PLANKTON TO PETROL PUMP

WHAT WOULD WE DO WITHOUT OIL AND GAS?

Plant plankton

Animal plankton

Well, this is a question that we should be asking ourselves as, depending upon which 'expert' we listen to, we have not got that long left before our ferocious appetite for hydro carbon products far outstrips our ability to find, ship, process and deliver oil and gas to the ever hungry consumer.

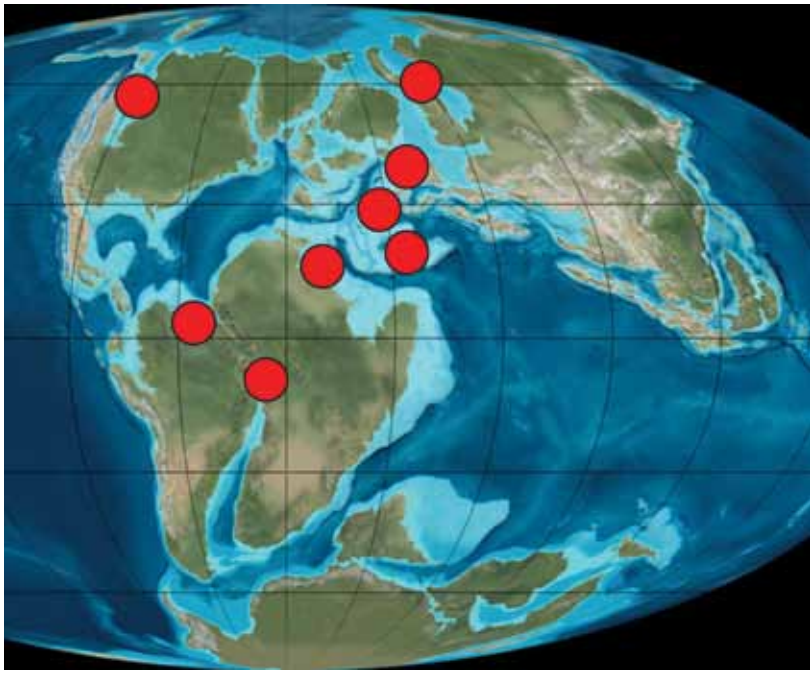
This article is about oil, sometimes referred to as 'black gold' by those who undertake the sometimes hazardous task of finding, exploiting, shipping, processing and delivering it and its multiple byproducts to us.

Where does it all come from and what do we do with it?

Most oil comes from microscopic animals and plants that live in our oceans. When these plankton die, it rains down on to the seabed to form an organic mush. Any animals/fish that live in this environment would quickly scavenge such delights and prosper on them. In warmer seas, however, with low oxygen levels, there is little or no opportunity for such animal life to live, let alone prosper, so the organic mush grows and accumulates in layers of organic matter and sand.

Where this happens, eventually sediment will build up and where such sediment contains more than 5% organic matter, we would describe it as a form of rock known as black shale. As the process is repeated and many layers of black shale accumulate, heat develops and eventually the organic mush changes, first into something called 'kerogen', which is a solid form or hydrocarbon.

As the temperature increases more changes take place and at around 90° C it turns into a liquid, which we refer to as oil. As the temperature increases further, at around 150° C, it changes to a gaseous form. The rock we find gas and oil in is referred to as a source rock. ▸



The world 150,000,000 years ago. Red represents areas perfect for plankton growth and laying down in low oxygen seas

"as much drilling is done horizontally as vertically nowadays, so the longest well is actually 40,320 feet, of which the horizontal element is 35,770 feet, (Maersk Oil Qatar)"

The hot oil and gas is less dense and so lighter than the source rock in which it occurs, so they migrate upwards, through the rock in much the same fashion as air bubbles might rise to the surface of water, as a diver swims beneath its surface. The rising oil and gas eventually get trapped in an impermeable layer of rock and start to accumulate in pockets of various sizes, which we generally refer to as reservoirs.

