Economics of used oil recycling: still slippery

Used oil recycling (non-burn) in the U.S. will nearly double in the next two years, if planned projects are completed. But even then, less than 0.003 percent of the 1.35 billion gallons of used oil generated annually will make it through the recycling loop.

A survey of current used oil recycling facilities identified annual capacities as 7.5 million gallons for Lyondell Petrochemical Co., Houston; 14 million gallons for Evergreen Oil Inc., Newark, California; 102 million gallons at two plants operated by Safety-Kleen Corp., in East Chicago, Indiana and Breslau, Ontario; and 35 million gallons for International Recovery Corp., Plant City, Florida.

Additional facilities and expansions are planned by many of the same players including:

- **Lyondell Petrochemical Co.**, a 30-million-gallon expanded capacity at its current refinery in Houston. Details are not available on the expansion plane, which are at least two years away.


- **International Recovery Corp.**, a 30 million to 35-million-gallon new facility to be operational by year’s end in Wilmington, Delaware.

- **Cibro Petroleum Products**, a 20-million to 30-million-gallon re-refinery to be added to a refinery in Albany, New York. More information to be available later this summer when the company reorganizes after filing for Chapter 11 bankruptcy protection in January 1992.

- **Shannon Environmental Services**, a 7.8-million-gallon rehabilitated facility to go on-line in August, operated by Shannon Environmental Services in Toronto.

A $15 million, 35-million-gallon capacity re-refinery planned by Environmental Services and Recycling, River Rouge, Michigan, has been removed from the planning list. “We dropped the project because of cost-effectiveness,” says Thomas O'Rourke, vice president of the Detroit-area company, which was planning to enter the used oil re-refining business.

He cited difficulties in controlling used oil supply and quality as part of the reason for dropping the project.

**Survival of the biggest**

Surveying the remaining players may seem too simple. But, during the last four decades, the used oil recycling market has followed the same Darwinian evolution as many U.S. businesses. Mom-and-pop oil recycling operations have given way to big-business-only facilities. Increasingly sophisticated technology and markets account for much of the change. The cost of environmental precautions accounts for the rest.

“Pretty much all the small operators have been put out of business,” says George Booth III, executive director of the Association of Petroleum Refiners, Buffalo, New York. “The ones that managed to survive the economics of the ’50 and ’60s, were crushed during the environmental movement of the ’70s and ’80s.”

“The little guy can’t afford to do it. It’s very difficult to comply with the [environmental] regulations without a lot of investment,” Booth says. He adds the cost of efficient technology and the sophisticated marketplace to his list of challenges.

Thus, the re-refineries and reuse facilities being designed by engineers have annual capacities of 30 million gallons or more.

“It’s important to be big enough to have economies of scale,” notes Gregory Ray, president of Evergreen Environmental Services, Newport Beach, California. Experience taught Evergreen management that critical mass is essential. The com-
Evergreen. The company runs a fleet of 60 trucks to industrial accounts, car dealers, service stations, quick lube shops and a few scrap dealers to pick up used oil for which generators pay Evergreen 20 to 25 cents per gallon.

Safety-Kleen Corp. operates the world's largest oil re-refinery in East Chicago, Indiana. This hydro-treatment plant was built in a former oily-water treatment facility (1 and 2).

For the customers who bring in their own oil, Evergreen charges them for the laboratory work done to test the oil for contamination. "We don't encourage it because we already have a transportation system set up," says Ray. "It costs more for a company to drop it off... and it's awkward to schedule receiving."

After re-refining the oil, the company sells more than 75 percent of the lube product to small blenders and compounders that return it to the industrial and automotive markets. Regular automotive oil additives are mixed into some of the lube oil and it is packaged for bulk sale as Evergreen Environmental.

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Motor Oil. A retail product is also being developed.

A growth market identified by Ray is the “close-loop recycling program.” The loop consists of municipalities or corporations — like Southern California Gas Co. — that bring their used oil to Evergreen. The firm then re-refines the lube oils and sells back the product.

As for making money in the market, Ray states, “When we sell the recycled lube oil, we’re selling into a commodity market. We tend to follow the price for base oil.”

