

CAREER OPPORTUNITIES IN THE WATER RESOURCES AREA  
(With Emphasis on the Area of Petroleum)

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Third in size, outranked only by agriculture and the investor-owned utilities, the petroleum industry now has investments in the U.S. in excess of \$71 billion. With an investment per employee at nearly \$78,000 petroleum ranks number one in the nation which is far ahead of the country's average of \$17,000 for all industry.

No other single industry offers such a wide range of career opportunities for today's college graduates. Oil companies employ some 1,500,000 people or nearly one out of every 50 employed in the United States.

The President of Humble Oil and Refining Company, Dr. Charles F. Jones, recently was quoted by Oil and Gas Journal on this very point when he said, "I know of no other industry, whose manpower needs cut across so many educational backgrounds of people emerging from the nation's colleges and universities."

Gulf Oil Company, one of the industry's majors, in a recent ad directed to college employables listed that firm's needs for graduates in agriculture and agronomy, engineering, chemistry, physics and geophysics, petroleum technology, geology, accounting, business administration, marketing, mathematics, data processing, and liberal arts. This broad field of professional offerings is matched by virtually every one of the fifteen or more major oil companies listed in the 1967 College Placement Annual. Altogether, there are more than 40,000 companies operating in some phase of activity in the petroleum industry.

The scope of activity within the industry is far too varied to do more than list the major phases in the time allotted. Most of the large, integrated companies are engaged in exploration, drilling, production, refining, transportation, petrochemicals, research and development and marketing. Allied activities, also offering countless career opportunities, are supply, service, and consulting firms which depend exclusively upon the oil industry for their existence.

By no means a complete listing of talents sought after by the petroleum industry--for there are some 2,000 occupations altogether--the following are given as examples of opportunities to be found in the industry: Accounting, Biology, Business Administration, Chemistry, Chemical Engineering, Civil Engineering, Economics, Electrical Engineering, Finance, Geology, Geophysics, Industrial Engineering, Industrial Relations, Liberal Arts, Law, Marketing, Mechanical Engineering, Metallurgical Engineering, Physics, Statistics, and Tax Specialist.

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In years past, the list of professional talents needed by the industry would not have been nearly so extensive for the technology had not yet developed to its present sophisticated status.

The great bulk of duties arising in the petroleum industry's water resources fields has fallen upon the shoulders of the omniscient petroleum engineer to perform in most instances. Water uses in the oil industry encompass a multitude of problems and applications most of which are not to be found in other technologies. Off-shore drilling and production practices, secondary oil recovery by waterflooding, waste water disposal and pollution control requirements are only a few of the recent industry developments which result in the urgent need for professionals in other than the strictly geological and petroleum engineering disciplines. Oil companies and their affiliated chemical, transportation, research and development and service activities have developed a myriad of career opportunities for chemical, civil, electrical, mechanical engineers and hydrologists. There are even naval architects and marine engineers working in the industry in the specific practice of their professions.

Demands for petroleum engineers, per se, were never so great as they are today. The supply cannot satisfy demand nor is it apt to in the foreseeable future. There is no competition from the petroleum engineering profession to any of you here today who seek career opportunities in the oil industry in the practice of your chosen professions. Your talents are being sought as well as those of the petroleum engineer.

The evolution of the applied science of petroleum engineering saw its Genesis at the University of Pittsburgh in 1910, according to Arthur E. Uhl of the Institute of Gas Technology, and consisted of seven courses in oil and gas geology, technology and law. Uhl reports in the April 1965 issue of the Journal of Petroleum Technology that the first petroleum engineering degrees were granted in 1915.

During the half-century from that time to this, the state-of-the-art has seen great technological changes. Uhl, in his manuscript on petroleum engineering education, has cataloged the ten year period from 1910 to 1920 as "The Emergence of a Discipline," the next decade, "The Development of a Curriculum," the thirties as "The Shift to Engineering" era, from 1940 to 1950, "The Rise of Reservoir Engineering" and the latest ten-year epoch as "The Change to Fundamentalism." By 1940, almost 3000 students were enrolled in petroleum engineering disciplines in a dozen American universities.

Enrollments continued to grow through the years and by 1956 numbered nearly 5000 petroleum engineering undergraduates. Then followed, beginning in 1958, a precipitous decline to fewer than 1000 enrollees in 1963 from which point a slight increase has developed to the present count of 1335 in 27 U.S. colleges.

