



Kingdom of Saudi Arabia Section



# SandRose

## EDUCATION

SandRose Education is a dedication from a passionate team of Young Professionals in the oil & gas industry to the ambitious youth of this great country. Through this booklet, you will understand the significance of hydrocarbons, and hopefully ignite your interest in joining the world of oil and gas.

## WHAT IS SPE?

Society of Petroleum Engineers (SPE) is the largest individual-member organization serving professionals worldwide in the upstream segment of the oil and gas industry. We are a global network of volunteers with an active section in Saudi Arabia.

## MEET THE TEAM



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## SPE-KSA'S MISSION

To collect, disseminate, and exchange technical knowledge concerning the exploration, development and production of oil and gas resources, and related technologies for the public benefit; as well as to provide opportunities for professionals to enhance their technical and professional competence.

## SPE-KSA'S VISION

Enable the global oil and gas E&P industry to share technical knowledge needed to meet the world's energy needs in a safe and environmentally-responsible manner.



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## WHAT IS SANDROSE MAGAZINE?

SPE-KSA Section's magazine that showcases SPE-related activities, industry highlights, and provides a platform to share and exchange knowledge.



## WHAT IS A SAND ROSE?

A unique product of nature that occurs in different shapes and sizes. It shares its physical appearance with a rose, and is commonly found in hot deserts. That's why it is known as the "Desert Rose".

Also available in Arabic  
at [spe-ksa.org/sandrose](https://spe-ksa.org/sandrose)

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# THE HIDDEN TREASURE

While you are on your way to school, have you ever wondered where does gasoline originally come from? If you answered with “subsurface or underground”, then you are absolutely right! Yet, remember that such fuel underwent a series of processes before it finally ended up in the tank of your vehicle.

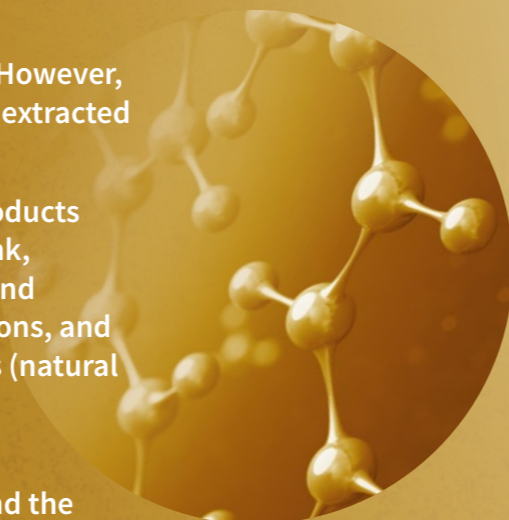


To best explain where fuel comes from, let us first discuss the original source of bread. If you were asked where white bread comes from, you would probably say wheat, a natural source that is grown in many regions around the world. This wheat, after being harvested, is then processed to produce several products such as bread, cereal and others.

Similarly, your car fuel comes from a natural source. However, this natural source is not harvested like wheat, but is extracted from under the ground.

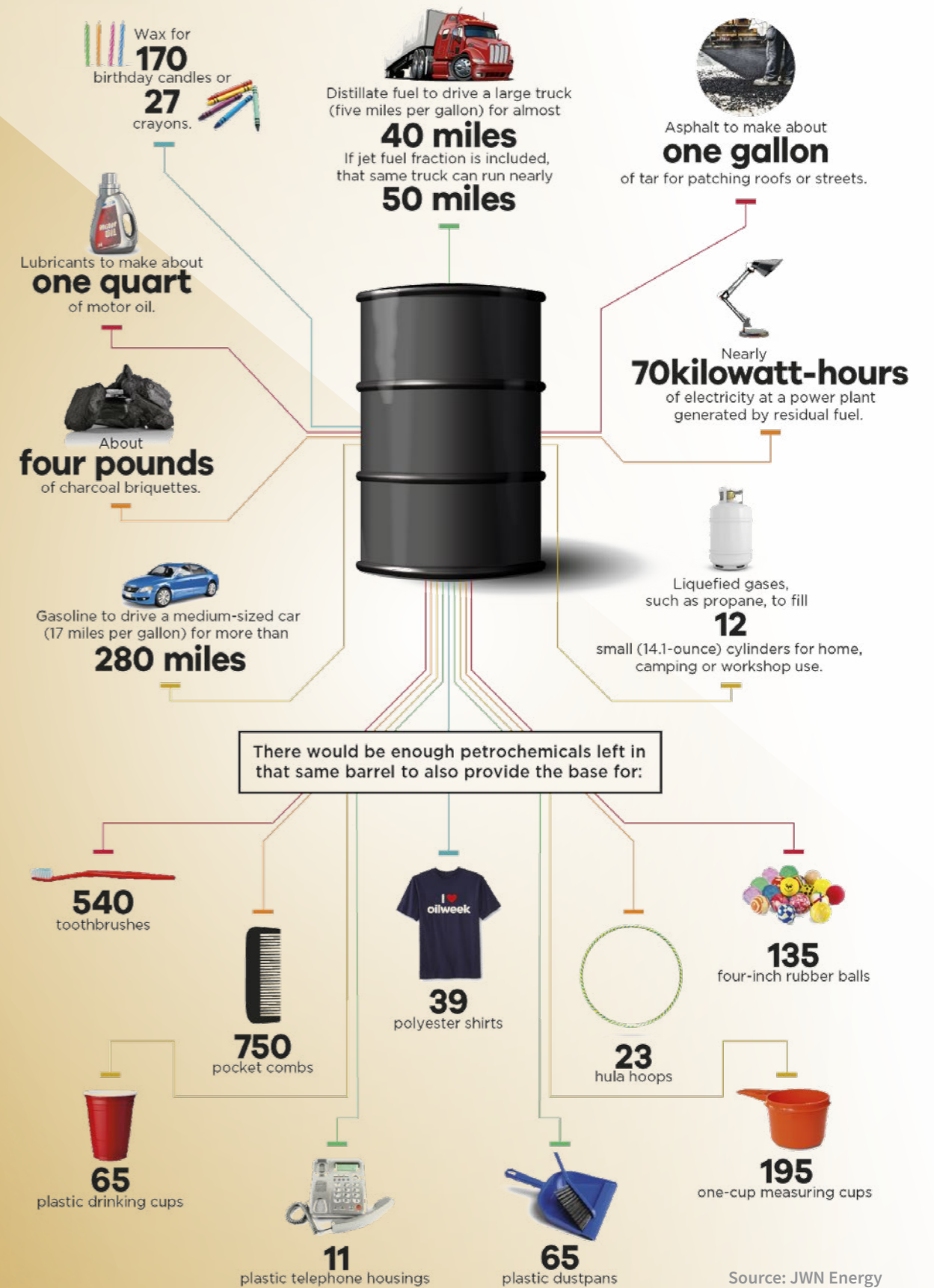
It is then processed and refined to produce useful products used in making cellphones, T-shirts, paint, asphalt, ink, supplying electricity, along with fueling cars, ships, and airplanes. This natural source is known as hydrocarbons, and can be found in different forms; liquid (crude oil), gas (natural gas), semisolid (bitumen) or solid (asphalt).