Fortunately for us, around 150 million years ago conditions were just about perfect for the build up of huge layers of black shale source rocks, where the world's main deposits of oil and gas formed in the warm shallow seas where the animal and plant plankton thrived. But where the sea bottom was low in oxygen, animal life was generally absent.

If we look at a model of the world as it was all that time ago, right, we will see that as the tectonic plates moved around, so did the reserves. It is noticeable that many of the oil rich countries, now separated by oceans, were once part of the same continent.

So how do we locate and exploit the reserves?

This depends greatly on whether the reserve is on land or sea. For land based exploration we induce seismic shocks into the ground and pick up the resultant vibration via geophones or sensors on the surface and, with great skill, specialists can tell by the patterns of return what is beneath the surface and - hopefully - the position of any reserves.

At sea the process is similar, except that we emit a sound source from a ship which again is transmitted down to the sea bed via the water, and the resultant return is 'heard' by a towed array behind the ship which again paints a picture of the sub-sea bedrock in a similar way to the land based survey.

How do we exploit the reserve?

Having located the reserve, we now need to exploit it by drilling down into the earth's crust. In early exploration and exploitation, the depths we drilled to could be measured in a small number of hundreds of metres. With all the easy pickings long gone, however, these days we often have to drill thousands of metres, with the deepest well yet being 35,050 feet deep - in a sea depth of 4,130 feet, (BP Tiber well in the Gulf of Mexico).

Interestingly, as much drilling is done horizontally as vertically nowadays, so the longest well is actually 40,320 feet, of which the horizontal element is 35,770 feet, (Maersk Oil Qatar). Incidentally, the current world water depth record is 10,011 feet of water, (Chevron, Gulf of Mexico).

Onshore drilling versus offshore drilling

Although the principles of drilling are the same, the difference between these two environments can't be more startling. On land we have all the usual climatic problems, ranging from the extreme heat of the desert to the extreme sub-zero temperatures of the arctic region, with all the diverse logistical problems these varying conditions can bring.

At sea, however, there are the additional problems of the sea itself, of course, making the offshore environment a mixture of a construction site, chemical plant and vessel at sea all rolled into one - compounding all the hazards associated with these normally dangerous workplaces, and more.

Safety measures - PPE

Serious thought needs to be given to relevant and suitable protective measures and safe systems of work in these environments. An obvious danger for an offshore worker is drowning, for which suitable lifejackets should be worn by those working over the side, along with harnesses and fall arrest equipment. There are, in addition, other hazards to which all workers could be exposed, including dangerous gases like H_2S, which is toxic, corrosive and highly flammable and for which suitable gas detection is required, along with respiratory protection for both longer term exposure and rescue activities.

Drilling operations will also involve various hazards, including high noise levels, dangerous chemicals for which suitable personal protective equipment must be sourced and purchased, including chemical proof gloves and ear defenders.

Indeed, ear defenders and gloves are but a small part of a sub industry that has evolved around the specialised needs of the gas and oil industry.

There are few active roles that do not involve some specific personal protective equipment; a good example would be the industry roustabout/floorman, a highly physical hands on role that requires the worker to wear specialist gloves, anti-static footwear, flame retardant and high visibility workwear, as well as a high specification protective helmet and eye protection. This type of equipment comes as standard in an industry with many highly visible as well as flammable risks.

It would perhaps come as a surprise to most people, the diversity and specialism of task that comes with the territory of getting our oil out of the ground. Each of these specific roles demand careful and rigorous personal protection planning. Some of these roles include:

- *Derrick man - Working about 90 feet above the floor of the rig in the 'derrick' (the distinctive high tower), the derrick man handles the section of drill pipe under the direction of the assistant driller*
- *Assistant driller - The assistant driller coordinates the activities on the drill floor, reports to the driller and communicates instructions and information from the driller to those working on the drilling*
- *Driller - The driller is responsible for the drilling team and controlling the rate and continuity of the drilling. This is highly skilled work as the drill may have to penetrate many different types of rock*
- *Tool pusher - The tool pusher oversees the drilling operations at night. He also ensures that the necessary equipment and materials are available*
- *Rig superintendent - The rig superintendent has overall responsibility for the drilling operation*
- *Drilling Engineer - The drilling engineer specifies the drilling programme, what kind of 'mud' should be used and the casing required for the well*

Of course all of these tasks are targeted towards one well defined task - the highly efficient and unrelenting extraction of one of our most valuable commodities.

