The Maryland Coal Combustion By-Product/Acid Mine Drainage Partnership

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ABSTRACT

The recent construction of a 400 megawatt circulating fluid bed coal fired power plant near Cumberland, Maryland has motivated the State of Maryland to form a strong partnership of our coal industry, power plant industry, and the State Departments of Natural Resources and the Environment to address the State's oldest environmental problem, acid mine drainage (AMD), with coal combustion by-products (CCB's). While the coal industry focuses on beneficial use of CCB's in current mine reclamation applications, the Maryland CCB/AMD Partnership (the Partnership) is focused on their use in reducing AMD from abandoned mines that are by default a State responsibility. Contributing in a substantial way to the activities of the Partnership is one of the Western Maryland Initiatives of the Maryland Power Plant Research Program.

This paper traces the history of the Maryland CCB/AMD Partnership and presents an overview of its current and planned activities. Details regarding the specific studies and experiments conducted by the Partnership and related work by the Power Plant Research Program are presented in various papers at this and other conferences.

The initial major activity of the Partnership was a field-scale experiment to place and monitor the performance of 5,600 cubic yards of grout prepared from mine water and CCB's in a small mine, the Frazee Mine, on Winding Ridge near Friendsville, Maryland in 1996. The results of the Winding Ridge experiment are so promising the Partnership has decided to go ahead with work on the largest source of AMD in Maryland, the Kempton Complex.

INTRODUCTION

Evolution of the Maryland Coal Combustion By-product/Acid Mine Drainage Partnership.

In 1992 there was an exchange of correspondence between the State of Maryland Public Service Commission and AES/Warrior Run, Inc., (AES) regarding the latter's petition to be relieved from the requirement to obtain a Certificate of Public Convenience and Necessity for its proposed circulating fluid bed coal combustion power plant (Warrior Run) at Mexico Farms near Cumberland, Maryland. The culmination of this exchange was a letter prepared by the Maryland Power Plant Research Program (PPRP) and signed by the Heads of the seven State Agencies it represents on power plant issues to the Chairman of the Public Service Commission recommending the relief sought by AES subject to certain conditions. One of these conditions is that AES arrange for beneficial use of the fluid bed ash (FBA) from Warrior Run rather than store or landfill the 400,000 tons per year of the alkaline ash the plant would produce in the Potomac Valley.

Local Government representatives in Western Maryland voiced considerable concern about the ash issue and potential of the alkaline ash to help with the severe acid mine drainage (AMD) problems in Garrett and Allegany Counties. In 1993 George Edwards, the State Delegate from Garrett Country, created the Fluid Bed Ash Advisory Committee (FBA Committee) with four representative each from the Maryland Bureau of Mines (BuMines) and the Maryland Coal Association to review and research the feasibility of utilizing the alkaline ash from Warrior Run on a pilot deep mine reclamation project in Maryland. At the same time it became apparent from PPRP studies of ash production and utilization in general that the State utility industry needed a massive use of coal combustion by-products (CCB's) including the 1.2 million tons per year of fly ash (FA) produced at coal fired power plants throughout the State. The deep mine application promised to be such a massive use.

PPRP joined with the BuMines and coal industry in support of the proposed deep mine demonstration project in 1994 using the FBA Committee as a defacto Board of Directors as it represented most of the stakeholders and potential contributors to the project. BuMines was subsequently transferred from the Maryland Department of Natural Resources (DNR) to the Maryland Department of the Environment (MDE) and ash utilization in mine reclamation became a joint effort of the two Departments and our coal and power plant industies. Working together in planning and executing the field-scale demonstration at Winding Ridge cemented the group into a strong very functional alliance identify as the Maryland CCB/AMD Partnership (the Partnership). As a result of the potential of CCB's to help with the AMD problem as demonstrated at Winding Ridge the Partnership decided to take on the largest source of AMD in Maryland, the Kempton Complex. Delegate Edwards has expanded his Committee to include representation from DNR, new landowners, and the West Virginia Department of Environmental Protection and renamed it the Coal Ash Utilization Committee (CAUC). The CAUC continues to guide the joint work of the Partnership.

Purpose and acknowledgements

This paper traces the history of the Partnership and provides an overview of its current and planned activities. Details regarding the initial demonstration at Winding Ridge and the extensive data that has been collected in monitoring that field-scale experiment are presented or have been presented in related papers at this and other conferences. The Partnership is particularly grateful for the background work completed in the U.S. Department of Energy (DOE) Ash Utilization or Haul Back Program. We are especially grateful for the personal technical support, analysis of data, and publication of results by William Aljoe and Terry Ackman at DOE's Federal Energy Technology Center. Of course, the Partnership is deeply indebted to each of the contributing partners for time, expertise, materials, transportation, and services–and ultimately funds to buy materials and services that had to be purchased. The level of cooperation in this loosely structured group with no legal obligation to bind anyone to its work is refreshing.

