Voraxial® 2000 Separator
Deck Drainage System

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1.0 Introduction

Enviro Voraxial Technology, Inc (EVTN) of Ft. Lauderdale, Florida, manufactures a series of separation equipment designed to treat a range of wastewater flow rates. EVTN's patented Voraxial® Separator can simultaneously separate liquid/liquid, liquid/solid, or liquid/liquid/solid mixtures flowing through the separator. This type of separation technology is particularly suited for treatment of deck drainage and run-off. This document describes the design and function of the Voraxial Separator Deck Drainage Treatment System.

The Voraxial Separator Deck Drainage Treatment System typically consists of a skid mounted Voraxial Separator configured with a coalescer, filter, and discharge pump. A skim tank is provided to recover separated oil. As an option, an Oil Monitor can also be included to provide automatic control of the discharge based on the oil concentration. This document describes the Voraxial technology and auxiliary equipment used for treatment of deck drainage. *The Voraxial Separator Treatment System can be customized to accommodate customers' specifications.*

2.0 Description of Equipment

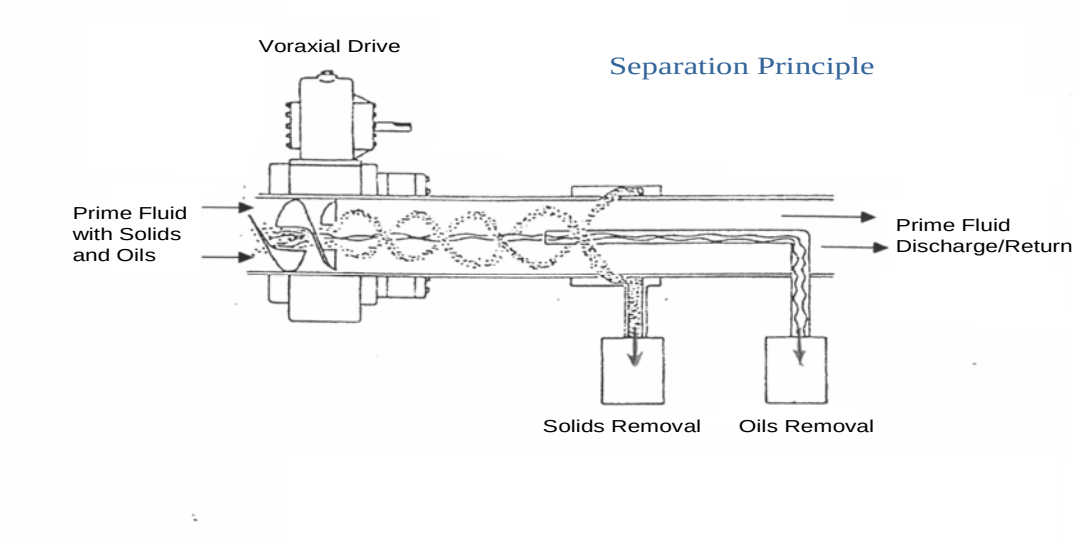
Voraxial Technology

EVTN's Voraxial Separator is a continuous flow turbo machine that generates a vortex to separate a mixture of fluids or a combination of fluids and solids by their different densities. The heavier elements are drawn to the outside of the vortex while the lighter materials are drawn toward the center, forming a central core of the vortex. The outer stream contains the heavier particles while the lighter elements are found in the inner core. A specially designed manifold is utilized at the exit of the separation chamber to collect the separated streams.

The Voraxial separation principle is illustrated on the figure below. This figure shows the methodology employed for liquid/liquid/solids separation.

To produce efficient separation, the Voraxial Separator is capable of generating a high "G" force. Depending on the model utilized and the operating speed, the Separator can produce a "G" force from several hundred to over a thousand. Due to this high "G" force, the Voraxial Separator can treat much higher flows compared to equipment typically used for separation of run-off.