Similar to how wheat is grown in specific locations, hydrocarbons are only found in certain regions around the world, and our Kingdom is one of them. In fact, the Kingdom proudly produces over 10 millions barrels of crude oil everyday to supply the world with energy!



# WHAT CAN YOU MAKE FROM ONE BARREL OF OIL?

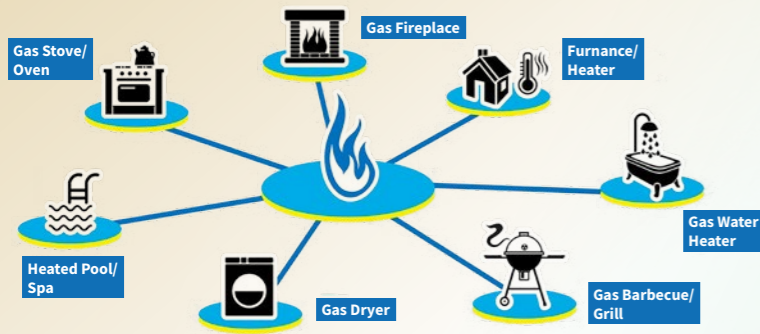
Researchers broke down what could be produced from a typical barrel of crude oil. Here's what a single barrel of crude oil can produce:



Source: JWN Energy

As shown in the figure, a single barrel of crude oil can supply enough gasoline to drive a medium-size car from Dammam to Riyadh, as well as provide fuel, diesel in this case, to drive a truck from Jeddah to Makkah.

We mentioned earlier that hydrocarbons supply us with electricity, but how much electricity does a single barrel of crude oil provide? Well, a single barrel can provide electricity that easily lights 700 100-watts light bulbs for one full hour.



With all of these important products provided by just a single barrel of oil, can you imagine what 10 million of those can do?

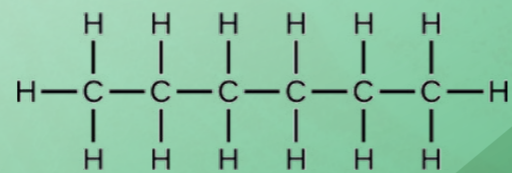
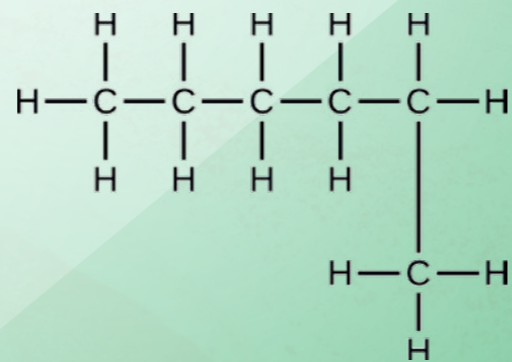
Besides crude oil, the world also benefits from gaseous hydrocarbons known as natural gas. This is widely used in heating, cooking, and electricity generation.

I bet by now you understand why the entire world is in a quest to look for crude oil and natural gas. Let us now dive deeper aiming towards realizing the value of hydrocarbon and understanding its journey from subsurface to surface.

## BUILD-UP YOUR KNOWLEDGE!

### WHAT ARE HYDROCARBONS?

Organic compounds that only consists of hydrogen and carbon atoms.



