The Use of Magnesium Hydroxide Slurry as a Safe and Cost Effective Solution for \( \text{H}_2\text{S} \) Odor, Corrosion, and FOG in Sanitary Sewer Systems

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Disengagement of Federal involvement in wastewater infrastructure build-out and maintenance as evidenced by dramatic decline in Federal funding has left many municipalities short on the means to conduct a demanding responsibility. Maintaining wastewater infrastructure is a challenge for many municipalities, particularly in areas where there are long retention times in the collection system, high sulfur content and a high concentration of fats, oils and grease (FOG) that can lead to the formation of hydrogen sulfide (H\(_2\)S) gas. The use of magnesium hydroxide (Mg(OH)_2) as a treatment agent is a significant development in wastewater management in the last 30 years.

Although the job of controlling water pollution remains unchanged, wastewater characteristics have changed from the beginning of publicly-owned treatment works (POTW) in the early 1900’s until the present. During the last 25 years, regulatory changes that were designed to help make sure that some parts of the environment were protected, have resulted in a deterioration of municipal wastewater infrastructure. These changes have fundamentally altered the physical, chemical, and biological properties of wastewater, making treatment more challenging to wastewater professionals than ever before.

Hydrogen sulfide has increased in recent years. Sulfides have risen steadily from the early 1980’s to the 2000’s due to longer retention times caused by urban sprawl with centralized treatment, and change in wastewater biochemistry due to pretreatment legislation. To protect public health, the Environmental Protection Agency’s (EPA) 1983 Categorical Pretreatment Act severely reduced metals limits for industrial dischargers. Heavy metals react with dissolved sulfide in wastewater and render it insoluble. In the absence of metals, the dissolved sulfide concentration has increased over the last twenty years. With longer retention times through the sanitary sewer system, the wastewater becomes anaerobic which favors sulfate reducing bacteria (SRB). As a result, H\(_2\)S gas forms which imparts a rotten egg odor.

Corrosion in the sanitary sewer system occurs when H\(_2\)S is biologically converted to sulfuric acid by \textit{Thiobacillus} bacteria. Although reducing metals was necessary to protect public health, pretreatment has contributed significantly to increased sulfides, leading to heightened H\(_2\)S odor and ultimately to accelerated corrosion. The implications of hastened corrosion are clear. In 2000, EPA estimated that municipal sewers are failing six times faster than their rehabilitation rate. The EPA predicts that by 2016, over 50% of the United States’ 600,000 miles of sewer lines will be in poor, very poor, or inoperable condition.

As the main contributor to odor and corrosion in wastewater collection systems, H\(_2\)S is typically treated with odor control agents that can be costly and ineffective in providing its long lasting removal throughout the collection system. Unlike odor control agents which are costly, ineffective, short lived, or narrowly targeted at a single issue, magnesium hydroxide slurry offers a safe and cost effective strategy for managing odor, prolonging infrastructure life, eliminating FOG and enhancing wastewater treatment processes downstream. Magnesium hydroxide is a concentrated alkaline slurry that neutralizes acids and prevents the formation of H\(_2\)S gas by controlling wastewater pH. It is available as an aqueous suspension, similar to milk of magnesia, which buffers to a controlled pH of 9.0. As such, it is non-hazardous, non-corrosive and safer to handle than most odor control agents.
Magnesium hydroxide is effective in eliminating H$_2$S by reducing both dissolved sulfide production and headspace H$_2$S gas, but it also offers additional benefits as well. For example, the introduction of magnesium hydroxide does not lead to the formation of additional unwanted sludge, as often happens with lime and iron salts. Additionally, it provides long-lasting alkalinity, slowly dissolving to increase the pH of the water to an optimum pH range that significantly reduces the formation of H$_2$S and prevents further corrosion of sewer lines. Magnesium hydroxide's pH buffering ability provides effective treatment for miles downstream from the addition point thus reducing the number of chemical injection points needed.

**How Does Magnesium Hydroxide Work?**

Magnesium hydroxide is effective in treating odor by raising the pH of the wastewater to a point where H$_2$S gas production is greatly reduced or eliminated. As shown in Figure 1, the solubility of the sulfide ion increases as the pH increases, resulting in greatly reduced H$_2$S gas release into the sewer headspace.

Not only is odor a problem when H$_2$S gas is formed, the presence of H$_2$S gas in the headspace also generates sulfuric acid as shown in Figure 2. The generation of sulfuric acid from H$_2$S gas can drastically reduce the life of a sewer system. Figure 3 shows the effect of wastewater pH on sewer line corrosion. Wastewater with a pH of 6.5 and a sulfide concentration of 5 mg/L can corrode at a rate of 0.1 inches (2.55 mm) per year. By raising the pH to 8, the corrosion is reduced almost 88% to a rate of only 0.012 inches (0.305 mm) per year. This reduction in corrosion rate changed the life expectancy of the sewer from 20 years to 160 years. Eliminating the premature line corrosion allows municipalities to get the full life out of the sewer system and saves millions in costly repairs.