Regional players evolve
Safety-Kleen Corp., Elgin, Illinois, is a public company in the Midwest watched by nearly every oil recycling operator interviewed. The oil and solvent recycler opened the world’s largest re-refinery in 1991. The 75-million-gallon throughput hydro-treatment plant in East Chicago, Indiana cost the company $50 million and was built in a former oily-water treatment facility.

“You have to build a big plant to make the economics work,” says Michael Carney, senior vice president of marketing for Safety-Kleen. And, startup doesn’t necessarily begin with a black bottomline. “It is now starting to make money,” Carney states, noting that a profit has been recorded in the past six months.

Safety-Kleen uses a technology similar to Mohawk’s and is, according to industry observers, the only other re-refiner recycling lube oil into lube oil. In addition to the record-setting plant in East Chicago, S-K operates a 35-million-gallon per-year facility in Breslau, Ontario. Both plants are operating at capacity, Carney said.

Like Evergreen, Safety-Kleen also uses its own fleet to pick up used oil from car dealers, service stations, truck fleets and industrial accounts, charging $50 for pickups up to 250 gallons. To feed such a large re-refinery, oil is collected east of the Mississippi. Good freight rates make sense to bring it in from as far as Florida, St. Louis and Baltimore.

Carney estimates the post-processing yield as 65 percent base lube stock, 7 percent asphalt extender and the balance as a product turned into fuel oil. “The vast majority [of lube oil] goes to compounders and blenders that replace additives and for industrial lubricants. We aren’t too big in downstream marketing,” Carney explains.

S-K does package some lube oil as America’s Choice which is sold through Wal-mart stores. And, the company sells some of its retail product to Lyondell Petrochemical Co., of Houston. Lyondell compounds, packages and sells the motor oil competitively nationwide as Enviroil. In its western region Lyondell buys

Table 1 — Used oil recycling operations

<table>
<thead>
<tr>
<th>Company</th>
<th>Plant location(s)</th>
<th>Annual capacity (1)</th>
<th>Cost (2)</th>
<th>Year operational</th>
<th>Pay/charge to collect</th>
<th>Transportation</th>
<th>End products</th>
<th>End markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evergreen Group</td>
<td>Newark, CA</td>
<td>14</td>
<td>$10 million</td>
<td>1986</td>
<td>Charges 20-25 cents per gallon</td>
<td>Own fleet to pick up</td>
<td>Lube oil (65%) Asphalt flux (15%)</td>
<td>Wholesale market</td>
</tr>
<tr>
<td>Newport Beach, CA</td>
<td>T.B.A.</td>
<td>38</td>
<td>$30 million</td>
<td>1994</td>
<td></td>
<td></td>
<td>Fuel oils (10%) Roofing tiles</td>
<td></td>
</tr>
<tr>
<td>Safety-Kleen Inc.</td>
<td>Breslau, ON</td>
<td>35</td>
<td>N.A.</td>
<td>1978</td>
<td>Charges $50 for up to 250 gallons</td>
<td>Own fleet to pick up</td>
<td>Lube oil (65%) Asphalt extender (7%)</td>
<td>Retail</td>
</tr>
<tr>
<td>Elgin, IL</td>
<td>East Chicago, IN</td>
<td>75</td>
<td>$50 million</td>
<td>1991</td>
<td></td>
<td></td>
<td>Fuel oils &amp; other Asphalt</td>
<td></td>
</tr>
<tr>
<td>Lyondell Petrochemical Co.</td>
<td>Houston, TX</td>
<td>7.5</td>
<td>(3)</td>
<td>1992</td>
<td>Payment varies</td>
<td>Distributors collect</td>
<td>Gasoline (40%) Diesel oil (40%)</td>
<td>Distributors return to their customers</td>
</tr>
<tr>
<td>Houston, TX</td>
<td>Increase to 30</td>
<td>(3)</td>
<td>T.B.A.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Buys recycled lube oil for retail market</td>
</tr>
<tr>
<td>International Recovery Corp.</td>
<td>Plant City, FL</td>
<td>30-35</td>
<td>$2-3 million</td>
<td>1986</td>
<td>Charges or pays</td>
<td>Own fleet</td>
<td>On-specification Fuel customers fuel products</td>
<td></td>
</tr>
<tr>
<td>Miami Springs, FL</td>
<td>Wilmington, DE</td>
<td>30-35</td>
<td>$4-5 million</td>
<td>1992</td>
<td></td>
<td>Independent haulers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cibro Petroleum Products</td>
<td>Albany, NY</td>
<td>20-30</td>
<td>Part of $100 million refinery expansion</td>
<td>1.8 A.</td>
<td>Pays 20 cents per gallon</td>
<td>Independent haulers/ truckers</td>
<td>Lube oil Fuel oil</td>
<td>Underdetermined</td>
</tr>
<tr>
<td>Bronx, NY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shannon Environmental Services</td>
<td>Toronto, ON</td>
<td>7.8</td>
<td>$27-30 million</td>
<td>1992</td>
<td>Charges</td>
<td>Independent haulers/ truckers</td>
<td>Light to heavy lube oils with four viscosities</td>
<td>Blenders/compounders Specialty blenders</td>
</tr>
<tr>
<td>Toronto, Ontario</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Services and Recycling</td>
<td>River Rouge, MI</td>
<td>35</td>
<td>$15 million</td>
<td>Cancelled</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>River Rouge, MI</td>
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</tbody>
</table>