Example of Hydrocarbons



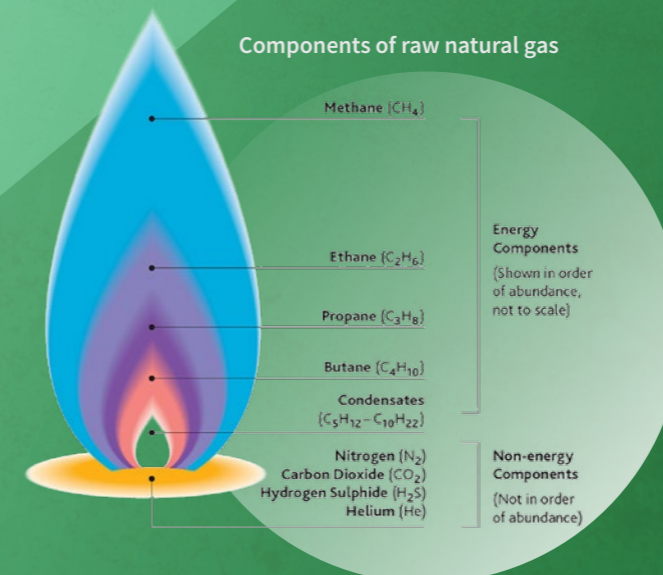
### WHAT IS CRUDE OIL?

It is a yellow-to-black organic liquid, made up of thousands of molecules composed of different hydrocarbons and dissolved gases like Oxygen (O<sub>2</sub>), Nitrogen (N<sub>2</sub>), Carbon Dioxide (CO<sub>2</sub>), and Hydrogen Sulphide (H<sub>2</sub>S)



### WHAT IS THE DIFFERENCE BETWEEN CRUDE OIL AND PETROLEUM?

The word 'petroleum' is derived from the Latin *petra* (which means rock) and *oleum* (which means oil). It is commonly used to refer to crude oil, but it may also refer to other related hydrocarbons.



Components of raw natural gas Copyright 2013 international Centre for Energy Information

### WHAT ABOUT NATURAL GAS?

Natural gas is made up of a mixture of naturally occurring gaseous hydrocarbons, primarily Methane, along with Ethane, Butane and Propane. It also has some other non-organic gases like N<sub>2</sub>, CO<sub>2</sub> and H<sub>2</sub>S.

## WERE HYDROCARBONS (OIL & GAS) FORMED FROM DINOSAUR REMAINS?

As fun as it seems, this is a myth. Crude oil and natural gas were formed from tiny plants and animals that lived millions of years before the Earth's first dinosaurs were even born. So, the answer is NO!

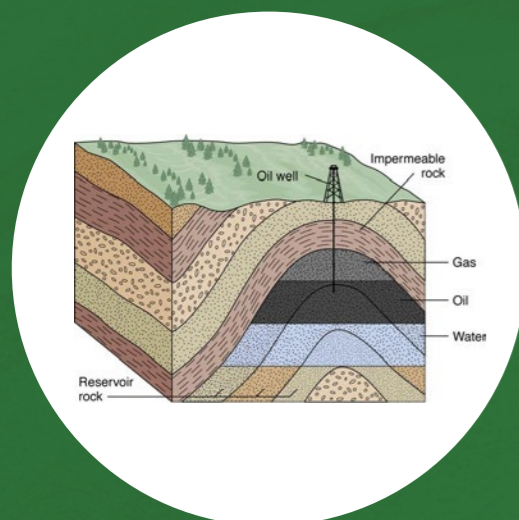


## IF HYDROCARBONS ARE NOT FORMED FROM DINOSAURS REMAINS, HOW DO HYDROCARBONS FORM?

The decomposition of dead organic materials, Like plants and marine animals beneath the ground results in what's called Kerogen and Butamin. After these get buried deeper, the impact of heat and pressure cooks the hydrocarbons into either crude oil or natural gas. To learn more, scan the code in the picture left.

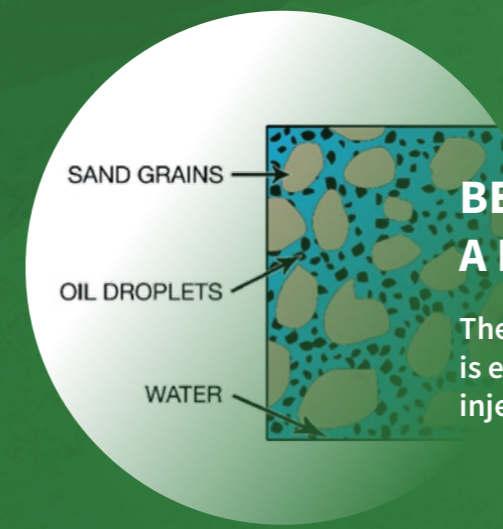
## ARE HYDROCARBONS STORED IN UNDERGROUND LAKES/POOLS?

Crude oil and natural gas are NOT found in underground lakes like some may expect. In fact, they are stored in the porous rock formations called reservoirs.



## WHAT DOES A RESERVOIR LOOK LIKE?

This picture shows an oil reservoir. You notice that the subsurface structure is bent up into an arch. This is called an anticline, and hydrocarbons are often trapped under them. If one of those bent layers is impermeable, hydrocarbons will be stuck in those traps, and only drilling can access the hydrocarbons in this case.



