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MICROELECTRONICS
CUSTOMER STORY \ SEPT 2020
MICROELECTRONICS MANUFACTURER

Replacing caustic soda with magnesium hydroxide

for metal ion precipitation

AMALGAM-60

The case study snapshot

Background

A microelectronics manufacturer in the Pacific Northwest was using a complex system of chemical additions in order to effectively remove heavy metal contaminants from their wastewater stream.

OBJECTIVES

Replace caustic soda with a safer and more cost-effective alternative.

CHALLENGES

- The wastewater operator – who was handling heavy bags of MgO and feeding hazardous caustic soda in a complex metal-ion precipitation application – was looking for a safer, better performing, and more cost-effective solution.

SOLUTION

- Bench testing showed potential cost savings of approximately $1,400 per month.
- IER provided and installed an agitated storage tank and metering pump required for the large scale on-line test, along with the associated feed line for AMALGAM-60 product delivery into the pH adjustment tank.

BENEFITS

- AMALGAM-60 successfully adjusted pH of the effluent stream to about 8.3, to maintain the heavy metal concentrations well below the required permit limits.
- AMALGAM-60 also provided a more compact solid settling precipitation and a clearer liquid fraction, when compared to caustic soda.
- This showed AMALGAM-60 was improving the coagulation properties of the polymer despite feeding at a reduced dose.
- An overdose of AMALGAM-60 never cause a pH spike above 10, which commonly occurs when dosing with caustic soda, requiring the operator to handle and feed another highly hazardous chemical - sulfuric acidic.
- AMALGAM-60 proved to be a safe, cost-effective and highly performing alternative to caustic soda for metal ion precipitation.

INTRODUCTION

A microelectronics manufacturer in the Pacific Northwest was using a complex system of chemical additions in order to effectively remove heavy metal contaminants from their wastewater stream.

Semiconductor wastewaters are inherently difficult to treat. They are usually characterized by strong color, high chemical oxygen demand (COD), high levels of volatile organic compounds (VOC) and heavy metals, resulting in potential contamination of the environment. Conventionally, chemical coagulation and biological treatment are used to treat wastewater before discharge.

IER offers innovative solutions to solve this tough-to-treat wastewater challenge.

Owned by Calix, IER is a distributor of magnesium hydroxide products and other innovative environmentally-friendly process water and wastewater treatment chemicals and equipment. Based in Spokane, Washington, IER primarily services the Pacific Northwest and Upper Midwest.

CHALLENGES

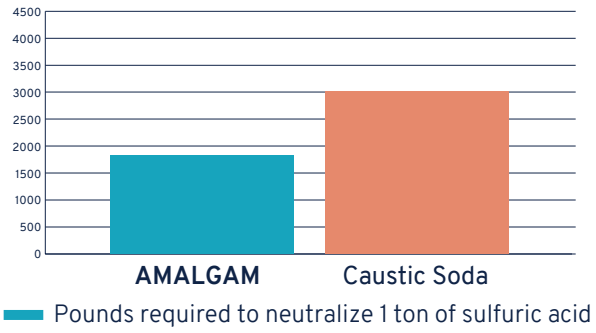
In this particular operation, an acidic wastewater of pH 1.7 containing primarily copper, zinc, and nickel was initially pH-adjusted with 50 lb bags of magnesium oxide (MgO), before the addition of caustic soda (50% NaOH) in order to drive the pH up to ~11.

This was done for the metal ions to be precipitated and separated from the final effluent stream, in the form of insoluble metal hydroxides.

Once the pH was properly adjusted, coagulant and flocculant polymers were added to aid in separation and sludge dewatering.

During a technical sales visit, IER introduced the wastewater treatment operator to the possibility of replacing heavy MgO bags and hazardous caustic soda with IER's nonhazardous AMALGAM-60 in this complex metal-ion precipitation application.

Additionally, he was interested in determining whether there could be chemical cost savings by replacing the use of ~1000 gallons/month of 50% NaOH with the use of AMALGAM-60.



AMALGAM-60 (60% $Mg(OH)_2$) has a higher neutralizing value per pound than any other alkaline additive.

This typically translates into a significant reduction in chemical usage when compared with caustic soda, while being significantly safer for operators to handle and more nutritive for the microorganisms being maintained – making it the most cost-effective option.

