Investing in oil and gas by Mike May

The target readership of this book can be divined from its format. Easy-to-read 14-point type – about the most one will ever encounter in a business publication. Even an old guy can read it without glasses.

Who would the old guy be? An American with $100K to $2M to invest in a speculative venture, an oil well. Why would he do it? A 2x to 3x or greater return on his investment if it hits. Where would he be? Most likely Texas, from which most of the examples in the book are drawn.

The book does an admirable job of providing an overview of the knowledge an investor ought to have going into such a project. This review incorporates the fantastic table of contents entries for the general-interest chapters, the ones that have more to do with finding and pumping oil and gas than with business deals or Texas.

Starting with Part I, Oil and Gas Operations, here are the headings in Chapter One describing petroleum.

Chapter 1: Petroleum

- Hydrocarbon groups
- Liquids and gases
- Crude oil
- Natural gas

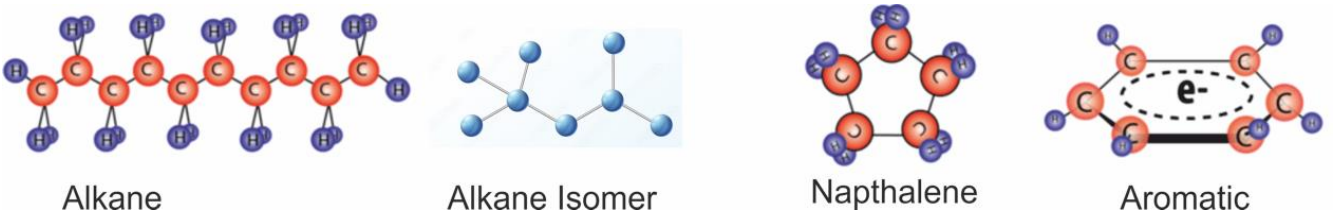
Crude oil and also oil products such as gasoline, diesel fuel and asphalt are composed of thousands of different organic molecules. Organic means they contain carbon and hydrogen atoms, though they can include many other elements.

Hydrogen and helium atoms have one and two protons in their nucleus, and room for two electrons in their single electron orbit. Helium, having two electrons naturally, is chemically inert. Hydrogen enters chemical reaction in which it either accepts or gives up an electron to arrive at two.

In a vast oversimplification, one can say that all atoms larger than helium have eight atoms have room for eight electrons in their outer orbit. Sodium, for instance, has one. It has a strong tendency to bind with chlorine, which has seven in order to reach the magic number of eight. The combination of sodium and chlorine, salt, is quite stable.

Carbon has four electrons in its outer orbit. It can either give away or accept another four. Since hydrogen is likewise indifferent – take or give – organic chemists can simply call them bonds. Hydrogen has one, carbon has four.

May says there are three major groups of molecules to consider in oil and gas, represented by the red and blue diagrams below.



Alkanes are long strings of carbon atoms. The ones in the middle each use one bond to connect to the two carbon atoms on either side, and the other two bonds to connect to hydrogen atoms. The carbons on the ends have three free bonds to connect to hydrogen. They thus contain some number n of carbon atoms and 2n+2 hydrogens.

Alkanes can structure the 2n+2 hydrogens differently, as shown in the all-blue diagram, which happens to be iso-octane. The blue balls are the carbon atoms, the hydrogens are not shown. The carbon atom in the left center uses all four bonds to connect to other carbons, which leave three of those carbons free to connect to three hydrogens.

Although the number of carbon and hydrogen atoms is the same, the energy level is different. As you might infer from the name iso-octane, this combination gives off more energy when burnt.

Napthalenes are rings of carbon atoms chained together with single bonds. The number of hydrogen atoms is 2n.

Just as in iso-octane among the alkanes, there are many different ways things can be combined into isomers, molecules with the same chemical compound but different structure and energy levels.

That's about all you need to know. Petroleum products are made up of a huge number of different hydrocarbons that provide different levels of energy when burnt. The business objective is to produce the mixture that provides the greatest amount of energy at the least cost.

Chapter 2: Geology is long, describing the theory of how gas and oil form and where to find them. Here is the table of contents.

Chapter 2: Geology

- Plate tectonics
- Folds
- Faults
- The origin of petroleum
- Traps
- Antikline trap
- Fault trap
- Stratigraphic trap
- Unconformity trap
- Minerals in the Earth's crust
- Igneous rocks
- Metamorphic rocks
- Sedimentary rocks
- Carbonates
- Clastics
- Precipitates
- Geological time scale
- Earth's history
- Archeon era
- Proterozoic Eon
- Precambrian Time
- Phanerozoic Eon
- Cambrian Period.
- Ordovician Period
- Silurian Period
- Devonian Period
- Mississippian Period
- Pennsylvanian Period
- Permian Period
- Triassic Period
- Jurassic Period
- Cretaceous Period
- Tertiary Period

The earth is a 4.5-billion-year-old sphere. Radioactive decay, primarily from uranium, keeps its iron/nickel core molten. It is surrounded by an outer core, solid by virtue of being subjected to less heat and pressure. Above that are the mantle and the crust.

The convection currents in the liquid core cause everything above them to move, however slowly. The light stuff rises to the surface and solidifies as it cools into dry land. The continents are made up of floating tectonic plates which move a couple of centimeters per year. Over time it adds up. Midway through the half billion years since multicellular life appeared on earth all dry land had drifted together into a single huge continent called Pangaea. Then it split up again into those we observe today.