## BESIDES HYDROCARBON, WHAT DOES A RESERVOIR CONTAIN?

The water that is mixed with hydrocarbons in a reservoir is either naturally occurring, or due to water that is injected to help push the oil to the surface.

## WHERE IN THE WORLD ARE OIL AND NATURAL GAS RESERVOIRS FOUND?

Besides our Kingdom, some of the top oil and natural gas producers around the world include the USA, Russia, China, Nigeria, Venezuela and many more. These reservoirs are not only in lands (onshore), but also in oceans and seas (offshore).



## WHERE IS THE LARGEST FIELD?

### ONSHORE

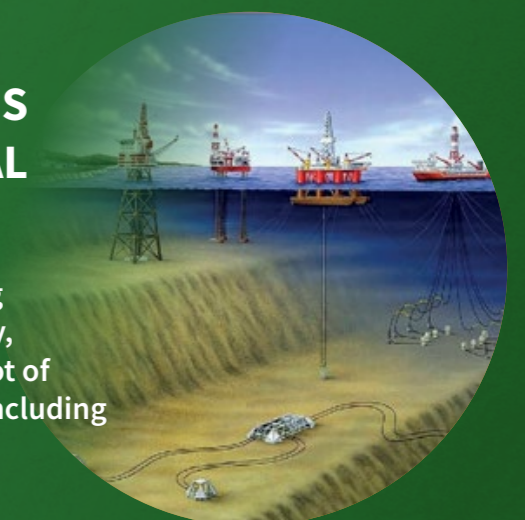
Ghawar near Al Hasa, Saudi Arabia

### OFFSHORE

Safaniyah in the Arabian Gulf.

## WHAT ARE SOME OF THE DISCIPLINES NEEDED TO PRODUCE OIL & NATURAL GAS?

The key educational backgrounds that help in exploring and producing oil and natural gas fields include geology, geophysics and petroleum engineering. In addition, a lot of other disciplines are involved in the oil & gas industry including economics and other engineering majors like chemical, electrical and mechanical.



# THE JOURNEY OF OIL & NATURAL GAS

You already know by now that oil and natural gas, i.e. hydrocarbons, play a huge role in our lives. For us to retrieve this treasure from the ground and process it, there is a challenging, yet exciting, stages and processes that you are about to explore. The main stages and processes are the following:



Exploration



Drilling



Reservoir Description & Monitoring



Production



Processing & Refining

You will get to know more about each stage in the upcoming pages.

## EXPLORATION



### EXPLORATION OF HYDROCARBONS

How do we look for oil and gas? Do you think we randomly drill the ground?

#### Main Goals:

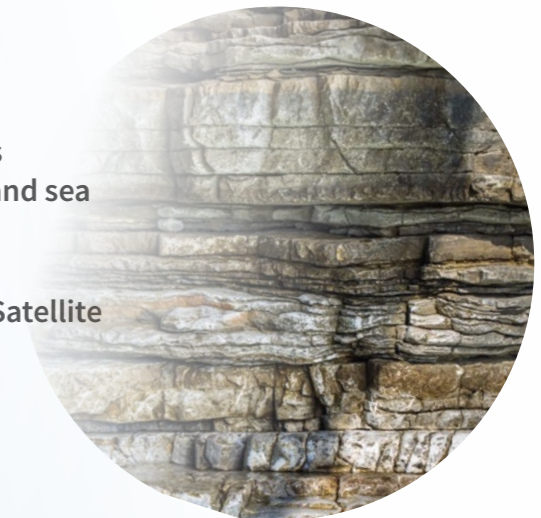
1. Looking for underground hydrocarbon resources
2. Examining the shapes of different subsurface layers
3. Determining the optimum locations to drill in land and sea

#### Popular Technologies Used:

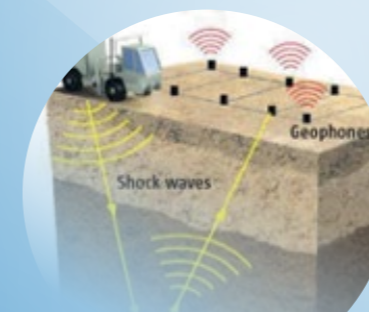
Seismic Imaging (Sound Waves), Aerial Photography, Satellite Pictures.

#### Work Location:

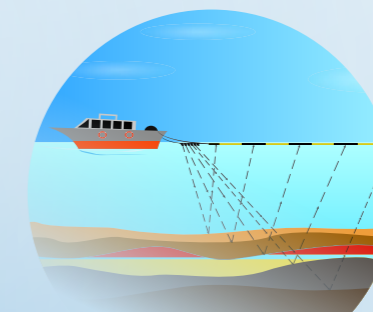
Offices, Labs or Fields.



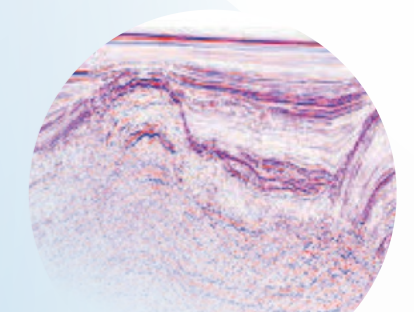
### LEARN ABOUT SEISMIC & GEOSCIENTISTS ROLE IN LOCATING RESERVOIRS



ONSHORE SEISMIC



OFFSHORE SEISMIC



RESULT OF SEISMIC





### DID YOU KNOW?

The earth subsurface consists of multiple rock layers that are different in properties. Two important properties are known as porosity & permeability.