T.B.A. — To be announced.
N.A. = Not available.

(1) In million gallons.
(2) All costs are reported in U.S. dollars.
(3) There was no increase in capital costs, because the feedstock was simply changed from virgin oil to used oil.

President Bush recently visited Evergreen Environmental Services' re-refinery in Newark, California.

Opponents delay IRC plant
In Miami Springs, Florida, a group of petroleum companies has developed its own way to mine the used oil market. International Recovery Corp. is a publicly held company serving the Southeast and Mid-Atlantic states. It currently converts used oil to customer specification fuel products—not lube oil—at a facility in Plant City, Florida. Opened in 1986, the plant cost $2 million to $3 million to build, and processes 30 million to 35 million gallons annually. It uses a "closed loop system," which the company calls proprietary.

IRC awaits final permits on a nearly identical plant nearing completion in Wilmington, Delaware. "We are optimistic that it will be operational by the end of September," says Howard Goldman, director of marketing for IRC.

The Wilmington plant has been delayed about two months by citizen group opposition. Construction has continued.trolled if the major oil companies would stop feeling threatened by the recycled oil market and throw more support behind the used oil industry.

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Defining the three Rs: recycling, reusing, refining

Defining paper recycling has been a slow, painful process for regulators. While used oil processing hasn’t yet entered any official definition process, discussing the technology used to reclaim the commodity is difficult without defining the terms. Purists will — and should — disagree with the use of terms, but these are becoming commonly accepted in oil recycling circles.

- Recycling/reusing are terms used to describe any kind of reuse, including turning lubricating oils into gasoline or burning them as fuel.
- Re-refining refers to the loop-closing process of cleaning and re-refining used lubricating oils to produce a specification-worthy new lube oil.

Though the process is similar to that used by Lyondell’s Houston refinery, the yield differs. Cibro projects end products to include recycled lubricants (50 percent) and fuels (10 to 15 percent). With the facility still in conceptual stage, he was unsure of percentages for asphalt-like material and other products.

“We’re working with everybody Safety-Kleen isn’t,” he says, half jokingly. He estimates New York’s used oil supply at 60 million gallons per year and says the competitor collects about 20 million of that amount. In preparation for its used oil treatment facility, Cibro has collected about 10 million gallons using independent collectors.

At present, Cibro pays an average of 20 cents per gallon to haulers that bring in the used oil; the company doesn’t have any contracts with suppliers. “At 20 cents per gallon for the cost of the raw material, the company is still in the black,” Mayo says. He contends pending legislation in New York may make generators pay the disposal in the future.

Being a refinery is an advantage if market dynamics should change, Mayo points out. “If the lube market were weak, we could convert it to fuel,” he said. “[Coupled with economics], that’s the advantage of integrating it with the refinery.”

