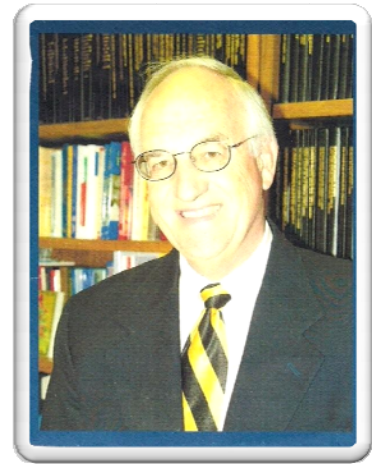


## **CLEAN COAL TECHNOLOGY**

### **What is Clean Coal?**

The Coal Leader has invited Dr. Richard Wolfe, a recognized coal scientist, to write a series of three articles discussing the future frontier of clean coal technologies. This article is the third in that series.

Dr. Wolfe earned his BS degree at Virginia Tech in Chemical Engineering and MS and Ph.D. degrees in Nuclear Engineering at the University of Cincinnati. He served as program manager with the U.S. Department of Energy in Washington, D.C. before joining United Coal Company in Bristol, Virginia in 1979 as Vice President of Research and Development. In 1988, he formed Coal Technology Corporation in Bristol, Virginia. He has been appointed by five different Governors of Virginia to the Virginia Coal and Energy Commission. He has served on the energy research staffs at the University of Kentucky, West Virginia University, Appalachian State University, and currently serves on the Board at Virginia Tech's Center for Coal and Energy Research..



### **Introduction**

Since the last article was written in September, 2008 on Coal Liquids much has happened. A new President of the United States has been elected; President Barack H. Obama, who is dedicated to a policy of energy independence and using our own natural resources to reduce this country's dependence upon imported oil. This country's leaders have been talking energy independence for more than 30 years and today, we import more oil than any time in the history of the United States. As a result of buying our energy from abroad, particularly oil ranging in price from \$15 dollars a barrel (42 gallons) to as high as \$147 per barrel in July, 2008, we have drained tremendous wealth from Americans and now we find this country in the worst economic depression since the Great Depression of the 1930's. It is clear that if the United States wants to remain the World's Greatest Democracy and a World Leader, we must turn this tide of dependence upon foreign sources for our energy and produce our own energy needs by using our own natural resources. The full utilization of our resources ranging from wind, solar, biomass, renewable sources, coal, oil, natural gas, and nuclear must be rapidly developed, creating jobs and economic wealth once again within these United States.

The development of our energy independence must be achieved in a manner to maintain, improve, and preserve our environment. This challenge and balance between both energy development and environment preservation can be achieved by working together and recognizing the importance of both. We are at a great cross-roads in American history. The establishment of a comprehensive energy and environmental plan is bigger than a single Administration and must be met by a by-partisan leadership working together for the benefit of the Country, not just one political party. This is the time for America to show the world the fabric of what Americans are made of and of our dedication to maintaining our destiny and our Democracy.

### **Fossil Fuels- What are they and where did they come from?**

To understand the importance of fossil fuels, we must first understand this planet Earth and where we came from. First of all, Planet Earth contains an atmosphere of 21 per cent oxygen, 78 percent nitrogen, 0.9 percent argon, and the remaining 0.1 percent made up of Carbon Dioxide and methane. This is the atmosphere that provides life to us humans and all other life forms on this planet. In addition all living creatures are sustained by organic matter. The compounds of carbon are called organic because the first known members were natural products synthesized by plant or animal organisms. The plant life that we eat and that lives in our environment helps removes carbon dioxide from the atmosphere and converts it into oxygen that helps sustain life on earth. As far as it is known, planet Earth is the only planet with life forms that are carbon based.

The earth age has been scientifically shown to be several billion years old. The first coal age began nearly 250 million years ago along with age of the dinosaurs. Fossil plants and fossil animals are found in many forms in various coal seams today that prove their coexistence. Human life as we know it has been determined by the discovery of various fossils to be on the order of 1.5 million years old.

The point in making this analysis in the development of planet Earth is that the fossil fuels of oil, coal, and natural gas came from millions of years ago. The coal and oil age was a time of warm, moist climate. Much of the land was low and swampy. From it rose dense forests of strange-looking trees, ferns and other plant and animal life. We know what these plants looked like because they left fossil imprints in the coal. As the plant life died it fell beneath the swamp water. Great layers of mud, sand, and marine deposits gradually formed over the plant matter and helped it turn into coal of various forms ranging from peat to lignite to sub-bituminous, to bituminous, to anthracite. As a result, this coal which is made up mostly of carbon and hydrogen also inherently contained various minerals of sulfur, iron, mercury and other trace elements that occurred naturally from the plant life and minerals in the soil that existed naturally in those early swamps.

