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A SURVEY OF SYNTHETIC FUELISHNESS*

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EXTENDED ABSTRACT

Wood, coal, oil, natural gas, kerosene and other petroleum derivatives and nuclear fission reactor plants, through "burn-up" of nuclear fuels, have all been used to provide heat for direct use in homes, institutions and industry, and to generate mechanical and electrical power using the Otto, Diesel and Rankine heat cycles. These fuels are considered to be natural since they are found in nature and are used after varying degrees of processing, enrichment or refinement. Other energy sources include hydro power, wind power, geothermal heat and heat or electricity converted from solar energy captured in stationary flat plate, one-axis tracking linear-trough and two-axis tracking spherical, parabolic or heliostatic collectors. These sources of energy also exist in nature, but are not fuels since burn-up is not required. This leaves a host of fuels which can be synthesized from natural materials using an equal number of electrical or chemical processes. These synthetic or manufactured fuels include coal gas, fuel oils derived from coal, solid fuel residuals, methane derived from sewage or kelp, ethanol derived from fermentation of grains, methanol derived from destructive distillation of wood, and hydrogen derived from electrolytic dissociation of water, or from fossil fuels using chemical processes. Hydrogen, in turn, can be synthesized with nitrogen to form liquid ammonia (NH_3) or with carbon monoxide to form methanol (CH_3OH). Synthetic fuels are not new. Early examples of synthesized fuels include charcoal, coke, coal gas and pure hydrogen gas. Coal gas was piped for sale and was the major "illuminant" until replaced with natural gas piped thousands of miles from the oil fields. This demonstrates the real need for a commonly available fuel gas irrespective of its source.

A major use of synfuels was made by Germany in WWII. Four coal-to-liquid fuel plants were built prior to 1939 and these sustained the German planes, tanks and troop carriers until 1943. Reduced to unsuccessful infantry attacks at Stalingrad, just short of the Baku oil fields, the bubble burst and a long retreat to ultimate defeat was under way. As a part of U.S.A. war spoils, we brought back numerous German V-1 and V-2 rocket engineers, the aniline dye process which is a coal derivative, and the guts of their coal-to-liquid fuel program. Here synfuelishness began. It was already known that the then existent US oil reserves would be exhausted by 1970, and a program to duplicate the German coal-to-liquid fuel plants was initiated and then dropped. Reasons included the tremendous proven oil reserves of Araby at less than $2 per barrel, assumed certainty of fission reactor power to do everything else, and progressive discoveries of new oil fields. Now we know that oil can be priced above $30 per barrel and that the new reserves as in Alberta, Alaska, the North Sea and Yucatan will merely prolong the problem. In America, we are asked to expend 140 Billion USD to reinvent the wheel. The conversion of coal to liquid fuel requires up to 2# of coal to yield 1# of oil or gas fuel. In addition, expensive process plants are required. When

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petrofuels are increased in price, it is not long after when the price of coal and nuclear fuels is raised to the same extent. It is clear that coal-based synfuels will always cost much more than vanishing fossil fuels, including coal. The proposed 140 billion USD program raises some very hard questions:

(1) What is to prevent OPEC from lowering oil prices after the first synfuel plants go into production?
(2) How is the sale of synfuels to the public to be enforced if other, less costly, fuels become available?
(3) If the synfuel industry becomes unprofitable, will investors be left hanging and employees laid off, or will taxpayers be forced to subsidize still another ineffective nationwide activity?
(4) Since fossil fuels are consumed twice as fast to create synfuels than if used directly, how can a nationwide program be justified in the light of equal national emphasis on energy conservation?

Synfuels have their place and a more modest program can easily be justified in line with the following points:

