Early days

Petroleum needed transportation form the producer to the consumer form the first day on. With higher demands the classical way of storage and transportation in barrels did not meet requirements.

Charles P. Hatch of the Empire Transportation Company in Pennsylvania invented the rail tank car in 1865. It was a flat car with wooden banded tubes mounted on top, capable of carrying 3,500 gallons of crude oil.

Shortly after that, railroads switched to larger wooden tanks mounted horizontally. The first metal tank cars came in 1869 and solved the problem of leaking wooden tanks and improved safety.

Time table of oil&gas transportation

1865 - Wooden cars used for the first time to serve the oil fields of Pennsylvania.

1869 - Cast iron replaces wooden tanks. Capacity was about 15 m^3 per car.

1888 - Tank car companies supply tank cars directly to the oil industry.

Capacities range from 25 to 40 m^3.

1901- Gushers at Spindletop in East Texas bring the Lone Star State into the oil industry in a big way and help lead to development of rail lines to serve the wells and refineries of Texas and Oklahoma.

1903 - The tank car industry develops safety standards for construction.

1915 - A classification system is developed by the industry to ensure the right use of the tank cars for the right products.

1920 - Welding technology replaces riveting in tank car construction, enhancing the safety of cars.

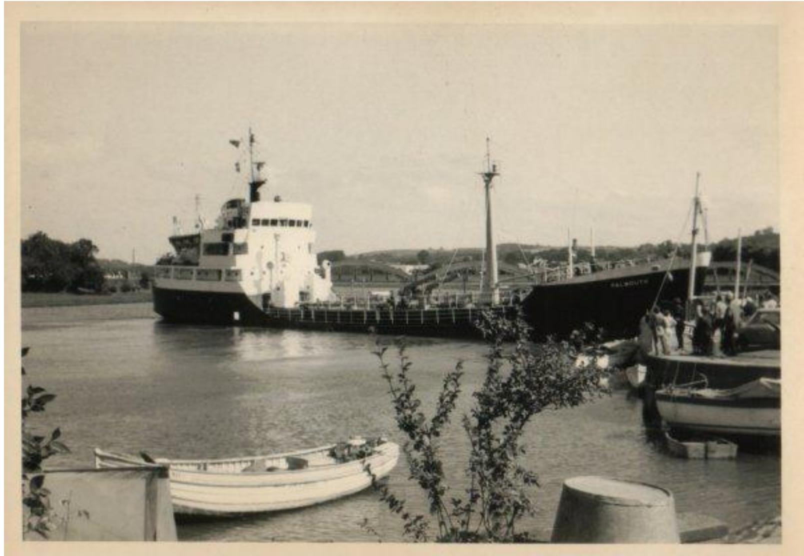
1930 - Tank cars expand their use - 140,000 tank cars carry 103 commodities other than oil to market in the US alone.

1940's - During World War II every tank car is used to transport oil for the war effort.

1950 - Pipelines and trucks lighten the load of tanks on railroads.

Endress+Hauser

Oil tankers



Oil tanker 1910

Before pipelines covering thousands of km were available oil tankers were the only means of transport to meet the growing demand of crude oil.

Oil tankers come in two basic categories, the crude carrier, which carries crude oil, and the clean products tanker, which carries the refined products, such as petrol, gasoline, aviation fuel, kerosene and paraffin.

Endress+Hauser

VLCC very large crude carrier



The boom of oil consumption in the 70ties led to the construction of super, large and even ultra large tankers of over 300 m length carrying over 300,000 tons. Only a few ports are today able to allow ships of such size requiring deep water depth. In many cases these tankers hardly see the shore or a harbour since they are charged and dischared offshore from buoys.