The past 10 years' general downward trend of graduating petroleum engineers has brought forth such industry alarm signals as the news headline in the

January 23, 1967 Oil and Gas Journal issue "PE-Grad Shortage Growing Acute", followed by the warning that "the shortage of petroleum-engineering graduates is fast moving from the serious into the critical stage" and "Oil companies desperately need PE graduates, and the 1967 supply will be at an all-time low".

Only 176 PE graduates will come out of U. S. colleges this year. So great is the demand for their services that the average salary offering is reported to be at least \$750/month.

What makes this picture all the more somber is the dim prospect of meeting engineering needs to supply the nation's future petroleum products requirements. Industry estimates tell us that per capita consumption of petroleum products will have increased from an average of 21 barrels annually to 26 barrels by 1975.

The growth rate of individual petroleum products promises to be even more dramatic. For instance, gasoline consumption will increase over the next 10 years by 44%, kerosene by 55%, distillate oil by 16.8%, residual oil by 32.7% and other products including lubricants by nearly 51%. The Oil and Gas Journal also forecasts petrochemical markets to double during the next decade.

Whether the supply requirements of these greatly increased demands can be met depends in large measure on the availability of engineering and other professional manpower.

There should be no question in the minds of educators, graduates or undergraduates concerning the promise of career opportunities in oil.

Now, let us turn again to the conference theme, "Water Quality - How Does It Affect You?" and to the specific assignment of "Career Opportunities in the Water Resources Area" as they may apply to the oil industry.

Secondary recovery of oil by waterflooding is on an accelerated course throughout large segments of the industry. In Lea County, New Mexico, the number one U. S. county in the production of oil and gas annually, a number of systems are now in operation and many more are planned. As primary production of oil wells decline it becomes necessary to turn to secondary methods to maintain economic production of oil properties. Primary methods normally recover no more than 20 to 30 percent of the reservoir oil in place. Recoverable volumes vary with different reservoir types and conditions.

In Southeastern New Mexico, where approximately 90 percent of the State's oil is produced, production is declining at an average annual rate of 15 percent. Unless supplemental recovery operations are put into effect, approximately 80 percent of the oil in place will not be recovered.

Oil operating companies in this area estimate that 604 million barrels of additional oil can be recovered by waterflooding, 103 such projects

already being in operation. The first such system was begun in April 1952. Total oil recovered through 1965 by waterflood is reported by the New Mexico Oil Conservation Commission to be 104,076,000 barrels.

The Economic Subcommittee, appointed by the New Mexico Oil and Gas Committee, reported in June 1966 that total water requirements extending over the next 20 years for secondary recovery of oil in the area described above would be 45,600 acre-feet per year. Only 22 percent of this volume is expected to be potable water, 53 percent would be re-cycled produced water and the remaining 25 percent would be non-potable water. The possible sources for such large volumes of water of the character contemplated will not be speculated upon in this paper. However, it is clearly evident that water treatment methods plus transportation, storage and pumpage problems altogether will require the talents of several engineering classifications. This is just one such development in the oil industry. It is not a particularly unique development nor is it the largest.

With the passage of the Water Quality Act of 1965, the Congress, as a consequential by-product, created many new career opportunities in the water resources field. However, the petroleum industry finds itself in perhaps a more favorable position than other industries when the subject of pollution is brought up. The American Petroleum Institute has had, for the past 36 years, a committee collecting, developing and publishing information on pollution problems of the industry. The petroleum industry has been deeply concerned with the nation's water resources, being one of its major users. Petroleum refineries have an intake of about 3.6 billion gallons of water per day, used primarily for cooling, 92.8 percent of which is returned to the source.

Dayton H. Clewell, Senior Vice President of Socony-Mobil Company recently told the National Water Conference of the U. S. Chamber of Commerce, that the petroleum industry is spending more than \$30 million each year for water treatment of all types. As disposal of oil field brines, waterflooding, petrochemical manufacturing and refining operations and thermal secondary recovery of oil by steam flood, requiring large volumes of water of high quality continue to grow at the present rapid rate, water treatment costs within the industry will increase proportionately.

Career opportunities for graduates in many fields of endeavor will likewise grow in the water resources field within the petroleum industry in the years ahead.