MULTIPLE CHOICE QUESTIONS ON OIL, GAS, AND PETROCHEMICALS

The Energy and Resources Institute

PREFACE

Petroleum as everyone knows consists of hydrocarbons of various molecular weights and other organic compounds. This naturally occurring fossil fuel is yellow-to-black liquid found in geological formations beneath the Earth's surface. It is commonly refined into various types of fuels. Petroleum has mostly been recovered by oil drilling. This is done after studying structural geology (at the reservoir scale), sedimentary basin analysis, and reservoir characterization. After petroleum is refined and separated, mostly by distillation, a large number of consumer products are produced including petrol, kerosene, asphalt, and chemical reagents used in plastic and pharmaceutical industry.

Readers can find a lot of resources on oil and gas sector. It ranges from exploration and production, refining, petrochemical, marketing and to a great extent on oil economics. Most of the resources are in the form of course documents and seldom include any questions. This makes it difficult for the readers to evaluate their understanding of the sector or refresh it on a regular basis. In short, in the absence of a question bank on the sector, a sector expert is unable to test his/her level of understanding of various aspects of the sector. Students are also unable to prepare for any competitive examination relating to the sector.

With this objective, the present book has been developed. This book attempts to present the subject in a simple and a precise manner for sector experts, students, and aspirants of various competitive exams. Keeping in view the present trends of various exams, the questions have been presented in the form of multiple choice. The book covers different forms of the oil and gas sector.

With over 1500 questions, the book has been divided into six chapters. Chapter 1 introduces the concept of exploration, techniques for drilling, refinery, and product specification. The remaining five chapters deal with multiple choice questions. Chapter 2 on "General Questions" has been developed to test the general understanding of the state of affair of the sector as a whole apart from dealing with the business aspects. Chapter 3 on "Exploration and Production", provides questions pertaining to the processes carried out in exploration and production. Chapter 4 on "Refining" tests the reader's knowledge on hydrocarbon refining. Chapter 5 "Natural Gas" as the name suggests is about this sector. Chapter 6 on "Petrochemicals" covers the petrochemical industry apart from including historical and general questions. Some questions in the book test the reader's understanding of general terms otherwise used in the sector.

Further, the questions in each chapter are classified into easy, medium, and tough. This classification has been undertaken based on the views of experts consulted. It is possible that a question which has been classified as tough may appear to a student as easy and vice versa. It is hoped that the readers will find this book useful. Any suggestion to further improve the content of the book will be gratefully received.

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Chapter 1
INTRODUCTION

EXPLORATION

Hydrocarbons occur naturally in the earth crust. They may be trapped a few metres to thousands of metres below the surface. Complex processes are deployed to extract oil and gas from their natural environments. The existence of oil and gas in an area can be confirmed accurately only when they have been drawn to the surface. There have been instances where preliminary processes have indicated the availability of oil and gas in the area, but drilling of wells has not yield any output. Due to this uncertainty, the cost of exploration can be staggering.

The place where hydrocarbons form and the place where they get stored naturally can be at two different places. Hydrocarbons are stored in reservoir rocks. Sandstones and carbonates (limestone and dolomites) are the two most common reservoir rocks. When hydrocarbons move from source rock to reservoir rock, it is termed primary migration. The subsequent movement of hydrocarbons within the reservoir rock is known as secondary migration. Hydrocarbon produced structural traps are formed by deformation of the reservoir rock, such as a fold or fault. Stratigraphic traps are formed by deposition of reservoir rock (for example, river channel sandstone or limestone reef) or by an angular unconformity. A combination trap has both structural and stratigraphic elements.

Drilling is a risky business. If a well drilled does not provide commercially beneficial amount of hydrocarbon, it is declared as a "dry hole". The success rate of drilling is defined in terms of the number of successful wells completed for commercial production divided by the total number of wells drilled. Initially oil well drilling was confined to areas that reported oil seepage. With the development of geological techniques and satellite imaging, oil exploration is being successfully conducted in areas where seepage is not reported. At present, geochemical techniques are also being extensively employed for this purpose. The contribution of seismic data in hydrocarbon detection has been paramount. Once the possible availability of hydrocarbon is established to high probability, the probability is checked against actual availability. A well drilled in a virgin area is termed wildcat. If the well drilled produces hydrocarbon it is termed discovery well; otherwise it is termed dry hole. Lately 3D and 4-C seismic explorations are also been employed in oil well drilling.

The time-lapse or 3D seismic exploration involves the technique of collecting, processing, and interpreting 3D seismic data taken from a producing reservoir over time intervals of few years. The objective is to help locate section from which further extraction of hydrocarbons can be achieved. 4-C seismic exploration, on the other hand, analyses the movement of compressional waves (P-wave) and shear waves (S-wave) to locate and determine the orientation of subsurface fractures and composition of source rock.

Wells are also drilled to establish the size of a field and are termed delineation or appraisal wells. When wells are drilled in the already producing fields, they are termed developmental wells. The reservoir permeability and viscosity of oil being produced may be used as an important factor to determine the spacing between wells. Traditionally, cable tool rig was used for drilling wells. This method was used to drill the first well in Pennsylvania. The speed of drilling is a major constraint in the cable tool rig technology. A good output of cable tool rig is 60 ft (20 m) per day with an average output of 28 ft (7.5 m) per day. The cable tool rig has been effectively replaced by rotatory drilling rig. It is faster with a drilling speed of several hundred to several thousand feet/day.

