Testimony by
G. Michael Lloyd, Jr.
Research Director Chemical Processing
Florida Institute of Phosphate research
1855 West Main Street
Bartow, FL 33830-7718

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FIPR Phosphogypsum Research

Finding environmentally sound ways to utilize phosphogypsum has been a priority issue for FIPR since the Institute was organized. One of the first activities of the Institute was to sponsor an International Symposium on Phosphogypsum in November 1980. The meeting was attended by researchers and users from all over the world and papers were presented describing how phosphogypsum was being utilized throughout the world.

The FIPR research efforts looked at three basic approaches to phosphogypsum utilization, use as a chemical raw material, construction applications (primarily for road beds), and agricultural applications.

In the early 1980s there was a great interest in recovering and recycling the sulfur values in phosphogypsum. This interest was largely economic since sulfur was selling for $156.00 per long ton and sulfur could be recovered from phosphogypsum for less than $100.00 per ton of sulfur. FIPR sponsored research to recover sulfur values as both hydrogen sulfide and sulfur dioxide. By the time the research was completed, the price of sulfur had fallen to well under $50.00 per ton and there was no interest in building full scale operating plants.

In the field of construction activities FIPR elected not to investigate the use of phosphogypsum in wallboard and other related products. While we recognized that phosphogypsum is one of the better gypsums that have been used for this purpose and was being used for wallboard production in a number of countries, the economics for using phosphogypsum for this purpose in this country are such that phosphogypsum cannot compete with FGD gypsum from power plant stack scrubbing. Our primary research thrust was to use phosphogypsum for roadbed construction. Our plan was to

build a secondary road and test it for both environmental and operating characteristics. The same procedure was to be followed next for a primary road and then for an interstate type road.

Two secondary roads were constructed, one in Polk County in central Florida and a second in Columbia County in north Florida. Both were subjected to environmental testing with testing continuing for the Polk County road until today. Testing by the FLDOT revealed that the physical strength of the Polk County roadbed increased with time and use. The road has needed fewer repairs than similar roads in the area. These roads were completed shortly before the EPA ban on phosphogypsum use was issued and plans for the other roads were curtailed.

Agricultural research has been somewhat varied. Early research by Auburn University demonstrated that using phosphogypsum on winter wheat increased yields. Winter wheat in Alabama is planted in the fall and cattle are allowed to graze on the plants until spring. This forage was good for the cattle. Phosphogypsum was tested on truck crops and while yields were not increased for all crops, the quantity of each crop that was considered acceptable for sale was increased since there were fewer blemishes on such plants as broccoli and cauliflower. A very detailed study was carried out on forage grasses to address both the radiological aspects of phosphogypsum application and the increase in protein in the grass and the resulting increased rate of weight gain for the cattle consuming the treated versus the untreated pasture grasses. Radionuclide uptake by both the pasture grasses and the cattle were measured.

Other phosphogypsum agricultural research included using phosphogypsum to ameliorate subsoil acidity syndrome by substituting surface applications of phosphogypsum for deep plowing down to as deep as six feet to turn the soil over and mix it with lime and surface applications of phosphogypsum to increase the rate of water penetration into the soil, thereby significantly reducing soil erosion in heavy rain downpours.

Other phosphogypsum uses that have been researched are the use of phosphogypsum for marine applications as oyster culch and artificial reefs, as a raw material for the production of glass type ceramics that can be use for tiles, etc., and for daily cover in municipal solid waste landfills as a means of speeding the decomposition of the solid waste.

Research into the production of phosphogypsum based glass type ceramic materials has resulted in a very interesting spin off development. One variation for preparing the phosphogypsum for use in ceramic manufacture offers the opportunity to produce hydrogen as a by-product. While this study is in an informal preliminary stage, both NASA and the DOE have expressed interest in the processing scheme under study. The process has the potential to produce significant quantities of hydrogen resulting in reduced green house gas emissions.

