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SOLID BOSS DECK DRAINAGE SYSTEM DESCRIPTION

Solids are a major problem on oil platforms – particularly drilling platforms. The SOLID BOSS Deck Drainage System is designed to process a wide variety of inputs, including, but not limited to, drilling mud, silty clay, sand, lubricants, emulsified oil, free oil, suspended solids, trace amounts of heavy metals, heavy oil and grease. The Deck Drainage System will handle large volumes of contaminants with minimal operating cost or maintenance. It is the most cost effective deck drainage system available.

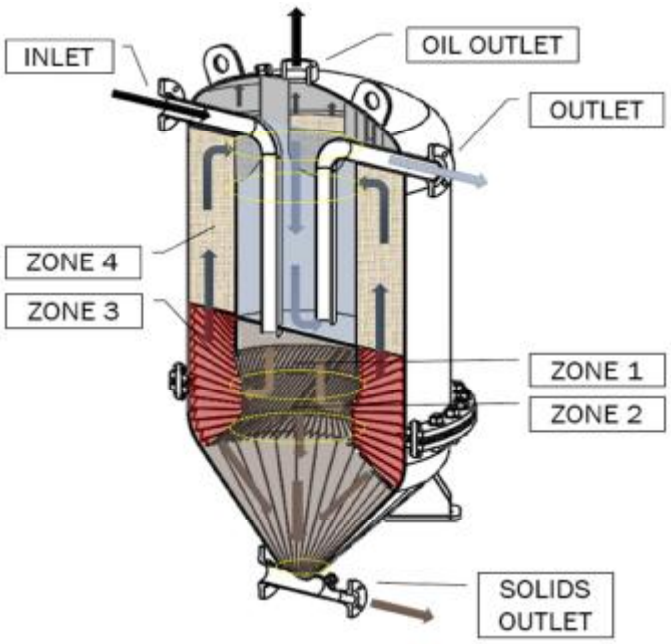
A. SYSTEM COMPONENTS:

- Solids Separator vessel, skid mounted
- Air diaphragm process pump with regulated air control so pump can be adjusted from 1% to 300% of design flow
- Air diaphragm solid discharge pump with regulated air control.
- Tuning fork for measuring heavy solids
- Density meter for measuring the rag layer
- Welded piping
- PLC control with 10” HMI touch screen
- SS enclosure with air conditioner and purge controller for Class I Div II area classification
- Marine coating (epoxy primer, polyurethane top coat)
- Oil removal option for removing oil
- High flow option to be able to process high volumes of water and discharge overboard without going through the oil water separator.

The SOLID BOSS can be attached on the front end of any other manufacturer’s OWS. Some other systems may require additional components, depending on the design of the OWS.

B. SYSTEM DESCRIPTION:

1. General Description of the Process:



The system is first filled with clean water. The system is designed for either gravity flow through the system or pressurized from an inlet pump up to 70 psig. (Higher pressures are available.) With either the Oil Option or the High Flow Option, the system must be pressurized at least 5 psig. The process pump does not come standard with the system but can be ordered as an option.

The carrier fluid goes down through an inlet pipe located in the center chamber (Zone 1), either from a process pump or from the head pressure of the carrier fluid. The velocity of the carrier fluid is not critical at this stage. Part way down the center chamber is a barrier plate that separates the center chamber. When the input stream reaches the bottom of the pipe the velocity of the carrier fluid is reduced to a laminar flow condition to match the terminal velocity of the solid particle at a specified specific gravity and viscosity. The heavier solids continue to fall to the bottom of the cone section of the vessel. The carrier fluid makes a turn through a series of lamella plates—entering the plates from the side of the plates (Zone 2). It is important at this and later stages of the process that the carrier fluid is in a laminar flow condition. As long as the flow is laminar the particle size that is removed can be calculated using Stokes Law with a high level of accuracy. If the flow is turbulent then the accuracy of the calculation is not predictable. It will still remove solids but we cannot predict the particle size that will be removed. The finer particles settle to the bottom side of the lamella plates in Zone 3. The combination of friction and gravity pull the solids down to the bottom of the plates and the solids fall into the cone of the separator. The lamella plates will remove solids to the level shown in the design tables for a specific size of unit based on the assumptions used for the calculation.