**Porosity:** The number (percentage) of pores (void) in a rock.

**Permeability:** the ability of a rock to allow fluids to flow through it.

## TRY AT HOME: WHAT IS POROSITY?

### What You Need:

- Different kinds of sponges
- Measuring cup - Bowl - Water

### Method:

- Fill the bowl with 2 cups of water and soak one of the sponges for 30 seconds
- Squeeze the sponge into a measuring cup, and report the reading
- Repeat the steps for the other two sponges

Which sponge squeezed out the most water?

Why do you think that sponge soaked more water than the others?

Describe the sponge that released the most water?  
Compare it to the other sponges.



## GHAWAR FIELD: A MAJOR DISCOVERY

In 1940, a young geologist, Ernie Berg, was mapping the nearby areas of Abqaiq and noted that the Wadi Sahaba, a dry river bed in the Haradh area, took a sudden bend from its east-west course to the south. He hypothesized the existence of an anticline, which was responsible for this wadi diversion. Further mapping confirmed the existence of what came to be called the En Nala (“the Slippers”) anticline. What made mapping this anticline possible was shallow drilling, down to about 300m in the desert. World War II hampered all these activities, but once the war ended in 1945 and exploration resumed, the En Nala anticline drew attention again. Shallow drillings were supplemented with gravity and magnetic surveys. In 1948, a

test well was drilled at Ain Dar hit oil. A second drill site at Haradh, about 185 km south of Ain Dar was then proposed. This wildcat also discovered oil in 1949. Then came Uthmaniyah No. 1, drilled in 1951, Shedgum No. 1 (1952) and Hawiyah No. 1 (1953), all of which discovered oil from the same reservoir at depths of 2,000-2,330m along the same anticline. By 1953, it was recognized that all these prospects were parts of a single field that was named Ghawar.

Source: GEO EXPRO

# DRILLING



## OIL & GAS DRILLING

Once the exploration team suspects the presence of either an oil or gas reservoir, the drilling stage begins!

### Main Goal:

Drilling wells to access hydrocarbon accumulations.

### Responsibility of:

Drilling Engineers & Field Operators.

### Common Equipment/Tools Used:

Mainly Rigs, Mud (Drilling Fluid), Bit & Casing.

### Work Location:

Field, Office, or Labs.



### DRILLING RIGS

The above-ground structure where the drilling procedure is controlled and supported.



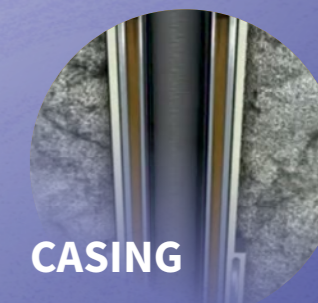
### DRILL BITS

To cut and penetrate the harsh Earth formations. Different bits are used depending on the type of formation.



### DRILLING FLUIDS

Used to lubricate and cool the bit, and clean the hole from cuttings as the mud is circulated. Most popular drilling fluid is mud.