EPA's Phosphogypsum Rule

Until December 1989 phosphogypsum was treated as any other item of commerce and was sold for agricultural and other uses in both central and north Florida as well as at all the locations where it was manufactured throughout the country. At that time EPA elected to classify phosphogypsum as a waste and prohibit all phosphogypsum research and uses. Prior to this time EPA had conducted public hearings on whether or not it was necessary to place layers of soil on top of the phosphogypsum stacks to reduce radon emanations from the stacks that might be harmful to people living in the vicinity of the stacks and had concluded that the risks associated with radon from the stacks did not justify such actions

For much of the time following this 1989 rule until the final rule was issued in June 1992, EPA announced they would not enforce the section of the rule related to the use of North Carolina and north Florida phosphogypsum in agriculture and allowed the farmers in Georgia, Florida, Alabama, and North Carolina to continue using phosphogypsum for fertilization. In the time period between November 1989 and June 1992 EPA developed the risk assessments that are used as the basis for the use ban in the 1992 rule. The 1989 proposed rule ban was not supported by such data.

The Fertilizer Institute, representing the industry, filed objections to the rule but EPA elected not to consider revising any part of the rule except that part relating to research. The research rule allowed the use of no more than 700 pounds (approximately one 55 gallon drum) for any single research project. The EPA risk methodology allowed you to use only one laboratory in a three-story laboratory with nine labs on each floor for phosphogypsum research. In addition EPA required that you sample the entire stack for radium before you could remove as little as a one-pound sample from the stack.

The ban on phosphogypsum use for agriculture and road building was based on building a house on the abandoned roadbed or on a field that had received agricultural phosphogypsum applications for 100 years. The residency values of 70 years used to calculate the risk is longer than the residency values used in some other EPA risk calculations.

The agricultural phosphogypsum ban was arrived at by averaging the amounts of phosphogypsum used for sodic soil treatment in California and fertilization practices for peanuts, primarily in Georgia. The two uses are completely unrelated. Considering a soil treatment and fertilization as the same is like saying that apples and oranges are the same because both are fruits or as a farming comparison equating planting seeds with harvesting because both involve using tractors. In this manner EPA arrived at a yearly

phosphogypsum application rate of 1350 pounds per acre per year that is virtually unknown in fertilization practices in our area and probably in much of the rest of the world.

In 1995 EPA proposed modifying the research rule to allow the researcher to have 7000 pounds on hand and to be able to replenish his supply as long as it did not exceed the 7000 pound limit. In addition you could do phosphogypsum research in all the labs in their three-story model laboratory building without incurring unacceptable risks. They also agreed that sampling the entire stack before you could remove a sample was unrealistic since the researcher would want to analyze his sample before using it and would know what he was using.

EPA's justification for changing the phosphogypsum research rule in February 1999 is quite interesting. These points, quoted from the February 1999 rule change, are discussed in the following paragraphs.

EPA: First, EPA revised the assumption made regarding the number of drums of phosphogypsum that would be opened at any one time and from which radon-222 could therefore escape to the ambient air in the laboratory. During the 1992 rulemaking, EPA's assessment assumed that five such drums would be open. EPA changed this assumption to reflect that at most only one single drum would be open under actual conditions in laboratories.

Comment: Since a single drum would contain approximately 700 pounds of phosphogypsum, having five drums in a laboratory or anywhere else at the facility would violate the 1992 rule limiting research to 700 pounds and was not likely to happen.

EPA: Second, EPA changed the assumption regarding how much of the radon-222 that is present in the phosphogypsum actually emanates into the ambient air of the laboratory. When setting the 1992 rule, EPA assumed that all the radon-222 generated by the radium-226 in phosphogypsum would be released.

Comment: The radon-222 emanations measured by EPA before making the 1989 rule and available to EPA when the 1992 rule was made did not support the emanation rates used.

EPA: Third, EPA revised the assumption on the number of hours a researcher spends in the laboratory from 4,000 hours down to 1,000 hours per year. The value of 4,000 hours that was used in the 1992 rulemaking exceeded by 100 percent the typical occupational year of 2,000 hours. The value of 1,000 hours was judged to be a more realistic estimate.