SOLUTION

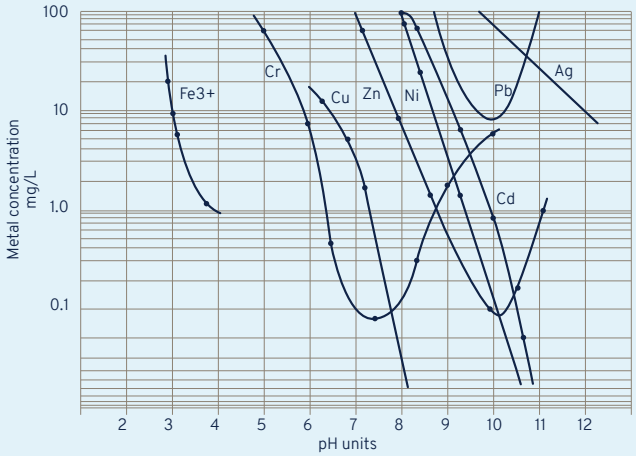
IER takes pride in being a technically credible wastewater treatment company, not simply a magnesium hydroxide supplier. For over 20 years, IER has worked with plant engineers and operators to offer the most cost-effective solutions for their specific needs.

An initial bench testing showed that about 750 gal/month of AMALGAM-60 could be used to replace 1000 gal/month of 50% NaOH, resulting in a cost savings of approximately $1,400/month.

A full-scale evaluation was arranged to determine if the bench testing results could be duplicated in large-scale. IER provided and installed an agitated storage tank and metering pump required for the on-line test, along with the associated feed line for AMALGAM-60 product delivery into the pH adjustment tank.

Hydroxide Precipitation Using Magnesium Hydroxide

The industrial standard method for removing contaminating metal ions from a wastewater stream is by raising the pH to a level that causes the formation of insoluble metal hydroxide precipitates. Below is a graph showing the solubility of common heavy metal ions versus pH.

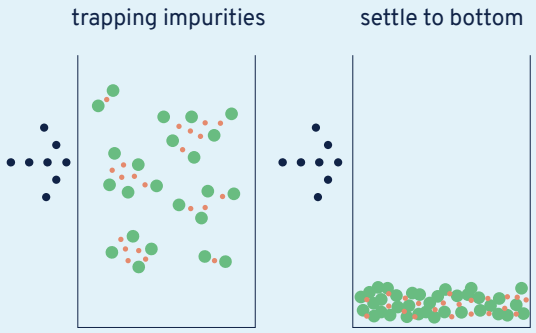


Note that the Y-axis is exponential, showing that changes in pH from 7 to 8 to 9 will result in the solubility of Zinc (Zn) to fall from about 100 mg/L to 10 mg/L to 1 mg/L, respectively. Metal ions of Nickel (Ni) and Cadmium (Cd) require even higher pHs in order to minimize the solubility and cause precipitation.

A unique characteristic of Magnesium Hydroxide is that it provides two different pH environments within the same solution matrix. Most obviously, as $Mg(OH)_2$ dissolves in water it releases free hydroxide ions (OH-) that neutralize any acidity in the water, driving an increase in the bulk water pH. Less obviously, any micron-sized particles of $Mg(OH)_2$ that have yet to dissolve possess a pH within their micro-environment that will be in the range of 9 to 11, providing a nucleation site for those metal ions that form insoluble hydroxides at higher pH values. It is believed that this dual function of magnesium hydroxide allows for effective removal of a full range of heavy metal ions even at bulk water pH values far lower than expected, especially for ions such as nickel. Therefore, though a two-step pH adjustment approach may be needed using caustic soda in order to effectively remove Chromium at pH 7.5 and Nickel at pH 10, the simple maintenance of a pH of 7.5 using $Mg(OH)_2$ provides effective removal of both heavy metal contaminants.

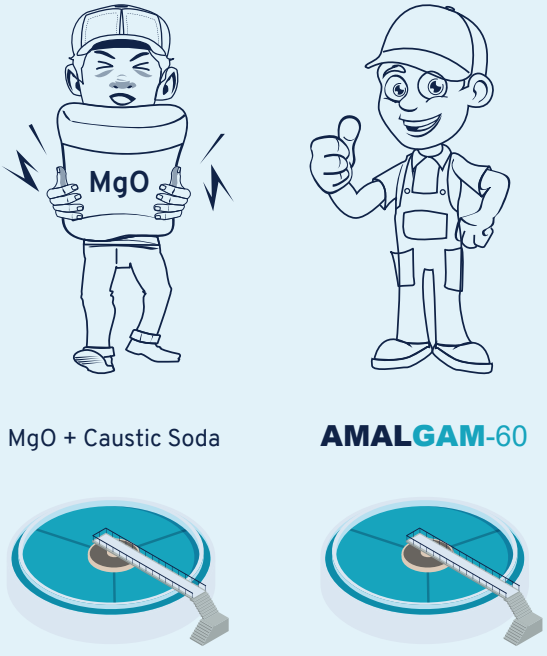
During the trial, AMALGAM-60 performed very well in adjusting pH of the effluent stream to about 8.3 while maintaining the heavy metal concentrations well below the required permit limits.

