INSTITUTO DE PESQUISAS TECNOLÓGICAS

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# Dependence of micro-morphology of lime on pH adjustment of iron-ore slurry for corrosion protection

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# Dependence of micro-morphology of Lime on pH adjustment of iron-ore slurry for corrosion protection

*Fabián A. C. Pastrián - Institute for Technological Research – IPT*

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# Dependência da micromorfologia do Leite de cal no ajuste de pH da polpa de minério de ferro para proteção contra corrosão


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# Summary

- Motivation
- Objective
- Methodology
- Results and discussion
- Conclusions

# Motivation

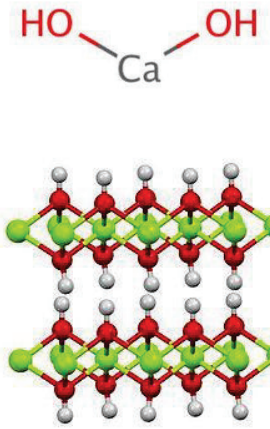
- Mining process


# Motivation

- Factors such as density and chemical composition can affect slurry transportation during the process.
- The pH of the slurry is usually adjusted to promote transport. This adjustment can improve the flocculation and rheology.
- In only water is transported. the pH is adjusted with NaOH. Although it is inexpensive and fast-acting. it is not environmentally friendly.
- The calcium hydroxide $Ca(OH)_2$ is added to iron slurry to adjust the pH.

# Motivation

- Milk of lime. also known as lime milk or lime slurry. is a suspension of calcium hydroxide ($Ca(OH)_2$) in water.




- pH adjustment.
- Precipitation of unwanted metal ions.
- Selective mineral inhibition.
- Improved dispersion and controlled aggregation.
- Cost-effectiveness and availability.

# Motivation

- At Anglo American Mining. they work with Neutrageo. a commercial product derived from milk of lime.
- It has been reported that it is difficult to determine the correct dosage of lime milk or Neutrageo to achieve the desired pH.

# Objetive

- Identify the parameters that influence the pH variations in the dosages of Lime Milk and Neutrageo.

# Methodology nº1

- The initial results with EB1 slurry are shown for Lime Milk and Neutrageo;
- Tests with new slurry (UnderFlow);
- Results using 50 % NaOH and water from the EB1 reservoir.
- **EB1 slurry supernatant – initial pH 11.9**

✓ Flask open to air
✓ Sample agitation done in air
✓ Sample volume: 200 mL
✓ Sample agitation: 200 rpm

- **Milk of Lime and Neutrageo**

✓ Flask open to air
✓ Agitation done in air
✓ Aliquot volume: 20 mL
✓ Aliquot agitation: 90 rpm
✓ Measuring using micropipettor


Sample prepared for testing

# Methodology nº1 – Results

### Milk of Lime

- Slow pH stabilization

| pH | Mean | Standard deviation |
|---|---|---|
| **12.0** | 3.9 | 0.2 (5 %) |
| **12.5** | 63.1 | 5.5 (9 %) |