Voraxial Separator Separation Principle



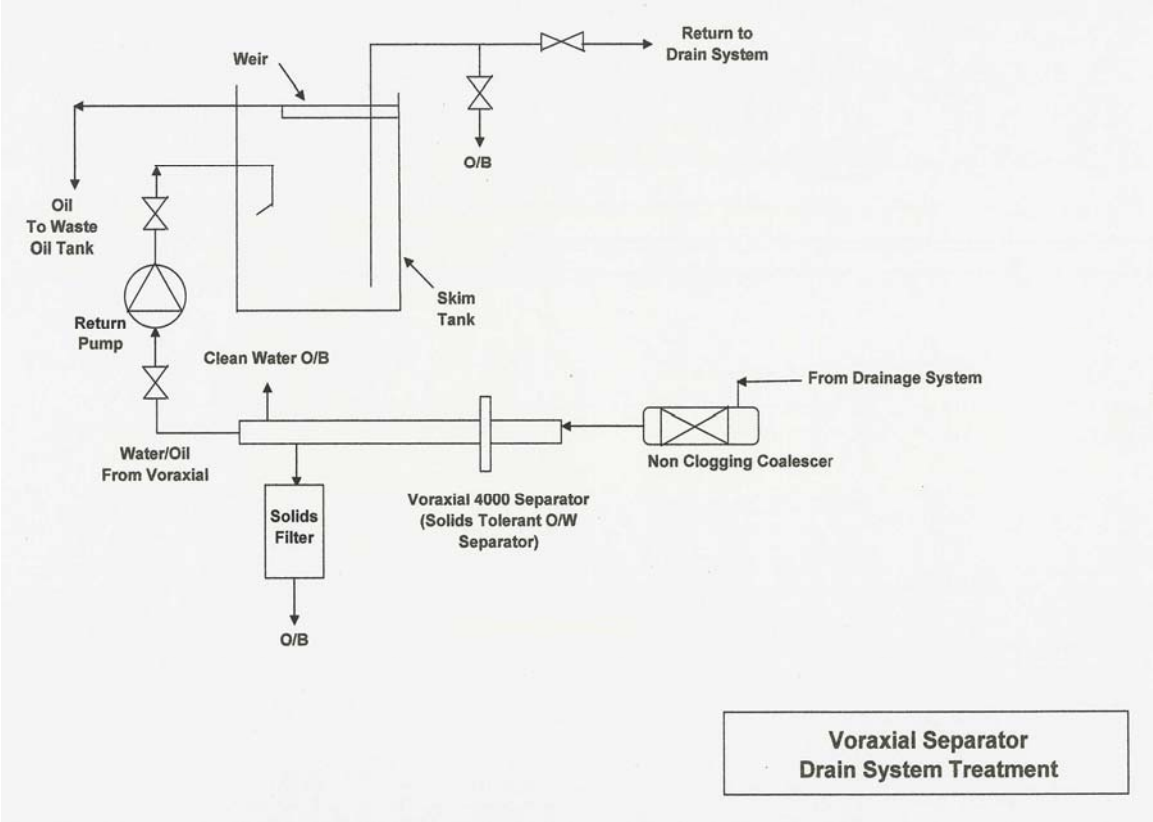
The Voraxial Separator is scalable and can be manufactured to process any amount of liquid. A list of products EVTN is presently manufacturing for Run-off Water Treatment is shown on Table 1, along with the equipment flow rate and energy requirements. As long as the Voraxial Separator remains flooded, it is not affected by changes in flow, even slugging flow. It does not rely on a pressure drop to achieve the separation so a sudden flow increase that might alter the ΔP is not a factor. Unlike other technologies, no additional shear is created that would make separation more difficult and the G's remain more or less the same resulting in a consistent vortex in the center of the separation chamber. The Separator is also ideal for intermittent flows due to the quick formation of the vortex in the separation chamber.

Table 1
Voraxial Separator Characteristics

Model	Flow (gpm)	Energy (hp)
Voraxial 2000	20-50	3
Voraxial 4000	100-500	25

The Voraxial Separator is energy self-sufficient and provides its own motive force (i.e., it provides the energy required to move the fluid being treated), as listed on Table 1.

A typical arrangement for a Voraxial Separator Run-off Treatment System is shown on the figure below. This arrangement includes a skid mounted Voraxial Separator, a coalescer, a solids filter, and a discharge pump. A skim tank is provided to recover separated oil. The Voraxial Separator and associated equipment used depends on the run-off characteristics and the design flow rates. The system can be designed for a wide range of flows, as shown by the Separator flow ranges in Table 1, and higher if required.



The main flow of water (clean water) is about 80-90% of the total run-off feed to the Voraxial Separator. The solids flow is typically about 5% of the feed, while the oily water flow is about 5 to 10% of the feed. A description of auxiliary equipment shown for this arrangement is provided below.

Coalescer

The coalescer vessel has the function to improve the efficiency of oil separation. The larger the oil droplets the higher the efficiency of separation. The coalescer vessel is fitted with a non-plugging coalescer pack.

Solids Filter

A strainer type of solids filter is provided to collect solids from the Voraxial Separator solids manifold. The water from the filter, typically 5% of the Voraxial Separator feed flow, can be discharged or returned to the drain feed tank. If heavy solids loading is expected a bag type filter arrangement can be provided.

Return Pump

Depending on the head required for the oily water discharge (e.g., skim tank elevation), a pump can be provided. Pumps provided are air-operated diaphragm pumps for hazardous operation.

