THE LAMBDA PROCESS - FOR DESULFURIZATION OF SLURRY COAL FINES PRIOR TO COMBUSTION

by

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Introduction

Coal is the basis of our economy and our only reliable, safe energy source. I believe it is possible to mine and burn the coal without destroying the wilderness in which it was produced. Clean coal and a healthy environment are the goals that led to the development of the Lambda coal-fines cleaning process.

Mined coal results from decomposition, sedimentation, compaction, and lithification of the swamps, marshes, fens, and other wetlands were created at high elevations in the Appalachians and in the low marshy areas of northeastern Ohio.

With few exceptions, the bogs, swamps, and wetlands are naturally acidic, with pH readings from 3 to 5.5, and replete with sulfur, iron, manganese, aluminum, and copper, plus trace elements of other metals. The sulfur, nitrogen, potassium, and phosphorus cycles provide nutrients necessary for balanced ecological continuity now, as they were when the coal was formed and is still being formed in swamp and peat acid bogs. The peat will compact into lignite, then lithify into a sedimentary rock called bituminous coal. Additional compaction and time will change it to a metamorphic rock called anthracite coal.

Most of the Appalachian coal, however, runs from lignite to sub-bituminous to bituminous coal. Coal is a unique geological structure - a most challenging "energy rock". It often seems to that no two coals chunks are the same, even when taken from the same seam.

I have studied the remnant bogs and swamps thought the eastern United States and the tundras in northwest Ontario for sixteen ears, and have carefully read journal articles and books on the geochemistry that relate to the eastern Appalachian coal fields. The bibliography at the end of the paper lists those articles and books that have been most relevant to my review of the literature and to the development of the Lambda process.

Coal is essential to keep the U.S. "energy independent": if properly mined and cleaned, it can provide sufficient energy beyond the 2,000, when the other fossil fuels are depleted.

The coal was formed from microbial decomposition of ancient tree ferns, cycads, and bog/swamp soil and compacted into the coal mined today.

The aim of this study is to prove that coal fines can be successfully cleaned using microorganisms that are acidophilic and ecologically balanced, to remove the sulfur, metals, and nitrogen, leaving the carbon, hydrogen, and oxygen bonds intact. Combustion of the "clean coal" releases the energy that has been stored there as chemical energy produced by photosynthesis in the plants that made up the coal millions of years ago. The energy released does not have to produce sulfurous and nitrous oxides and dry particulates that create acid deposition. This can be accomplished for $10 per ton or less, requiring few changes to present prep plants. The process will create jobs and lower energy bills because it is a scientifically sound, technically feasible, and commercially reliable microbial coal-fines cleaning process. It brings high sulfur fines into compliance prior to combustion at a reasonable cost in a reasonable periods of time.

Transparency #1 shows the basic ecosystem that led to the development of the Lambda process and transparency #2 shows the negative feedback system that maintains the population at carrying capacity.

MATERIALS AND METHODS

The problem is the apparent dilemma between safely and cleanly mining West Virginia's coal and maintaining her forests and streams for hunting, trapping, and fishing. One solution is the Lambda coal cleaning process. It is simple and inexpensive. It can be applied in three different ways, depending on where the coal is cleaned and what part of the coal is being cleaned. The materials are the same in all three processes, but the one method of application is flexible.

Microorganisms live in ecological balance in acid bogs, swamps, and wetlands, also in and around strip- and deep-mined areas. These wild strains of bacteria, algae, and protozoa were the fist of three components used in the process. The second consisted of "pure" strains form the American Type Culture Collection in Rockville, Maryland, and Texas Algal Depository in Austin, Texas, Carolina Biologicals in Burlington, North Carolina, and Nasco Biological Supply company in Wisconsin. The third component was cultured out of wild strains from water and coal washings taken form each of four sites in Ohio (four coal samples form four different mines where we are presently working under an Ohio coal Development Office grant). Tubes of each separate organism from all three sources were used to produce a vigorous hybrid species of that bacteria, algae, or protozoa with the "species preservation gene," or "Lambda strain," that makes it possible for them to withstand environmental stress.

The custom hybrids were then mixed in a nutrient medium developed by Lambda, forming a balanced ecosystem that was symbiotic, synergistic, mixotrophic, and lacking the energy substrates of coal. Sulfur, iron, etc. Being deprived of their normal energy substrates in solution made them react even faster when put into the coal slurry. This Lambda process "soup" was the fist generation. Developed on 1984. It was effective on gob piles and in sedimentation pits and ponds. And cam be used to clean coal fines in a 33% slurry.

The second generation of the Lambda process used bacteria only. Custom hybrids were added to warm wax or warm agar, or imbedded in catalytic carriers by low heat and pressure. The cooled wax and agar and the catalytic carriers, in pellet form, contained the enzymes from the dead organisms. The pellets also effectively cleaned 33% slurry coal fines. Larger than the fines, these pellets could easily be separated with dewatering screens and reused. The catalysts were not used up, either in the breakdown of sulfur and metals from the fines, or in their chelation to the oxygen in the system, but they had to be there for the chelation/oxidation process to occur. They were captured and reused, or captured and mixed with additional bacterial enzymes, then reused.

The third generation of the Lambda process consisted of (1) complete microecosystems of bacteria, algae, and protozoa imbedded (2) a nutrient matrix that allowed the flow of gases and (3) 33% coal slurry fines. The organisms were recovered after cleaning a slurry run and placed back into a second, third, fourth, and fifth run. No additional materials were added and they continued to clean.

Results

These are slides of the coal samples before cleaning, the residue after cleaning, and the cleaned coal using all three generations.

Chart #3 shows total sulfur before and after, using the Lambda 1, 2, and processes on coal from (1) West Germany, (2) Rehobeth, (3) Sand Hill Ohio #8 Mine coal, and (4) Sands Mine Ohio #6 coal.

Chart #3
(results through 3 generalization; all runs for a 4-hr. duration)

Origin of Coal and/or Coal Type	Pre-Test Data pH	Redox	Fe	SO_4
1Sands Hill Mine	2.38	420	1,500	130,000
2Rehobeth Fines	2.59	365	350	100,000
3W. German Coal	1.03	372	420	1,500
4O.U. #6 Coal	2.49	446	24	185

Origin of Coal	LP I		LP II		LP III	
and/or Coal Type	Fe	SO4	Fe	SO4	Fe	SO4
1Sands Hill Mine	300	9,000	280	7,000	27	1,300
2Rehobeth Fines	160	850	16	700	3.7	580

3W. German Coal	30	250	18.5	62.5	0.04	23
4O.U. #6 Coal	1.1	90	0.42	28	0.01	1

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All of these results were achieved in for hours or less. I monitored pH and redox, and tested aliquots each hour for iron and sulfur. All the results on the transparencies were verified by Columbus Test Laboratories and/or Ohio University and /or Ohio State University. The charts in the paper reiterate the data on the transparencies.

Discussion

The results were promising. They verified that the Lambda process does clean coal fines. And add another market for the coal production companies.

We are working with Dr. Robert Savage of Ohio University and Dr. Dwayne Skidmore at Ohio State University on the design of the alpha prototype and hope to have it built and cleaning ten to twenty-five pounds of cola per day by August.

The lambda processes are three more methods of addressing the cleaning of cola fines prior to combustion quickly and cheaply - four hours at $10 per ton.

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