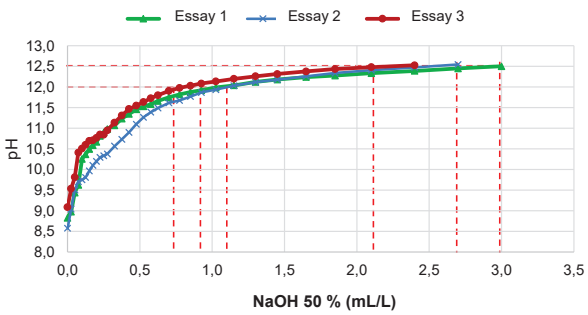
### Neutrageo

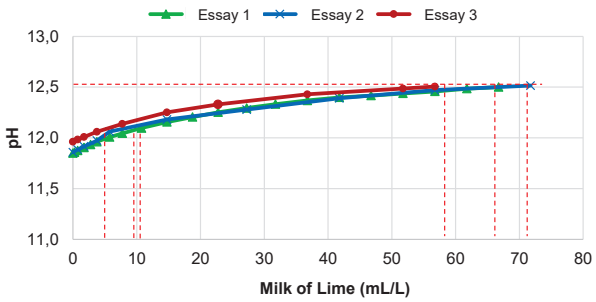
- Fast pH stabilization

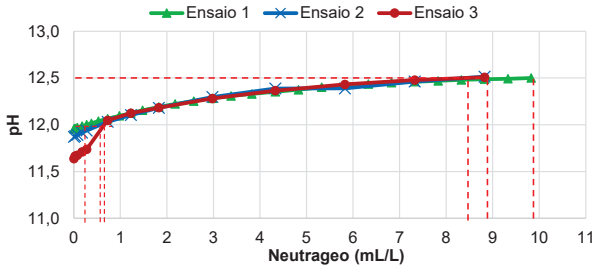
| pH | Mean | Standard deviation |
|---|---|---|
| **12.0** | 0.6 | 0.3 (50 %) |
| **12.5** | 9.0 | 0.7 (8 %) |

**Results with high deviation and initial slurry pH close to 12.0**

# Methodology nº1 – Results



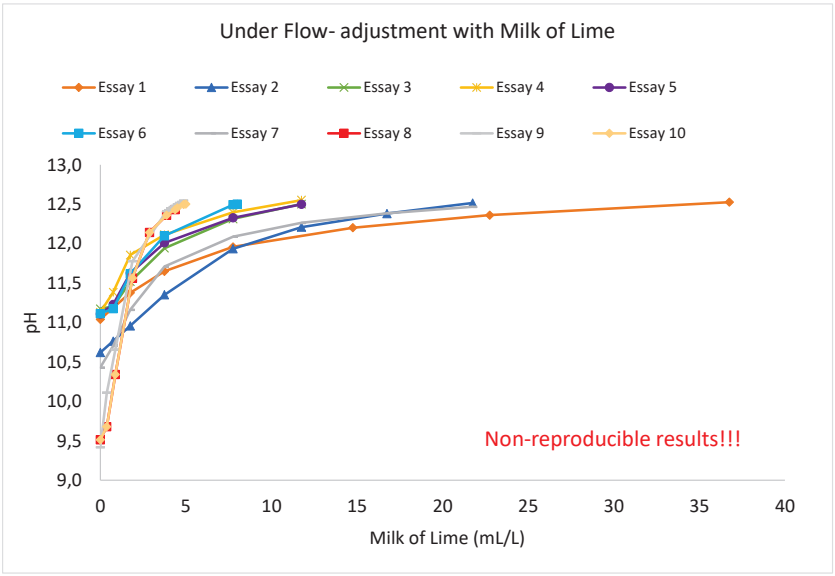
# Methodology nº1 – Results

**Table 1** – Consumption of alkaline reagent to adjust the pH of water and slurry – Methodology 1.

| Fluid | Reagent | Essay | Dosage mL/L. pH=12.0 | | Dosage. pH=12.5 | |
|---|---|---|---|---|---|---|
| | | | Values | Mean (St. Dev.) | Values | Mean (St. Dev.) |
| EB1 Reservoir | NaOH 50 % | 1 | 1.02 | 1.0 (0.2) | 3.0 | 2.6 (0.4) |
| | | 2 | 1.15 | | 2.7 | |
| | | 3 | 0.77 | | 2.2 | |
| EB1 slurry | Milk of Lime | 1 | 5.75 | 3.9 (0.2) | 66.7 | 63.1 (5.5) |
| | | 2 | 4.21 | | 65.7 | |
| | | 3 | 1.75 | | 56.7 | |
| EB1 slurry | Neutrageo | 1 | 0.27 | 0.6 (0.3) | 9.82 | 9.0 (0.2) |
| | | 2 | 0.72 | | 8.38 | |
| | | 3 | 0.72 | | 8.82 | |

**Reference**: Corrosion and Protection Laboratory - IPT

# Methodology nº1 – Results



# Methodology nº2

- Results with lime milk and Neutrageo
- Results with 50% NaOH and water from the EB1 reservoir.

