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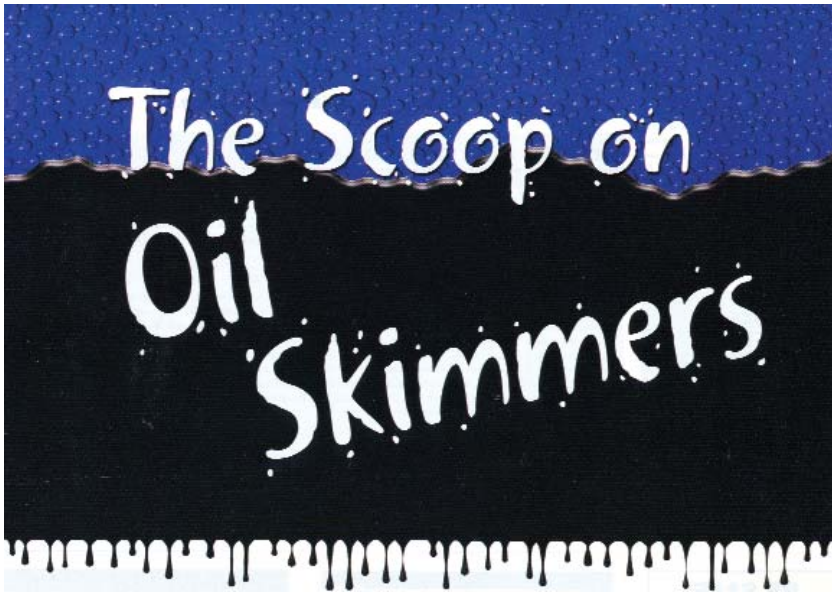
Oil/Water Separation Technology



Five steps to help you choose and use the right oil/water separation technology

By Tom Hobson

Oil skimmers are simple, dependable and effective tools for removing oil, grease and other hydrocarbons from water. They usually pay for themselves within a few months. In order to ensure the oil skimmer you choose is right for your operation, there are certain steps you can follow.

Step One: Understand the Basics

First, understand that while designs vary, all oil skimmers rely on the fluid properties of specific gravity and surface tension. Most use a moving medium to remove floating oil from the fluid's surface , as shown in **Figure 1** (the exception is a floating suction skimmer). Floating oil and grease cling to skimming media more readily than water. This allows media in the shape of a belt, disk, drum, etc. to pass through the fluid surface and pick up floating oil and grease while rejecting most of the water. The oily material is subsequently removed from the media with wiper blades or pinch rollers.

Second, realize that the kind of contaminant being removed does affect the kind of skimmer you should choose. Grease skimming involves higher viscosity hydrocarbons. These skimmers must be operated at temperatures high enough to keep the grease fluid. This may require heating elements in the fluid reservoir and skimmer unit to keep the grease in a liquid state for easier pick-up and discharge. If floating grease forms into solid clumps or mats in the reservoir, a spray bar, aerator or other mechanical apparatus can be used to break up the grease and facilitate skimming.

When using bioremediation techniques, skimmers can be used to first remove the bulk of the oil from the groundwater.

Finally, be aware of the power of a skimmer. Often a skimmer by itself can achieve the desired level of water purity. In more demanding situations, skimming is a cost-effective means of removing most of the oil before using more complicated and costly treatments, such as coalescers, membrane filters and chemical processes.

Step Two: Ensure Your Application Applies

When properly selected and applied, oil skimmers are highly economical solutions for separating oil from water to allow its reuse or safe disposal. However, there are certain applications that can expect optimal results. Typical applications best suited for oil skimmers encompass:

- Wastewater sumps where removing floating hydrocarbons can reduce the cost of disposal and lower the contingent liabilities of wastewater discharge.
- Coolants and cutting fluids where skimming tramp oils extends coolant life, improves the quality of machined parts, reduces irritating smoke that forms during machining, lessens the chance of dermatitis and helps prevent the fluid from developing a "rotten egg" odor.
- Heat treating operations where trench oils must be removed from heat-treated parts, and can be captured with a skimmer for re-use or disposal. This reduces oil purchases, prolongs wash water life and lowers disposal costs.