If the system includes the Oil Removal (OR) option then the system is designed to remove oil as well as solids. The lamella plates will also scrub oil out of the water. The oil will collect on the underneath side of each plate while the solids will collect on the top side of each plate (Zone 3 area). The water and oil will flow to the top of the outer section of the separator (Zone 4), passing through polypropylene coalescing media that will accelerate the coalescing process. The water goes over another weir and the velocity changes to the terminal velocity of the oil. The oil rises to the top of the separator and is collected in an oil reservoir until the reservoir fills up. A level control transmitter signal when the oil needs to be discharged. The water goes down the center chamber and is drawn out of the vessel just above the divider plate in the center chamber.

The attached design data tables (one for each standard size system) show the relationship of flow rate, velocity and particle size based on a set of standard conditions (specific gravity, plate surface area, viscosity, plate angle). A more thorough explanation of how the tables work is included on the back side of the tables. These tables can be used as a guideline to determine the flow rate range that the system will perform.

The flow design tables show the final particle size of both solids and oil that can be removed through the lamella plates at different flow rates and velocities. The green area shows the operating range that can be calculated accurately using Stokes Law. The yellow area starts to become less accurate and the white area with the numbers crossed out is not predictable because of turbulent flow conditions. Keep in mind that these tables are based on a standard set of conditions. Actual conditions will vary. It is important to note that these tables are only guidelines and actual conditions will vary. If you will provide us with your parameters we will generate a table for you that fits your conditions. To do that we would need to know the specific gravity of the carrier fluid and particles, the viscosity of the carrier fluid and any known information regarding emulsions that are formed in the process.

2. Solids Removal

Solids in the cone of the vessel are detected in 2 methods. Heavier solids are measured by a level switch. When the solids reach the top of the solids level switch (tuning fork) the sensor sends a signal to the control system that opens the discharge control valve and turns on the blowdown pump. The speed of the pump is controlled by the control system. The pump can either be set to remove a specific volume of material or it can be set to pump a certain flow rate until the solids reach a low set point. This is all adjusted using the HMI interface. The solids discharge pump can be adjusted from 1% of its flow capacity to 100% of its flow capacity.

Lighter solids that are in suspension in the “rag” layer (area including the bottom section of the plates down to the heavy solid interface) are not detected by the tuning form when they are in a suspended condition. A solids level transmitter (density meter) is located in this area to measure the density of the solids (displayed either as density or % solids). When the density reaches a preset level the meter sends a signal to the control system that opens the discharge valve and turns on pump. Once again the pump can be set to either pump a specific volume or it can pump a certain flow rate until the density reaches a low set point. The method of measurement and set points are easily controlled on the HMI touch screen.

The SOLID BOSS uses an air diaphragm pump so the pulsing of the pump will help keep the solids in the bottom of the vessel from compacting and make it easier to remove the solids. In addition the air diaphragm pump allows the output of the pump to range from 1% of capacity to 100% of capacity. The solids are discharged to either a tote or to a dewatering device.

The pump will push the solids up to a higher deck level depending on a number of factors, including air pressure, flow rate, viscosity and specific gravity. In most situations the SOLID BOSS could be located at a lower deck and the tote can be on the upper deck. The head pressure of the pump will be 10 psig less than the supply air

pressure assuming the pump is pumping water. The pump can handle up to 150 psig. We have sized the blowdown line so that the impact of the viscosity should be minimal. The flow rate of the pump will not allow for a flow that will have a significant impact. The specific gravity will impact the amount of lift. A general rule of thumb is that you can divide the head by the specific gravity of the fluid to determine the impact of specific gravity on the available lift. As an example, if the air pressure is 100 psig and the specific gravity of the fluid is 2 and there is approximately 2 feet head per psig then the available lift would be 200/2 = 100 feet. The flow rate, viscosity and number of bends in the pipe could all have an additional impact on the total lift available.

3. Water Discharge

The water discharge exits the center chamber of the separator just above the divider plate. The pressure drop of the SOLID BOSS is minimal. If the flow to the SOLID BOSS has more than 5 psig pressure (10' head) there should be adequate pressure to push through to the OWS without needing another process pump. If the OWS is at a higher elevation or if the OWS pump has no suction capability then a process pump will be required. A process pump can be ordered as an option. It is possible to have a totally gravity system as long as the SOLID BOSS is below the collection system and the discharge from the SOLID BOSS is to a point below the SOLID BOSS. The oil removal and high flow options are not available in a vacuum situation. Those options need a positive pressure.