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the same product from Evergreen for re- casting as Enviroil.

Reuse recycling, not re-refining
The tenth largest U.S. oil refinery, Lyondell just entered the used oil recycling business this year with an estimated annual capacity of 7.5 million gallons. "We're still learning some of the nuances," says David Harpole, manager of public affairs. "We're learning what our capabilities are."

Lyondell's process differs from the two re-refiners. The used oil is fed through a refinery conversion unit known as a coking unit that is usually fed crude oil, says Harpole. He estimates that the used oil could replace as much as 1 percent of the 265,000 barrels per day of crude oil processed at the Houston refinery.

End products include gasoline (40 percent), diesel oil (40 percent) and other fuel products, including petroleum coke (a hard material that is crushed and sold to fire boilers).

Lyondell is further removed from the original generator than Safety-Kleen or Evergreen. Oil distributors collect and return the used oil to the refinery. As such, collecting used oil is a Lyondell customer service.

"If you buy a lube oil from Lyondell, we'll buy it back from you," states Harpole. He wouldn't give a price, saying it varies by amount of oil and cost of transportation.

He says supply and demand are promising. "There is more used oil available than there is capacity to process," he notes. However, capital for expansion isn't easy to come by. Looking long-term, Lyondell hopes to increase capacity to 30 million gallons annually with a new coking unit. Because of financing, those plans are at least two years down the road, Harpole predicts.

With more than one billion gallons per year of used oil available even after new capacity comes on-line, everyone seems to agree that more facilities are feasible. Current operations are serving as case studies for those who want to enter the market profitably in the future.

But building new capacity isn't so simple. Developers are being delayed by permitting, financing and citizen opposition hurdles. One industry leader says some of these weaknesses could be con-

Used oil conference
The Seventh International Conference on Used Oil Recovery and Reuse will be held from September 29 through October 2, 1992 at the Sheraton Chicago Hotel & Towers.

With the theme of "Today's Reality," conference sessions will discuss the latest developments in used oil management. Topics will include the role of government in regulating used oil; state-of-the-art re-refining technology and its impact on product quality; the use of re-refined lubricants in motor oil; recycling programs targeting do-it-yourself oil changers; and regulatory and technological trends. A tour of Safety-Kleen's re-refinery in East Chicago, Indiana concludes the conference.

More information is available from the Association of Petroleum Refiners, P.O. Box 605, Ellicott Station, Buffalo, NY 14205-0605; (716) 855-2757 or fax (716) 855-0339.

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The Newark facility originally cost Evergreen $10 million, said Ray. As a rule of thumb, he estimates that technology costs about $1 per gallon of annual capacity. As capacity increases, thereby gaining economies of scale, that average drops. For example, he estimated the company's new 38-million-gallon-capacity refinery to cost about $30 million.

For comparison, he estimates building capacity to refine crude oil costs two to three times more. A public relations representative at the American Petroleum Institute couldn't confirm the figure, but stresses that the near-impossibility of permitting new refinery capacity makes cost estimations moot.

Sensitivity to such Not-In-My-BackYard concerns accounts for Evergreen's secrecy about its next location. The proposed Southern California plant won't be announced until Evergreen has discussed the operation with the community, said Ray. Community relations will happen in conjunction with financing and permitting. Ray projects an early fall 1992 deadline for the planning.

"We have so much demand for our services now," states Ray. "Major companies want us to collect from more and more remote areas." He says 65 percent of the oil collected between the Oregon border and Bakersfield is handled by...
pany entered the oil re-refining business in 1984, when it secured financing for the then-7.5-million-gallon-per-year plant in the San Francisco Bay area town of Newark, California.

The plant's timeline offers a good perspective on oil recycling. Construction began in 1985, with the plant on-line in October 1986. The facility had two years of difficult, unprofitable operations until it changed its process, says Ray. Because of the legal situation, he can't talk about the unprofitable technology and resultant frustrations.

Between 1988 and 1989, it licensed a process developed by Mohawk Lubricants of Vancouver, British Columbia. "We think it's really the best thing out there," he concludes. The privately held company has been "profitable since the technical problems were solved."