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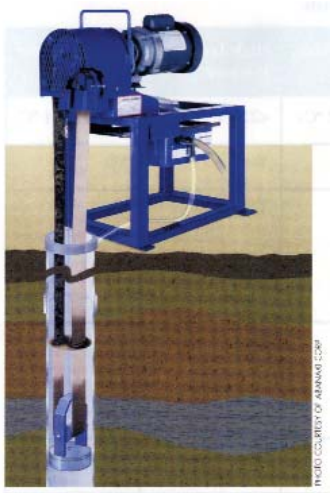

Figure 1. Belt skimmer removing grease from a wastewater sump.

■ Parts washers where removing floating oils from a wash tank prevents re-contamination of the parts as they are removed from the fluid and extends fluid life.

■ Food processing facilities where the removal of vegetable oils, greases and animal fats from a plant's wastewater stream reduces processing and disposal costs.

■ Parking lots, garages and service facilities where waste oil from leaks, spills and other sources must be retrieved from sumps before water can be discharged to storm or sanitary sewers.

■ Outdoor ponds, lakes and basins where floating oils are present, skimmers provide inexpensive and effective removal, solving a serious environmental problem.

■ Recovery/monitoring wells where a belt skimmer can be used instead of a down well pump to remove oil, fuel and other hydrocarbons. Generally, this is more cost-effective and reduces maintenance headaches. Skimmers can reach depths of 200 feet or more and remove floating products despite fluctuating water tables.

■ Remediation processes where skimmers can be used effectively in tandem with other means and reduce the overall cost and increase the speed of the cleanup. For example, when using bioremediation techniques, skimmers can be used to first remove the bulk of the oil from the groundwater. Then more biological agents may be used to clean up the remaining contamination. The remaining oil will clean up faster, as there will be less of it.

Step Three: Select by Application

There are several types of industrial oil skimmers. Choosing one best suited for your application will maximize oil removal while minimizing capital outlay and skimmer operating costs. You may define the application in terms of the following characteristics:

■ *Operating Conditions*. The performance and life of the pick-up medium, wiper blades, pulleys, etc. are affected by operating conditions. These include temperatures in and out of the liquid, the pH of the solution and the presence of solvents or other reactive chemicals.

■ *Hazardous Materials*. Applications involving flammable materials or explosive vapors require the use of explosion-proof (or air-driven) motors and controls.

■ *Temperature/Viscosity*. All skimmers require floating oil to be in a liquid, free-flowing state. (See Note 2 under **Table 1** for an exception.) If the oil congeals or solidifies at ambient temperatures, the reservoir and/or skimmer will require heaters to maintain fluid flow.

■ *Removal Rate*. Skimmer removal rates, expressed in gph, vary with oil viscosity. Typically, manufacturers rate skimmers using SAE 30 weight motor oil at 65 degrees Fahrenheit (18 degrees Celsius). It's wise to ask for test data, especially if your application involves a much different viscosity. Your skimmer selection should be based on the maximum amount of oil to be

Figure 2. A concentrator or decanter can reduce the water content of skimmed oil.

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removed within the shortest available time. For instance, suppose total oil influx is 200 gallons a day. The calculated average would be 200/24 = 8.3 gph. However, if most of it comes during a single 8-hour plant shift, you probably need a removal rate three times that average, especially if you need to prevent the discharge of contaminated water to a sewer system. As a rule of thumb, specify approximately twice the maximum capacity you anticipate needing for normal conditions.

■ *Skimmed Water Content*. All oil skimmers pick up some water with the oil. Suction skimmers pick up more water than other types. High water content increases oil recycling and disposal costs. Generally, the ratio of water to oil decreases with thicker films of floating oil and slower moving pick-up media. A concentrator or decanter installed at the skimmer discharge port provides secondary oil/water separation that can reduce water content to nearly zero.

■ *Residual Oil*. A skimmer removes oil as long as it is present. Depending on oil influx rate and the skimmer's removal rate, residual oil in the water may be as low as a few parts per million. When further reduction is required, a secondary removal stage such as membrane filtration may be needed.