  - **Under Flow Slurry Supernatant**

  ✓ Closed vial with synthetic air bubbling to avoid $CO_2$
  ✓ Sample volume: 400 mL
  ✓ Sample agitation: 500 rpm

  - **Milk of Lime and Neutrageo**

  ✓ Stored in the original bottle
  ✓ Manual shaking inside the bottle to homogenize
  ✓ Dosage using a micropipette

Sample prepared for testing

# Methodology nº2 – Results

### Milk of Lime

- Slow pH stabilization

| pH | Mean | Standard deviation |
|---|---|---|
| **12.0** | 2.7 | 0.1 (4 %) |
| **12.5** | 4.6 | 0.4 (9 %) |

### Neutrageo

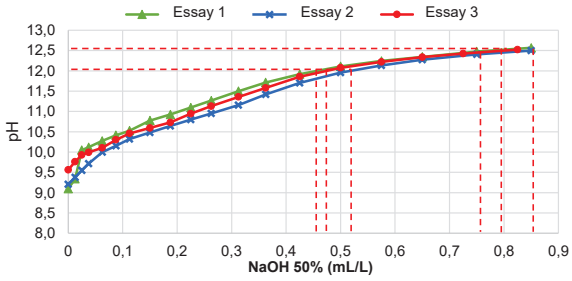
- Fast pH stabilization

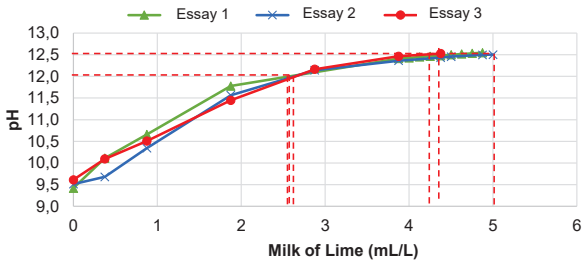
| pH | Mean | Standard deviation |
|---|---|---|
| **12.0** | 2.6 | 0.5 (19 %) |
| **12.5** | 4.1 | 0.7 (17 %) |

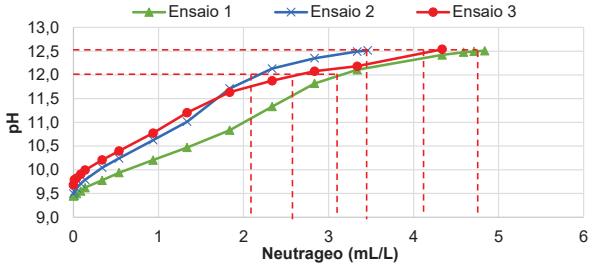
**Results with high deviation**

Essay 1 Essay 2 Essay 3

# Methodology nº2 – Results



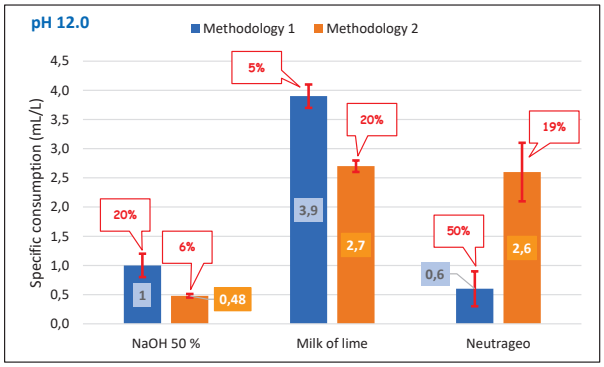
# Methodology nº2 – Results

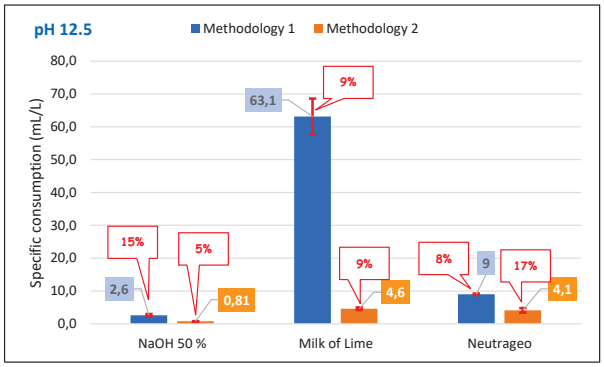
**Table 2** – Consumption of alkaline reagent to adjust the pH of water and slurry – Methodology 2.