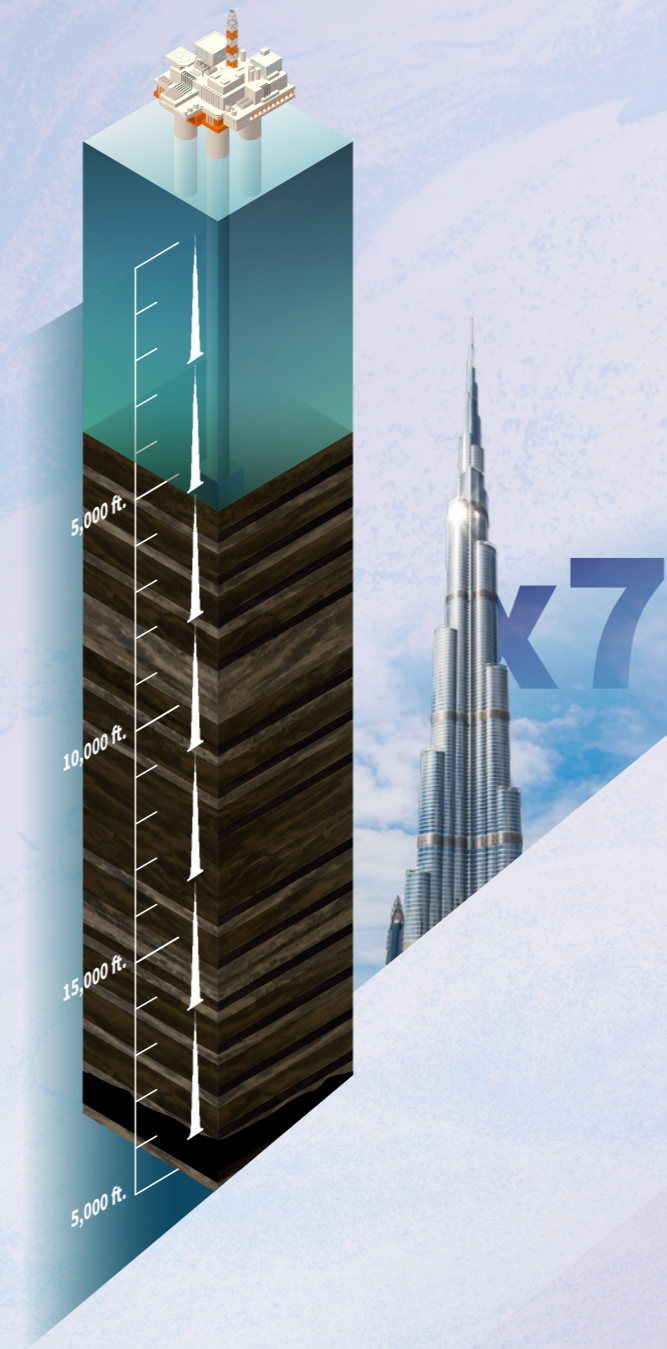
### CASING

Large, medium and small diameter casings are installed and cemented to prevent the hole from collapsing and protect any underground water.



## INTERESTING FACTS ABOUT DRILLING

Drilling can be as deep as 7 times the height of the tallest building in the world, i.e. Burj Khalifa.



### THE REVOLUTIONARY DRILLING OF MANIFA FIELD

The Manifa oil field was discovered in 1957, making it one of the oldest offshore fields in the Kingdom. The six-reservoir field, situated 255 kilometers northwest of Dhahran, measures approximately 45 km in length and 18 km in width. It lies offshore in less than 15 meters of water.



# RESERVOIR DESCRIPTION & MONITORING



## OIL & GAS RESERVOIR DESCRIPTION & MONITORING

The reservoir rocks accommodate and store the treasure i.e. hydrocarbons. Therefore, describing and monitoring targeted reservoirs is essential.

### Main Goal:

Visualizing & Monitoring the Reservoir.

### Equipment Used:

Simulators, Logging Tools and Logs.

### Responsibility of:

Reservoir Engineers & Petrophysicists.

### Work Location:

Office and the Field.



## THE POWER OF SIMULATION



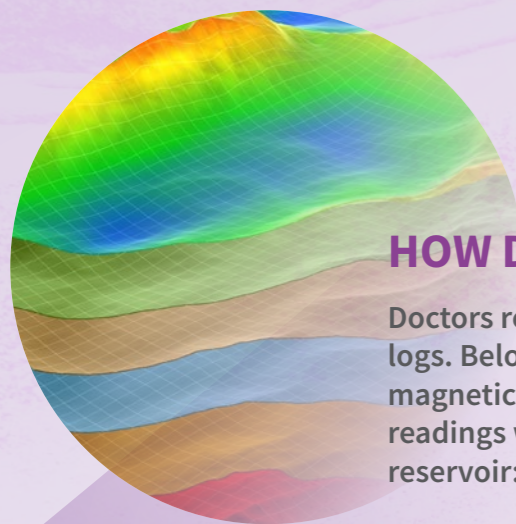
Just the way video games offer you a unique experience to live the game while playing, reservoir engineers are able to visualize what is beneath the surface through reservoir simulator software.

Reservoir simulator software help us in estimating how much hydrocarbons are in the reservoir, and planning the methods needed to extract the hydrocarbons.



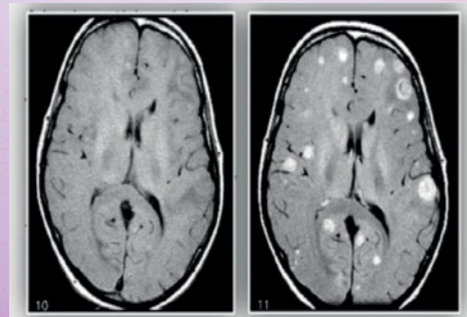
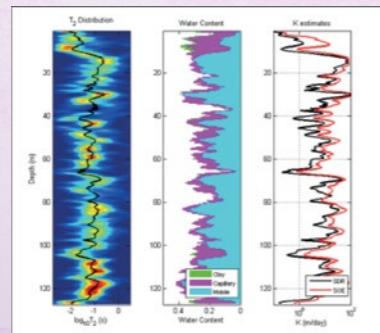
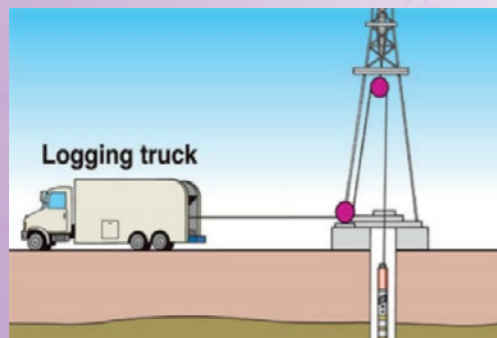
# RESERVOIR DIAGNOSTIC

How can a doctor detect the condition of a specific body organ? Well, Magnetic Resonance Imaging (MRI), for example, is heavily utilized in hospitals to see what's happening inside the body. In a similar fashion, petroleum engineers use logging tools to see what's happening underneath the surface.