■ *Portability*. In some plants mobile equipment service shops and at remediation sites, a portable skimmer can sometimes service multiple machines, sumps or wells.

When using bioremediation techniques, skimmers can be used to first remove the bulk of the oil from the groundwater.

Table 1. Application criteria for typical belt materials.

Application Variable	Stainless Steel	Elastomer	Standard Polymer	Extended Temp. Polymer	High Temp. Polymer	Fuzzy Polymer Fabric
Temp Range	<200 °F (104 °C)	<120 °F (49 °C)	140 °F (60 °C)	<180 °F (82 °C)	<220 °F (104 °C)	<160 °F (71 °C)
pH range 2-13 [1]	Yes	Yes	Yes	Yes	Yes	Yes
Operates in the presence of grit fines and other suspended particles	No	Yes	Yes	Yes	Yes	No
Removes certain DNAPLs[2] and some emulsified oils	No	No	Yes	No	No	Yes
Effective for very light oils	No	No	No	No	No	Yes

[1] At ambient temperatures
[2] Dense non-aqueous phase liquids — These can be skimmed if the polymer belt reaches to the bottom of the tank where they have settled.

■ *Tank or Sump Characteristics*. The location, shape and capacity of a tank or water impoundment are major factors in choosing the right skimmer. Also consider fluctuations in water level, turbulence and possible emulsions. Although skimmers do not cause emulsions, they may have trouble removing certain types.

■ *Size/Design*. Oil and water can emulsify when subjected to turbulence and other mechanical agitation. Avoid this by having water return to the tank below the liquid surface at as low a velocity as practical. Make sure the tank or sump provides quiet areas, weirs and sufficient volume to allow adequate time for oil/water separation.

■ *Shape*. Tanks without nooks and crannies for oil to accumulate in are best. If you have an irregular shape, put the skimmer where the largest amount of oil accumulates. Consider a means of directing oil toward the skimmer such as a floating boom or baffle plate.

■ *Location/Installation*. Questions to ask about the physical location and characteristics of the tank and collection container: Does skimmed material need to be pumped from the skimmer to the container? Will skimmer access for periodic maintenance be a problem? How much mounting space is available? Are tank or container modifications required? (Total skimmer system costs may involve additional components, tank modifications and skimmer maintenance.)

Step Four: Determine the Right Design

For industrial oil skimming, there are six basic designs commonly used in moving media skimmers. (Suction skimmers are excluded, as they are generally unsuitable except for relatively thick (1/4 inch) layers of oil; otherwise they tend to ingest large amounts of water.)

In more demanding situations, skimming is a cost-effective means of removing most of the oil before using more complicated and costly treatments, such as coalescers, membrane filters and chemical processes.

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Figure 3. Various pulley assembly designs help improve oil removal by stabilizing a skimmer belt in turbulent fluid.

Belt-type skimmers use an endless belt of stainless steel, elastomer or polymer medium, which is lowered into the tank or vessel to be skimmed. The belt passes through the fluid, and then through the skimmer's resilient wiper blades where the oil is removed from both sides of the skimmer medium. Removal rate is not affected by belt length. The length is chosen to ensure contact with the liquid at its lowest level. The belt length should also allow easy mounting of the skimmer where oil discharge is convenient, and assure easy access for routine service. Lengths up to 100 feet or more are possible.

Different belt materials are available for various application conditions (Table 1). Corrosion-resistant stainless steel is for applications with high temperatures and harsh chemicals. Elastomer is used where abrasive particles are present, or when physical abuse of the belt is likely. Various engineered polymers can also be used for resistance to high temperatures and to many chemical types. Fuzzy (raised nap) polymers can pick up low viscosity hydrocarbons, such as fuel oils, gasoline and diesel fuel.

Wiper blades made of standard nitrile material (also known as Buna-N) are suitable for about 80 percent of all applications. Other wiper materials, such as ceramic hybrid types, are designed for harsh operating conditions.

Mop skimmers use an endless medium shaped like a rope that has mop-like tendrils that pick up the oil. As the medium leaves the liquid and enters the drive unit, it is pressed and wrung out with pinch rollers. For higher viscosity oils, this medium tends to mat down and lose effectiveness. Generally, a decantation system must be used with these units, as water pickup can be quite high. Also, replacement mops tend to be more expensive than belt type media.