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Other benefits of using magnesium hydroxide can include reduction of FOG, additional alkalinity in the system and in the wastewater treatment plant, and increased settling at the wastewater treatment plant by increasing the divalent-to-monovalent cation ratio. Magnesium hydroxide is a milder alkali than other industrial chemicals used for pH control and has limited solubility, which makes it unlikely for pH excursions past 9.0. This proves to be beneficial to wastewater treatment plants with biological systems. If an accidental release or over usage of slurry occurs in the system, most “bugs” can withstand that pH range and the additional magnesium hydroxide

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**Sanitary Sewer System Benefits**

Because magnesium hydroxide adjusts wastewater alkalinity and is not dependent upon dissolved sulfides, changes in sulfide levels in wastewater do not alter treatment effectiveness. Instead, magnesium hydroxide decreases the rate of sulfide production by shifting the pH range upward, away from the ideal sulfide production range of sulfate-reducing bacteria. While wastewater ionization and retention times vary from system to system, typically 100 to 200 gallons of magnesium hydroxide per million gallons of flow are required to raise and hold wastewater pH to the target range of 8.0-8.2.

Magnesium hydroxide particles dissolve only as the pH calls for it, providing residual effect miles downstream of the injection point. Since alkalinity is released as needed through dissolution, magnesium hydroxide acts as a buffer, without overshooting pH. Magnesium hydroxide will continue to dissolve and remain available hours after its addition. As a result, less feed points are required compared to other odor control methods thus reducing equipment costs and maintenance.

Municipalities are making the conversion from commonly used odor control agents to magnesium hydroxide slurry in order to effectively eliminate H2S odor and corrosion, as well as FOG. Here are typical examples showing H2S elimination during the addition of magnesium hydroxide:

![Graph showing H2S data over time](image)

**Figure 4.** Thioguard® Magnesium Hydroxide Treatment of H2S at a Lift Station in Canton, OH.

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In all cases, the pH of the wastewater was raised to a pH above 8.0 to prevent the formation of H₂S. The H₂S concentration was significantly reduced over the length of the treatment period.

Figure 5. Thioguard® Magnesium Hydroxide Treatment of H₂S at a Lift Station in Beach City, OH.

Figure 6. Thioguard® Magnesium Hydroxide Treatment of H₂S at a Lift Station in Steuben Lakes, IN.
Magnesium hydroxide saponifies FOG, which eliminates potential pipe blockages that result in back-ups and sanitary sewer overflows (SSO’s). The fats, oils and grease contained in FOG are converted to glycerin and crude soap. Below are photos taken before and after the addition of magnesium hydroxide into a wet well containing FOG. Shortly after adding magnesium hydroxide, the FOG was eliminated.

![Figure 7. FOG in a wet well prior to Mg(OH)\textsubscript{2}.](image)

![Figure 8. FOG is eliminated after addition of Mg(OH)\textsubscript{2}.](image)

**Treatment Plant Benefits**

The lion’s share of wastewater treatment financial and human resources goes toward treatment plants. This begs the question, “So why is collection system treatment important?”:

1. The collection system presents an opportunity to begin the treatment process early to lessen process burden at the plant.
2. Upstream treatment allows the collection system to realize important benefits.
3. Earlier-in-system start of treatment increases the quality of discharged flow and can reduce total treatment costs.

With magnesium hydroxide, long-lasting alkalinity is provided in the collection system flow which will later benefit the wastewater treatment plant. The slow reaction allows residual magnesium hydroxide to reach the treatment plant where higher quality of collection system flow offers a number of important process benefits:

**Clarifiers** – Plant operating efficiency is improved by treating for Biological Oxygen Demand (BOD), and turbidity, while enhancing sludge volume index (SVI) and settling. Magnesium hydroxide also aids bioflocculation and improves sludge density and sludge dewatering, thus providing for potentially significant savings in transportation.

**Aeration** – pH is shifted into a range more ideally suited for both BOD and ammonia removal. Odor-causing sulfides held in solution by magnesium hydroxide undergoes accelerated oxidation. Because nitrification in the activated sludge process depletes alkalinity, pH often drops potentially arresting second-stage nitrification and...
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Incomplete nitrification, in turn, allows nitrite to pass through the clarifiers and into the chlorination tank, consuming excessive amounts of chlorine and threatening effective disinfection.

**Digesters** – Magnesium hydroxide provides the necessary alkalinity to buffer acid-producing processes typical in biosolids treatment with optimum control and lower solids output. Additionally, dewatering improvement from magnesium hydroxide use reduces drying, hauling, and disposal costs.

Magnesium hydroxide controls the entire wastewater system – not just that portion of the system local to the injection point. Total system treatment is what differentiates magnesium hydroxide from other agents. Unlike these odor control agents, magnesium hydroxide slurry offers a safe and cost effective strategy for managing odor, prolonging infrastructure life, eliminating FOG and enhancing wastewater treatment processes downstream.

**Thioguard® Case Studies Links**

**Pinellas County, FL**
Ronn Chase, Senior Project Manager, Premier Chemicals

http://ww.pennnet.com/articles/article_display.cfm?Section=ARCHI&C=Edito&ARTICLE_ID=256997&KEYWORDS=odor&p=41

**Brunswick, GA**

http://ww.pennnet.com/articles/article_display.cfm?Section=ARCHI&C=Cases&ARTICLE_ID=75140&KEYWORDS=odor&p=41

**Clarksville, IN**
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http://www.wwdmag.com/Becoming-a-Good-Neighbor-article6325