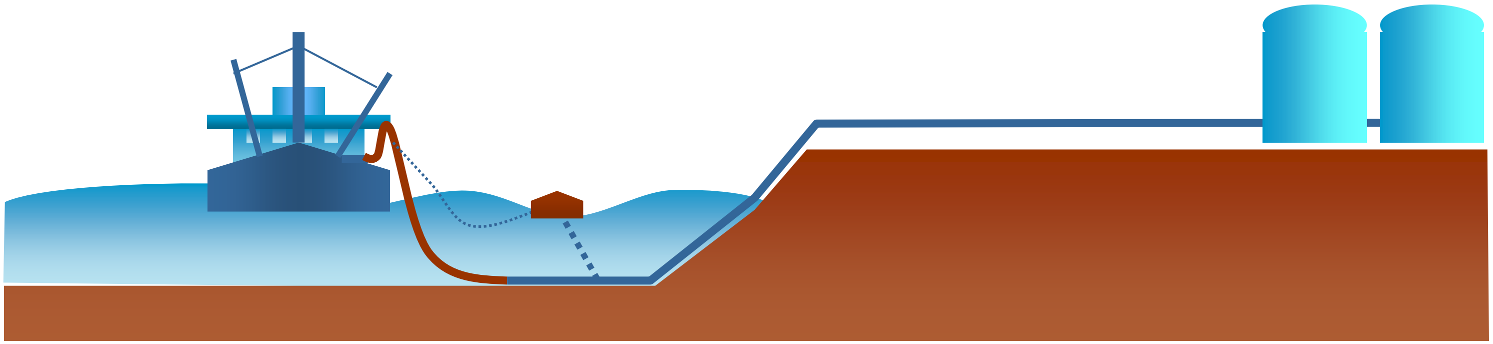
Tankers range in all sizes, from the small bunkering tanker (used for refuelling larger vessels) of 1000 DWT tons to the real giants: the VLCC (Very Large Crude Carrier) of between 2-300,000 DWT and the ULCC (Ultra Large Crude Carrier) of over 300,000 DWT

Tanker jetty and power station

Three tanker terminals for oil depots at South Tsing Yi

While super tankers usually only transport crude most normal size tankers supply various industries with refined products, e.g. cities with petrol, power plants with fuel, petrochemical industry with raw material and air ports with jet fuel.

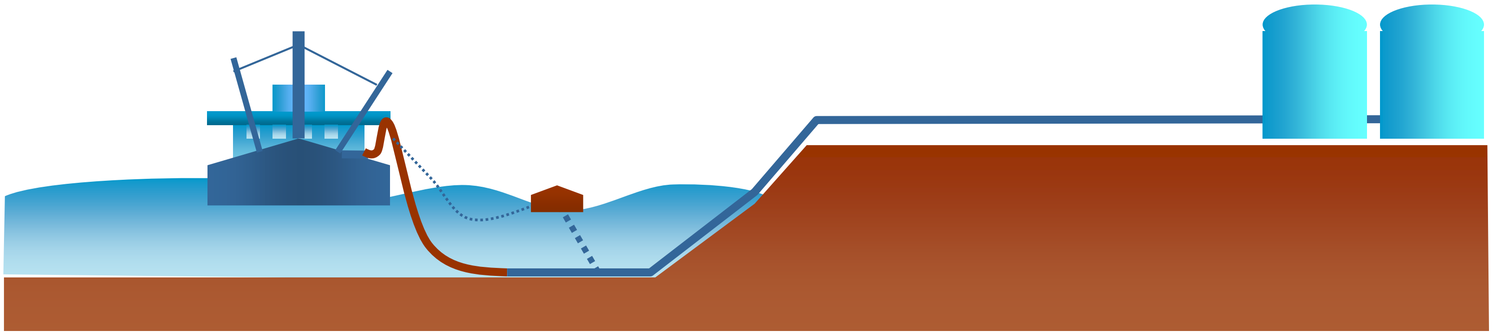
Oil tanker filling-offloading



Buoy station

- A buoy is permanently anchored offshore.
- To minimise risk of pollution the buoy might be as far as 30 nm (55 km) offshore.
- A hose is attached to the buoy by chain.
- This hose is flanged off and flooded with sea water when not in use. The pipe and hose has to be flooded to prevent lifting and floating by buoyancy force.
- The hose is picked up by the ship’s crane and connected to the ship’s manifold.