Today when we use these fossil fuels either in the making of electricity or transportation fuels, a carbon dioxide gas is released along with various amounts of sulfur dioxide, nitrogen oxide, mercury and other impurities. In order, to preserve our environment and reduce the amount of these impurities which are affecting our very existence on planet earth, we must find better technologies to reduce and contain these emissions.

### **Cleaning Coal of its Impurities**

Now that we know what fossil fuels are and where they came from, now the question arises can you clean the impurities from coal, reduce their emissions and by what means. The answer is a positive Yes We Can, but with the development of newer technologies, we can do more in the future.

Power plants being built today emit 90 percent less pollutants (SO<sub>2</sub>, NO<sub>x</sub>, particulates and mercury) than the plants they replaced from the 1970s while coal use has tripled. Examples of technologies that are deployed today and continue to be improved upon include: Fluidized-bed combustion, Integrated Gasification Combined Cycle (IGCC), Flue Gas Desulfurization, Low Nitrogen Oxide Burners, Electrostatic Precipitators, just to mention a few. Technologies now being developed include High-efficiency fuel cells, advanced high-efficiency combustion, Hydrogen production, Carbonite, coal to liquids, and carbon capture and storage.

Coal is found in every continent, but more than a third of the world's supply is in the United States. Thirty-six of the 48 states have some coal, and it is plentiful in 28 states. Coal exists in many different forms and in many different seams below the earth. Different mining techniques must be used ranging from deep mining to mining the coal from the surface. Each mining technique has its own special challenges ranging from the personal hazards of deep mining techniques using shafts, slopes, and massive air ventilation methods to the environmental impacts of surface mining. Over the past 25 years, great improvements have been made in deep mine safety and reclamation of the hills and mountains after the coal has been extracted from the surface. Is there still more to be done and the answer again is a positive Yes There Is. Many miners over the past have died from breathing in coal dust during deep mining, including my own Father, but today through improved ventilation, mining machinery, and air filtration, black lung disease has been greatly reduced. However, deep mining still remains one of the most hazardous jobs in industry.

Once the coal is removed from the mines, either deep mines or surface mines, it is the processed through modern multi-million dollar coal cleaning facilities. A majority of the sulfur and other attached minerals are physically removed during this process by mechanical and chemical technique.

**Figure 1. United Coal Company's Wellmore Coal Cleaning plant in Grundy, Virginia.**

Over the years, great improvements have been made to physically clean coal and there still is room for further improvements in efficiency and the quantity of coal recovered. However, to go deeper into the coal's structure to remove further the sulfur, ash, and mercury, newer technologies are now being developed to thermally treat the coal and convert the coal into new carbon products and the recovery of the coal liquids, which will introduce in the future the term of "Coal Refineries" which will operate very much like the oil refineries of today. Then one can say, "We are getting the squeal out of the pig".

For example, a new technology has recently been developed and proven in 2008 with patents pending by "Yours Truly" called the "Carbonite Process" that thermally takes coal apart, removes 100 percent of the mercury and produces a new super clean carbon product called "Carbonite". The US Patent Office on February 17, 2009 registered a Trademark for "Carbonite" as a new carbon based energy fuel. The process also yields at least one barrel (42 gallon) of coal oil as a by-product depending upon the quality and type of coal processed. Figure 2 shows Dr. Wolfe in the laboratory producing the first quantities of super clean Carbonite and Coal Oil. The Carbonite has a higher heat value than the initial coal thus reducing the amount of Carbonite needed to produce a mega watt of electrical energy, thus reducing the amount of carbon dioxide emitted to the atmosphere by as much as 25 percent depending upon the coal type.

**Figure 2. Dr. Dick Wolfe conducting the first experiments in a laboratory during 2007-2008 to produce a new super clean carbon product called "Carbonite" and coal oil from coal.**

The coal oil has a yield of about 42 gallons per ton of coal processed into Carbonite. The coal oil has many applications in the petro chemical industry including refining into gasoline and diesel fuels.

The significant of this new clean coal technology breakthrough is that it is just the beginning of understanding how coal can be transformed into new super clean carbon products that reduce the environmental emissions while using coal for producing electricity and transportation fuels. The United States used about one (1) billion tons of coal during 2008, this means that if all the coal was processed first through the Carbonite process before combustion, then about one (1) billion barrels of coal oil could be recovered as a by-product at very low cost and then refined into transportation fuel as a means of reducing our dependence upon foreign oil. Coal has this potential for being used in both the utility market and the transportation market.

