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SYNFUELS: APPROACHES TO DEVELOPMENT

INTRODUCTION

Nearly six years have passed since the OPEC oil embargo put the world on notice that the era of cheap, plentiful energy had passed. In spite of the passage of time, strong, decisive action to address the problem has not been forthcoming. Recently, the proliferation of lines at gas stations across the nation appears to have injected a sense of urgency into the debate, and from this sense of urgency have sprung a number of schemes aimed at solving the problem. Prominent in many of these schemes has been the suggestion that our nation turn to its vast reserves of coal, oil shale, and tar sands to provide synthetic alternatives to the petroleum-based fuels upon which our economy is so dependent.

The so-called synfuels concept has captured the imagination of both the legislative and executive branches of our government. Within the Congress, a number of bills have been introduced, and one, the Wright-Moorehead Amendment to the Defense Procurement Act has passed the House of Representatives. On the Senate side, S.1308, introduced by Senator Henry Jackson (D.-Wash.), is pending in committee. The Administration has its own version of synthetic fuels legislation, calling for the creation of a government-chartered Energy Security Corporation to oversee the expenditure of some $88 billion to create a synthetic fuels industry, quite possibly operated by the government.

In spite of the apparent level of activity regarding synthetic fuels, there remains, both within the halls of Congress and among the general public, considerable misunderstanding of what synthetic fuels are, what they can contribute, when they can make their contribution, and what the cost will be. This lack of understanding has, in part, been responsible for the advocacy of targets and goals regarding production levels which are highly questionable, and for the proferring of incentives which might be unnecessary, or even inappropriate. For this reason, it is useful to take a look at synthetics: what they are, how they can be produced, and how various approaches to fostering their production will actually perform.

SYNFUELS: THE RATIONALE

While the term "synfuels" is widely used, its meaning has gone through a sort of metamorphosis with the passage of time. At first, synfuels was generally thought to refer exclusively to those processes which would be used to convert coal to various types of fuels, and even there the emphasis was on liquid fuels. Recently, the meaning of "synfuels" has broadened. As currently used it is meant to include coal liquefaction, coal gasification, the production of liquid fuels from oil shale, the production of fuels from tar sands, and, most recently, the production of fuels from biomass. The emphasis in most synfuels proposals remains on coal and oil shale, as these are the resources found in the greatest abundance in the U.S.

The total fossil fuels reserves of the United States come to some 7,700 barrels of oil equivalent. Of these reserves, 77.3 percent are in the form of coal deposits, and 14.4 percent are in the form of oil shale. This means that 91.7 percent, or the equivalent of 7,061 billion barrels of oil are in solid form. Crude oil deposits account for another 4.5 percent of total reserves, natural gas for 3.4 percent, and natural gas liquids for 0.4 percent. The problem is that while the bulk of our resources are in solid form, the bulk of our demand is for fuels in a liquid or gaseous form. In 1976, 48 percent of the energy we consumed was in the form of oil-derived products, 27 percent came from natural gas, 18 percent from coal, 3 percent from nuclear energy, and 4 percent from hyroelectric power stations, and geothermal wells. This mismatch between the form in which our energy reserves are found and the form in which our energy is consumed provides one of the major reasons for embarking on a program to develop synthetics.

The need for synthetics has been further accelerated by the rapid increase of our dependence on imported oil. This increase has been largely a function of a corresponding decrease in activities aimed at exploration and discovery of oil deposits within our own borders, which has resulted from the lack of economic incentives. It is interesting to note that the real price of crude oil declined 31 percent between 1948 and 1972, and that total drilling declined 55 percent between 1956 and 1971. Between 1947 and 1977, total imports increased from 0.16 billion barrels of oil per year, to 3.2 billion barrels per year, a 2000 percent gain. In 1977, imported oil accounted for 26 percent of all energy consumed in the U.S. It is this increasing reliance, perhaps more than any other factor, which has provided the impetus for the recent synthetics push. Further, since the primary source of concern stems from questions related to the methods of converting coal to liquid fuel, the other being "direct liquefaction."

The difference between direct and indirect liquefaction is implied by the names of the respective processes. In direct liquefaction, coal is dissolved in a solvent which can be either process-derived, or from an external source and subjected to high temperatures and pressures. In some cases, a catalyst is used to enhance the process. The solvent serves to loosen the molecular bonds of the hydrocarbon chains which make up the coal so that they can accept hydrogen atoms. The chemical transference of the hydrogen converts the coal to either heavy oil or a liquid fuel.