Offloading a tanker



Offloading: Tanker full of crude or refined oil

- The ship’s pumps, approx. 5 > 1,000kW strong each, pump the crude/refined oil onshore with 6-15 bar pressure.
- The water cushion in the hose and pipeline is directed into the ballast water tank.
- There is usually no flow metering and one decides by time and experience when to switch to the oil tanks.
- There is usually no monitoring of the filling of the tanks. E.g. FuelsManger is used to calculate a flow for monitoring and to direct the pump rate of the ship.

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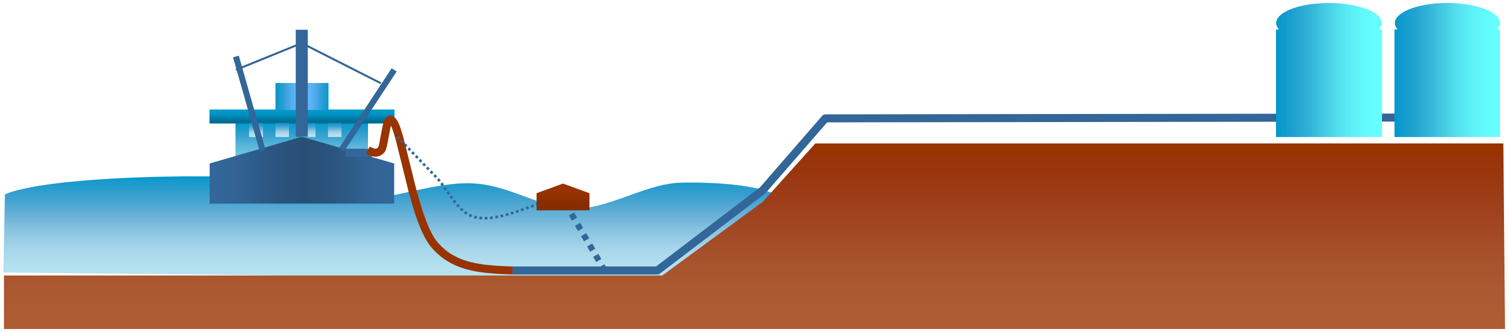
Filling of a tanker



Tanker in ballast

Empty tankers are never really empty (MT) at sea, it would be not save.

The tanks are partly filled with sea water, ballast water.

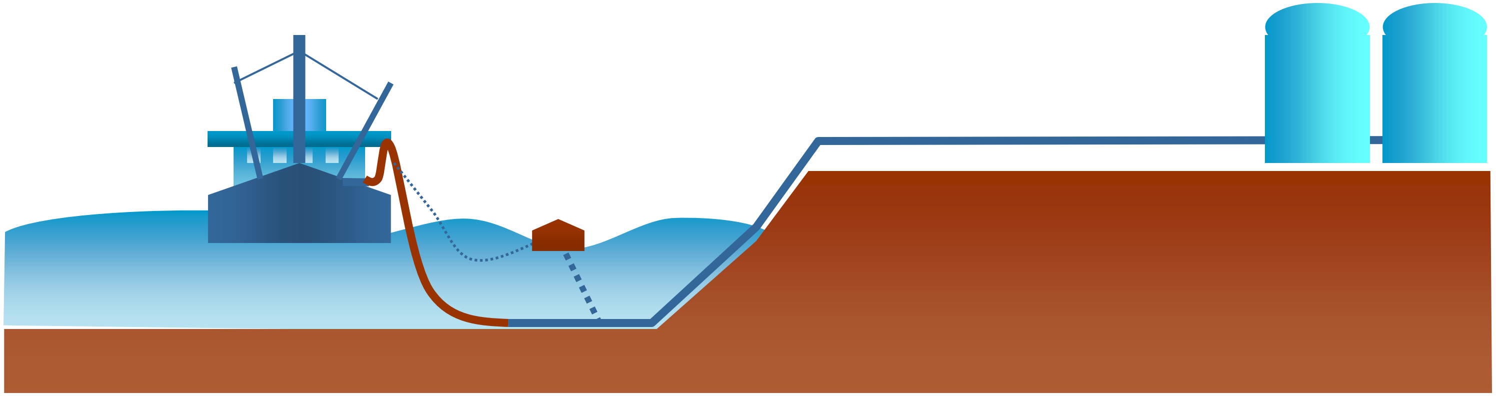
First the tanks are emptied by pumping the ballast water onshore into the ballast water tanks of the tank farm.