Oil recovery

In the days when we believed we had an unending supply of natural gas and oil, the fact that we could only efficiently push 40-50% to the surface seemed unimportant. Today, however, it is of vital importance to maximise this figure and find new and innovative ways of doing so.

In order to enhance this recovery rate, we needed to get smart and find ways of increasing production, and we did this by using various pumping techniques; but even that was not good enough to justify the huge financial risk and investment required to locate and exploit the reserves we have left.

It's why these days we use a variety of methods, ranging from hot water to steam to force more of this valuable resource from the ground. In simple terms, we achieve this by drilling a second hole into the source rock and injecting a combination of hot water and steam into it in order to force the oil up the production well. In fact, we are now capturing carbon dioxide from various sources and injecting that too, back into the ground, with the double benefit of it acting to force out the oil and then capturing it in the ground and not into the atmosphere.

Oil and gas transportation and storage

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Oil and gas is moved around the world to be processed, sold and ultimately used for a variety of purposes. Such transportation can be by pipeline; for example, the Trans-Alaskan Pipeline, which at its peak in 1988 moved 2.03 million barrels of oil per day, but still transports around one million barrels a day. Another method of moving oil is by ship, with vessels carrying in the region of two billion metric tonnes around the world each year. Other methods are by road and rail.

Shipping and storing oil and gas products around the world is not without its drawbacks. The above picture was taken at the fire at the UK fuel storage facility in Buncefield following an explosion and fire there in December 2005, which resulted in an explosion:

- *Equivalent to 2.4 on the Richter scale*
- *Which was heard 300 km away*
- *Resulted in 25,000 people being displaced from their work*
- *Resulted in 2,000 people being displaced from their homes*

Transportation of oil and gas products can be undertaken by ship, land and sub-sea pipelines, trains and road tankers. The obvious problem with transportation is the occurrence of leaks, but we should also remember that at times oil and gas products are shipped at very cold temperatures, offering the opportunity for cold burns, so thought must be given to provision of suitable personal protective equipment for those involved in transport and receipt of products.

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Again, highly task specific PPE is used: anti-static, flame retardant boots and overalls. Specialised industry training and refresher courses are received by all personnel involved in the final delivery stage of this by now, highly invested in byproduct.

Refining and processing

Initial processing of oil and gas is often undertaken at the wellhead, with unwanted impurities removed and often re-injected back into the reservoir, rather than shipping it needlessly and expensively around the world to then cause an additional headache for disposal at a later date.

Oil refining uses heat to 'crack' the oil down into the various products that we require, from petrol to bitumen, with each product requiring a different temperature range in order to be distilled off. A little like a kettle may boil water and turn it into steam, oil will heat up and release different products at different temperatures.

Having removed the various impurities found in it, gas, on the other hand, requires cooling and pressure in order to turn it back to liquid for economical transportation and storage before being 'warmed up' again, and shipped at lower pressures around the country in pipes to factories, power stations and residential areas.

How much is left and where is it?

It is fairly well accepted that we know where most of the oil and gas reserves are by now, if not by exact location, at least by broad geographic region. As mentioned previously, however, the easy pickings have gone which means greater risk financially, but more importantly, also in terms of potential harm to humans required to locate and exploit these hard to reach reserves. This requires those of us who work in the safety world to be ever vigilant and equally imaginative to ensure the safety of those workers in more and more remote and hazardous environments.

Obviously, with any apparent scarcity, always comes an increase in value. With the prices of crude and therefore all oil derivatives increasing massively of late, however, there is some good news. Some reserves, notably the Tar sands in Canada, have become viable at the increased price per barrel of oil, meaning that those vast reserves, said by some to account for 1.75 trillion barrels equivalent, or put more simply, about half of the world's known oil reserves, are economic to exploit.