In indirect liquefaction, the coal is first converted into a gas by subjecting it to high temperatures in the presence of steam, under pressure. This produces a so-called synthesis gas composed primarily of hydrogen and carbon monoxide. The synthesis gas is then converted through catalysts to one of a variety of products. It is also scrubbed of sulfur at the same time. While the product mix can vary, Fischer-Tropsch plants are usually set so as to maximize gasoline production. Other variations of the Fischer-Tropsch process produce methanol which can either be used directly as a fuel, upgraded to technical grade, or later subjected to further processing to produce gasoline. One advantage to the indirect liquefaction process is that it can also be used to produce highly pure hydrogen which can be catalytically combined with atmospheric nitrogen to form ammonia for fertilizers.

Of the technologies under consideration today, only indirect liquefaction techniques have reached the commercial stage, although it is anticipated that at least one, and possibly two, direct liquefaction techniques will be commercial by the mid-1980s. The one commercial plant in operation, Sasol I, as noted, uses the Fischer-Tropsch process, which is indirect. Gulf Oil Corporation is currently working on a demonstration plant for its SRC I and II processes, which are direct liquefaction technologies. SRC I produces a solid fuel suitable for utility boilers, and SRC II produces a variety of liquids, including both fuel oil and gasoline. Of the developing direct liquefaction technologies, the Gulf processes are considered among the most promising.

Another direct liquefaction process which has received considerable attention is the H-Coal process. This process is being developed by Dynalectron Corporation. It employs what is termed catalytic hydrogenation to convert the coal. In this process, coal is dissolved in process-derived solvent, but the addition of hydrogen atoms to the coal molecules is primarily effected through mixing the dissolved coal with gaseous hydrogen in the presence of a catalyst. Like other direct liquefaction process, the reaction takes place under relatively high temperatures (around 850 degrees F.) and relatively high pressures (around 2000 psig).

While there is considerable controversy over whether coal liquefaction is best achieved through direct or indirect means, the fact is that at present the indirect methods are the only one with which there is commerical experience and there, it is only the Sasol experience with the Fischer-Tropsch process. Given this fact, it will likely be some time before the optimum method of conversion is developed. Also, it should be remembered that technologies change rapidly, and what may seem highly advanced today may be outmoded tomorrow.

SHALE OIL

For some six decades, the promise of untold energy resources has been put forth by advocates of shale oil. While it is true that total U.S. oil shale resources are equivalent to some 1.8 trillion barrels of oil, only about a third, or the equivalent of 600 billion barrels of oil, is contained in deposits which might be readily recovered. The reason that these deposits have not been developed in the past has been a matter of simple economics. As long as there was a cheap, plentiful supply of crude oil, it was not profitable to mine shale for oil, and as a result, the promise of abundant energy remained unfulfilled. With the startling escalation of the price of crude oil, that situation may be changing.

The most promising deposits of oil shale are found in the Piceance Basin in Colorado. The Basin lies to the west of Denver, and runs between the White River and the Colorado River. Other deposits are found in Wyoming and Utah. At present, the most significant activity in shale oil development is being conducted by Occidental Petroleum, although Mobil Oil, Getty Oil, Cities Service Company, Texaco, Conoco, Arco, Sohio, Chevron, Superior, and Union Oil all have ownership of leases in the basin. There is also a large Naval Oil Shale Reserve located in the area.

The technology for extracting oil from shale is fairly straightforward. Basically, the rock must be pulverized, and then heated to a temperature of around 900 degrees F. This causes the shale to release an organic material called kerogen. Kerogen can be recombined chemically into oil. This method of extracting the kerogen from shale would entail extensive mining, and presents some problems from an environmental standpoint. First, the processing of the shale causes it to increase in volume by around 20 percent, and the spent shale must be disposed of. Therefore, from a simply volumetric standpoint, the problem is a significant one. Each 100,000 barrel per day shale plant will have to dispose of some 150,000 tons of spent shale per day, at least 30,000 tons of which could not be returned to the mines from which it was taken. Secondly, the retorting process changes the chemical make-up of the oil shale, decomposing certain innocuous components into the form of soluble compounds. These can, when exposed to rainfall, cause groundwater to increase in alkalinity and salinity. As a result, the spent shale would have to be treated to prevent this before it is discarded.

