

# New Jersey Program for Manufacturing Excellence



NJME is a technical assistance program for NJ industries that is operated through the Center for Advanced Energy Systems (CAES) at Rutgers, The State University of New Jersey.

Funded by the New Jersey Department of Environmental Protection's Office of Pollution Prevention and Right to Know, the purpose of the program is to improve the competitiveness and efficiency of New Jersey companies, while also reducing the impact on the environment. NJME accomplishes this by promoting energy efficiency and pollution prevention.

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## Casting Company Finds Solution and Savings with the NJME Team:

### Background:

As part of the manufacturing process at a turbine blade casting company, a ferric chloride ( $\text{FeCl}_3$ ) solution is used to etch finished parts. The complete mixture includes hydrochloric acid, nitric acid, water, and ferric chloride. During the etching process, the ferric chloride removes cobalt, chromium, and nickel from the manufactured pieces and produces the waste product ferrous chloride ( $\text{FeCl}_2$ ). Ferrous chloride cannot be used further in the etching process. This in turn produces a large amount of spent etchant as well as sludge that consists of the etched metals and small amounts of ferric hydroxide. In order to find a solution to their problem, the NJME team assessed their facility and investigated potential replacement and treatment options.

### Solution:

The simplest solution to this casting company's problem with ferrous chloride was to find another cleaning agent for the manufactured products. However, after further investigation, resourceful methods of ferrous chloride reduction were found. It was NJME's recommendation that the ferric chloride be regenerated from ferrous chloride. There were two options to consider for this proposed regeneration; one using a precipitation method and the other using electrolysis to regenerate the needed ferric chloride. Upon researching the chemical make-up from the requested lab tests, the team was able to see how much of the ferrous chloride could be regenerated into ferric chloride. NJME recommended that a combination of both methods be used at the facility.

### Options:

#### Chlorine Gas Method:

By introducing chlorine gas to ferrous chloride, it is possible to regenerate ferric chloride. The NJME Pollution Prevention team needed to determine how much chlorine gas was needed to convert the company's 49,997 lbs of ferrous into ferric chloride. Upon further analysis, it was determined that the company would need 13,984 lbs of chlorine gas. It was estimated that the company would have to spend approximately \$5,035 for the chlorine gas per year.

**Electrolysis Method:**

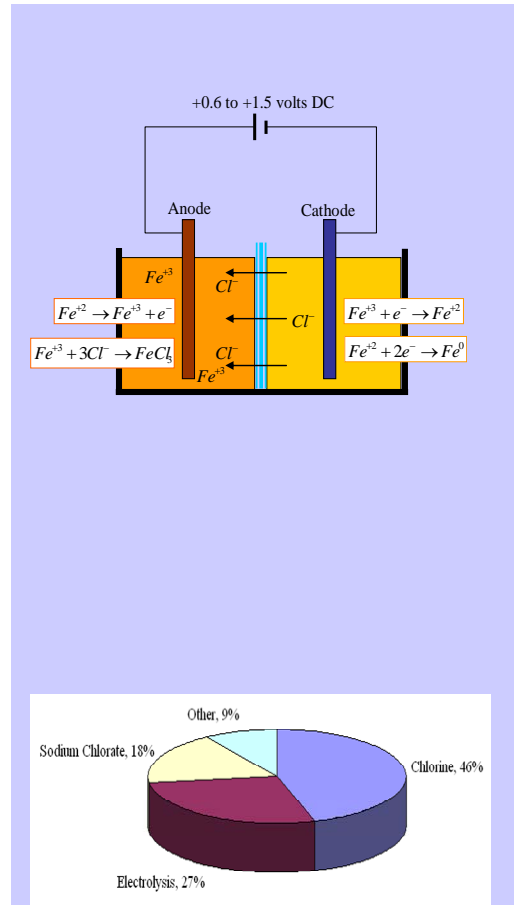
This method is comprised of an electrolysis cell having an anodic compartment containing an anode, a cathodic compartment containing a cathode, and an anion-exchange membrane (which passes chlorine ions and restricts Fe ions) that separates the anodic compartment from the cathodic compartment. The diagram on the right shows the set-up for this method. We again needed to determine how much hydrochloric acid would be needed to regenerate the 49,997 lbs of ferrous chloride. After some research, the NJME team estimated that the company would have to spend approximately \$611 per year for the hydrochloric acid.

**Savings:**

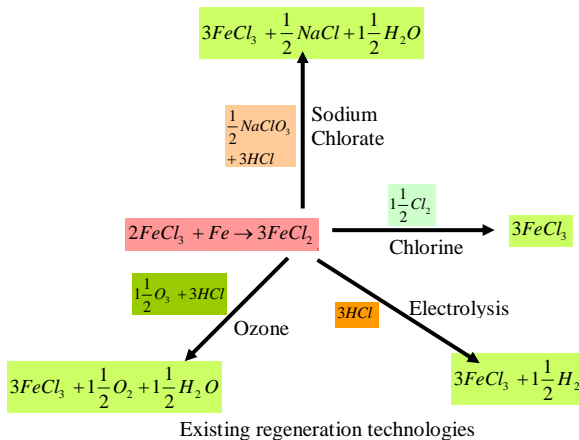
Savings for implementing either or both of these two methods come from the reduction in removal costs from an outside contractor. However, by utilizing the two different methods, the individual savings must be calculated to yield two different cost savings.

The regeneration by chlorine gas yielded savings of \$13,564 per year with a payback period of less than three years. The regeneration by electrolysis yielded savings of \$8,600 per year with a payback period of less than nine years. Though the regeneration by chlorine gas yielded better savings, it has the negative drawback of forcing the company to carry chlorine gas on the site.

These two methods of regeneration are not the only two methods that are being utilized by today's market. However NJME's Pollution Prevention team recommended these two techniques based upon superior convenience, cost, effectiveness and savings.



These are the current practices used to regenerate ferric chloride in industry. It is obvious to see that the majority of industries are currently utilizing either the chlorine regeneration method or the electrolysis method.



The above diagram demonstrates the different methods currently being used and the results of each process.