THE MARYLAND ASH PROBLEM

The five active CCB landfills in Maryland occupy a total of about 1000 acres. Ash disposal in Maryland is an increasingly difficult problem for our utilities as landfills reach capacity limits and the public opposes new landfills. Over the next 40 years it is expected Maryland coal fired power plants could require 1,100 to 2,300 acres of land for ash disposal if there is no massive increase in beneficial use. In addition Mettiki Coal Corporation has won the long term contract to supply fuel to the Virginia Electric Power Mount Storm Power Plant, the contract includes taking back CCB's. Mount Storm has one scrubber installed and two more planned so Mettiki's haul back obligation will include considerable flue gas desulfurization (FGD) material.

Maryland is "The Land of Pleasant Living" and no one wants an ash pile in their backyard or anywhere close to their backyard. PPRP expects great difficulty in siting any future ash sites.

THE MARYLAND ACID MINE DRAINAGE PROBLEM

The first coal exported from the United States was from Baltimore in 1751 and Baltimore was the first U.S. city to have gas lighting, with gas produced from coal, in 1816. The first railroad in the United States connected the Port of Baltimore to Maryland's coal country in the 1840's. And the Chesapeake and Ohio Canal, that never reach Ohio, connected Washington, D.C. and the navigatible portion of the Potomac River to Cumberland just down the mountain from the "Big Seam" of the Georges Creek Basin in the 1840's. Ships and trains liked to fire Maryland coal because of its high heat content. The favorable metallurgical properties of coal from the upper Potomac Basin had much to do with what was once the largest steel mill in the World being built at Sparrows Point near Baltimore. The combination of these factors caused the Maryland coal industry to bloom early and enjoy sustained growth for decades. The downside was early and sustained AMD problems. William Jennings Bryan commented on the "yellow acrid water" flowing from the mines when he visited Maryland coal fields in 1860.

Maryland now has 450 abandoned mines that predate the Mine Reclamation Law of 1977 and coincidentally about 450 miles of streams severely impacted by AMD from about 50 of these

abandoned mines. Maryland is proud of her waterways and wants these streams restored to their pristine condition. Unfortunately from the standpoint of mine reclamation funding, Maryland's current coal production rates only minimum reclamation funding for the State. MDE does have a very successful dozer program treating the most important flows of AMD in the State.

THE HYPOTHESIS TO BE TESTED WITH COAL COMBUSTION PRODUCTS

After studying some successes and numerous failures in treating AMD the Partnership concluded an important hypothesis to test would be whether a slurry prepared from CCB's would setup in an abandoned mine and reduce acid formation by reducing exposed pyritic surfaces. No chemistry was to be counted on except the hydration of the slurry to set up into a low grade cement that would more or less permanently cover exposed pyritic surfaces. Six mechanisms were anticipated to result in reduction of exposed pyritic surfaces:

1) As the slurry flowed through the abandoned mine it would entrain and ultimately entomb high surface area mine dust and small mine debris.

2) The slurry would cover the mine pavement and if the mine could be completely filled it would cover most of the mine walls and roof.

3) The slurry would flow into and around large mine debris and roof falls.

4) The slurry would penetrate joints, cracks, and fissures.

5) The slurry would fill subsidence chimneys to some degree.

6) The slurry once it set up would prevent further subsidence that would expose more pyritic surfaces.

THE WINDING RIDGE EXPERIMENT

The Partnership selected the Frazee Mine atop Winding Ridge near Friendsville, Maryland to test the above hypothesis and demonstrate how acid production might be reduced in abandoned mines. The Frazee Mine is a good experimental site, the mine is perched high on an isolated ridge, the recharge area is well defined, the mine entries are known, and the effluent does not reach any water course. Unfortunately, the internal mine geometry is not well known. As a small kitchen mine abandoned 30 years ago no mine map was available and the mine geometry had to be established by interviewing miners who had worked in the mine, by exploratory drilling, and some down hole camera observations.

The Partnership retained the University of Southern Illinois to design the grout as they had some appropriate experience in the DOE Program. We used ash from the Morgantown Energy Associates Plant in Morgantown, West Virginia, as surrogate material for Warrior Run ash as the later plant would not come on line until 1999. Virginia Electric Power Company donated FA and FGD material for the test. The partnership dictated that no additives were to be used to achieve flowability or strength and that mine water was to be used for the mix. A formula of 60% FBA, 20% FA, and 20% FGD material was selected for the demonstration.

The Partnership contracted with Dyna Corporation, an experienced and innovative concrete contractor, through Environmental Resources Management, Inc. (ERM), a PPRP support contractor, to do the actual injection. Dyna Corporation injected 5600 cubic yards of slurry into

the mine via boreholes selected from the exploratory drilling holes under the close observation of BuMines, PPRP, and ERM personnel.

Baseline monitoring started a year before injection to measure flows and water chemistry at the single mine opening that had effluent and ground water chemistry in strategically placed monitoring wells. This monitoring continues. Annual coring into the grout is conducted to observe its effectiveness in continuing to cover exposed pyritic surfaces, its strength and chemical properties as it matures.

The results are encouraging. There are favorable trends in the important parameters of AMD: pH and aluminum and iron content of the mine effluent. Most importantly the cores clearly show that the slurry entrained and entombed mine debris, covered and bonded to the mine pavement and walls, penetrated joints, and at least in one case entombed debris in a collapse chimney.