There is a new technique under development which might circumvent most of these problems. It calls for the so-called in-situ processing of the shale. (By "in-situ" it is meant to say "in place.") The in-situ process calls for the excavation of shafts some 200 to 300 feet into the shale seam. Once the shafts have been dug, explosive charges are set off in them, fracturing the shale. A slow-burning fire is then set, heating the shale in place. The heat causes the kerogen to flow to the bottom of the explosion chamber, from which it can be extracted. At present, Occidental Petroluem has a pilot in-situ plant in operation which processes 1000 tons per day. Future plans call the the construction of a 150,000 ton per day facility, provided siting and water rights problems can be overcome.

TAR SANDS

In addition to coal liquefaction and extraction of kerogen from shale, tar sands also present a promising technology for the production of synthetic fuels. This technology, however, holds more promise for Canada than for the U.S., as the Canadian deposits are far greater and richer than those found in the United States. Basically, there are two methods for separating bitumen, a form of petroleum deposit, from the sand in which it is trapped. The first of these (the one currently in commercial operation) is to mine the sands on the surface with drag lines, and then move them by conveyor belt to the extraction plant where the material is broken down into its component elements (principally sand and bitumen), and the bitumen is cleaned and then further processed. The processing consists of upgrading the bitumen through the use of a catalyst and hydrogen, so-called hydrocracking. A plant in Alberta, Canada, was opened by the Sun Oil Company ten years ago, and is currently producing some 50,000 barrels of oil per day. Syncrude of Canada Ltd., which is jointly owned by a consortium of companies and the Canadian government, also has an operating plant, which is producing from 80,000 to 100,000 barrels per day, and should produce as much as 130,000 barrels per day when its maximum output is reached. This means that over its life, the plant would produce more than one billion barrels of oil.

The second approach to tar sands development stems from what is called the "huff and puff" process. This process is aimed at eliminating some of the problems associated with getting at deeper tar sands deposits, and minimizing the need for strip-mining. In this process, steam is pumped into the deposit, causing the bitumin to rise to the surface, where it can be recovered. This process is not as far along as the more conventional drag-line/ conveyor belt system currently employed, and some problems with water reclamation are still to be resolved, but it may serve to expand recoverable deposits substantially.

APPROACHES TO DEVELOPING SYNFUELS

Although there are numerous proposals regarding synfuel development circulating at present, most of them can be placed in one of three general catagories. The first of these might be termed the "market approach," the second the "government approach," and the third the "industry approach." The market approach would allow the forces of the marketplace to bring about the development of a synthetic fuels industry by removing the present substantial government intervention there. This approach would include such actions as the elimination of all federal price controls on the sale of petroleum, petroleum products and natural gas, the removal of environmental barriers to the construction of energy facilities, and the easing of federal leasing policies. Advocates of this approach note that it does not bias the market in favor of any particular technology or energy resource. In addition to fostering a synthetic fuels industry, if such an action is warranted, this approach would also result in the production of additional oil and gas from domestic sources, further reducing the necessity to import such fuels.

The market approach would result in higher prices for energy, but its advocates note that regardless of what approach is taken, energy prices will rise due to increasing scarcity. In the long run the market approach might actually result in cheaper energy for the consumer, as efficiency and innovation come into play.

A second approach might be termed the "government approach." This scenario would entail the development of a synthetic fuels industry through some sort of government-sponsored entity such as President Carter's proposed Energy Security Corporation. Advocates of this approach generally draw parallels between this approach to the development of energy supplies and the World War II experience with the creation of a synthetic rubber industry. Critics of this approach note that the two endeavors are not comparable. First, the creation of a synthetic rubber industry took place during time of war, when the materials involved were essential for the conduct of that war, and when there were no substitutes available. Secondly, the magnititude of the two programs would be vastly different. One critic has noted that all of the synthetic rubber plants constructed during the Second World War would fit into the area occupied by one or two synthetic fuel plants built to turn coal into liquid fuels. To achieve the President's ambitious goal of having 2.5 mbd of synthetic fuel capacity in 1990 would require 50 such plants, at a cost of between $150 billion and $300 billion.

Another criticism of the President's suggestion, and of the government approach in general, is that our experience with government-run corporations has not been encouraging. Both the postal system and Amtrak have been frequently cited for inefficiency and incompetence. There is no reason to believe that a government-run energy corporation would be managed more efficaciously, especially in light of the experience with the Department of Energy's allocation of oil supplies during the most recent shortage. This allocation was credited with being largely responsible for transforming a 5 percent shortage of crude oil into a 20 percent to 25 percent shortage of gasoline at the pump in some areas. Further, the cost of some $88 billion for the President's version of how to foster the development of a synthetic fuels industry is thought to be far in excess of what the cost would be were the private sector allowed the freedom to develop such an industry on its own.

