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LIME IN ENVIRONMENTAL USES
MUNICIPAL WASTE WATER TREATMENT

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The early use of lime by man is lost in the remote antiquity of civilization. Archeologists tell us that prehistoric man was aware of some of the properties of lime as early as 700,000 years ago: that it reacted with water, and that lumps of quicklime melted in the rain to form the white paste we know as hydrated lime. They used this white paste to paint their bodies, and maybe even to make bricks and treat human waste.

We do know that the Indus civilization, Central Iraq, about 2500 BC had a highly developed culture, with extensive production of gold, bronze, tin and a well developed commerce including wheeled vehicles. They also had well-built houses with baths, and drainage systems made of brick. Practically every house in Mohenjo-daro had a bathroom, always placed on the street side of the building for the convenient disposal of waste water into the street drains. Upper floor baths drained through terra-cotta pipes with closely fitting spigot joints. These ancient terra-cotta pipes are still sound after nearly five thousand years!

We don't know that they used lime in treatment of sewage, but I suspect that they did, for historical accounts show the Egyptian soldiers using lime to control odors in their field latrines.

During the dark ages, civilization lost many arts and sciences, among them the art of sewage collection, treatment and disposal.

The great cities of Europe - Rome, Paris, Berlin and London became cesspools and the odor was so bad that often people could not stand the stench. Even Parliament was often dismissed! We do know chloride of lime was used to disinfect and control odors, after the fact.

However, it was late in the 19th century before sanitary engineers developed waste water treatment plants in England and Europe. Germany developed land application schemes that worked fairly well, but all were faced with separation of the solids from the waste water.

Chemical treatment was first tried in Paris around 1740; however, little progress occurred until about 1860. More than 400 patents were issued, mostly English, covering this method of treatment in the ten years preceding 1875. Many systems were tried successfully in the laboratory, but often failed in the plant, frequently due to the operator problem.

Many interesting chemical schemes were tried such as lime, wood ash and animal blood as clarifiers. Perhaps the animal blood supplied iron salts; as you know, iron salts mixed with lime is a standard treatment today. Also many types of clays were used, along with wood pulp and shredded paper. Patents were issued in the late 1800's covering the use of lime in the clarification of waste water. Some processes used lime similar to the lime softening process. Excess lime flocculated the small particles and aided sedimentation, creating a sufficient alkalinity/pH to control odors and kill bacteria.

In the United States, several processes were patented that used lime to treat waste. All were certainly ahead of their time, but often were not successful because waste water plant operators were generally unable to understand the relatively simple chemical processes and controls necessary for the successful operation.

In the early part of the 20th century several successful early chemical plants in the U.S. included Grand Rapids, Dearborn, Coney Island, East Lansing, Birmingham, Indianapolis, Oklahoma City and San Antonio.

In the 1930's, E.E. Butterfield proposed and patented a waste disposal system to treat waste water with lime, dewater the solids, mix them with solid household refuse and incinerate the entire mass, generating steam and electricity for the city, thus paying for the process. Several pilot plants were built in Dearborn, MI, Philadelphia, PA and Washington, DC. It seems to me to be a super idea! It still does today. But, what happened? Well, I'm not sure, but the Depression and the demand for financing for further development of the process and the availability of "wide open spaces" (i.e., landfills) resulted in short term denial, and long term problems. So, here we are today, still facing these same problems.

In the late 1930's, the Putnam Process utilized lime, carbon and ferric chloride. The carbon was obtained from distillation of the dewatered (cake) sludge. The off gases were used for fuel. This process accepted waste water solids and garbage.

In the mid 1940's, the Lewis process was installed in many cities such as Lebanon, OH, Freeburg and Dillsburg, PA, and others. Mr. Lewis treated waste water with mixtures of lime, wood pulp and cottrell dust, doing an effective job of clarification, with the resulting solids being stabilized by the lime and the cottrell dust.

Do you know what cottrell dust is? Mr. Cottrell, who just last year was inducted into the "hall of fame" for inventors, was the inventor of the electrostatic-precipitator, dust control devices. These were used to control dust from the cement manufacturing industry. Cottrell dust is cement kiln dust or CKD! In the 50's Mr. Cottrell's company was re-organized into Research Cottrell.

Many other processes have been patented using the properties of lime as a major component of their process. Even today we are still seeing new processes being developed around lime or lime based products such as kiln dust. I encourage and applaud these developments. Some are very good and when utilized in specific applications are beneficial.

The Natural Cycle: The Natural Cycle is Beneficial Reuse. We grow food - plant and animal sources, and humans and animals consume foods, generating waste. That waste is spread upon the land, fertilizing the soil to grow more food. A beautiful, beneficial reuse - Nature's way of maintaining soil fertility. It is a good plan!