The Mohawk process resulted in less downtime and expansion to 14 million gallons without much capital investment. "Because we're pushing the limits of technology, we have to keep testing to see how much we can put in the plant safely," Ray notes.

**The Evergreen process**

Gregory Ray, president of Evergreen Environmental Services, Newport Beach, California, described his company's used oil re-refining process as a six-step hydrogenation process.

- **The Mohawk process**, which includes a proprietary pre-treatment process. Ray elected not to elaborate.
- **Atmospheric flash evaporation** uses heat to remove water, gasoline and other light-boiling components from the used oil.
- **Vacuum distillation** applies a vacuum while heating to remove diesel fuel and gas oil.
- **Thin film evaporation** begins as temperatures rise and a vacuum increases. The used oil is stirred with a rotating blade to keep it from cooking on the side of the container. The lube oil vaporizes and an asphalt material remains. This contains chemical additives to the oil, such as long-chain hydrocarbons and heavy metals. This asphalt material is shipped in a liquid form to a maker of roofing tiles.
- **Hydrofinishing or polishing** is a process also used in virgin lube oil refining. At high temperatures, under pressure and in the presence of a catalyst, the lube oil is processed with pure hydrogen gas. The gas bonds with trace elements such as sulfur, chlorine and others that might color or contaminate the oil.
- **Fractionation** splits the lube oil into two separate grades of different viscosity.

The six-step process yields 65 percent lube oil, 15 percent asphalt flux, 10 percent waste water and 10 percent fuels. The lube oil is sold to small blenders and compounders, to the industrial and retail markets, and some closed-loop clients. The asphalt flux is sold to roofing tile manufacturers. Waste water is treated before disposal. The remaining fuels are separated and burnt or sold to other fuel companies.
minimum of water is used for pulping the scrap paper. The gentle agitation of fiber against fiber in this pulping process allows the hot-melt glue pieces to remain fairly intact and thus they are easily screened out.

The flexibility of the company's deinking process will be an important factor in allowing it to handle the challenges posed by using greater amounts of OTD. Flexographic inks are difficult to remove because of their water-solubility. Many directory printers have gone to this type of ink. The company will adjust its deinking system to handle the flexographic inks and the ultraviolet coatings from directory book covers.

The Port Angeles mill is using the deinked pulp for 30 percent of its furnish, with an intention to be at the 40 percent level consistently by the end of 1992. There has not been one complaint from the directory printers about the performance of the recycled sheet. In fact, the dirt count of the deinked sheet has been about 30 percent less than the virgin sheet.

The caliper, or thickness, of the recycled sheet for a given basis weight has been about 7 percent less than the virgin sheet. It seems the recycled fibers are more compact and less puffy than the virgin ones; however, the recycled sheet has maintained its opacity and strength. When the recycled pulp is blended with the virgin pulp, it allows papermakers to more easily meet the caliper requirements of their customers.

The Port Angeles mill is procuring the majority of its ONP and OMG through Smurfit Recycling and Recycle America, the recycling division of Waste Management of North America. The mill is working directly with the regional Bell operating companies for the recovery of OTD. Daishowa is taking the OTD loose in trailers and is using an automated dump system to empty the trailers. OTD have a nominal market value at present; however, that value is expected to increase as the value of ONP and OMG goes up. The output of the Port Angeles mill is dedicated almost exclusively to the directories of the regional Bell operating companies.

The Quebec City mill has a goal of obtaining 50 percent of its scrap fiber needs from the province of Quebec and the rest from the U.S. At present, the Canadian province is supplying only a little over 35 percent of the mill's needs. The mill will depend on three U.S. firms to source scrap paper.

For information on scrap paper procurement, contact Ray Christiansen, fiber procurement manager, Daishowa America Co., Ltd., 7200 Columbia Center, Seattle, WA 98104; (206) 623-1772, fax (206) 382-9130; or contact Barry Hutchison, manager of recycling procurement, Daishowa Forest Products Ltd., P.O. Box 1487, Quebec City, PQ G1K 7H9, Canada; (418) 525-2500, fax (418) 525-2945.