Skim Tank

A skim tank is provided to recover separated oil in a dedicated oil collection tank, and to return water to the drain system feed tank for re-processing. The skim tank is designed for a detention time of about 20 - 30 minutes to provide additional separation of recovered oil.

3.0 Materials of Construction

The Voraxial Separator is constructed for the following conditions:

- A maximum temperature of 250 ^{o}F
- A maximum working pressure of 200 psig, fitted with ANSI 150 RF flanges rated to meet ASTM A182 and ANSI B16.5 requirements

The Rotor Assembly is equipped with the following:

- A 316 Stainless Steel low shear, open impeller
- Hybrid deep groove ball bearings with ceramic balls.

The separation chamber is a schedule 40, 316 Stainless Steel pipe.

The Voraxial Separator can be manufactured to accommodate customers specifications.

4.0 Electrical Systems

Electrical systems for the Voraxial Separator are designed for the following conditions:

- Electrical motor is explosion-proof and rated Exd IP56,
- Electrical motor is rated for 230 V or 460 V, 3-phase @60 Hz power supply,
- Motor Starter with explosion-proof enclosure

5.0 Automatic Operation

The Deck Drainage System Schematic shown on page 4 shows the "clean" water being discharged directly overboard. As an option an Oil Monitor System can be added to the Voraxial Deck Drainage System to monitor the oil concentration of the Separator discharge, and to provide for automatic control of the disposal of the treated wastewater. The Oil Monitor System is described below.

Overview

A schematic of the Oil Monitor System is provided on drawing TRANS OWS-001. The major equipment for this option includes an oil monitor, a pump, a 3-way valve, and a filter.

The system is configured to measure the oil concentration of the Voraxial "Clean Water" discharge and to direct the discharge overboard or to recycle the flow depending on the measured oil concentration. If the concentration is below a set point, the 3-way valve will direct the discharge overboard. If the concentration is above the set point, the 3-way valve will direct the discharge back to the Drainage System Feed Tank for further treatment.

The filter is provided to remove solid particles from the sample line which could affect the oil in water reading. The pump is designed to provide the energy needed to send the discharge overboard or to return the fluid to the Feed Tank.

Oil Monitor

The oil monitor is a Northeast Controls, Inc. explosion-proof monitor, Model OCM (EX 2-1). The monitor uses infrared light measurement techniques to measure the oil content. This measurement technique requires the sample being analyzed to be free of entrained air and to have a particulate concentration of less than 50 ppm. The system has been supplied with a filter to remove solid particles.

The monitor has an adjustable alarm point. The alarm point is adjustable from 15 ppm to 50 ppm. The monitor is supplied with a flow regulator that keeps the sample flow at 0.25 gpm for any pressure from 10 psig to the

maximum operating pressure of 125 psig. If the sample pressure is below 10 psig, the sample flow will fall below 0.25 gpm, but the monitor will still operate.

Intermittent sampling is acceptable if the sample cell remains filled at all times. An empty cell will produce a high ppm alarm. Thus, the piping must be arranged so that the sample cell does not drain or siphon out. A solenoid valve is supplied and wired to shut off the drain flow from the cell when the Voraxial 2000 Separator is shut off (with a low level in the Settling Tank). The solenoid valve is opened for sample discharge when the Voraxial 2000 is started up.

Provisions should be made to supply "zeroing" water to the cell. A clean water supply at 10 to 125 psig is suitable for this purpose. The piping arrangement for this is shown on drawing TRANS OWS-001.

Pump

An air-operated 40 gpm double diaphragm pump is used to pump the discharge overboard or to return the fluid to the Feed Tank. The air-operated pump is suitable for a hazardous environment, but the pump must be grounded before operation.