Then, as humans began to congregate into cities, the crowding of many people and animals together - waste could not easily be hauled and spread on the land, and the wastes became a nuisance and harmful to our health.

No longer being recycled as nature intended, we looked for other solutions. About 1900, we developed waste water treatment plants to digest waste - actually use up the beneficial materials that are natural fertilizers, and only spread the residuals - sludge - on the land - certainly not the beneficial reuse as God had planned. Now this concentrated waste can and does cause problems: odors, diseases, and later heavy metal concentrations in the soil, poisoning the soil.

So, why do we treat sewage?

1. Reduce Volume
2. Odor Control - H_2S
3. Disease Control - Bacteria/Virus
4. To Chemically Fix Heavy Metals (Lead, Cadmium, etc.) that are carried in the sludge to prevent migration to our soils and water

Chemical lime (Calcium Oxide/Calcium Hydroxide) a natural chemical has been used so successfully because it does meet those requirements of: Odor Control, Disease Control (both bacterial and virus control), and Heavy Metals.

Its use is probably the most economical method of treating waste materials available to any municipality! And because it is such a simple, straight forward natural process, it often is the choice process for treating wastes.

Today, lime is used in the treatment of municipal liquid wastes to clarify and settle raw sewage, to adjust the pH in digestors, to condition liquid sludges (along with Ferric Chloride) prior to dewatering, and to bacterially stabilize the sludges making them safe for beneficial reuse. Lime treatment also removes phosphates from the sewage preventing eutrophication and algae blooms in the receiving waters.

Lime - quicklime, hydrated lime, is a wonderful chemical. It is not a carcinogenic or toxic material and is relatively safe to use. When mixed with water it imparts a high pH - 12.4 and calcium alkalinity. This high pH environment will destroy pathogens and viruses and eliminate odors such as hydrogen sulfide. When quicklime is mixed with water, such as in sludge cake, an exothermic (heat generating) reaction occurs as the quicklime hydrates. Theoretically, temperatures of up to 576°F can be achieved with quicklime and water vapor! Pasteurization temperatures (158°F/30 minutes) are easily achieved (in insulated containers). The resulting treated biosolids are safe to use in land application and agricultural use. These lime treated bio-solids are valuable fertilizer and soil conditioning agents.

The process is not new. Many municipalities in the Northeast have been utilizing quicklime in sludge for years. It was recommended by the EPA in 1974 (Dean and Smith), and is utilized by many plants in Sweden, Denmark and Europe, as reported by Anderson in '78 at the International Lime Congress in Hershey, Pennsylvania.

Land application of lime treated sludge was evaluated by Counts and Shuckrow in 1975 in an EPA sponsored research project and is promoted by many patented processes such as Manchak's Roediger's, Nicholson's, Bio Fix's, RDP's, Wurtz's and others. Post lime treatment is described in the EPA Process Design Manual in 1979. (Stabilization plus pasteurization) pages 6 - 114.

Dr. Ririe stated in his doctoral thesis at Rutgers University, Soil and Plant Studies with Liming Materials, that "the maintenance of a suitable soil pH is the chief factor in the control of the availability of many soil nutrients to plants, and in limiting the action of toxic quantities of some elements. In addition, lime serves as a suitable source of Ca and Mg, two of the key elements in plant nutrition. It also exerts an influence on the physical condition of the soil, by flocculating soil colloids and aiding in soil aggregation. It stimulates organic matter production by increasing crop growth, microbial population and activity, and animal life, such as earthworms - all of which play a vital role in the maintenance of soil tilth, fertility, and conversation."

Dr. Ririe's work also pointed out that even when hydrated lime was applied in large amounts (16,000 lbs/A $CaCo_3$ equivalent) the soil pH remained at an acceptable level - between 6.1 and 7.6 - showing that lime application to agricultural soils is very beneficial.

Septage

In household septage collection, hydrated lime is used to bacterially stabilize the septage prior to disposal on agricultural lands. Sufficient hydrated lime is added to the pump tank truck so the pH of the septage remains at 12 or greater for a period of 30 minutes or longer. This generally requires about 50 lbs of lime per 1000 gallons of septage. To insure good mixing, lime is added to the septic tank, or vacuumed into the suction hose as the septage is pumped into the tank truck.

Summary

Most of the early processes were "before their time," with no real need perceived by the municipalities. I believe that "now" is e time to again evaluate these processes because there is a real need to effectively, economically treat and use this valuable bio-solids resource.

Lime the natural chemical is certainly worth consideration and evaluation when exploring processes to treat our wastes.

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