



Enviro Voraxial[®] Technology

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Case Study

Voraxial[®] Oil Spill Recovery System

A System Designed for Service on Open Waters

Summary: April 2010

This Case Study summarizes the design and function of the Voraxial[®] Oil Spill Recovery System. The Voraxial[®] Oil Spill Recovery System is designed to recover the free floating oil from surface waters and industrial facility wastewater ponds. The oil is separated by a Voraxial Separator into a clean water stream and a concentrated oil stream. The water is returned to the water source, or discharged, and the recovered oil stream is collected in a storage tank.

The Voraxial Separator has high collection/separation efficiency for the free oil in spills. The Voraxial Separator has demonstrated separation efficiencies in the 95% to 100% range for this oil condition. In addition to high collection/separation efficiency, there are many other benefits provided by the Voraxial Separator. These benefits include: operation at low pressure, high flow rates, low energy requirements, an open low shear non-clogging impeller, treatment of a wide range of flows, high “G” force, and a compact unit with small footprint.

In order to protect The System Equipment against ingress of water on open waters all electrical equipment is designed to meet IP66 standards. IP66 standards require complete protection against strong jets of water or conditions found on ship’s decks.

In summary, EVTNs high efficiency Voraxial Oil Spill Recovery System has many benefits and is designed for operation on open waters with a system which meets IP66 standards.

Voraxial[®] Separator

Enviro Voraxial[®] Technology, Inc (EVTN) of Ft. Lauderdale, Florida, USA manufactures a series of separation equipment designed to treat a range of wastewater flow rates. This patented technology can treat wastewater flows from 3 gallons per minute (gpm) to over 3000 gpm.

The Voraxial Separator is a continuous flow turbo machine that separates large volumes of fluids or a combination of fluids and solids based on their different densities. The Voraxial impeller is a non-clogging, low shear device designed to produce a vortex in the fluids flowing through the Unit with the heavier materials being drawn to the outside of the vortex, while the lighter materials are drawn to form a central core. In this manner,



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separated streams are produced. A specially designed manifold at the exit of the separation chamber is utilized to collect the separated streams.

The separation principle for the Voraxial Separator is illustrated on Figure 1. This figure shows 3-way separation: liquid/liquid/solid separation. For an oil spill project, the Separator is configured for 2-way separation: liquid/liquid (aqueous stream/oil stream). Solids separation was not required for an Oil Spill Project.

As shown on Figure 1, the primary fluid enters the separator. The impeller creates cyclonic flow which forces the heavier materials to the outside of the stream, while the lighter materials (oil) are drawn to form a central core. At the exit of the separation chamber, the separated streams are collected and the primary (clean) fluid is released for discharge, or returned to the water course.

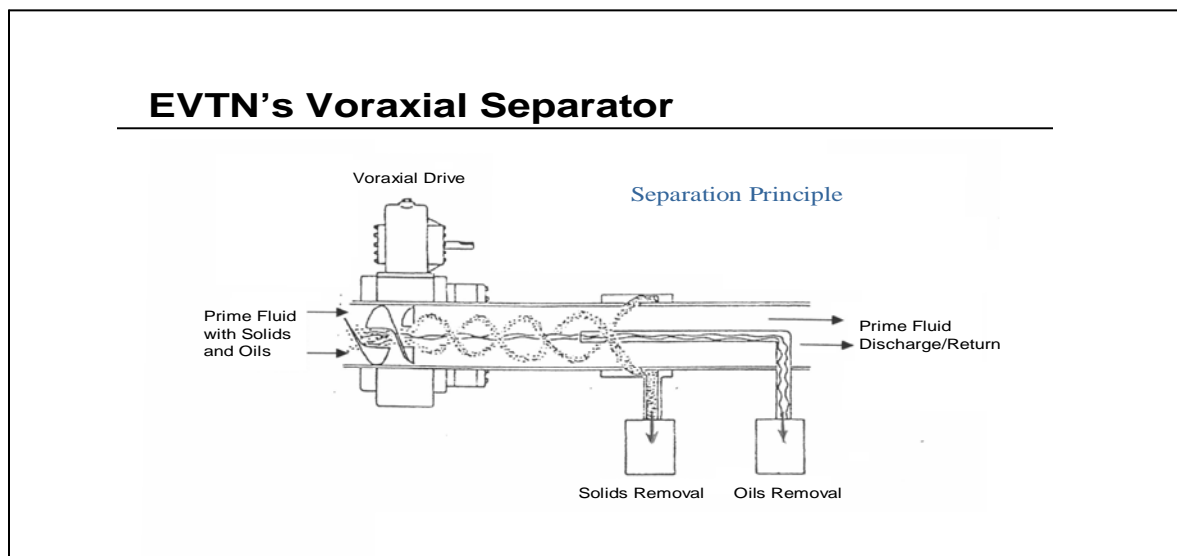


Figure 1 – Separation Principle

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 of over 2000. The Voraxial Separator is scalable and can be fabricated to process any amount of flow. EVTN presently manufactures four (4) Voraxial Separator models which can be used for oil spill recovery. These models are listed on Table 1 along with nominal flow rates and motor sizes.

