

**ANNUAL PROJECT REPORT
AS OF JANUARY 2002**

1. PROJECT SPONSOR

University of Cincinnati
Clifton Ave.
Cincinnati, OH 45221
U.S.A.

2. PROJECT MANAGER

Paul L. Bishop
Professor of Env. Eng.
University of Cincinnati
Cincinnati, OH, U.S.A.
PHONE: (513) 556-3675
EMAIL: paul.bishop@uc.edu

3. OCDO GRANT NO. CDO-D-96-16

4. PROJECT UPDATE____ OR
FINAL REPORT X.

5. PROJECT TITLE: Use of Reclaimed Magnesium Hydroxide as a Wastewater
Treatment Reagent

6. PROJECT TERM: FROM: October 1, 1997 TO: January 31, 2002

7. BUDGET:

CO-SPONSORS NAME	COST-SHARE
OCDO	\$275,575
University of Cincinnati	\$70,421
Cinergy Inc.	\$139,976
Dravo Lime Co.	\$65,281
TOTAL PROJECT COST: \$551,253	

I. ABSTRACT

8. OVERVIEW OF PROJECT & OBJECTIVES:

The Clean Air Act Amendments allow the burning of high-sulfur coal for power generation, provided that highly effective technologies for sulfur dioxide removal from the stack gases are used. There are many flue gas desulfurization systems available, but all have the drawback of costly disposal of the calcium-based sludge generated. Dravo Lime Company has for many years supplied a magnesium-containing lime for use in flue gas desulfurization. Dravo Lime and Cinergy have demonstrated that the magnesium hydroxide can be successfully and economically recovered from the magnesium-enhanced desulfurization process.

This project investigated the potential applications of the recovered magnesium hydroxide for municipal wastewater treatment. More specifically, the objectives included:

- Comparison of magnesium hydroxide with other acid neutralization chemicals in terms of acid neutralization capacity and buffering intensity;
- Evaluation of magnesium hydroxide in improving activated sludge's settleability in secondary clarifiers and dewaterability in sludge dewatering processes;
- Investigation of magnesium hydroxide in enhancing anaerobic sludge digestion efficiency;
- Exploration of magnesium hydroxide in nutrient removal from wastewaters;
- Cost analysis on the use of magnesium hydroxide for wastewater treatment; and
- Research on the problems of struvite formation in wastewater treatment plant and the corresponding preventive strategies.

9. WORK DONE AND CONCLUSIONS:

Extensive and intensive research were carried out at bench, pilot and field scales, and exciting results were obtained. Comparison studies between magnesium hydroxide and other commonly used chemicals revealed that magnesium hydroxide was a more effective neutralization agent than other chemicals tested, which implies that with its use less chemicals would be required to neutralize the same amount of acids than with the use of conventional neutralizing agents. Evaluation of the effect of magnesium hydroxide on the microorganisms' physical and biological properties demonstrated that magnesium hydroxide could effectively improve the settleability of the mixed liquor in aeration tanks and the dewaterability of the anaerobically digested sludge in the sludge dewatering facilities, respectively. Investigation of magnesium hydroxide application in anaerobic sludge digesters showed that magnesium hydroxide enhanced the overall process, in terms of percent organic matter destruction and biogas production rate. Furthermore, with the amendment of magnesium hydroxide, the anaerobic supernatant had a lower level of nutrients, implying that the biosolids thus generated have a higher agricultural value. Experiments on nutrient removal revealed that magnesium hydroxide was very effective in the removal of phosphate from the wastewater generated in the sludge dewatering facilities. It is more effective than other commonly used chemicals, e.g., ferric chloride and aluminum sulfate. Cost analyses indicated that magnesium hydroxide could be a very cost-effective chemical agent for pH/alkalinity adjustment in sludge digesters and for nutrient removal from anaerobic sludge digestion supernatant. Removal of the phosphate and part of the ammonium present in this wastewater decreases the nutrient back-load to the treatment plant head works, reduces the risk of struvite formation in the pumps and pipes, and generates a potentially valuable agricultural fertilizer.

Both lab scale and pilot scale experiments were conducted to study struvite formation in sludge dewatering facilities. The experiments indicate that struvite formation occurs easier on rough materials (cast iron, for example) than smooth materials (stainless steel or PVC). It also occurs where the flow rate becomes slower.