| Fluid | Reagent | Essay | Dosage mL/L. pH=12.0 | | Dosage. pH=12.5 | |
|---|---|---|---|---|---|---|
| | | | Values | Mean (St. Dev.) | Values | Mean (St. Dev.) |
| EB1 Reservoir | NaOH 50 % | 1 | 0.47 | 0.48 (0.03) | 0.80 | 0.81 (0.04) |
| | | 2 | 0.46 | | 0.78 | |
| | | 3 | 0.52 | | 0.85 | |
| Under Flow Slurry | Milk of Lime | 1 | 2.60 | 2.7 (0.1) | 4.50 | 4.6 (0.4) |
| | | 2 | 2.73 | | 5.00 | |
| | | 3 | 2.64 | | 4.15 | |
| Under Flow Slurry | Neutrageo | 1 | 3.17 | 2.6 (0.5) | 4.76 | 4.1 (0.7) |
| | | 2 | 2.16 | | 3.37 | |
| | | 3 | 2.61 | | 4.25 | |

**Reference**: Corrosion and Protection Laboratory - IPT

# Methodology nº2 – Results




- What is the reason for the significant differences in the results?
- Which parameter had we not yet controlled?

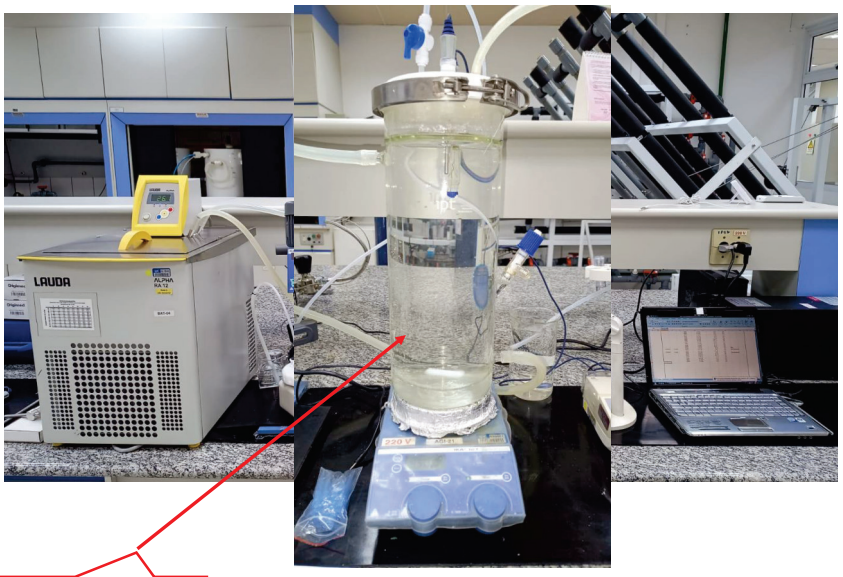
# Methodology – Temperature control

- **Under Flow Slurry Supernatant**

✓ Closed vial with synthetic air bubbling to avoid $CO_2$
✓ Temperature control with thermostatic bath
✓ Sample volume: 2500 mL
✓ Sample agitation: 500 rpm

