MOVING OIL AROUND THE WORLD

For 150 years, we have extracted petroleum oil from under the Earth to power our modern way of life. Today, petroleum oil is used to help make everything from plastic to candles, from crayons to lipstick, and from Aspirin to solar panels.

As you might have guessed, though, the most *common* use of petroleum (sometimes called "crude oil") is in making fuel for cars, aircraft, and industrial machinery. Here's a look at the four ways nearly 100 million barrels of oil is moved every day from deep below the Earth to the fuel tanks of more than a billion vehicles, furnaces and pieces of machinery:

PIPELINES

Figure 1: Above-ground pipeline.

Pipelines up to a metre wide are the main way processed and unprocessed oil gets moved hundreds and sometimes even thousands of kilometres to the cities where it's used. So how does the oil actually travel through these steel or plastic tubes that can snake across entire continents?

Pumps at the source and all the way to the final destination keep oil moving through the entire pipeline at speeds between 5 and 20 km/h. To protect them from rust, steel pipelines may be reinforced with wood slats, concrete coatings, or polyethylene (the stuff used to make plastic bottles.)

Figure 2: 'Pig' used to clean out pipelines.

To make sure they stay clear of debris and waste material build-up, oil companies regularly send special scrapers known as 'pigs' or 'go devils' down lengths of pipeline. Pigs have been used as far back as the 1850s, when they were little more than cylinder-shaped metal plugs inserted in one end of a pipeline and retrieved at another. Today, 'smart pigs' sent down pipelines are sophisticated probes with on-board computers, sensors, and powerful magnets to help collect tiny bits of metal in the pipes.

Above-ground and underground pipelines are the most efficient way to move oil over land from its source in the ground to refineries where it's processed. The cost to move $800 of oil through a pipeline is only about $8.

While oil moving through pipelines is separate from the natural environment it moves through, construction of pipelines often disrupts the ecosystems in which they are installed. This can involve the removal of trees, clearing of topsoil and digging of trenches to accommodate the pipes. Ecosystems can also be affected if pipelines leak oil due to damage, such as from design flaws, sabotage or age. While pipelines have more spills than trains or oil tanker ships, the amount (volume) of oil spilled from pipelines is small overall.

SHIPS

Figure 3: Oil tanker ship.

We've been moving oil over water since the 1880s, when 60-metre long sailing ships carried up to 250 tonnes of crude oil between ports. Today, 360-metre long supertankers can weigh up to half-a-million tonnes when fully-loaded, and transport more than 3 million barrels of oil per trip.

Double-hulled "crude tankers" move unrefined oil in 8-12 multi-chambered tanks from near the source of the oil to refineries near seaports. Smaller "product tankers" move oil from refineries to destinations near where it will be used (such as train tracks or storage facilities serviced by tank trucks bound for gas stations.)

Aside from pipelines, welded-steel tanker ships are the most efficient way to move oil great distances across water. They're also some of the largest pieces of technology ever built. At nearly half-a-kilometre in length (458 metres) with a fully-loaded weight of 657,000 tonnes, the former U.S. oil tanker *Seawise Giant* (also known as *Knock Nevis*) was the longest ship ever built and the largest self-propelled object ever made.

Because of their size, modern oil tankers have made transporting oil much cheaper than it used to be. Back in the 1950s, shipping costs made up about 33% of the price of oil transported from the Persian Gulf to the U.S. After the development of supertankers in the 1970s, the cost of shipping along that same route dropped to 5% of the oil's final commercial price. Since 2010, that cost has been less than 3%: These days, for a ton of crude oil worth $800, the shipping cost is only about $20, or about $0.08 a litre at your local gas station pumps.

This method of transporting oil isn't without risks though. Oil tanker spills from accidents at sea or while loading or unloading have devastating effects on the environment. A large oil spill at sea or near shore can kill millions of birds, fish and large sea animals. While oil spills from tanker ships happen less often than spills from pipelines, trains, and trucks; spills at sea tend to be much larger in terms of the amount of oil spilled. Oil tanker exhaust is also a major source of pollution and oil tankers can pose a large environmental risk if damaged by collisions or onboard fires as well as while being disassembled after they're taken out of use.