The third approach to the development of synthetic fuels might be termed the "industry" approach. This would entail some modest government incentives such as accelerated depreciation, tax credits, and the like, coupled with a speed-up of the permitting and licensing process. Advocates of this approach contend that the pure market approach is not feasible, because it would entail political actions such as the elimination of many environmental laws and regulations currently on the books and therefore this sort of program, a compromise between a purely public sector and a purely private one, is necessary. Advocates of this method of fostering synfuels development note that in Canada, a similar program has resulted in a private-sector synfuels program, which is expected to begin making a profit this year. In the Canadian example, the government merely allowed the companies involved to take an accelerated depreciation, writing their plants off in three years instead of the conventional thirteen, and guaranteed that they would be allowed to sell their output at whatever the world market price for crude oil was.

In the United States, perhaps the most critical element of a successful approach of this nature would be the establishment of an expedited siting and permitting process. At present it can take as long as six to eight years to obtain the hundreds of permits required for a large industrial facility. At almost any stage of the process the facility can be blocked by intervention in the courts by groups bent on stopping the plant. Clearly, this degree of uncertainty is a significant barrier to the development of any energy facility. Recent examples abound: the Sohio pipeline, the Alaska pipeline, the San Diego Refinery, the Hampton Roads Refinery, the Diablo Canyon nuclear plant, the Seabrook, New Hampshire, nuclear plant, and on and on. All of these facilities, which were blocked by environmental litigation, could have contributed substantially to relieving our current energy shortage, yet all were victims of the entangled permitting process. If a synthetic fuels industry is to be developed, then something will have to be done to enable companies to avoid such pitfalls and bureaucratic snarls.

Among those supporting this type of program, there appears to be some consensus that the optimum policies would include a variety of incentives such as a five-year write-off of energy facilities, or a tax credit, and perhaps some guarantees of purchase of a plant's output. Decontrol of oil and natural gas prices would also be essential to the success of such a program.

CAPITAL INTENSIVE FACILITIES AND INFLATION

One aspect of the development of synthetic fuels frequently overlooked is that while the facilities are capital intensive, their real cost may not be as high as it appears on the surface. If we were to build the 50 plants necessary to meet the President's 2.5 mbd goal, the capital cost would be between $150 billion and $300 billion, as noted, exclusive of infrasture. This outlay, however, will take place in the early stages of the development of the program, and be repaid over the 25 to 30 year life of the facilities. Since inflation will reduce the value of the dollars expended to repay the debt, the actual cost will be considerably less than the apparent cost. This fact has a significant impact on the overall economics of the output of these facilities, as their capital costs will steadily decrease as a portion of the price of their output, while the price of crude oil continues to rise.

According to studies conducted by a number of research organizations, including a recent one by the Electric Power Research Institute, the effect of this decreasing capital cost in real terms will be to make synthetic fuels competitive with crude oil during the 1990s. The projected price of a barrel of oil in 1990 (in 1990 dollars) has been variously estimated at between $90 and $100. Synthetic fuels will be similarly priced during that same period. Further, the EPRI study indicated that the production of middle-Btu gas will be competitive without subsidies by as early as 1985.

What all of this means is that given a relatively modest range of incentives, coupled with some significant improvements in the siting and permitting process, it is entirely possible that our nations's industrial sector would develop a synthetic fuels industry on its own, without burdening the taxpayer with yet another bureaucracy and almost certain cost overruns. Interestingly, the advent of an improvement in these processes would also allow the more rapid development of a wide range of other energy facilities as well.

CONCLUSION

In the final analysis, all evidence indicates that the possibilities for synthetic fuels in the United States are significant. We have vast reserves of coal and oil shale, and have the technological and industrial infrastructure to enable us to develop them. The problems which exist tend to be more institutional than logistical or technological. Environmental regulations, siting and licensing red tape, and the lack of rational incentives, are the real barriers to the development of domestic energy resources. Under present conditions, it would not be possible to achieve the President's target of some 2.5 mbd of synthetic fuel capacity by 1990. Some capacity, though more likely in the range of 500,000 b/d to 1 million b/d, could readily be on line by that time, provided that the proper policy environment exists. For that policy to come into being, it must be recognized that there will of necessity be trade-offs between environmental considerations and energy considerations, and that proper financial incentives are necessary if industry is to undertake such a task. It should be noted that even if the government were to decide to develop the synthetics industry on its own, it would still have to turn to industry for the technical expertise, and manpower to do so. It would therefore appear to make sense to eliminate the creation of yet another agency, and simply allow industry to develop synthetic fuels on its own.

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