As long ago as 1956, however, a very clever man by the name of M King Hubbert predicted with some degree of accuracy that oil production would peak around the year 2000. Even allowing for a degree of error in Hubert's prediction, if we balance this prediction with the growing world population and corresponding massively increased demand for oil due to the growth of the so called 'Developing World', we really do need to reconsider our insatiable appetite for this once thought inexhaustible resource.

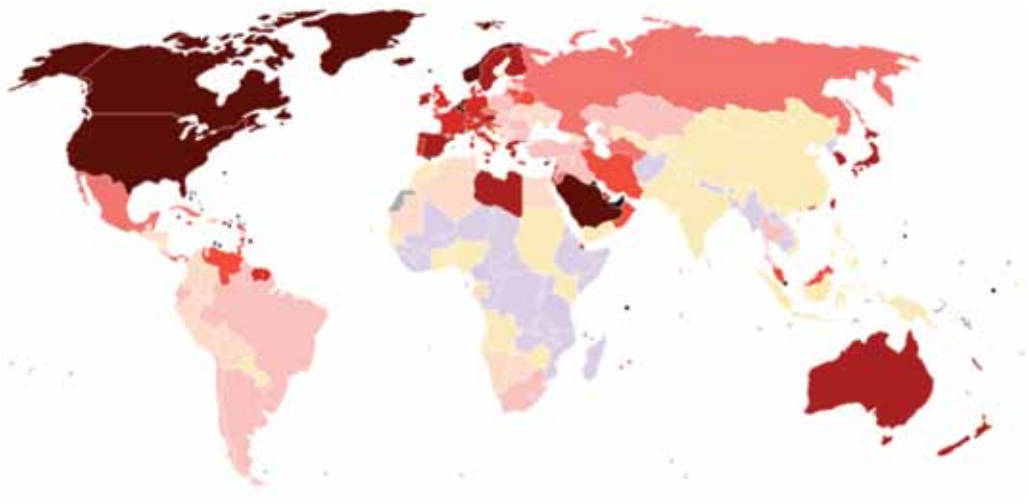
Where does it all go?

Estimates indicate a huge proportion of our oil consumption is to power motor cars and aeroplanes, while the manufacture of plastics for our drinks bottles, fertilisers and food additives is another ingenious use we have found for that ancient rotting plankton from 150 million years ago.

In the map of the world, above, we can see the main areas of oil and gas usage per person is denoted by the lighter colour indicating less usage, while the darker colours suggest higher levels of oil use.

By way of example, in 2007 world oil consumption grew by 1,200,000 barrels a day and, if they agreed to, the main oil producing nations and trading blocks could only increase production by 2,500,000 barrels a day.

This indicates that Mr Hubert's prediction of peak production coupled with an increasing demand, means that the time may well be near when rationing may occur, with all that will follow from that. ■



Author

Pat McLoughlin, co-founder of BSS

British Safety Services (BSS) is an international consultancy offering advice and training on health and safety issues. Established in 1990, BSS has gained an international reputation as a major provider of high quality safety training that gets results. The team at BSS also provides guidance on all aspects of public safety, specialising in workplace legislation and best practice.

BSS advise clients on their health and safety strategy and policy, and assist in implementing procedures as required. By conducting training needs analysis, BSS help clients identify skills gaps in their workforce and then develop and deliver bespoke training programmes to meet these gaps, to improve safety awareness and performance in the workplace. BSS have been successfully providing these services to companies throughout the world for almost 20 years.

BSS has its Head Office in Birmingham, UK, and has regional offices in Qatar, Dubai, Yemen, China, Libya and Algeria. With a team of specialist staff grounded in a detailed understanding of each country's cultural issues, as well as specific industry and country safety requirements, instructors are all qualified to NEBOSH standards and have a minimum of 15 years of experience.

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