A Wastewater Case Study:

Sulfate Precipitation

KUSTAN®

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Plastic Engineering for Corrosive Media.

Key
A Focus on the Core Competency of Processing & Handling Corrosive Liquids & Gasses

Focused
- Battery production & recycle
- Metal surface treatment,
- Wastewater & gas treatment
- Industrial chemical handling.

Mission
Quality Engineered Solutions.
Process Innovation.
Customer Satisfaction.

70 Years
Accumulated knowledge in plastic technologies

2
Manufacturing sites in Germany

80
Employees

20 Mio. €
Annual turnover in group

No. 1
Worldwide leading specialist for battery formation

Your Partner for Customized Solutions.

- Turnkey projects
- Compliance with environmental & safety regulations
- Contract engineering
- Custom machine design & development
- Process and equipment optimization
- Design-for-manufacture assistance
- System manufacturing
- Installation, commissioning
- Continuous Improvement
- Lifetime Service Support
- Global spare parts network

Recycling/EHS

It's About Chemistry!
It's About Flow!

Recycling/EHS: Ideas

Lead-Acid

- Equipment Air Scrubbers
- Wastewater treatment—stop shipping totes!
- Acid cleansing and reuse (closed loop)
- Elimination of dump & fill for final gravity
- Automate gel prep & Fill operations

Lithium

- Management of shredding by-product (water, gas)
- Neutralization of waste electrolyte on-site
- Investigation of CAM direct recycle
- Black Mass Value-Add at Recycle Center

Other Ideas

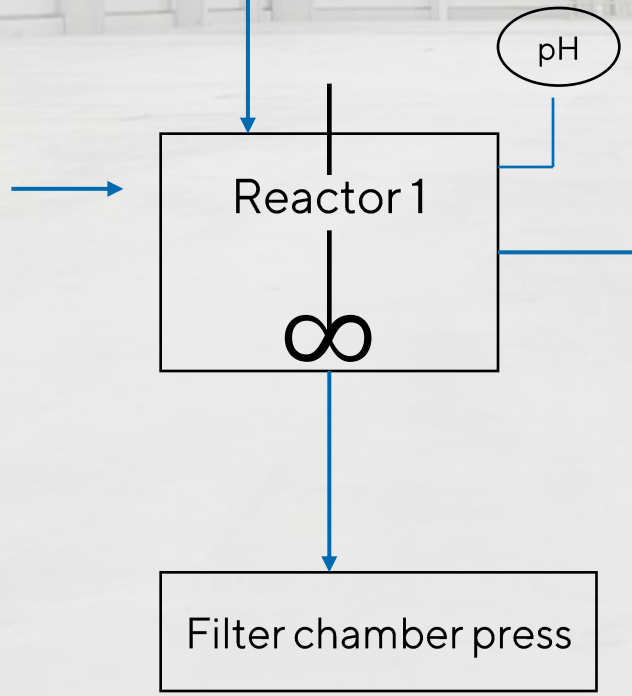
- 2nd life for flow battery electrolytes
- In-Process or External Batch Black Mass "Grading"
- Reactivation through electrolyte refreshment
- Field deactivation of stationary applications

Case Study: Sulfate Precipitation

- EU Lead-Acid Factory
  - Not Meeting Local Wastewater Requirements
    - High Sulfates
    - High Non-Lead Metal Content
  - A Previous Attempt Failed
- To protect concrete, Discharged Wastewater into Sewer System:
  - <400 mg/l or <600 mg/l sulfate content in EU
  - Removal of heavy metals such as antimony, tin, Ni, Cr
- A specially developed precipitation process was developed in-house to meet legal limits
  - ADF 400 2-Stage Process
  - 50 m^3 of wastewater per day
  - Reduces the sulfate content to <400 mg/l, lead content to <0.5 mg/l, other metals well below requirement
- The dewatered sludge is sold as a by-product (gypsum) due to its low heavy metal content.