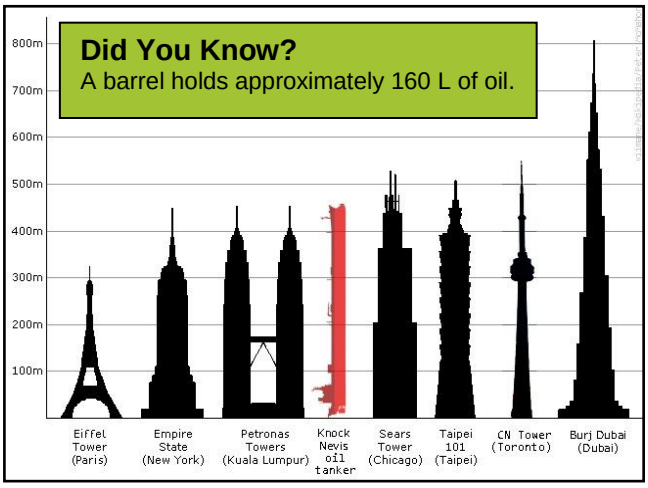

Figure 4: Image comparing the Knock Nevis tanker to other objects.

Figure 5: Oil spill clean-up.

TRAINS

Tanker cars capable of carrying oil have been pulled by trains since they were made of wood back in the 1860s. Between the 1920s and 1950s, modern tank cars were a popular way to move oil, but by the 1960s, pipelines, sea vessels, and tank trucks became the main ways of transporting crude. By 2010, though, demand for oil surpassed existing pipelines' ability to move it. So trains were once-more in high-demand to move crude through 'virtual pipelines' of oil trains made with long strings of tank cars.

Figure 6: Train with long string of oil tank cars.

Figure 7: Oil tank car.

In Canada alone, oil transport by rail increased by a factor of 280 (or 28 000%) between 2009 and 2013. There are currently about 300,000 tank cars in North America that can carry petroleum oil by train.

Each one can hold as much as 131 000 Litres (34,500 gallons) - or about 93 tonnes of crude oil. That's about 600 barrels of unpressurised oil per rail car. The cost to move $800 of oil by train is about $12 to $18. Unlike pipelines, which take many years to construct and only follow fixed routes, oil trains can go on any train track and additional tank cars can be added on when there is increased demand.

But more trains moving oil means more risks, like spills, explosions and fires if trains carrying oil are involved in crashes or derailments (when a train leaves the tracks). Several lethal derailments have occurred in recent years, most notably the derailment and fire in Lac-Mégantic, Quebec in July 2013. In this case, an unattended train rolled down a hill into the town where it derailed leading to several large explosions and an extensive fire.

Spills also occur more on trains than on other forms of land-based oil transport. About half of the oil is spilled during transport and roughly the other half is spilled during loading or unloading.

As more trains carry oil from coast-to-coast, oil companies, rail authorities, and governments are being called on to create more rules and policies to help protect against accidents.

For example, modern tank cars have special couplers (the part that connects one car to the next) that prevent the cars from separating in the event of an accident such as a derailment. This has virtually eliminated the chance of a car's couplers puncturing the tank car in front or behind them.

TRUCKS

Figure 8: Oil refilling truck at Vancouver International Airport

Transport by truck is usually the last step in getting oil to the gas station and other places where it will be used by consumers.

One of the biggest reasons for transporting fuel by trucks is that they're often the only way to get fuel directly to gas stations - imagine how difficult it would be if the only place you could get gas was right next to a set of train tracks, a major waterway, or an oil pipeline!

Tank trucks move processed oil in cylinder-shaped containers that look a lot like the tank cars pulled by trains. These trucks can each carry between 10,000 and 45,000 litres of fuel from refineries or storage facilities to the pumps at a gas station.

The gas in tank trucks is often held in many compartments to separate different grades of fuel. That way, they can carry all the kinds of gas a service station needs, all in one trip. In addition to hauling petrol to gas stations, tank trucks can also carry jet fuel to planes at airports, and propane, furnace oil, and other residential fuels to houses that use them for heating or cooking. Trucks are the most flexible way to move oil as they can go anywhere there is a road.

Figure 9: Gas station.

As with almost all forms of oil transport, one of the drawbacks to tanker trucks is the possibility of spills during loading or unloading, or due to traffic accidents. Driving one of these vehicles is trickier than most truck loads. That's because of tank trucks' high-centre-of-gravity (think of all that heavy liquid sloshing around above the height of the driver). This can cause tank trucks to tip over more easily than other kinds of trucks.

And while there are more instances of tanker truck spills than train, ship, or pipeline spills, oil spills from trucks tend to be smaller in volume than those from other kinds of transports. These spills, however, tend to be on roads where many people drive every day.

Each of the four methods of moving oil has advantages and disadvantages in terms of cost, efficiency, safety and environmental impact and no single method meets all of our transportation needs. We will always need a mix of transportation systems as long as we use oil.