EXCLUSIVE

Frontiers Of Coal Technology

In its March 28 lead editorial, titled "Coal or Uranium," the *Washington Post* dismissed both fuels as too dangerous on the basis of the recent Ford Foundation-MITRE Corporation report which is widely acknowledged to be a basis of the Carter Administration's forthcoming energy policy statement. "Coal, on present evidence, is more dangerous than the present generation of nuclear reactors running on enriched uranium," the editorial stated. Since coal's "poisons" kill and since "serious nuclear accidents" are probable, the *Post* concludes, both should be junked and replaced with a policy of conservation and a "great reduction" in energy generating capacity.

This telegraphed indication that the Administration's energy policy will amount to "no energy" was confirmed in a leak in the April 1 *New York Times*, based on statements by a member of the team which is working under Carter Energy Czar James Schlesinger to draft the President's April 20 message. The drafter described the gist of the plan as "Use less and pay more." Emphasis is on methods to reduce consumption, including a possible $400 to $800 tax on large automobiles, measures to encourage greater use of insulation, etc. Schlesinger has little hope of increasing oil supplies, the article states, and sees the U.S. "headed for a serious economic squeeze and possible diplomatic blackmail unless a rapid start is made on using less energy, using it more effeciently and accelerating the shift to coal and solar energy."

As far as coal is concerned, coal gasification projects play a big part in the Administration's planning. An examination of the process, borrowed from Nazi Germany, by Wayne Evans, the U.S. Labor Party candidate for Vice President in 1976 who is now working with the USLP's Research and Development staff, concludes that coal gasification is too expensive and wasteful to a significant part in fulfilling the nation's energy needs. However, Evans points out, the process, carried on with concentration camp labor by the Nazis, fits in well with the Administration's emphasis on labor-intensive, "deindustrialized" jobs projects.

While Schlesinger focuses on technologies and conservation methods that will add nothing to the nation's energy supplies, research is nevertheless proceeding on a variety of promising new high-technology methods of generating energy. One, called "magneto-hydrodynamics," which involves the use of high-temperature plasmas also employed in fusion energy generation, promises to have particularly sucessful application with coal, and a detailed report on the process, presented below, provides an instructive comparison with the inefficient coal gasification methods.

Coal MHD: Twice The Efficiency And No Pollution

The dirty truth about the Carter Administration's "anti-pollution" crusade against U.S. coal production and coal-using utilities is that a technology has already been developed that uses coal to generate electric power at potentially *twice* the efficiency of standard coal-burning generators with *no* sulfur emissions.

The application of this technology, magnetohydrodynamic electricity generation (MHD), has been stalled for the last two decades by the government's refusal to invest in its development. As a result, U.S. companies have had to sell their privatly developed MHD technologies to the Soviet Union, while American power-generating facilities are forced toward bankruptcy by the imposition of expensive and grossly inefficient "smokestack scrubbers" and other anti-pollution devices and processes.

Today almost two thirds of U.S. coal use is devoted to electricity generation, and in the transition to a fusion economy this will necessarily continue to be the case — at an annual growth rate for electricity use of 25 percent. MHD, which is now in the final demonstration stages, could be on line and on the way to helping meet this demand by 1980.

The Carter Administration and its accompanying swarm of neanderthal "friends of the earth," on the other had, using the pretext of the sulfur pollutants produced by the burning of the Midwest's abundant supplies of high-sulfur coal, are trying to whisk through Congress a series of bills that will saddle the coal industry and its customers with impossibly severe "clean air" regulations. This strategy is guaranteed only to price current coal use out of the market compared with even the most screwball of the Rockefeller banks' planned "alternative energy" boondoggles.