Sulfate Precipitation: Stage 1

Wastewater Sources:
- Paste Production
- General Dust
- Floor Cleaning
- Acid management

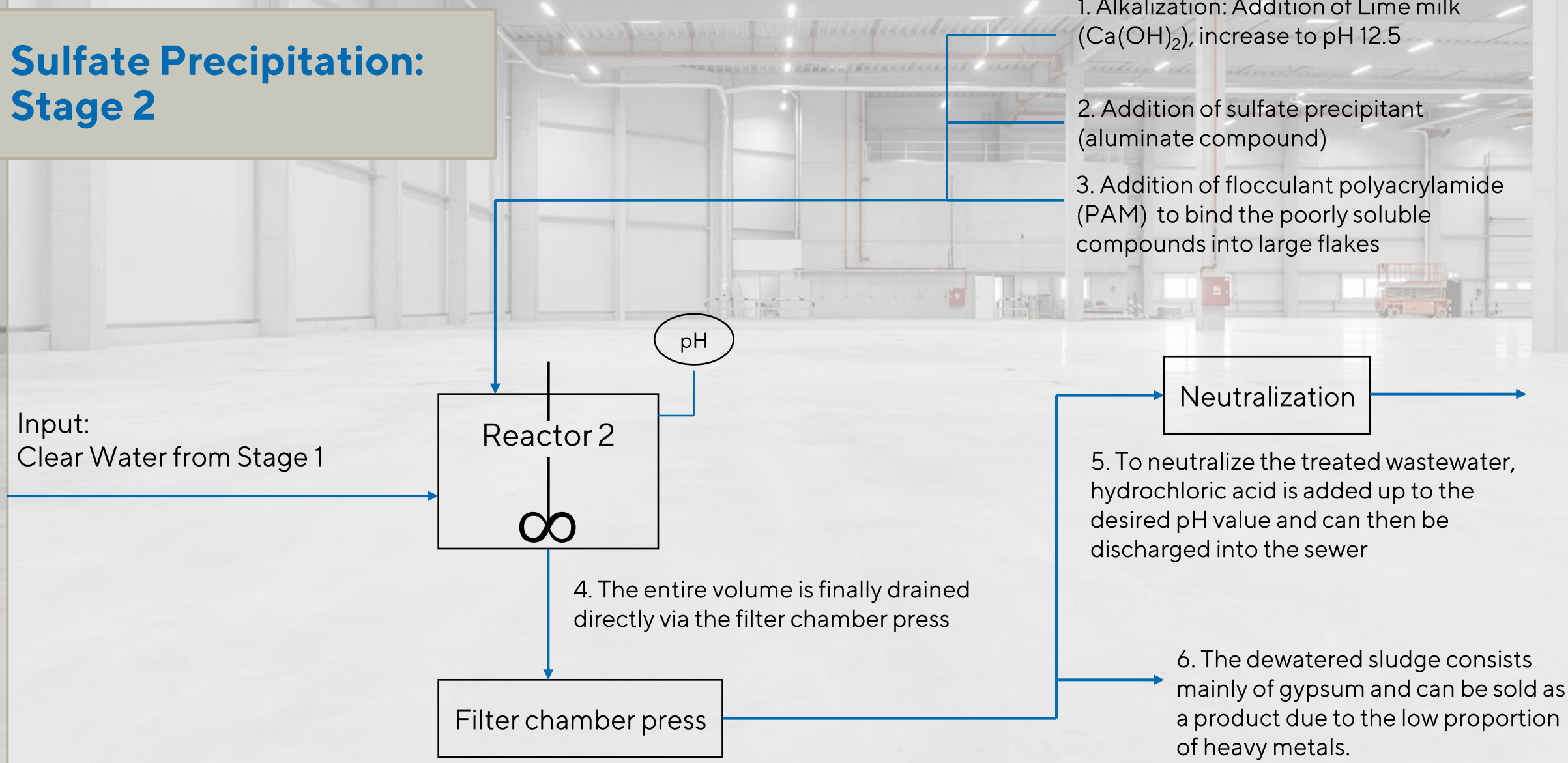


1. Addition of Iron(III)chloride ($FeCl_3$)to enable better precipitation and phase separation
2. Alkalization: Addition of Lime milk ($Ca(OH)_2$), increase to pH 9
3. Addition of precipitant (organosulfide) to form lead sulfide
4. Further addition of Lime milk ($Ca(OH)_2$) up to pH 10.5 to precipitate further heavy metals (Ni, Cr, ...)
5. Addition of flocculant polyacrylamide (PAM) to bind the poorly soluble compounds into large flakes