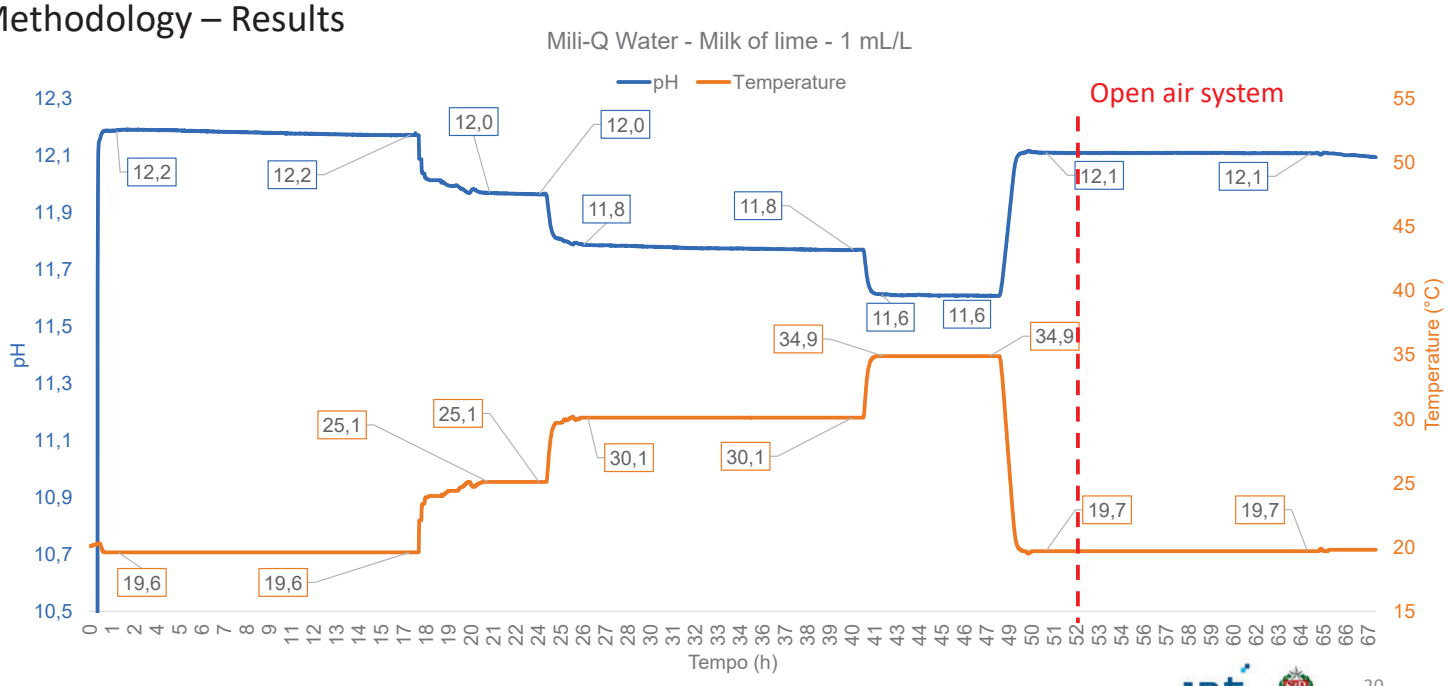
- **Milk of Lime and Neutrageo**

✓ Mechanical agitation to homogenize
✓ Measuring using a micropipettor

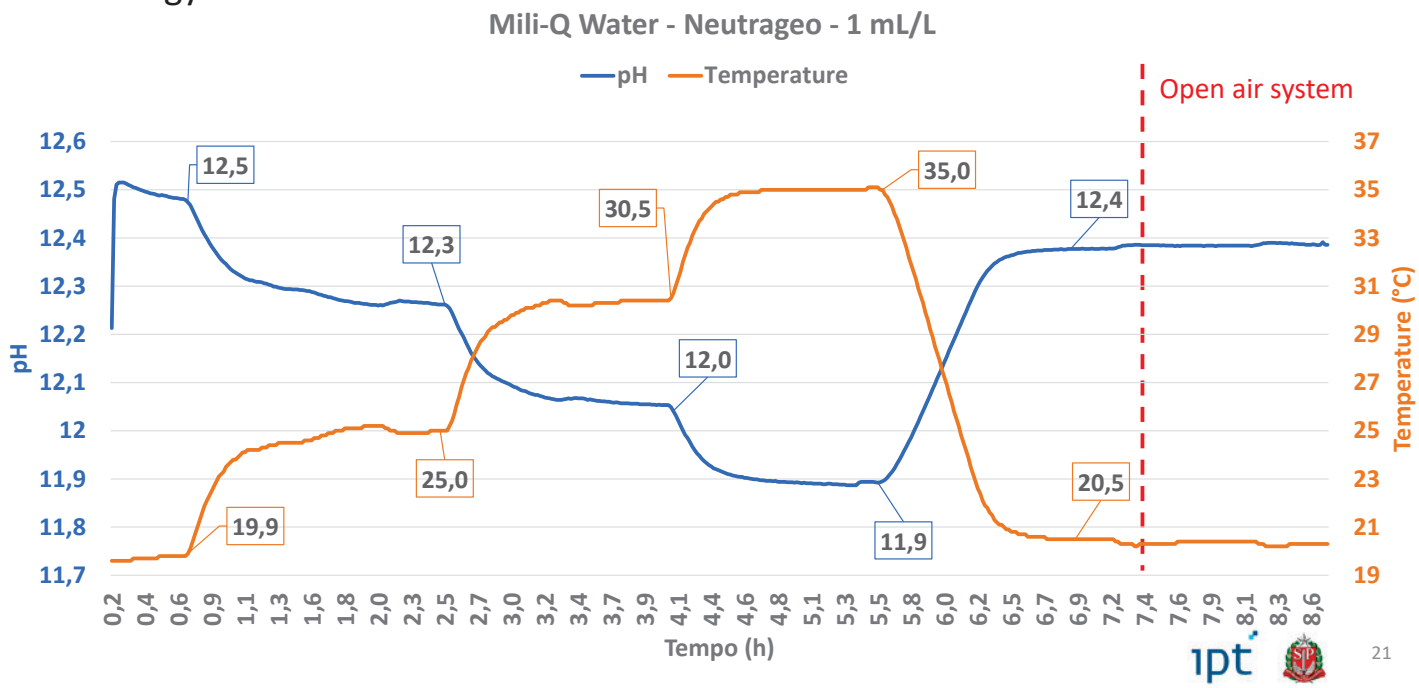



Single dosage of milk lime or Neutrageo

# Methodology – Results



# Methodology – Results