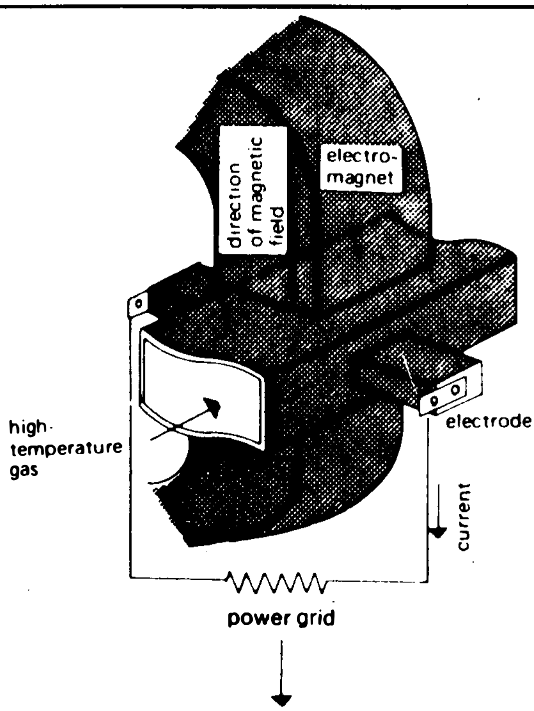
The MHD process is not to be confused with coal gasification, the Third Reich "energy alternative" that the

Rockefeller crew are pushing as a major plank in their program for U.S. energy. Even if coal gasification were an energy-efficient procedure, there is no reason to devote substantial social resources to turning coal into gas which is then burned to produce electricity, when the electricity can be produced directly from a coal plasma. And coal gasification as a primary energy source is in fact grossly inefficient, demanding double the processing compared with MHD for something like one quarter efficiency.

How MHD Works

Magnetohydrodynamics is a technology which is transitional to fusion in that its development rests on the forward thrust into the frontiers of scientific knowledge and engineering technique. Like fusion, it requires the juxtaposition of a high-temperature plasma (in MHD, 3,000 degrees Centigrade), and superconducting magnets with temperatures near absolute zero (—273 degrees). Therefore the theoretical work and materials development being carried out for MHD electric generation are also critical for the design of fusion reactors.

The fundamental principle involved in MHD is the same as that of the conventional generator: Faraday's principle of magnetic induction, which states that moving an electric conductor through a magnetic field generates electricity. In MHD, the conductor is a high-temperature gas which has been ionized (given an electric charge). This plasma is passed at high speed through a strong magnetic field, producing an electric current along the duct carrying the plasma. Thus there is no need to convert heat into mechanical energy to turn a turbine — the heat energy in the plasma is transformed directly into electrical energy.



A section of an early MHD electric generation design. The more advanced technology, using a superconducting magnet, brings the low-temperature magnet into close proximity to the high-temperature gas, posing challenging materials problems. The photograph at top shows the partially assembled (non-superconducting) magnet in a U.S. test MHD device.

Different fossil fuels have been used to create the plasma, according to the availability in the various countries where MHD work has been carried out. The Japanese have tested petroleum, the Soviets, natural gas, and in the U.S. the program has centered on the use of coal. Setting aside the minor variations depending on what fuel is used, the method is essentially as follows. The coal is placed in a conventional furnace and heated to about 3,000 degrees Centigrade by injecting a mixture of air and oxygen which has been preheated to 1,200 degrees. When the coal is gasified, potassium or some other appropriate metal is added as a "seed." Travelling at a slower speed than the coal gas, the potassium ions collide with the plasma ions, causing a transfer of the heat energy to electrical energy in the plasma-s magnetic field. At approximately 1,000 meters per second the plasma is pushed through a duct which is surrounded by a super-conducting magnet; electrodes attached to the duct carry the generated current off through a circuit (see Figure 1). This current can be used as is, as direct current, or converted to alternating current and integrated into a commercial power grid. The sulfur from the coal chemically bonds with the potassium, as part of the slag produced as waste.

At the end of the duct this slag can be removed and the "seed" (potassium) can be recovered. In a closed MHD system the medium is recycled—basically, heated and fed through the duct again. A more efficient system is to use the cooled gas (still at about 2,000 degrees) to power conventional steam turbines for additional electricity generation.

The thermal efficiency of a conventional coal-burning power plant is between 30 and 40 percent. In the closed MHD system this can be brought up to 50 percent; and by combining MHD with conventional steam turbine generation in an open system, thermal efficiency increases to 60 percent. Therefore, it is possible to generate almost double the amount of electric current with the same amount of coal. The use of a seed metal that combines with the sulfur pollutants means a clean system, and the open system's use of the excess heat for additional power generation leaves little thermal pollution.

