ENVIRONMENT, SAFETY AND STORAGE OF OIL AND GAS

ENVIRONMENTAL AND SAFETY PROBLEMS OF PETROLEUM EXTRACTION

While oil and natural gas are naturally released into the environment from surface seeps an **oil spill refers to an unintentional release of hydrocarbons due to human activity.** Spills can occur both during extraction and during transportation, on land and at sea. These are both fire and environmental hazards.

Petroleum in any form is **highly flammable** so just a single spark can cause devastating fires and explosions.

The **2005 Hertfordshire Oil Storage Terminal fire** was accompanied by explosions that were the largest reported during peacetime in Europe. Offshore platforms and oil rigs are the most vulnerable. In **1988, the Piper Alpha** disaster occurred when an oil platform in the North Sea exploded after a gas leak.

Blowouts (where oil gushes uncontrollably to the surface) are rare these days but usually **catch fire and burn ferociously. Specialist companies** are brought in to deal with oil fires and blowouts. Often the only way forward is to **dig a relief well** to **reduce the pressure at depth** so the fire **can be put out with water**.

Smoke from unburnt crude oil contains a cocktail of dangerous chemicals including p**articulate matter (soot), sulphur dioxide, carbon monoxide, benzenes and dioxins**.

Extraction of hydrocarbons from a reservoir rock results in **surface subsidence** which can trigger small earthquakes of damage structures at the surface.

Another big environmental problem is the disposal of old oil rigs and platforms One of the most popular methods used is to **tow and sink them in deep water.** These may be used as **artificial reefs to provide habitats for coral and fish** but there is **negative publicity** on the effect this could have on the marine environment.

ENVIRONMENTAL AND SAFETY PROBLEMS OF PETROLEUM TRANSPORT

Oil and natural gas are usually transported **via pipeline or a seagoing tanker**. Oil spills at sea not only damage **marine habitats** and **marine life** but also **threaten coastal areas**.

- The **light fraction of** oil **floats** at the surface, causing severe problems to **seabirds** (**weighing down their weathers** so they can't fly and drown or can't reach fish below the water). It can be **contained using booms** or **dispersed using chemical detergents** which make the **oil sink** to the seabed.
- The **heavy fraction of** oil is very difficult to clean-up as it **sinks to the bottom** of the ocean and **is highly toxic** to marine life**, persisting** for a long time.

Pipelines are the most economical way to transport oil and natural gas. They are made **of steel or plastic** (diameter ~ 0.3 to 1.2 m). The hydrocarbons are **kept flowing along a pipeline using a series of pumping stations**. They are usually built above ground, but pipelines can also be buried in built-up, environmentally sensitive or potentially dangerous areas.

UNDERGROUND STORAGE FACILITIES FOR NATURAL GAS (UGS)

I**mported gas fr**om abroad is essential to the UK to **meet the demand**. This must be stored so it can be used at **peak times**. The solution is **underground gas storage (UGS**). **Onshore facilities are more convenient** than offshore ones but may have to be sited in environmentally sensitive areas.

Depleted oil and gas reservoirs (all recoverable oil and gas has been extracted)
Such sites are ideal as the **geology is already well known** to be capable of **storing large quantities of oil/gas** in the now empty reservoir rock. **Equipment will also be left over** from when the reservoir was in production, this can be re-used. To **maintain pressure, 50%** of the reservoir must be kept **full of gas.** Depleted oil/gas reservoirs are therefore attractive since they still **contain some gas** and **do not require injection** of (as much) gas that would otherwise be **unrecoverable.**
Salt Caverns
Evaporites are impermeable to gas so are ideal for UGS. **Salts are useful raw materials in the chemical** industries and can be extracted using **underground mining or solution mining**. As the shape of the old cavern is not ideal, **new cavities are often created**. This is achieved by **dissolving the Evaporite rock salt** and pumping it **out as brine**. Natural gas can be **withdrawn and replenished more quickly** with salt caverns than from depleted hydrocarbon reservoirs.

CASE STUDY: TRANS-ALASKA PIPELINE

This is a 1300Km oil pipeline built to transport oil from Prudhoe Bay to the nearest Ice-free port in Alaska.

<u>Challenges faced by the construction:</u>

- It passes through a remote, mountainous, environmentally sensitive area.
- Much of the area is underlain by permafrost which becomes boggy and unstable if it melts.
- It passes over active faults that are prone to earthquakes.

- **Permafrost** = a thick subsurface layer of soil that remains below freezing point throughout the year, occurring chiefly in polar regions.

<u>Strategies used to stabilise the pipeline:</u>

- Building zig-zags into the pipeline, rollers and shock absorbers in the supports to allow for movement during earthquakes.
- Building the pipeline above ground on supports.
- Using refrigeration plants to pump cold brine into the soil below to maintain a temperature below freezing so the permafrost does not melt and destabilise the pipeline.
  Periodically the pipeline is checked by sending pipeline inspection gauges ('pigs') through it. The pipeline is also surveyed several times a day by air.