The flow rates listed on Table 1 are nominal rates for typical conditions encountered. The units can operate outside these ranges, depending on the Voraxial Separator employed, and system hydraulic conditions.



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Table 1 - Voraxial[®] Separator Models

Voraxial Model	Separation Chamber Diameter (Inches)	Nominal Flow (GPM)	Motor Sizes (Hp)
1000	1	3 – 7	0.5
2000	2	15 – 60	3
4000	4	100 – 500	25
8000	8	1000 - 3000	50

A Voraxial 4000 Separator is shown on Figure 2. As shown on this figure, the separator configuration has a very small footprint. This separation chamber has a 4” diameter, while processing high flow rates (over 15,000 BPD).

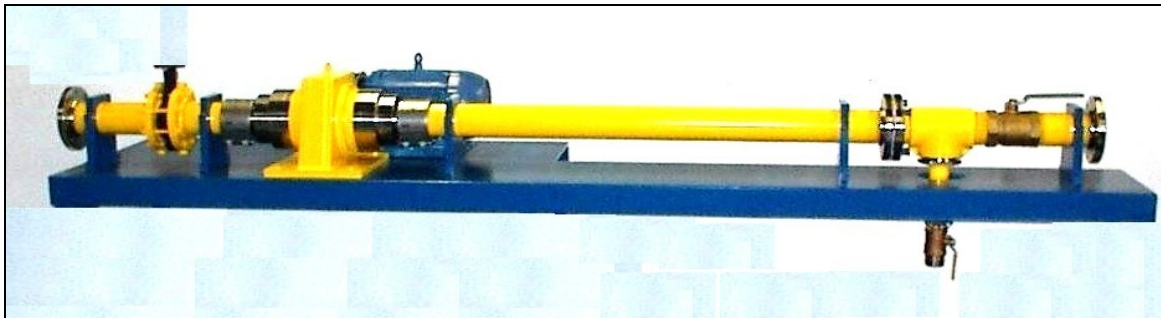


Figure 2 – Voraxial 4000 Separator

The Voraxial Separator does not need a pressure drop to perform separation. The Voraxial Separator actually performs like an axial flow pump (high flow, low pressure increase) with an open, low shear impeller. As long as the Separator is flooded, it can handle a wide range of slugging flows. The open design of the impeller blades makes the Separator a low shear, non-clogging device. This design minimizes oil emulsification.

The Voraxial separator has show very high efficiency for separation of non-emulsified oil. The data on Table 2 was collected by EVTN for separation of oil (specific gravity of 0.85) from water by a Voraxial 2000 Separator. The data was analyzed by Spectrum Laboratories, Inc.; a laboratory certified by the EPA and the State of Florida. These low outlet concentrations were achieved with a reject flow of only 2 to 3 % of the inlet flow.



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Table 2
Oil/Water Separation Performance
Voraxial Separator Model 2000

Run	Speed (rpm)	Flow (gpm)	Inlet Oil* (ppm)	Captured Oil (ppm)	Outlet Oil (ppm)	Efficiency (%)
1	2677	26.4	323	11700	13.2	95.9
2	3146	31	435	21300	3.5	99.2

* Inlet concentration determined by mass balance

As a further indication of the oil/water separation capability of the Voraxial Separator, it should be noted that a unit was purchased by the State of Alaska's Department of Environmental Conservation (DEC). The unit is being utilized by the Alaska DEC's Division of Spill Prevention and Response, which is charged with providing the State's response to spills of oil and other hazardous material. The Division of Spill Prevention and Response, through its Prevention and Emergency Program, oversees the development and enhancement of the States' hazardous materials response team, while also being responsible for reviewing and analyzing for the usage of BAT, the Best Available Technology.