This water is of course contaminated with oil. With time water settles down and separates form oil. The remaining water is disposed or used for the next tanker for ballast.

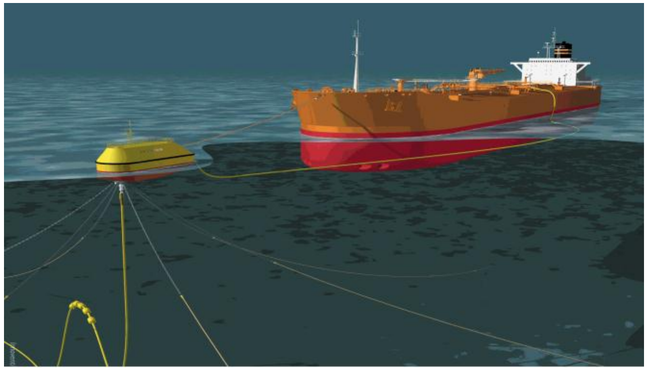
When a tanker is empty the tank farm starts pumping or uses gravity to fill it.

Modern ships have radar level detection, but in some cases the tanks are filled by manual control, i.e. a man looks through the open hatch or constantly uses his dip stick.

Inert gas cushion



To minimise the risk of explosions triggered by static electricity the empty space in the oil tanks are purged with inert gas. Usually the boiler exhausts or specially produced exhaust from inert gas generators.



VLCC at buoy
being filled

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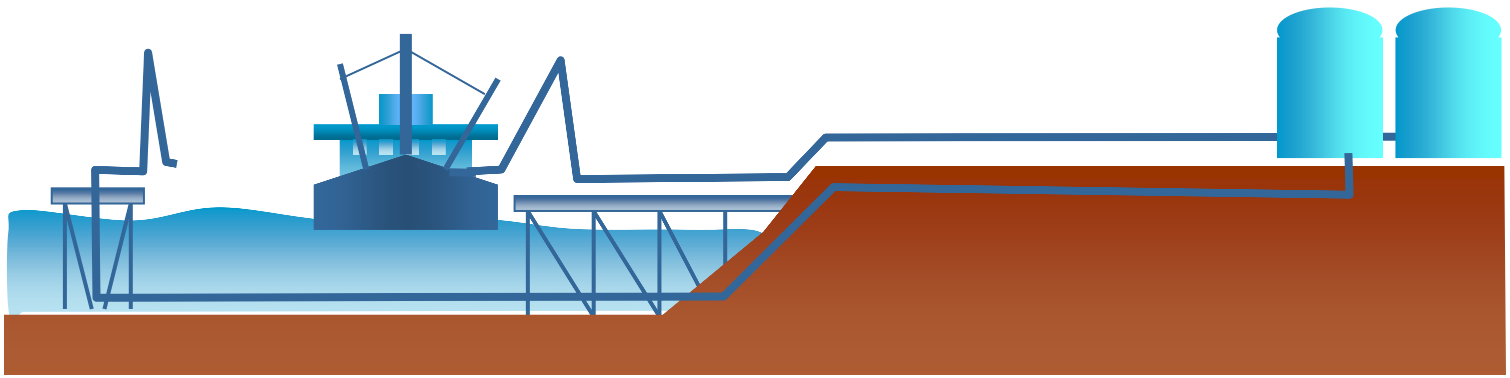
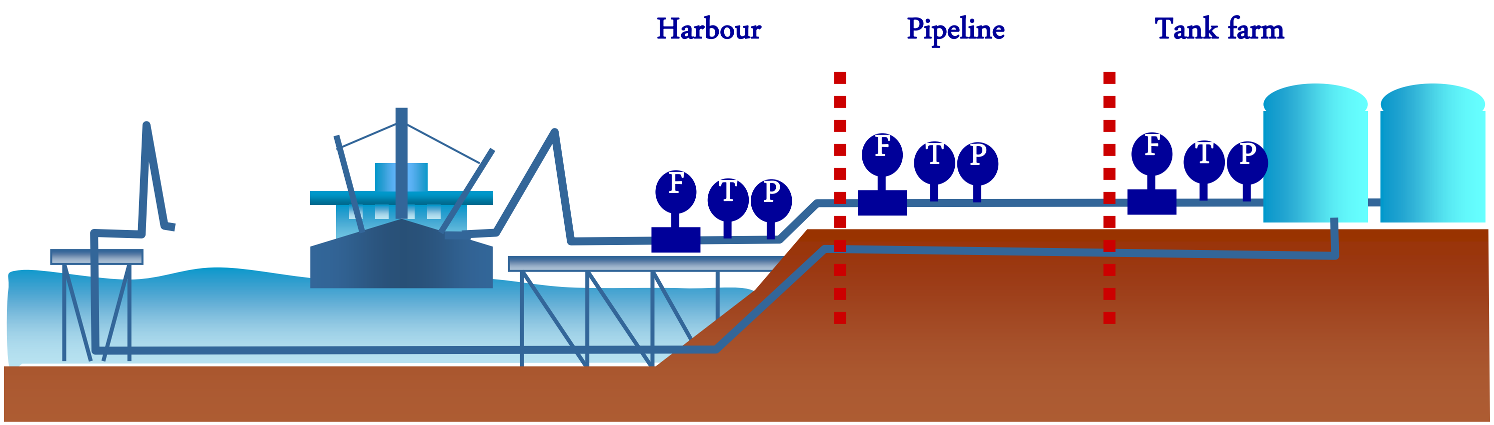
Jetty station