Though it is no more than a theory that oil and gas are the fossilized remains of dead life forms, the fact is that oil and gas are only found in sedimentary rock formations laid down in the time since plant life colonized dry land. Geologists have several techniques for determining the age of rock, the fossils they contain being the earliest and easiest of them.

Organic material gets buried, usually among the strata of sedimentary rocks. Heat and pressure cause it to undergo chemical changes – the deeper, and hence the hotter, the more likely it is to turn to smaller molecule stuff – gas and light liquids. These things tend to rise towards the surface, often floating atop water.

Tectonic movements cause the earth to fold and to split along fault lines. There are a number of ways they can form traps that capture rising petrochemicals, where they sit, saturating the shale or sandstone through which they were rising. These are the beds from which crude can be pumped.

Chapter 3: finding a prospect

- Seismic surveying
- Subsurface control
- Political considerations
- Oil and gas producing regions in the USA

There are several techniques for locating pockets of petrochemicals trapped underground. The most obvious is to look close to where successful wells have been drilled in the past. Seismic

surveys send sound waves through the earth and capture their reflection off underground rock formations. Drilling is expensive and is used only when there is evidence it is likely to pay off.

The United States is one of the few countries in which oil and gas rights can be privately owned. Elsewhere in the world mineral rights have usually been reserved by government and private petroleum companies nationalized. That's why the US is the primary focus of this book.

Chapter 4: drilling a well. Table of contents.

Chapter 4: drilling a well
- Positioning a drilling rig to drill a well
- Deviated wells
- Drilling permit
- Drilling and spacing unit
- Surveyor's plat
- Drilling contractors
- Day rate
- Turnkey
- Staking the location
- Drilling rigs
- Cable tool drilling rigs
- Rotary drilling rigs
- Rotary system
- Rotary drill bits
- Circulating system
- Drilling fluid
- Hoisting system
- Casing
- Example casing program
- Cementing

This chapter describes the complicated process of drilling a well. Water wells are simple by comparison – a few hundred feet. The average oil well is now about one mile, with a maximum on the order of five miles. Drilling a well is an expensive and complicated process.

Within the hole drilled in the earth they place a metal casing. They then pump concrete into the gap between the casing and the sides of the hole. This keeps things from caving in and keeps water and other fluids from entering the hole.

Chapter 5: Formation Evaluation

Chapter 5: Formation Evaluation
- Logging
- Electric wireline logging
- Logging while drilling
- Logging tools
- Resistivity tools
- GammaRay tools
- Final formation evaluation
- Density porosity tools
- Neutron porosity tools
- Acoustic tools
- 3D resistive tools for thin beds
- Magnetic resonance tools
- Elemental composition tools
- Borehole imaging tools
- Fluid sampling
- Pressure tests
- Coring
- Whole cores
- Rotary sidewall chorus
- Percussion the sidewall chorus

Expensive as drilling is, when to stop is an important question. The drillers continually gather evidence of the well's prospects as they go. Cutting their losses is one consideration. Since a single well may penetrate several oil beds, a more pleasant question to answer is which one to do first. Usually it would be the deepest, but not always, and sometimes it is worth the effort to pump from multiple depths simultaneously.

Chapter 6: Completion
- Perforating
- Hydraulic fracture stimulation
- Acidizing

- Production test

There is a go-no go decision to be made when the well has reached its planned depth. If the decision is to go, the well has to be prepared for pumping oil. They make holes in the casing and concrete to allow oil and gas to enter the well. They may also loosen up the rock surrounding the well so that oil and gas flow through it most easily. The most common techniques are dissolving surrounding limestone with acid and hydraulic "fracking" to break up the rock.

Chapter 7: Production

Chapter 7: production

- Artificial lift
- Rod pumping (sucker rod lift)
- Submersible pump
- Gas lift
- Surface facilities
- Gun barrel and stock tanks
- Dehydrators
- Separators
- Sale of produced oil and gas
- Selling crude oil
- Selling natural gas
- Sales pipeline pressure

Sometimes there is enough pressure in from water below the oil, or from gas within the oil bed itself to force the oil to the surface. If not, the oil needs to be pumped to the surface. Once it is there it needs to be separated from the water that comes up with it. Propane and butane gas need to be separated from methane. The product needs to enter a pipeline or otherwise be transported to market.

Chapter 8: Reservoir drive mechanisms

- What are drive oil reservoirs
- Solution gas drive oil reservoir
- Gas Drive oil reservoir
- Volumetric gas reservoir
- What are drive gas reservoirs

This chapter describes a number of techniques for forcing the product out of the rock where it sits and into the well from which it can be pumped.

Chapter 9: Workovers

What do you do when your well develops a problem a mile or two underground? There are techniques, and specialists to employ those techniques to fix things.

Chapter 10: Plugging and abandoning

Every oil well eventually has to be taken out of service. Production volume falls off over time, usually something on the order of 30% per year. Exhausted wells have to be capped to get them out of sight and prevent environmental damage. Dry holes – unsuccessful wells – have to be plugged immediately.

Part II: Oil and Gas Business

These chapters describe the business end of oil and gas operations. The chapter titles are self-explanatory. The focus is on the United States. As mentioned above, in most other countries the government retains mineral rights and national oil companies exploit them.

Chapter 11: Oil and gas leases
Chapter 12: Oil and gas deals
Chapter 13: Economic evaluation of oil and gas deals
Chapter 14 Oil and gas taxation

Part II:150 Questions to consider before you invest

These are questions for the American investor, the guy reading this book in 14-point-type and prepared to plunk down between $100,000 and 2 million to give it a shot.