According to current design and engineering estimates, the eventual cost of an MHD generator plant is 30 percent less than the comparable cost of a fossil fuel plant. Adding in the advantage of producing twice the electric power with the same amount of fuel, the commercial feasibility of MHD becomes quite attractive. And further, since the sulfur content of coal is not a restriction on MHD use, utilities will not need to bear the costs of transporting low-sulfur coal from the West while high-sulfur reserves in the East and Midwest go untapped thanks to "anti-pollution" laws — costs which today are passed on through rate hikes to industrial and private consumers.

Another "Sputnik"

Work on MHD began in the United States in the 1950's. The Air Force was conducting exploratory research on a broad range of research and development aspects, mainly for military purposes, and the National Aeronautic and Space Administration was examining a closed-cycle MHD system which could use nuclear energy as the source of heat.

In both military and space applications, however, the MHD was regarded as a way to profile a relatively short pulse of electric energy, either for weapons detonation or space vehicles. The problem of developing materials that could generate power for longer durations was not systematically explored — for example, the development of electrodes that could tolerate super-high temperatures, and of duct material with sufficient durability — and was not funded by the federal government.

But although at first virtually no government money was available, a few corporations, led by Avco and Westinghouse, and scientists and engineers at the Tennessee Space Center, Stanford University, and Argonne National Laboratory in Illinois, took up the study of MHD. In 1966 Avco proposed the building of a demonstration plant to the Department of the Interior, but the government refused. The current head of the U.S. Energy Research and Development Administration's MHD program, Dr. Jackson, recently recalled the frustration of his efforts and those of a handful of other scientists ten years ago to convince the government of the tremendous potentials of MHD and the urgency of developing it.

Therefore the corporations had to look elsewhere for interest in the new technology — particularly, to the Soviet Union. Researchers at Westinghouse who have done much of the materials development for MHD — including work on high-temperature electrodes and duct insulation — say that up through the mid-1970's the only market for their components was the USSR, which (along with Japan) had an aggressive program of MHD development. Although the U.S. did eventually begin its own official development program, by the early 1970's the Soviets and Japanese had pulled significantly ahead of the half-hearted U.S. The MHD "Sputnik" came at the April 1971 Fifth International Conference of Magnetohydrodynamic Electrical Power Generation in Munich, when Soviet scientists announced the operation of an experimental MHD facility designed to produce 25 Megawatts for at least 1,000 hours, setting the record for duration.

Goaded by the Soviet breakthrough, the U.S. began to look seriously at the feasibility of MHD for commercial use, and an MHD program finally began in earnest in 1974. The current Energy Research and Development Administration's MHD budget is only half of what experts in the field say is needed. Although the U.S. is now readying a $50 million demonstration project in Butte, Montana, for operation by the early 1980s, U.S. companies must still send their most advanced MHD components to the USSR for testing. For example, the first superconducting magnet developed in the U.S. for an MHD generator is now on its way to Moscow's High Temperature Institute to be tested at facilities there.

An International Effort

The Soviets have already brought MHD into operation on a small scale, integrating their test facility, through conversion to alternating current, into the Moscow power grid. The Soviet facility is a $200 million effort using what the Soviets' term a "breadboard" approach, meaning that various ducts, electrodes, and other components can be easily inserted and removed to allow experimentation with different types of components.

The U.S.-USSR Joint Program on MHD Power Generation that was set up in the wake of the Soviets' advances is facilitating the testing of U.S. components in the Soviet MHD prototype. Clearly this cooperative effort must be expanded, rather than pouring millions into a competing demonstration plant in the United States that won't be operable for another five years. With maximal U.S. input from work already done, the best possible MHD system can be developed for commercial availability to both countries by 1980 or soon after.

As the Energy Research and Development Administration's own evaluation of MHD notes, "No problems presently exist for which there is not experimental evidence of a solution." But the necessary international cooperation to achieve MHD depends on a seriously funded and competently organized U.S. research and development program, not only for coal-based MHD but for the crash development of nuclear fusion technology that will eventually supercede it.