Tankers filled or offloaded from jetties or platforms

The main difference to buoys is that the pipeline is nor purged with sea water but with gas. Gas could be nitrogen, carbon dioxide or natural gas

Three different ownership



There might be three different owners involved to transfer oil from a tank site to a tanker.

The jetty belongs to the harbour authority, the pipeline (could be some hundred meters or several km long) could belong to a pipeline company and the tank farm might belong to a third company.

Their payments depend on the amount of fluid pumped through. Thus there is an interest in metering. We sold Ultrasonic Flow (no pressure drop) for monitoring and control and Promass for custody transfer.

Pipelines

Courtesy OMV, pipeline project in Russia

There are many projects under construction to further enhance the pipeline network. Specially gas pipelines are the only commercially interesting way of transporting gas. Pipes of over 1 m diameter can handle over 60 bar pressure and thus export huge quantities with little difficulty.

Pipelines connect the world

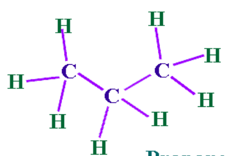
Pipeline projects in Turkey

As of 1950 more and more pipelines are connecting mayor oil and gas fields with major consumer areas stretching over thousands of kms. Once installed, the operation costs of a pipeline are very low. While first mainly gas pipelines were built, today also crude pipelines cover large distances to provide refineries with their raw material.

