

## AN EXAMPLE OF CIRCULAR ECONOMY



*“A circular economy is an economic system aimed at minimizing waste and making the most of resources. This regenerative approach is in contrast to the traditional linear economy, which has a “take, make, dispose model of production”.* Wikipedia

Our responsibility toward the environment is an important pillar of ACAT’s mission. ACAT is constantly making efforts to identify the direct and indirect impacts of its customers

business on the environment to help minimize them. ACAT is actively working on circular economy by promoting use of low-impact and regenerative materials. Our team is working in the steel production field to contribute towards it’s re-use of acidic wastes. In particular, ACAT is taking care, in collaboration with 2 multinational companies, of reuse of Spent Pickling Liquor (SPL) in two big groups of steel factories.

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*Steel molten hot*

### PICKLING PROCESS

The purpose of pickling is to achieve a perfectly and chemically clean metallic surface of the steel to facilitate the metallurgical reaction that generate final desired product. During the hot rolling of steel, oxygen from the atmosphere reacts with the surface iron to form a scale of oxides. This scale needs to be removed before steel is further processed in cold rolling mill.

Remove of scale is important for the following reasons:

- A dirty surface will cause the rusting of the strip.
- Scale accelerate corrosion.

- During coating of the strip, scale would causes poor to total adhesion failure.
- Scale removal is essential for cold rolling, annealing and coating operations.

### SCALE REMOVAL

The most used method of scale removal for hot rolled strip is by pickling. The pickling of hot rolled strips is one of the finishing steps of production process by which scale is removed from the surface of steel by dissolution in an acid before hot strip is cooled down and rolled. Pickling is a chemical process and it could be done either with Sulphuric Acid (H<sub>2</sub>SO<sub>4</sub>) or Hydrochloric Acid (HCl). Pickling process with HCl acid started in 1964 and gradually main pickling installations have

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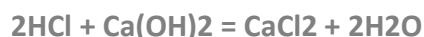
adopted HCl instead of H<sub>2</sub>SO<sub>4</sub>. Hydrochloric acid is now the primary cleaning agent for the process of steel production. HCl solution dissolves the scale from the surface of the hot rolled strip without any significant attack on the steel strip. In this process the following chemical reactions take place:



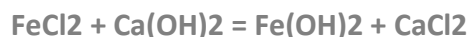
The exhausted acid solution (SPL) can cause severe environmental damage if discharged without an appropriate treatment.

In the small and medium-sized enterprises, the traditional treatment of SPL is an alkali neutralization.

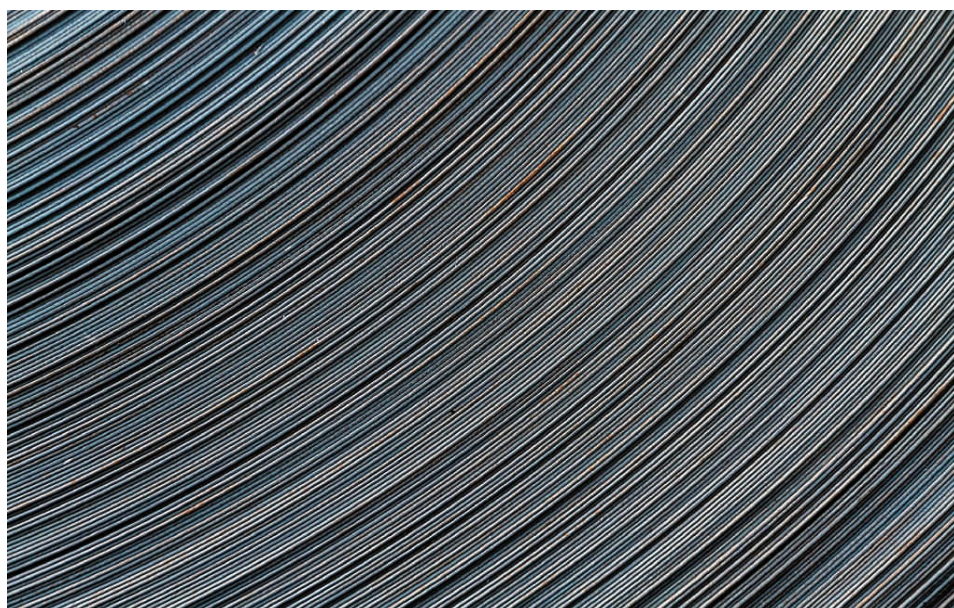
Neutralize excess of HCl with Lime:



This neutralizes the acid but does not solve the problem, as simultaneously a reaction converts the ferrous chloride (FeCl<sub>2</sub>) to a solid ferrous hydroxide (Fe(OH)<sub>2</sub>).



With further flocculation, sedimentation, filtration, and sludge dewatering the treatment effect of this process is in general acceptable, but needs a large amount of chemicals, with production of a lot of sludge to be disposed. Alternatively, concentrate solutions of ferrous chloride can be used to produce Ferric Chloride (FeCl<sub>3</sub>), or used as coagulant in wastewater treatment plants in particular for precipitation of phosphorus.



*Steel Coils after pickling process*

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The action of bivalent or trivalent iron salts converts phosphorus to a solid, insoluble precipitate that can be separate in the sedimentation tank and may be landfilled after separation or used for phosphorus recovery process.

### FERRIC CHLORIDE

Ferric Chloride ( $\text{FeCl}_3$ ) is largely used, as coagulant in sewage treatment and drinking water production. Ferric chloride is used due to its high efficiency, effectiveness in clarification and very good turbidity removal. Ferric Chloride is usually produced and sold as a concentrated solution with a concentration around of 40% by weight.  
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### PRODUCTION OF FERRIC CHLORIDE

Ferrous chloride can be converted to ferric chloride by chlorination:



Pickling solutions are an ideal iron salt source for above reaction, as these solutions are composed of ferrous chloride and diluted hydrochloric acid. SPL ( $\text{FeCl}_2$ ) is converted in ferric chloride normally using chlorine gas.

### FROM A WASTE TO A RESOURCE

Production of ferrous metal products consumes high quantities of limited natural resources (iron ores) and is very energy consuming. However, ferrous metals are 100% recyclable and can be recycled unlimited amounts of times.

Re-Use of SPL ( $\text{FeCl}_2$ ) coming from steel production process saves not only natural resources, but also reduce substantially impact on environment.



*Ferrous Chloride (SPL)*