox will out-perform and outlast any competitor gearbox available in the market. Many competitor gear boxes have a drive system that cannot sustain the torque required to provide proper or continued separation. Many of these gear boxes cannot be serviced and are essential "disposable".
5. **Serviceability** - Given our experience and ensuring that we carefully listen to our customers, we have developed a VCD product line that makes field servicing practical. With 360 degrees of access around the VCD, operators have direct access to the gear-box and screen. Elgin has further improved system access by providing optional split upper covers (when overhead height access is limited) and full-length maintenance access doors for cleaning of the screen and for inspection. Even Elgin's stands include jib cranes to allow easy removal of the top cover for screen servicing.

6. **Reliability** - Given the use of premium motors, electronic components, and the industry's most rugged gear box, there is no other dryer in the market that will ensure maximum uptime. Elgin uses premium drive-motors that are provided with the industry's longest lasting warranty. Today, each Elgin dryer motor is provided with a 3-year warranty. Elgin uses fully certified UL-listed, NEMA 7X, Class 1 – Division 1, ATEX Zone 1 or IECEx Explosion Proof Control Panels built and assembled in the United States to ensure a durable and reliable start every time the power is turned on.

7. **Market Leading R&D** – Elgin's Engineering Team continues to develop new proprietary and patented technologies. We continue to research upgrades to base metal, manufacturing techniques, new design technologies, etc. to improve the product and ensure customer satisfaction. Recent technological advancements include a new patented CSI Cyclone Pro™ direct drive system that removes the need for sheaves, a belt tunnel and belts.



Figure 13 – Elgin's patented CSI-D4 Cyclone Pro™ direct drive dryer eliminates drive belts and provides a guaranteed Class I – Division 1 and Class I – Division 2 compliant drive system. No other dryer available in the market can make those same claims.