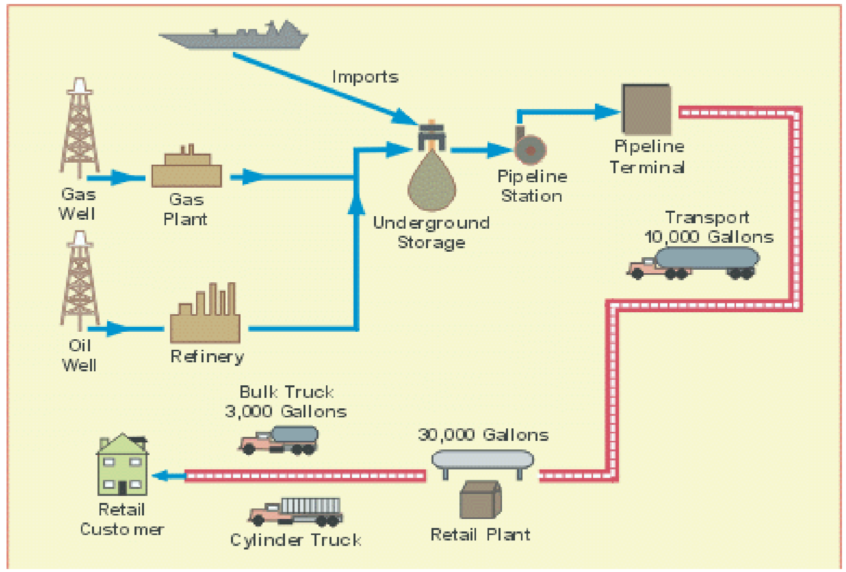
Offshore pipeline

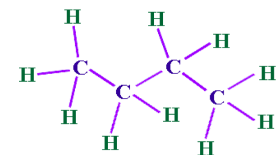
With the beginning of offshore production the need for an easy export of petroleum became imminent. New techniques had to be developed. Special pipe carriers supply a pipeline layer with pipeline sections. The pipes are welded together on board and continuously lowered into the sea over a long bridge type support to prevent sharp bending. The pipelines end in subsea manifolds with valves and control instrumentation.

LPG



Propane





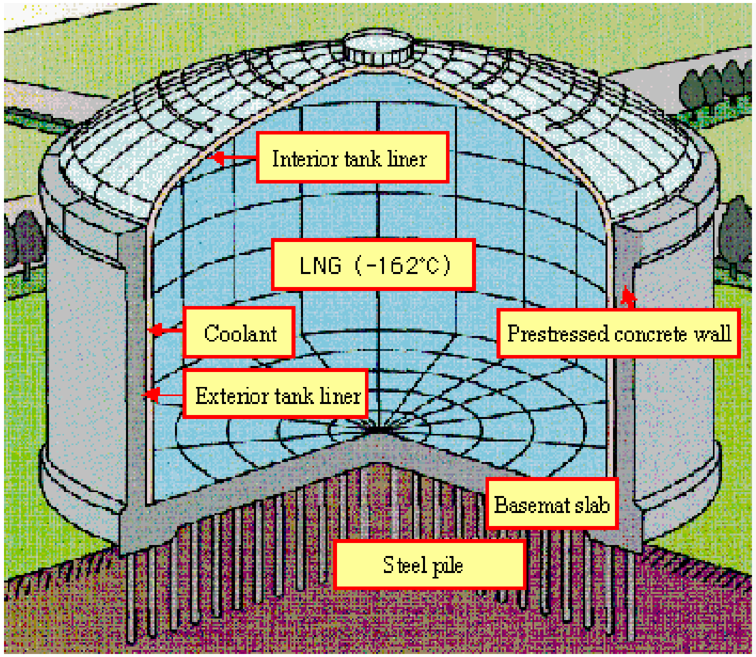
Butane

LPG cycle form the refinery to the end consumer

Liquefied gas is available world-wide and is the dominant source of clean energy. Liquid gas is mainly propane and butane hydrocarbons liquefied under pressure (~ 8 bar).

The principal advantage of liquid gas is its high mobility and high specific energy which allows a large quantity of gas to be transported and stored in a small volume. When converted from liquid to gas, one litre of liquid produces approximately 260 litres of gas.

LNG



While LPG is mainly propane and butane, LNG is liquefied natural gas or pure methane..

Liquefaction of methane is usually done by cooling the media down to -162°C. With a density of 0.45 g/cc the gas volume reduces 600 times.

High demand of industrial gas and environmental concerns reduced flaring off natural gas during production. Modern FPSOs will be designed to liquefy gas and export it.

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