## HOW DOES IT WORK?

Doctors read X-rays, while petroleum engineers analyze logs. Below is a depiction of a log called NMR that uses magnetic resonance pulses just like the MRIs. One of the readings we obtain from this log is the porosity of our reservoir:



# PRODUCTION

## OIL & GAS PRODUCTION

In the production phase, petroleum engineers ensure the safe delivery of the hydrocarbons from the reservoir to the surface.

### Main Goal:

- 1) Monitoring the performance of wells in terms of hydrocarbon production
- 2) Resolving production issues, such as inadequate production rates due to low reservoir permeability and porosity, i.e. reservoir's poor quality

### Equipment Used:

Tubing, Wellhead and Surface Flowlines.

### Responsibility of:

Production Engineers.

### Work Location:

Between Office and the Field.

### Did You Know?

When the drilled hole is entirely cased, production engineers activate perforation guns that carry explosives to create a pathway from the reservoir.



## SUBSURFACE TUBINGS

Tubing provides isolation for the casing from well fluids and eventually prevents corrosion and damage of the casing.



## WHAT IS THE PURPOSE OF SURFACE WELL HEAD:

At home, you can control how much water is flowing, i.e. pressure of water, by controlling the valve. One of the main functions of the wellhead is to control the pressure, in the same way you do with water at home. Also, a flowline connects to each wellhead in order to deliver the production to separation facilities & plants.

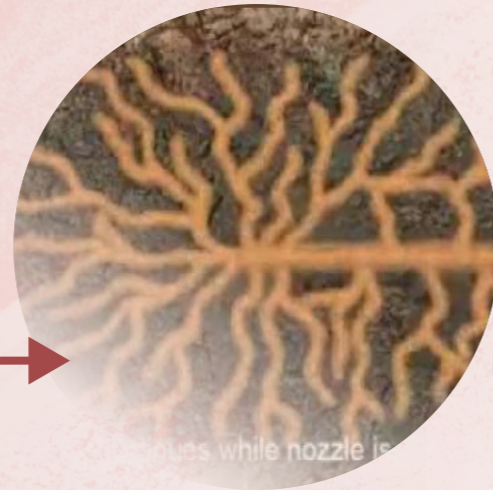
## HOW CAN PRODUCTION ENGINEERS IMPROVE THE QUALITY OF THE ROCK?



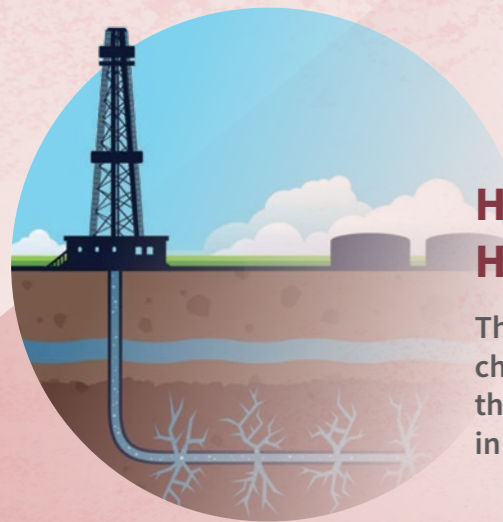
Poor-Quality Reservoir Rock

+

HCl



Acid Creating Cracks in the Reservoir to Improve its Quality



## HAVE YOU HEARD OF HYDRAULIC FRACTURING?

The use of a mix of high pressure water, chemicals and sand to create fracks in the reservoir. It is commonly performed in natural gas reservoirs.



TRY IT AT HOME:  
WOULD IT FLOW  
WITHOUT  
PERFORATION?



# PROCESSING & REFINING



## OIL & GAS REFINING AND PROCESSING

The journey of hydrocarbons does not stop at the surface. In fact, there is typically little value of the produced oil or gas if not separated, treated, and refined. So, how can we refine oil to produce useful products like your car fuel?

### Main Goal:

Transform oil and natural gas into useful products.

### Equipment Used:

Separators, Distillation Columns & Other Reactors.

### Responsibility of:

Chemical and process engineers

### Work Location:

Refineries, Offices or Labs



## WHAT IS A REFINERY?

An industrial plant where crude oil is transformed through multiple processes into useful products, such as gasoline, diesel, jet fuel, etc...