(1) Prayerfully, nuclear war will never happen, but "conventional wars" seem to go on forever. Our armed forces cannot remain strong if most of our mobile equipment is dependent on foreign petrofuels which can easily be cut off. In the interests of survival over a non-nuclear long haul, the USDOD must have firm, local sources of synfuels.
(2) The policies for insuring such firm, local sources of synfuels can be established by executive order by our President as Commander-in-Chief of our armed forces.
(3) These policies will be backed by appropriations because a majority of our Legislators will be in favor of such a logical program intended to insure that we remain strong and free for the foreseeable future.
(4) The armed forces synfuel procurements should be arranged to create a steady market for the synfuel industry. These procurements can also be used to encourage the continuous seeking of higher yields of synfuels per pound of coal.
(5) The synfuel industry should be free to expand capacity above and beyond the needs of the armed forces, at its own expense, for sale of synfuels to citizens whenever this may prove profitable.
(6) The synfuel industry should guarantee to meet the stated needs of the USDOD at a reasonable supply rate as to preclude excessive stockpiling. The USDOD should pay enough for synfuels as to permit an attractive return on plant investment.
(7) The conversion of only the USDOD requirements to synfuels will permit the USDOE much greater latitude in searching for alternate energy sources having replenishable energies for general use both in the U.S.A. and abroad.
(8) Such alternate energy sources are a must over the long haul which is the central theme of an earlier publication /1/.

Synfuelishness has more comical aspects than the foregoing which dealt with wars, the necessary chemical processes to permit wars and the easy forgetfulness in semi-peaceful times when a useful technology can be set aside and forgotten. Here I refer to gasohol. Alcohols have been used to drive torpedoes in wartime and the highest priced racing cars in times of relative peace. Gasoline might have been used in the absence of alcohols, but never gasohol. Gasohol is the generic name for a mixture of 10-15% of ethanol or methanol with 85 to 90% of gasoline. It has been briefly tried in numerous places in cars and trucks. On the whole, gasohol introduces more problems than it solves. Carburetors can easily be designed to fire in admixed air either ethanol, methanol, hydrogen or any other liquid or gaseous fuel. Any of these individual fuels fired from the proper carburetor or air admixer ratio will work all right in any existing automotive system. In general, vehicles firing alcoholic fuels instead of gasoline must have alcohol resistant gaskets and twice larger fuel tanks because the specific heat content of alcohols is less by the same ratio. In all other respects true alcohols appear to be superior to gasoline as a fuel for our cars, trucks and busses and other power drives using volatile fuel. The main superiority is that each growing season replenishes liquid or gaseous fuels derived from growing things in the field or kelp from the sea. Secondly, emissions are much cleaner.

Methane, or marsh gas, is generated by the decay of organic substances and is a principal component of natural gas. When all of God's creatures, large and small, pass gas, this gas contains methane and is highly flammable. Methane has been extracted from sewage and can be extracted from kelp. Kelp beds can be inhabited by seals, birds and fish and form mini-ecological enclaves wherever such beds can be induced to grow. There is no fuelishness here because the technology exists. In addition, kelp can be converted in part to food and could help vanquish hunger, another ancient enemy of man. Needless to say, there has been little backing to date available to the pioneers in Kelp technology, but its future is necessarily bright /1/.

Alternate energy sources are often variable sources. Witness the wide variation in wind velocity, solar insolation, tidal eagre velocity, and water current velocity of many rivers. For such sources, energy storage is a must if these are to be used as firm sources of power. Let us discuss solar-electric plants since insolation is at best a less than 50% proposition. At MICAES I and MICAES II, papers were presented which described such firm power solar-electricity plants /2/ /3/. These were referred to as dual purpose plants, since the output would be electricity, hydrogen gas and oxygen gas. The latter two items would be stored for later recombination in fuel cells having no fuel preparation section, boilerless steam turbines and compressorless gas turbines. Fuel cells, if operated at 68 atma pressure and 811°K, could have exhaust steam passed through AIEEE/ASME preferred standard units to obtain the highest thermal efficiencies attainable in the absence of 80% efficient fuel cells /4/. Above 80% fuel cell efficiency, or in very small units, the need for backup steam turbines ceases to exist. During normal sunny days, sodium-potassium liquid metal eutectic alloy coolant would be recirculated to remove heat from solar energy collectors with weightless balloons having sun tracking means /5/. The coolant would bring condensate heated from the AIEEE/ASME preferred standard temperature to the boiling point, boil the feedwater, superheat the steam and reheat the steam in low cost stainless platefin type heat exchangers in order to drive modern high efficiency steam turbine generator units. As these large plants are built further from the USA sun belt, they become larger and generate more hydrogen and oxygen. This is of interest, since heating gas is of least interest at the Yuma, Arizona capital of the Sun Belt, and of most interest in winter in places like Minneapolis-St. Paul and Boston. Generation of hydrogen for such plants requires low cost rectifiers and electrolyzers /6/.

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