A side benefit was that the precipitated solids settled more densely (more compact) and the liquid fraction was much clearer (less turbid) when using AMALGAM-60 as compared to caustic soda, indicating that AMALGAM-60 was aiding the polymer to give superior coagulation properties despite feeding at a reduced dose as compared to 50% NaOH.



In order to test the effect of an overdose, a 500 mL sample of acidic wastewater was dosed with AMALGAM-60 to raise the pH to 6.9. At that time, we then injected an additional dose equivalent to 12 times above that which was needed for treatment.

After 30 minutes of stirring the pH had stabilized below a value of 9, illustrating that even a gross overdose of AMALGAM-60 will not exceed their pH regulatory requirement of 10. This was done because it was common for them to accidentally over-feed caustic, requiring them to back titrate with another hazardous chemical – sulfuric acid.



Conclusion

IER was able to demonstrate the safety and performance benefits of replacing caustic soda with Magnesium Hydroxide (AMALGAM-60) for metal ion precipitation.

As a result, IER was awarded the pH adjustment contract, as well as the supply of polymers; thereby becoming the primary wastewater treatment chemical supplier for this facility.

We pride ourselves in being a wastewater treatment partner, rather than a product supplier:

Technically credible

High quality products

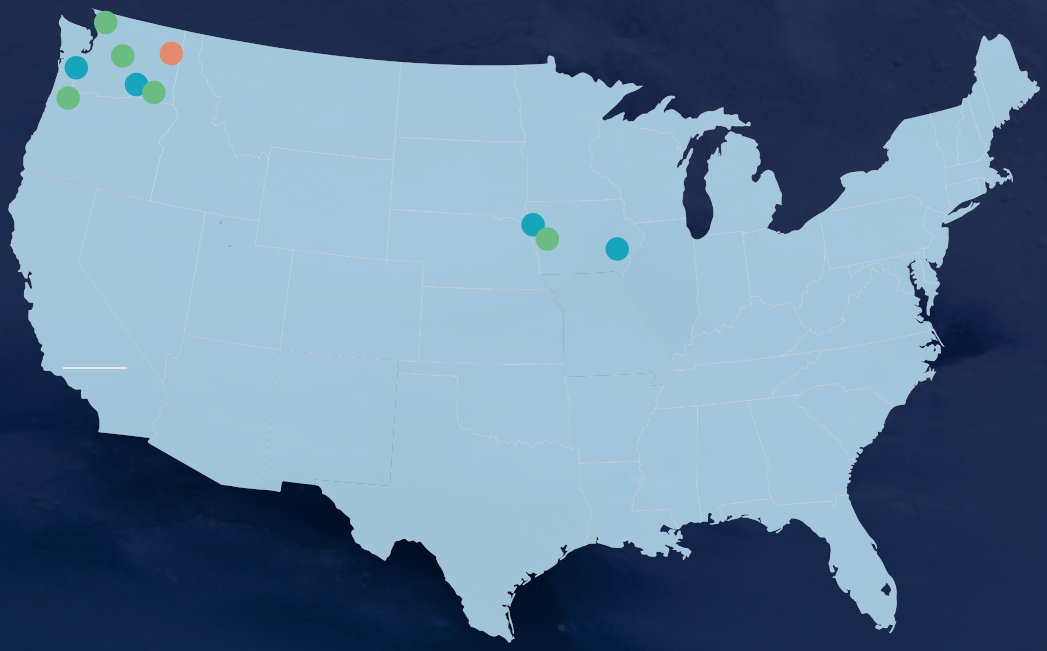
Proactive customer service

IER
A CALIX COMPANY

Corporate Office:
- Spokane, WA

Based in Spokane, Washington, IER primarily services the Pacific Northwest and Upper Midwest with plant locations in Sioux City, Iowa; Muscatine, Iowa; Centralia, Washington and Pasco, Washington.

Operations:
- Pasco, WA
- Centralia, WA
- Sioux City, IA
- Muscatine. IA



Sales/Technical Support Staff:
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- Sumas, WA
- Walla Walla, WA
- Denison, IA
- Gaston, OR

We pride ourselves in being a **wastewater treatment partner.**

We take pride in providing high-quality products, technical credibility in the applications of water, process water, and wastewater treatment, dedicated delivery specialists and equipment, and proactive on-site technical service.

A global supply network

Owned by Calix, an Australian company with global operations, IER brings 20 years of experience working with plant engineers and operators to offer the most cost-effective solutions for their specific needs.

www.calix.global/IER

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