As discussed above, the Voraxial Separator has many benefits. These include:

- No pressure drop and operation at low pressures
- Low shear impeller
- High flow, low energy
- Non-clogging impeller
- High "G" force
- Treatment of a wide range of flows, even slugging flows
- Compact Unit – small footprint
- Variable speeds to optimize separation
- Patented technology
- High efficiency separation

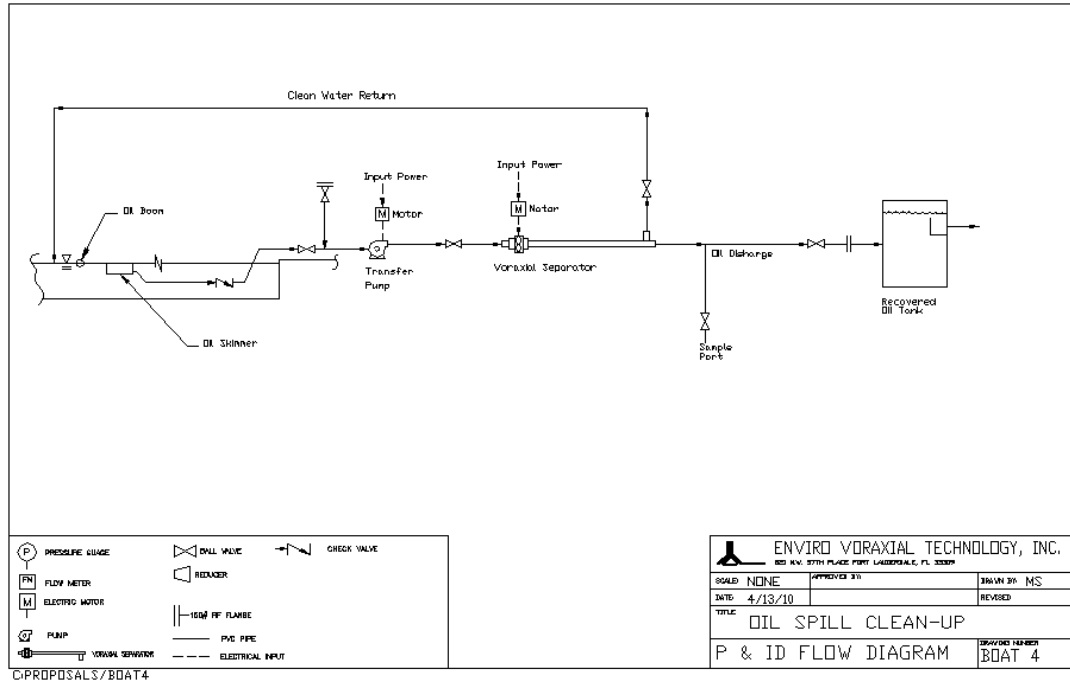
Oil Spill Recovery System

The main features of the Voraxial Oil Spill Recovery System include a Voraxial Separator, a boom, a skimmer, and an Oil Transfer Pump. A flow diagram for the Oil Spill Recovery System is shown on Drawing Number BOAT 4.



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The Voraxial is available in 4 different sizes. The System Design Specification ranges for the 4 model sizes are listed on the table that follows.

System Design specifications

Nominal Inlet Flow Rate	3 to 3000 gpm
Design Pressure	0 to 50 psig
Design Temperature	40 C (104 F)
Construction materials	316 SS
Pipe size	1 to 8 inches
Protection Classification	Designed for IP66
Electrical Input	240 V/460V, Three Phase, 60 Hz,
Voraxial Separator Power	3/4 to 50 Hp
Voraxial Rotational Speed	3500 RPM
Maximum Voraxial "G" Force	170 to 1500



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The boom to contain the floating organic solvent is a PVC Industrial boom. For floatation, the boom has molded high-density polyethylene foam filled float cells (closed cell).

The skimmer is a light weight structure constructed from ABS plastic. The floating skimmer has a heavy duty suction hose. The hose is reinforced with a rigid helix to withstand suction pressures, and crushing or kinking. The hose cover and tube are made with a durable Pliovic compound.

The skimmer creates a skim with 360° attraction for 100% removal of surface product with minimal underlying liquid. The body of the skimmer floats on the surface and follows liquid level changes. Inside the skimmer there is an independent and self-adjusting floating weir. When the skimmer is "turned on" by pumping, an amount of liquid equal to the pumping rate is drawn into the skimmer over the weir. In this manner, the weir will create a skim equal to the rate that the sump is evacuated. The weir will continually and automatically adjust to maintain the skim.

An Oil Transfer Pump is utilized to provide suction flow to the Voraxial Separator. The head provided by the Oil Transfer Pump is sufficient to deliver the recovered oil to storage.

Electrical systems to accommodate IP66 requirements are designed for the following conditions:

- IP66 Electrical Enclosure with Variable Frequency Drives (VFDs)
- IP66 three-phase Electrical motors
- A Control Panel designed to meet IP66 standards
- One IP66 Main Disconnect

Conclusion

In summary, EVTNs high efficiency Oil Spill Recovery System has many benefits and is designed for operation on open waters with a system which meets IP66 standards. IP66 standards require complete protection against strong jets of water or conditions found on ship's decks.

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