6. After a settling period, the clear water is drawn off and conveyed to the next precipitation stage.

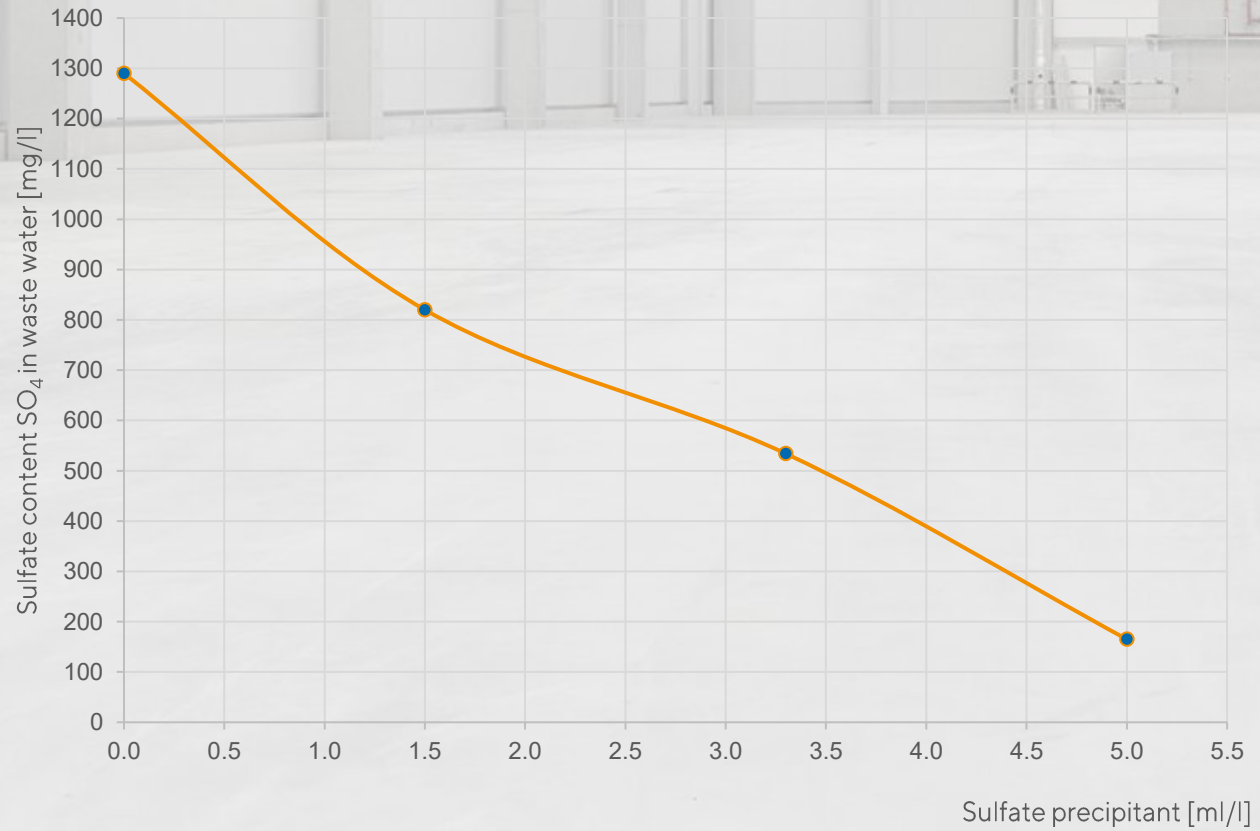
7. The sludge is dewatered using a filter chamber press and can then be disposed of as hazardous waste. Main components: Pb, $PbSO_4$, PbO, $Pb(OH)_2$