Comment: No comment needed.

Another problem with the 1992 rule is the procedure for requesting an exemption to the rule that would allow use of phosphogypsum for any purpose other than the one stated in the rule. While EPA said in 1992 that they would define the requirements for an exemption request, they have failed to provide this guidance. After asking for assistance a number of times, FIPR elected to file exemption requests that we felt satisfied the rule

requirements. In these instances we have been faced with a long wait before being advised that some additional information is needed only to be told after another long wait that some other additional information is needed. This makes it extremely difficult to make any progress.

The 1992 rule allows the use of north Florida and North Carolina phosphogypsum in agriculture and prohibits all other uses. Using EPA's own methodology it is easy to demonstrate that the risk associated with using north Florida phosphogypsum for road beds, municipal solid waste landfills, and any other use will not generate a risk that exceed the EPA's acceptable risk. In fact the calculated risk for use in roadbeds is less than the risk associated with agricultural uses

Another difficulty in dealing with EPA is the almost constant changes in personnel responsible for responding to requests for instruction relative to the phosphogypsum rule and how to prepare an acceptable exemption request. About the time the person in EPA learns what the rule is, he or she is off to some other position and we start all over with a need to repeat everything again to get back to where we were before the personnel change took place.

It should be noted that most of the time whenever we have been able to get EPA to meet with us to discuss our concerns, progress is made. However, it is not always simple to arrange such a meeting.

The question may be asked as to why we are so interested in using phosphogypsum for the purposes we have researched. To begin with we are convinced that the long term adverse environmental effects of leaving the phosphogypsum in stacks greatly exceeds any risks associated with its use for any of the purposes we have researched

When it comes to road building the economic advantages are impressive. When a two lane sixteen foot wide secondary county road was built in Polk County, FL, the saving when using phosphogypsum for the road base as compared to traditional road building materials and practices is almost $100,000 per mile. This translates to approximately $300,000 for a mile of interstate where there are two lanes that are twenty-four feet wide for each direction. The other interesting fact is that the phosphogypsum road base increases in strength with time as determined by FLDOT testing. The economic benefit of this effect has not been estimated. We recognize that phosphogypsum transportation costs will limit the areas in Florida where phosphogypsum could be used for road building but the economic advantages where it could be used are significant.

The potential economic importance of phosphogypsum to agriculture could easily exceed the advantages that could be realized in road building. Soils in Florida and all of the southeastern United States are generally deficient in sulfur. Phosphogypsum is the lowest cost way to correct this deficiency and it provides a sulfur source that is slowly available to the plants due to its limited solubility and is not easily leached out of the soil

by rainfall. There is hardly a crop in Florida that would not benefit from improved sulfur fertilization but perhaps the greatest advantage would be to use phosphogypsum on pastures. With adequate sulfur pasture grasses contain more protein that is more digestible by livestock and results in significant increased weight gain for the animals. It is generally accepted that weight gains increases of twenty per cent over a given time period are not uncommon where the sulfur content of grass is optimum. Since Florida raises more cattle than Texas the potential economic benefit to the Florida cattleman is quite interesting.

Another use that FIPR would like to continue researching is the use of phosphogypsum as a daily cover in municipal solid waste landfills. We have completed both bench and pilot scale testing but have been prevented from going on to a field demonstration test by the EPA's requiring an exemption request for the field testing. It has been more than two years ago that we requested the exemption and we are still waiting. The beauty of this approach is that the bacteria that decompose the waste will use the phosphogypsum as an energy source and continue to operate at top efficiency for the life of the landfill. In a normal landfill bacterial action slows to a crawl shortly after the waste is covered each day by soil. As a result of using phosphogypsum bacterial action is accelerated and it is possible to recover 45-50% of the landfill volume in approximately five years, thereby reducing the need for future landfills by 50%.