Large tube skimmers use a floating plastic hose that snakes out over the surface of the liquid and is then drawn back through the drive unit where oil is removed. This design requires a relatively large amount of fluid surface area for proper operation. Length considerations are the same as for belt skimmers; a typical tube diameter is 1 inch.

Mini tube skimmers are very similar to the larger tube units, but typically have either a 3/16-inch or a 5/16-inch diameter tube. The 5/16-inch diameter is preferable as it has enough stiffness to not drag on the housing and prematurely wipe off oil when drawn into the unit. Pickup rates vary from 1 quart/hour to 1.5 gph, depending on diameter and speed. These units can be used where space is limited. Units that have the motor mounted underneath reduce the amount of space required over the rim of the tank to nearly zero.

Disk skimmers rotate a disk-shaped medium through the liquid. Oil is wiped off and discharged into a collection container in a manner similar to belt skimmers. When specifying disk diameter, it is important to consider reach, the portion of the disk that actually gets immersed. Less disk area in the fluid means less oil removed. Obviously, fluctuating fluid levels can be a real problem. Also, it is important to look at how much of the disk the wipers are

Table 2. Typical oil skimmer removal rates[1].

Skimmer Type	Nominal Removal Rates
Disk Skimmer	Up to 1.0 gph
Compact Tube Skimmer	Up to 1.5 gph
Stationary Belt Skimmers, 1- to 2-inch Wide Belts	2 - 6 gph
Portable Belt Skimmers, 1- to 4-inch Wide Belts	6 - 20 gph
Stationary 4-inch Belt Skimmer	20 - 40 gph
Stationary 8-inch Belt Skimmer	40 - 80 gph
Multiple 8-inch Belt Skimmers (2 to 5 Belts)	80 - 200 gph
Grease Skimmer With 80-inch Wide Belt	120 - 160 gph[2]

[1] Based on typical product specifications and SAE 30W oil at 65 °F (18 °C)
[2] Grease skimmer capacity is based on tests with Brooks Technology Plexelene 725 grease.

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actually wiping. If they wipe only 2 inches from the edge, then any reach into the fluid beyond 2 inches is wasted. As a result, removal capacities for disks can be relatively low.

Drum/barrel styles are similar to the disk type, but use a rotating drum-shaped medium. Compared to disk types, they are usually more rugged and have higher removal capacity. These units can also be rendered ineffective by fluctuating fluid levels.

When properly selected and applied, oil skimmers are highly economical solutions for separating oil from water to allow its reuse or safe disposal.

Finally, note that the principal criterion in skimmer selection is removal rate. Typical rates for different moving media skimmers are listed in **Table 2**.

Step Five: Consider All the Options

All moving media skimmers use motors to move the belt, tube, disk, etc. While many are designed with standard, industrially rated, continuous-duty motors and also may use fully enclosed speed reducing drives, some can be specified with a number of motor options. These may include:

- Any common voltage or electrical requirement
- Explosion proof
- Drip proof
- Tropicalized
- Dirty conditions duty
- Food service duty
- Water wash-down duty

Consider also any optional equipment that may be available with the skimmer you are evaluating. Accessories allow customized systems that can ease installation and optimize performance.

Some of the more common options include:

- *Special Drive Components*. Tail Pulleys can help improve removal rates by stabilizing belt assemblies in the fluid. Yoke-and-tether assemblies help prevent pulley loss due to human error or belt breakage.
- *Mounting Stands and Adapters*. These include pre-engineered mounting stands for easier installation. Models also are available for pits, walls and free-standing units.
- *Shelters/ Enclosures*. Reinforced polyshelters and below-grade enclosures provide protection from the elements.
- *Controls/Accessories*. A float switch and warning light can be used to monitor fluid level in the oil collection drum, which helps prevent overflow. Other options include a timer, control panel, variable speed drive and power packs.
- *Concentrator*. (See Skimmed Water Content earlier in the article.)
- *Heaters*. Many skimmers can be ordered with heating devices to keep skimmed product fluid in cold environments.

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