4. Oil Water Separator Interface

The SOLID BOSS is designed to go on the front end of any existing OWS. With that said some OWS's are more sensitive to solids than others. The water discharged from the SOLID BOSS will still contain very fine particles. Some OWS's will still be sensitive to these fine particles. If a finer solids removal is necessary it will require a 1 to 3 micron bag filter. The SOLID BOSS will take out about the equivalent to a 5 micron filter.

The BOSS oily water separator has a coalescing separator that is not impacted by solids. The polisher consists of a bulk organoclay polishing filter. The bulk media acts like a sand filter and collects solids. The solids are backwashed to the tote. The timing of the backwash can be manual or can be controlled by the OWS control system automatically. The BOSS oily water separator will handle fine solids better than most other OWS and should be considered if the existing OWS is having difficulty. Any existing BOSS oily water separator can be retrofitted to operate in sync with the SOLID BOSS.

5. What to Expect

The SOLID BOSS separator should provide the following results:

a. Removal of solid particles down to < 25 micron particle size. Refer to the chart in design data table relating to your model to determine the particle size. Keep in mind that this chart is based on an assumed specific gravity and the results will be different if your specific gravity is different.
b. Removal of some of the oils that are emulsified with the particles to the extent that they come out with the solids.

c. Removal of oil down to <70 micron particle size if the oil recovery option has been purchased.
d. The SOLID BOSS will improve the performance of the existing OWS.

6. System Pressure

The standard system operates at a range of 5 - 70 psig. Higher pressures are available as an option. The system itself has minimal pressure drop.

7. Pre-filtration

The discharge pump will handle particles up to 1/2" size. That is the maximum size particle that the system will handle. A screen may be required upstream of the SOLID BOSS to ensure that the inlets particles are small than 1/2" in size.

8. High Flow Capacity

It is common for an Offshore Platform to experience heavy rainstorms that overpower the capacity of the holding tank or existing OWS. The SOLID BOSS system has the ability to flow 3 times it nominal flow rate with predictable particle size removal. It can flow even more in situations where there are very few if any solid particles – such as a heavy rainstorm.

The flow to and from the SOLID BOSS is only limited by the inlet and outlet line size. The system can be designed to handle whatever flow will come through the lines. Essentially the SOLID BOSS becomes a wide spot in the pipeline. It will still remove particles at whatever the flow. As the flow rate increases the particle size that can be removed goes down. In a heavy rainstorm that is not generally an issue because the rain will have very few particles.

An oil content monitor (OCM) can either be added to the SOLID BOSS next to the control panel, along with a discharge and recycle control valve or the OCM can be located remotely. In this situation the water is sampled by the OCM. If the OCM detects less than 15 ppm oil the water can be discharged overboard and will bypass the OWS system. If the OCM detects more than 15 PPM oil, the water would have to go to the holding tank and would have to wait for the OCM to catch up. In a heavy rainstorm the presence of oil in the water is highly unlikely and most of the water should be able to be discharged overboard.

With the OCM option the water going through the SOLID BOSS can continually be sampled and any time that it has < 15 ppm oil the OWS can be bypassed. This condition could happen even when there is not a heavy rainstorm, depending on how the water comes out of the holding tank. In many situations, the holding tank will act as a first stage separator and the water coming from the holding tank could be from a section that does not have oil and the OWS can be bypassed.

9. Area Classification:

The SOLID BOSS comes standard rated for Class I Div II hazardous area classification. NEMA 4X and Class I Div I options are also available.

C. OPERATIONS AND MAINTENANCE:

The operating costs are as follows:

- Small amount of electricity for the pump actuator and control system
- Air for the pump(s)
- There are no bag filters or media to change
- There are no flocculants and chemical additives

Maintenance costs are as follows:

- There are no moving parts and no centrifuge. The only maintenance is for the pump, instruments and control system.
- The lamella plates are less likely to plug than other solid separation systems because most of the mass of solids are removed before going to the plates. If the plates should need to be cleaned for some reason the flange can be unbolted and the top section can be easily removed for full access to the plate pack. The plate pack can be easily removed and pressure washed.