CRITICAL PHASES OF CCB APPLICATION PROJECTS

Based on the demonstration at Winding Ridge the Partnership suggests organizing CCB application projects in at least the following seven phases.

1) Site characterization.
2) Baseline monitoring.
3) CCB characterization and grout design.
4) Injection engineering and design.
5) Construction of mixing and injection facilities.
6) CCB injection.
7) Post injection monitoring.

PROGRESS AT THE KEMPTON COMPLEX

Kempton Complex is our name for the 12.2 square miles of underground works created by 10 interconnected mines in Upper Freeport coal extending north from Davis, West Virginia, under the headwaters of the North Branch of the Potomac River to Laurel Run, in Maryland. Mining generally proceeded north starting in Davis in 1885 and terminating in Maryland in 1950. This part of the Upper Potomac Basin is a large synclinal structure, dipping northeast, so most of the mine drainage is to Laurel Run. An average of 3.5 million gallons per day of 3.5 pH water flows from an abandoned airshaft and borehole into Laurel Run. This effluent is currently treated in Laurel Run by MDE with a newly installed dozer using lime kiln dust, the former dozer using limestone remains in place as backup.

Following our own suggestion, the Partnership is addressing the problem of reducing acid production in the Kempton Complex in the first four of the seven phases enumerated above.

Site Characterization

Organized site characterization has been underway for two years. The approach is to organize the enormous amount of information available on the mines into a single Geographic Information System (GIS). This effort initiated with Professor Ben Hayes at Bucknel is continuing under a Memorandum of Understanding with the Geography Department at Frostburg State University (FSU). The landowner, Pocohantas Land Company, has made a major contribution by digitizing a large mine map in their possession.

Baseline Monitoring

BuMines and FSU are collaborating on gathering historical data on water flows and water chemistry. With the assistance of BuMines' hydro-geology support contractor, Miser & Earl, they are setting weirs and surveying streams to establish the water budget for the area. Funds arranged by Senator Sarbanes through the Environmental Protection Agency will pay for a major hydro-geologic study of the Complex. All data being collected is being incorporated into the GIS at FSU.

CCB Characterization and Grout Design

Warrior Run will start up this year and MDE will analyze their FBA. Virginia Electric Power Company has purchased and restarted the North Branch Power Plant at Bayard, West Virginia. North Branch is a fluid bed combustion power plant that will now burn a mixture of coal and gob, it will be the closest source of FBA to the Kempton Complex. PPRP has set up a Memorandum of Understanding with the University of Maryland at College Park to provide material science support to our overall Beneficial Ash Utilization Program. Samples of Mount Storm FA and FGD material and North Branch FBA have been provided to the University of Maryland for analysis. John Sherwell of the PPRP staff is managing the material science work for PPRP and he participates in an ASTM Technical Committee considering a *Standard Guide for THE USE OF COAL COMBUSTION PRODUCTS FOR UNDERGROUND MINE RECLAMATION*.

Injection engineering and design

BuMines and PPRP have discussed targets for early corrective action in the Kempton Complex. We have isolated five conditions where early corrective action may be highly beneficial:

1) Loss of surface water via subsidence chimneys.
2) Inter-aquifer transfer of water via abandoned boreholes and shafts.
3) Inter-basin transfer of water where watershed integrity has been breached by mines.
4) Isolated pockets of high acid production.
5) Ongoing subsidence that further modifies the flow of water.

PRIORITIES FOR MARYLAND CCB/AMD PROJECTS

The Partnership is guided in general by the following priorities in planning future work to be supportive of National and State priorities:

1) Focus on North Branch of Potomac River since the Potomac River has been designated as a National Heritage River.

2) Unusual problems of the heavily mined Georges Creek Basin.

3) Derive the most beneficial use of the 400,000 tons per year of Warrior Run FBA. (The Partnership may support a test of dry injection of Warrior Run FBA into some remaining void space in the Frazee Mine at Winding Ridge to take advantage of the baseline of data available for this site.)

4) Application of CCB's in active mines to improve existing water quality and to reduce subsidence and improve resource recovery in underground mines.

CONCLUSIONS

The Maryland CCB/AMD Partnership is satisfied the properly engineered application of CCB's in abandoned and active coal mines is not a threat to the environment and can be very beneficial. However, each power plant is unique and the properties of its combustion products are determined by the fuel burned and emission control technologies employed. Thus both the combustion products employed and the site where they are to be used must be carefully characterized before combustion products are used in mining situations.

The Winding Ridge project not only demonstrated a technical approach to using CCB's in deep mine reclamation, it has demonstrated that Industry and State and Federal Agencies can work jointly with Local Governments on legacy environmental problems that are too big for any one entity to take on alone. The initial results at Winding Ridge and initial characterization work at the Kempton Complex suggest that abandoned mines may just be the best place for a large percentage of our coal combustion products. The replacement of coal with artificial stone prepared from coal combustion products may save both our mountains and our mountain streams.