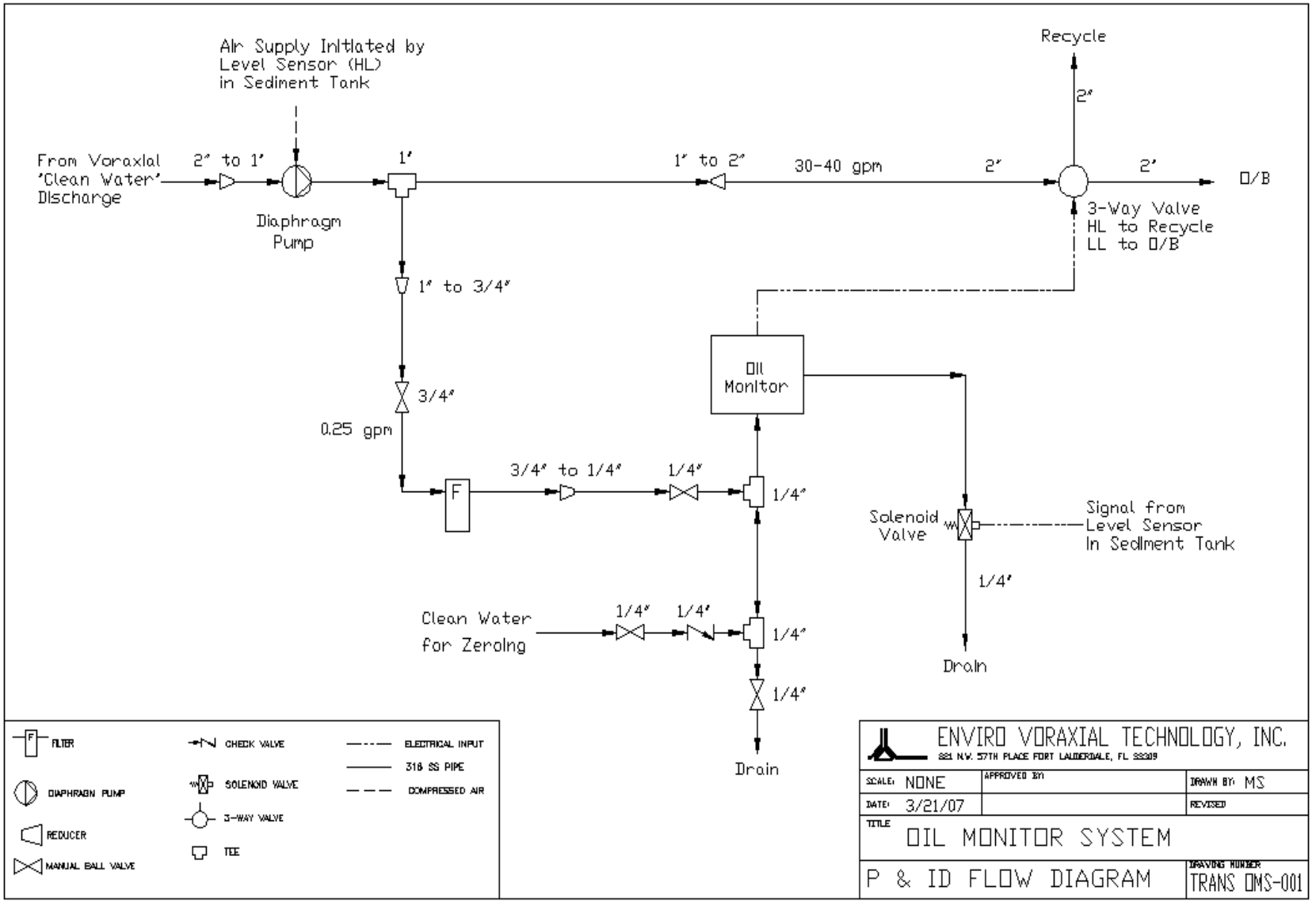
The air supply to operate the pump is initiated when the Voraxial 2000 Separator is started up with a high level in the Feed Tank. The air supply is shut off when the Voraxial 2000 Separator is shut off.

3-Way Valve

A 2", 3-Way, explosion-proof, 316 stainless steel, ball valve is used for flow diversion of the Voraxial 2000 "Clean Water" discharge. The valve is equipped with a direct mount electric actuator to control the disposition of the discharge, depending on the input signal from the oil monitor. If the oil concentration is below the set point, the 3-way valve is wired to direct the discharge overboard. If the oil concentration is above the set point, the 3-way valve directs the discharge back to the Feed Tank for further treatment.

Filter

A 10", 316 stainless steel filter housing with a 25 micron, grooved disc filter is used to remove solids from the monitor sample which could affect the oil in water reading. The grooved disc filter is cleanable. The filter element should be cleaned periodically. Operating experience will determine the required cleaning cycle.



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6.0 Dimensions and Fittings

Approximate dimensions and fittings for the Voraxial 2000 Separator Skid are tabulated below. The dimensions can be modified to meet customer's space requirements.

		With Skid
Size	Length	9.8 feet
	Width	4 feet
	Height	4. feet

Fittings/Connections	Input Piping:	2 inch diameter 150 RF flange
	Major Media:	2 inch diameter 150 RF flange
	Light Media:	½ inch diameter 150 RF flange
	Solids Media:	1 inch diameter 150 RF flange

Approximate dimensions and fittings for the Voraxial 4000 Separator Skid are tabulated below. The dimensions can be modified to meet customer's space requirements.

		With Skid
Size	Length	15 feet
	Width	4 feet
	Height	4 feet

Fittings/Connections	Input Piping:	4 inch diameter 150 RF flange
	Major Media:	4 inch diameter 150 RF flange
	Light Media:	1 inch diameter 150 RF flange
	Solids Media:	2 inch diameter 150 RF flange