Sulfate Precipitation: Stage 2



Sulfate Precipitation

Sulfate precipitation using ADF 400 process



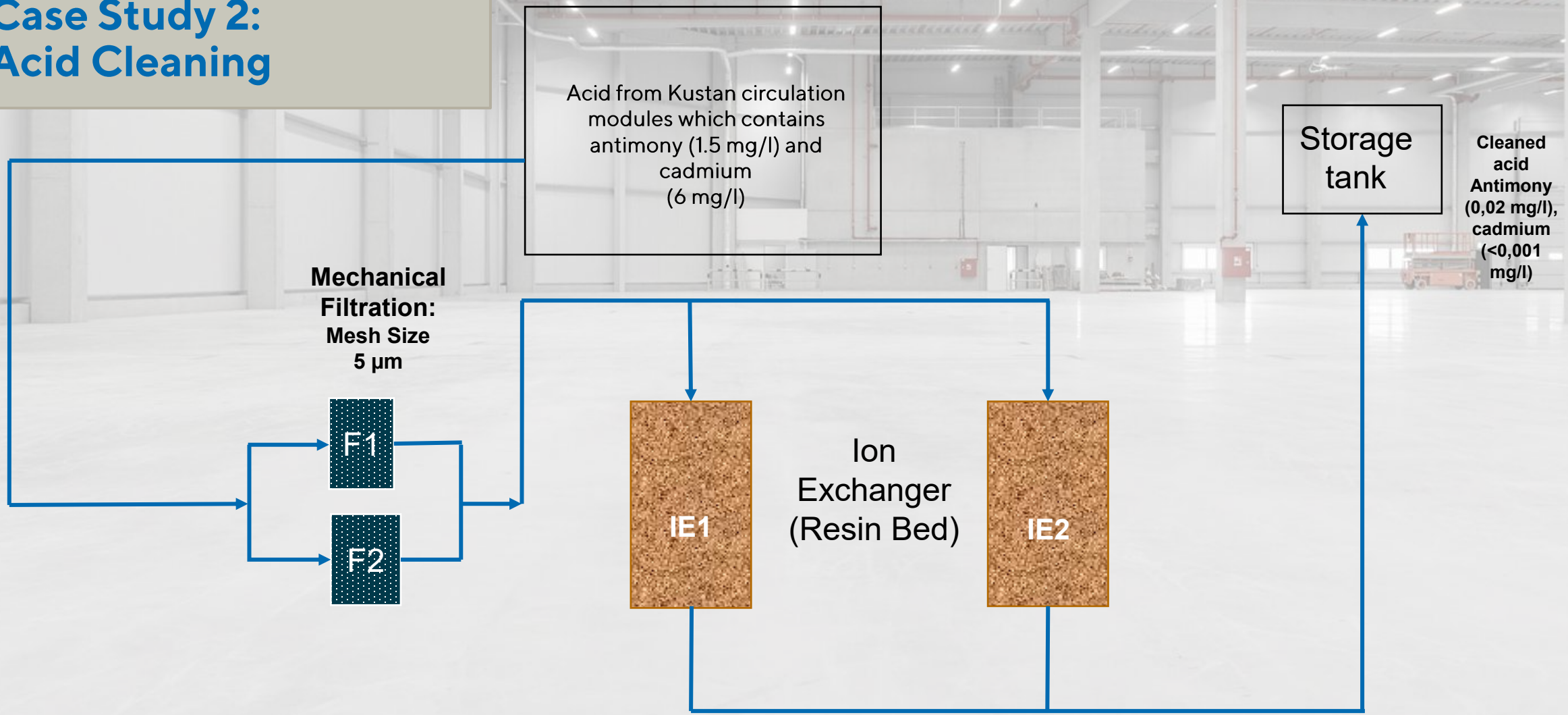
Sulfate Precipitation: In Action

Sulfate Precipitation In Action

Case Study 2: Acid Cleaning

- During the formation of lead-acid using acid circulation or closed-loop acid management:
  - Certain metals such as antimony or cadmium dissolve in the electrolyte over time.
- Metal removal from the acid using an ion exchanger is possible.
- Why pay high disposal costs?

Case Study 2: Acid Cleaning



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KUSTAN®

Let's talk Recycle/EHS!

We Know Flow!