Rotatory drilling rig is very complex in nature. Its major systems are power system comprising diesel engine, hosting system comprising derrick/mast and draw work, rotating system comprising swivel, kelly, rotary table, drill string, drill pipe, drill collar, and drill bit, and circulating system comprising mud tanks. To make a rotatory drilling rig operational, 1000 to 3000 horse power (hp) is required. The hosting system of the rotatory rig raises, lowers, and suspends equipment in the well. Drill floor is located under the derrick and mast. It is the platform where most of the drilling activities take place. The rotating system of the rotator rig is used to drill a hole in the ground. It is the drill bit that cuts into the rock when drilling an oil or gas well. It is located at the tip of the drill string, between the drill collar and the drill pipe. The drill collar is attached with the drill pipe. The entire rotator system is attached with the rotary table that is a circular table in the derrick floor and rotates clockwise by the prime mover to dig hole. To maximize output, various types of drill bits are used. These include milled-teeth or steel-tooth bit, insert or bottom bit, diamond bit, and polycrystalline diamond compact (PDC) bit. When a drilling bit wears out, there is a change in the noise during drilling or in the rate of drilling. The worn-out bit is changed by making a trip. It is a process during which the drill string is pulled from the well, the bit is changed, and the drill string is put back in the well.

During drilling, a viscous mixture of clay (usually bentonite) and additives with either water or oil or an emulsion of water with droplets of oil or a synthetic organic fluid is circulated in and out of the drilling hole. This is known as drilling mud and it helps in lowering the temperature of the drilling bit. Drilling mud is described by its weight. The mud is pumped out from the mud pits through the drill string where it sprays out of nozzles on the drill. It then flows back through the annular space between the outer

side of the pipe and the drilled hole, carrying with it chips of rocks that are cut. Before the mud is reused, the coarser well cutting is separated.

Drilling a well is not an easy task and challenges, such as pipe sticking, lost circulation, hole deviation, pipe failures, borehole instability, mud contamination, formation damage, hole cleaning, H_2S-bearing formation and shallow gas, and equipment and personnel-related problems are faced. There are also problems related to increase in temperature and pressure with increase in depth. Oil and gas may come out at high temperature and thus have to be handled carefully. Further, there is a possibility of equipment breaking in or falling down in the well being drilled. This hampers the drilling process till the affected equipment is not removed. Continuous monitoring of well parameters, such as drill mud coming out of the well, porosity and density of shale through well logs is necessary for maintaining proper and smooth drilling.

Techniques for Drilling

Traditionally straight hole has been commonly followed. However, technological improvement has enabled drilling at pre-determined direction and deviation. Deviation is generally defined angle from the surface of oil wellbore from the vertical. Deviated wells are generally straight-in and S-shaped wells. The deviated well can be drilled by using down hole assembly with a bent sub, a down hole mud motor, and a diamond bit. Examples of deviated well include horizontal drain and extended reach well. Moreover, air and foam can be used instead of drill mud. The entire setup remains the same except that in place of circulating drilling mud system, air is pumped down the bore hole's annular space or down the drill string itself. Similarly, a specially formulated chemical or foam is added to the water and air mixture to create specific conditions.

During drilling, logging technique is employed to ascertain hydrocarbon potential of the well, determine hydrocarbon type and volume, the types of fluid will flow and at what rate, and optimize well construction and hydrocarbon production. The data obtained from logging helps in identifying hydrocarbon reservoirs and define total and recoverable reserves. Logging devices deployed for collecting and analysing the fluids and rocks that come out during drilling helps in defining the geological history and the properties of the reservoir. Various types of logs are deployed for carrying the analysis. These include lithologic log, drilling time log, mud log, wireline well logs, electrical log, induction and guard logs, radioactive log, caliper log, and so on.

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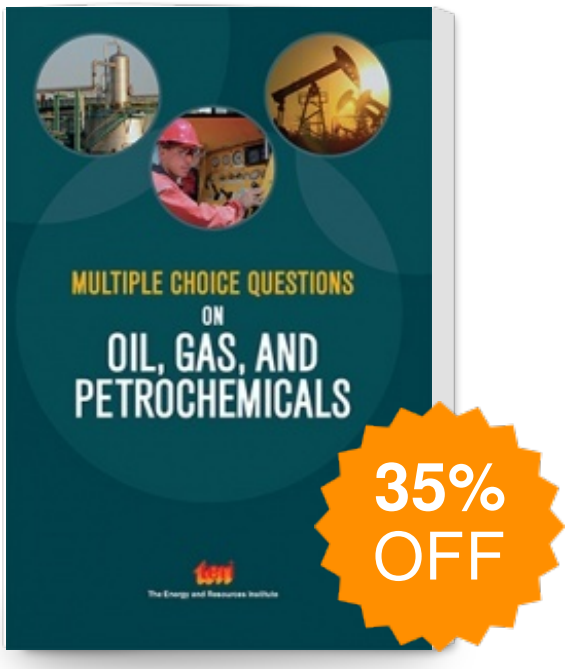

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