Coal Gasification: An Economic 'Lemon'

There is a fundamental "litmus test" which is used to determine the viability of a method of energy production. A system which produces high energy density at low overall social cost —i.e., in labor, materials, energy inputs — is a practical system. A system which is justified by its proponents by other considerations, while this criterion is avoided, should be regarded as a very suspicious animal, one that should be tested with this indicator long before financing is arranged or equipment ordered.

This cost efficiency test is nowhere more studiously avoided than among proponents of coal gasification. The reason is that, measured against this criterion, coal gasification is one of the most expensive *and wasteful* of the new energy sources now under consideration.

The basic reason involves the energy lost in the double burning necessary to produce coal gas. Coal gas is produced by reducing the amount of oxygen to a coal fire, so that the oxidization releases carbon monoxide rather than carbon dioxide, and then the carbon monoxide is burned again to produce a combustible gas. This is coal gas.

However, the process of burning the coal to produce the coal gas also releases energy, an equivalent of about 8 million BTUs per ton of coal, or about one-third the potentially recoverable energy in the coal. With one exception, which will be mentioned below and which at present is not envisioned as a part of any of the coal gasification methods presently under serious consideration, there is no way of recapturing that energy. Thus, the process of producing the coal gas results in the irretrievable loss of 33 percent of the energy that would be recovered if the coal were simply burned and converted directly into useful energy.

When capital costs of coal vs. coal gasification equipment are added in, the comparison becomes even more unfavorable. For each ton of coal burned in a standard, modern, coal-fired power plant, 2,370 kilowatt hours of electricity are produced. For each ton of coal burned for coal gas for use in generating electricity, 1,280 kilowatt hours will be produced.

Contrasted with the cost of the natural gas it is designed to replace, of course, coal gas also scores poorly, since it obviously costs far more to mine coal, burn it and process the vent gases than to simply pump natural gas flowing from a hole in the ground.

The arguments advanced to counter the poor economic showing of coal gasification are flimsy at best. For example, coal gasification's supporters point out that it is easier to remove sulfur from carbon monoxide than from carbon dioxide. Therefore, they claim, a power company burning "gasified" coal can meet federal Environmental Protection Agency standards, which call for low sulfur emissions, more easily than one burning ordinary coal. Says Dr. Ezediel Clark of the U.S. Energy Research and Development Administration's coal gasification project: "Because of the EPA standards, there would be about a five percent saving in overall costs."

But the claim that coal gas is more easily treated to remove sulfur is questionable on economic grounds. The problem is that to remove the sulfur with the best processes requires cooling the carbon monoxide below 120 degrees Centigrade. Either more heat energy is lost, or more expensive equipment must be designed to trap and use it in some way as the carbon monoxide is cooled. Which of these two choices is selected depends on local considerations, but either reduces the energy efficiency of coal gasification compared to direct use of coal for energy generation.

A sales engineer for one of the largest U.S. coal gasification plant manufacturers admitted, when asked what level of sulfur content of coal would be required to make gasification competitive with primary combustion: "I wish I could say it would be competitive. I would like to sell them. The truth is that if you have a gas burning electric generating system, it might be cheaper to convert to coal gasification rather than investing in new, coal burning equipment. I have to be honest. At the present time (in a new installation -ed.) it would be cheaper to put in a coal fired plant."

It is also claimed as an advantage of coal gasification that the carbon monoxide produced in the gasification process can be burned or precessed for a variety of other fuels or chemicals. For example, the carbon monoxide can be upgraded by reacting the hot gas with steam and a catalyst to form hydrogen and carbon dioxide. Methane (natural gas) can be produced in this way, by hydrogenating the coal, using heat and pressure and the hydrogen from the carbon monoxide-steam reaction. The problem, of course, is that this process is a very expensive way of making hydrogen. In fact, most hydrogen is now made from methane and not the other way around.