A LOOK  
INTO REAL  
REFINERIES





## WHAT HAPPENS IN THE REFINERY?

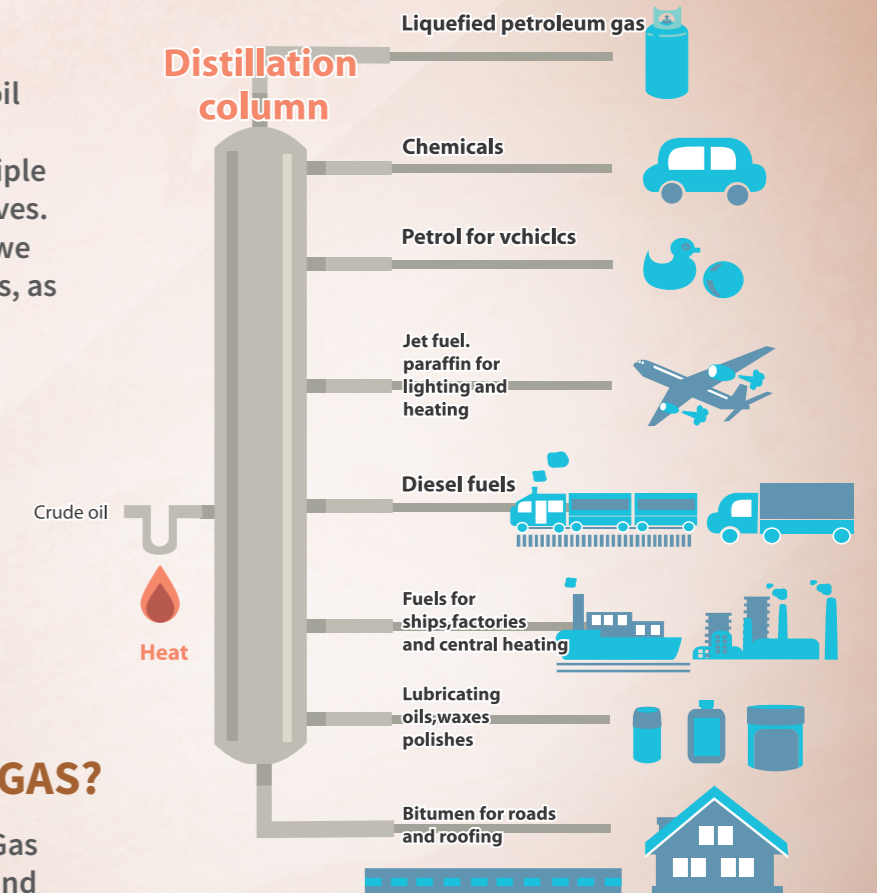
### WHEAT PRODUCTS

We mentioned earlier that harvested wheat undergoes some processes that converts it to flour from which bread, pasta, and other food items are made.



### OIL PRODUCTS

What about crude oil? In a refinery, oil that is separated from produced gas and water is heated to produce multiple products that are used in our daily lives. As you can see in the figure, the gas we use for cooking is one of the products, as well as petrol for our cars.



### WHAT ABOUT NATURAL GAS?

Well, it is typically sent to a Natural Gas Processing Plant, where impurities and non-useful products are separated. In some cases, the cleaned natural gas is sent to a facility that turns gas from the gaseous state, to the liquid state. This process is called Natural Gas Liquefaction, or NGL.

# INTERESTED IN JOINING THE OIL & GAS?

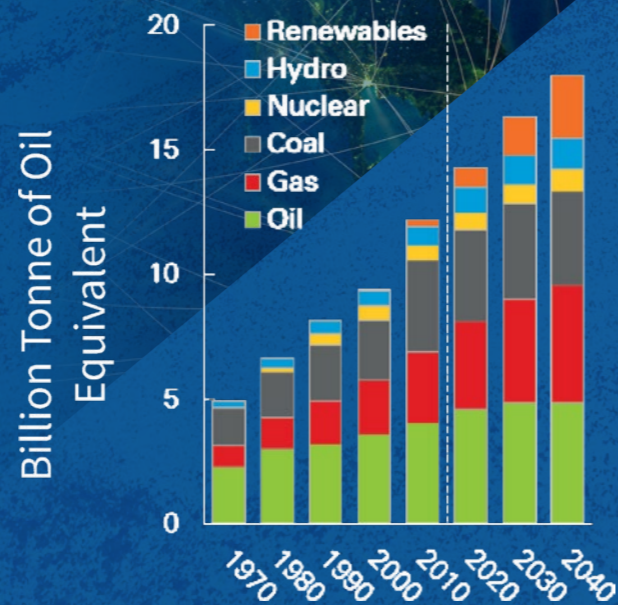
here are some good reasons why petroleum engineering is a great major to consider:

## 1 THE WORLD IS IN CONSTANT NEED FOR PETROLEUM ENGINEERS

Where would we get fuel for airplanes without oil? What about our electricity?

What about the future? Would renewable resources replace oil & gas?

Experts predict a rise in the use of renewables for the next 25 years. However, the world would still depend on oil and gas as an efficient energy source!



Source: BP 2017 Energy Outlook

## 2 PETROLEUM ENGINEERING OFFERS DIVERSE DISCIPLINES & WORKING ENVIRONMENTS

Petroleum engineers work in several environments. Some work in the field (offshore or onshore) whereas others conduct research and analyze data in labs and offices respectively.



Labs



Offices



Drilling Offshore



Drilling Onshore

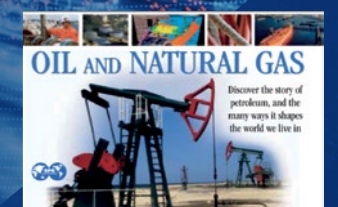
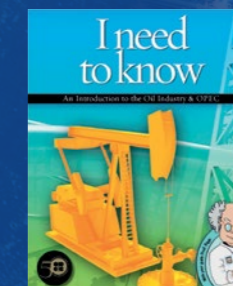
## 3 PETROLEUM ENGINEERING HAS A ROOM FOR INNOVATION

With the future revolving around the 4th industrial revolution, petroleum engineering offers many opportunities to apply innovative technologies that can advance the industry!



### WANT TO KNOW MORE?

What you have in hand is aimed to ignite an interest in you to know more about the oil & gas industry. We trust that you would want to know more. Hence, we recommend checking out the following resources:



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