The Carbonite Process is just one example of new clean coal technologies being developed that allows coal to be used more cleanly than ever before. Other technologies are also on the horizon that will be developed as new leadership is provided for using one our most abundant natural resources to meet our energy and environmental requirements..

**FutureGen- Is this a clean coal technology?**

The idea for developing a super clean coal technology called FutureGen was established several years ago by the Bush Administration. A small town located near the massive coal seams in the town of Mattoon, Illinois was selected in a nationwide competition. FutureGen was promoted across the world as an environmentally sound way to produce power from coal. Then what happen to stop or redirect the project? The age old story, Washington politics got in the way and the Bush Administration essentially killed the project. Very much like what happen to President Carter's efforts in 1978 to develop synthetic

fuels from coal like is now being achieved daily in South Africa and China. In my opinion, this country's leaders, on both sides of the aisle, must start putting what is good for this country First Above Politics. If our leaders continue to play politics as usual, we just may lose this great Democracy that our forefathers fought so hard to establish.

Now, under President Obama's new leadership, FutureGen is again being raised much like the Phoenix and is now back on the table with funding from the new Stimulus Package. Is it needed, again a positive Yes It Is and this project will demonstrate to the world that coal can be used cleanly without major emissions of carbon dioxide (the green house gas).

If FutureGen lives up to its promise, it would revolutionize the use of coal. On what is now 400 acres of cornfields in Mattoon, Illinois, a commercial-size power plant will be built to produce 275 megawatts of electricity, enough to power 150,000 homes. Instead of releasing the resulting carbon dioxide emissions into the air as pollution, the plant would pump these gases into deep geologic formations thousands of feet below the Earth's surface. The project's goal is to test and develop affordable technology, on a commercial scale, that can remove 90 percent of the emissions produced by coal plants.

Now, if one can couple the Carbonite Process with the FutureGen Project, which is certainly possible, coal oil can be recovered as a by-product and used in the transportation sector.

### **Sequestration of Carbon Dioxide**

While the FutureGen project is getting back on its feet, a major project is already under-way to develop and demonstrate sequestration of carbon dioxide in underground non-minable coal seams in Southwestern Virginia. The Department of Energy along with several industrial companies like Dominion Power Company are cost sharing a field demonstration project to prove the feasibility of sequestration of carbon dioxide. This project is referred to as the Southeast Regional Carbon Sequestration Partnership (SECARB) and headed-up by Dr. Michael Karmis, Director of the Virginia Center for Coal and Energy Research at Virginia Tech.

Allow me to reference one more clean coal technology that is well under way and that is Clean Coal Biotechnology where microbes taken from termites eat coal and produce clean methane gas. The residue by-product of this process is humic acid that is the basis for fertilizers. By using the fertilizer to enhance plant growth, more carbon dioxide can be removed naturally from the atmosphere. This technology development was the subject of my first article published in this paper in May, 2008 and this technology has picked up momentum by the recent appointment of Dr. Steven Chu, a Nobel Prize winning Scientist, as the new Secretary of the U.S. Department of Energy. While Dr. Chu was Director of the Lawrence Berkeley National Laboratory, he directed his staff of scientist to begin work on using renewable biomass cellulosic plant materials coupled with microorganisms, tiny microbes that are genetically engineered to convert cellulose into an ethanol-like fuel. The combination of both coal and cellulose renewable materials can certainly enhance the further development of Biotechnology as a new clean coal method for producing clean energy in both the utility and transportation sector.

### **Now- Is There Such a Thing as Clean Coal?**

It has been my attempt in this article to show from a scientific point of view that coal mining and its use are cleaner from an environmental standpoint than ever before and will become even cleaner in the future as we as a Nation fully use our most abundant natural resource. Yes there is Clean Coal and it is getting cleaner and greener all the time.

It is time we put to bed this national controversy between the environmental groups and the energy producers and once again unity to put our Nation first in these most difficult of economic times. By working together, we can produce the energy we need to be less dependent upon foreign sources, create jobs in both the energy and environmental sectors, and provide economic stability in our Country. To quote Dr. Martin Luther King's famous speech, "NOW IS THE TIME". Now is the time to set this country

on a path of energy independence and environmental protection with no turning back while, also, rebuilding the industrial and economic strength back in America. "NOW IS THE TIME"