Coal Gas and the Nazis

In fact, because it is so expensive and wasteful, the use of coal gasification as a major energy source is only thinkable in the context of a cannibalistic, fascist-statist economy based on slave labor, such as Nazi Germany, a fact of which the Wall Street proponents of the process are quite aware. A February 4 editorial in the *Washington Star* urging funding of coal gasification projects was explicit: "The technology for converting coal into oil and gas has been available for decades. The Nazi air force used gasoline made from coal when the allies closed off Germany's oil supplies during World War II...The fact is that plants are so expensive — estimated at $1 billion — that probably not even the largest companies are going to get involved without federal help."

Not stated by the Star but certainly known to it is the fact that the Nazi coal gasification plants were only feasible economically because of the concentration-death campt system, as, for example, the Auschwitz coal gasification plant which drew its labor supply from the Auschwitz concentration camp that was an integral part of it. It is a gruesome fact that the Nazi German manufacturers planned to use the carbon monoxide produced at the plant to eliminate both "used-up" workers and the "useless eaters" interned in the camps, but found it too inefficient for that purpose. Another gas, Zyklon B, was developed instead.

It is no coincidence that the largest coal gasification plants in the world have been built under the Hitler regime and more recently under the white-minority Vorster regime of the Republic of South Africa today, where the government's low-wage policy for blacks and the policy of shipping "excess" black workers to deindustrialized "home-lands" corresponds precisely to Hitler's population and labor policies. The government-approved Sasol II plant in South Africa, by the way, plans to give training and "opportunity" to low-paid black workers.

Just as large-scale coal gasification depends on cannibalization of labor, it also requires the cannibalization of higher-efficiency energy sources. Coal gasification, unlike other energy sources today, not only is not sufficiently "negentropic" to be the basis for such more advanced energy systems as fusion, it is not even self-reproducing. Even with the fascist labor methods available to a Hitler, coal gasification plants can only be erected by an economy that still has available sources of energy less expensive than gasified coal.

In Nazi Germany, for example, the decision to go the route of coal gasification, as opposed to simply seizing accessible petroleum fields (Hitler's finance minister, Hjalmar Schacht, actually opposed the introduction of the gasification method, and advocated seizures of gas and oil fields instead), had to be made while the infrastructure of the lower cost natural gas and petroleum-based international energy system was still available, that is in the mid-1930s. The South African plants, the smaller one now in operation and the $3 billion facility under construction, were also built with presently available oil and gas (still cheaper than gasified coal even at prices inflated by the 1973-74 oil hoax), in anticipation of a future international energy embargo against the white minority regime.

Selling Coal Gasification

It is a none-too-funny irony, in view of its economic history and associations, that coal gasification today is being sold to local U.S. communities on the grounds that it will lead to "jobs" and "prosperity." There are now dozens of coal gasification projects in various stages of planning around the country, and the methods being used to promote them have borrowed far more from door-to-door encyclopedia sales techniques than from serious industrial planning.

After a likely spot has been chosen, a coalition of business and political operatives move into an area with feasibility studies, financing proposals, and propaganda. Leading local supporters are recruited, usually from among desperate labor union officials faced with high unemployment, local land speculators who stand to make a killing, etc. Before the local citizenry knows what is happening, they find themsleves embroiled in a competition with some other locality to be selected as the site of a complex for generating and using coal gas.

From this point, the duped and greedy labor and community leaders strive to prove that their community is a better location for the complex, and the fact that coal gasification is a poor system of generating energy is lost in the fight for the real estate, financing and equipment contracts.

The 69-page Battelle Research Report to the Appalachian Regional Commission, Commonwealth of Kentucky, Pike County Fiscal Court, gives a clear sense of the process. This report, a feasibility study designed as "bait" for potential investors in the complex ("suckers") was written after the completion of site selection. After a perfunctory introduction, the "Final Report on Analysis of a Coal Gasification Facility and Potential Gas Using Industries for Pike County, Kentucky," begins. First there is a justification of the report's assumptions of the available labor supply, which can be summed up as, "these people are desperate, they will work for almost any wage." Then a teaser of about $50 million of "seed money" from the state of Kentucky, a section on industry selection ("we can get you financing if you join us"), a report on who has the inside track on the gasifier contract, pages of funding, "industrial recruitment," transportation, water, and electrical supply, etc., are liberally salted with appeals to grab a chunk of the action.