10. PLANS FOR COMING YEAR:

The project is now complete.

II. HIGHLIGHTS/ACCOMPLISHMENTS

11. The primary objective of this project was to determine the efficacy of using a component of the waste treatment stream from a coal-fired power plant as a chemical agent in the treatment of municipal wastewater and/or sludge. The results are a conversion of a waste material into a usable product, a reduction in waste disposal costs to both the power utility and the wastewater treatment plant, and a potential new source of income to the utility. The benefits to the general public are improved environmental quality, prevention of pollution at its source, rather than having to deal with it in the environment, and lowered costs for both power production and municipal wastewater treatment. More importantly, the generated product from the nutrient removal process using magnesium hydroxide is a valuable slow release agricultural fertilizer.

III. ARTICLES/PRESENTATIONS

12. Several technical papers have been or will be published/presented in high quality journals/conferences. These include but are not limited to:

- Bishop, P.L., Wu, Q., Keener, T.C., Zhuang, L., Gurusamy, R. and Pehkonen, S., "Application of recovered magnesium hydroxide from a flue

- gas desulfurization system for wastewater treatment”, *Proceedings 16th Annual International Pittsburgh Coal Conference*, Pittsburgh, U.S.A., Oct. 11-15, 1999.
- Wu, Q., Bishop, P.L., Keener, T.C., Stile, L. and Stallard, J., “Improving anaerobic sludge digestion using magnesium hydroxide, *Proceedings International Symposium on Biogas Technology (Anaerobic Digestion) and Sustainable Development*, Beijing, China, Oct. 24-27, 2000.
 - Wu, Q. and Bishop, P.L., “Sludge digestion enhancement and nutrient removal from anaerobic supernatant by $Mg(OH)_2$ application”, *Proceedings Conference on Wastewater and EU-Nutrient Guidelines*, Amsterdam, The Netherlands, Sep. 27-29, 2000.
 - Wu, Q., Bishop, P.L., Keener, T.C., Stallard, J. and Stile, L., “Sludge digestion enhancement and nutrient removal from anaerobic supernatant by $Mg(OH)_2$ application”, *Water Science and Technology*, 2001, Vol. 44, No.1, pp. 161-166.
 - Wu, Q., Bishop, P.L. and Keener, T.C., “Enhancing struvite formation from anaerobic supernatant”, *Proceedings, 2nd International Conference on Recovery of Phosphates from Sewage and Animal Wastes*, Noordwijkerhout, Holland, March 12-13, 2001.
 - Wu, Q., Bishop, P.L. and Keener, T.C., “ Biological phosphate uptake and release: effect of pH and Mg^{2+} ”, *Proceedings, WEF Special Conference on Plant Operations and Maintenance of Small & Medium Wastewater Treatment Plants*, Cincinnati, Ohio, USA, September 16-18, 2001.
 - Wu, Q., Bishop, P.L. and Keener, T.C., “A New strategy to reduce the risk of struvite deposition in municipal wastewater treatment plants”, *Proceedings, WEF Special Conference on Plant Operations and Maintenance of Small & Medium Wastewater Treatment Plants*, Cincinnati, Ohio, USA, September 16-18, 2001.
 - Wu, Q., Bishop, P.L. and Keener, T.C., “Improving the settleability and dewaterability of activated sludge: applications of magnesium hydroxide”, *Proceedings WEF Special Conference on Plant Operations and*

Maintenance of Small & Medium Wastewater Treatment Plants, Cincinnati, Ohio, USA, September 16-18, 2001.

- Wu, Q., Bishop, P.L. and Keener, T.C., “Use of seeding materials to enhance struvite crystallization”, *Environmental Technology* (in preparation).
- Wu, Q., Bishop, P.L. and Keener, T.C., “Applications of magnesium hydroxide for municipal wastewater treatment: pros and cons”, *Journal of Environmental Engineering* (in preparation).
- Wu, Q., Bishop, P.L. and Keener, T.C., “A new strategy to reduce the risk of struvite deposition in municipal wastewater treatment plants”, *Water Environment Research* (in preparation).
- Wu, Q., Bishop, P.L. and Keener, T.C., “Biological phosphate uptake and release: effect of pH and Mg^{2+} ”, *Water Environment Research* (in preparation).