The financing and raw materials group who started the project plan to emerge with a "captive" manufacturing complex that can be controlled through ownership, financing and prices. Then with a system of decreasing wages and shrinking availability of natural gas — upon which the system depends — they expect to have a guaranteed flow of profits on the otherwise uneconomical system.

Can Coal Gasification Play Any Role?

While it is clear that coal gasification has no role to play as a primary source of fuel in today's industrialized society, there are indications that the process could play a valuable subordinate role in an economy that is making the transition toward the use of thermonuclear fusion power as its primary energy source. But it is also clear that these techniques will require a radically different orientation from that taken by the present proponents of coal gasification.

The most significant potential use of coal gasification would be as a by-product of the yet-to-be-introduced Jordan steel process. The Jordan process is a method of reducing iron ore in which pure oxygen is injected into the blast furnaces, yielding iron at a rate approximately twice that obtained in the present blast furnace process. The giant blast furnaces are in fact coke gasifiers, and used with the Jordan process they would become efficient coal gasifiers, with a doubled rate of iron production as a bonus.

Work pointing in the direction of this process is actually underway. Current research is exploring methods of removing sulfur from a hot carbon monoxide stream, to make a better case for coal gasification's ability to meeting environmental standards. A process under consideration — and backed by a $500 million ERDA contract — is one in which carbon monoxide is passed over iron oxide. But carried to its logical conclusion, this process is nothing other than the Jordan steel process. Research priority should be given to developing the Jordan concept, and particularly to methods of removing from the molten iron the sulfur which enters it from the coal during combustion, in order to be able to effectively use coal of an even higher sulfur content than that reasonably projected by present technology. This present technology indicates that 2 or 3 percent sulfur coal could be economically used in the Jordan concept.

At present, however, U.S. steel companies — and their bankers — have ruled out the Jordan concept, primarily because they fear that its potential for a vast increase in steel productivity would simply lead to a market glut under present stagnant would economic conditions.

The other coal gasification technique which bears promise of some utility is the in situ process. While all of the drawbacks of conventional coal gasification apply to the in situ process, and the capture of the heat generated in the conversion to carbon monoxide is even more difficult, the in situ process could prove to be economically viable in remote areas where the transporting of other forms of energy is expensive and where the coal is of low quality.

At present there are three ERDA-funded in situ projects, of which the Laramie Energy Center in Wyoming is probably the most advanced of the projects in the United States. In this project, parallel shafts are drilled into a 30-foot-thick seam of coal, the coal is broken up with explosives to allow oxygen to enter, a fire is ignited in the seam to produce carbon monoxide, and then air, oxygen or a mixture of oxygen and air, is pumped into one shaft and the gas pumped out another. Steam can be added in another shaft to "upgrade" the gas produced. It is obvious that this method is very expensive if the coal is in a deep vein and very wasteful if near the surface.

However, the Soviet Union has operated in situ coal gasification plants for several years on a commercial basis, and has leased the technology and engineering involved to Texas Electric Utilities, which is considering it for hundred-foot-deep lignite formations in eastern Texas.

In sum, while coal gasification is not as ludicrous an energy source as "solar energy collectors" (solar collectors are able to achieve an energy flux density of only .0002 Megawatts per meter of reactor surface squared, as compared to a figure of around 10 megawatts per meter squared for the average fossil fuel-fired plant), the process can play only a tertiary rôle in an economy growing at the rate of approximately 20 percent per year which experts now calculate will be needed to achieve a transition to a fusion-powered global economy in the 1990s.

Present supplies of petroleum, natural gas and coal and adequate to supplement nuclear fission-generated energy in achieving that growth rate. Such process as the Jordan concept and MHD will make that transition easier. Wasting captial on expensive and inefficient coal gasification schemes — a net minus from world economic growth — will make that transition more difficult, and could make it impossible.

— *Wayne Evans*

About the Author

Wayne Evans was the U.S. Labor Party's candidate for Vice President of the United States in 1976. He worked for more than 20 years as a research laboratory technician for the Dow Chemical Company, and presently works with the Research and Development staff of the U.S. Labor Party.