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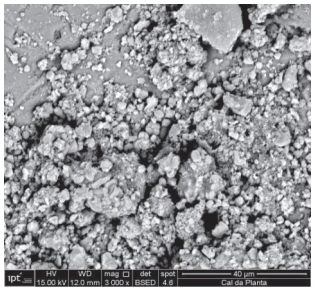
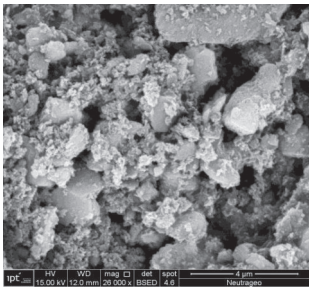
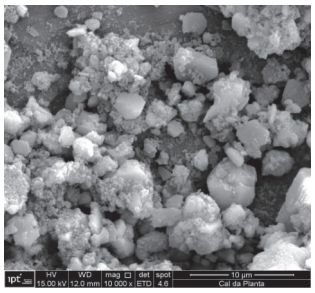
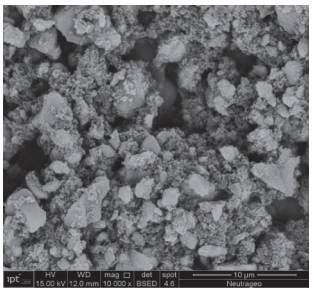
## Results



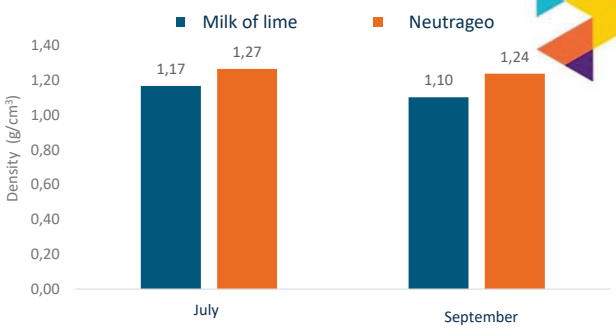


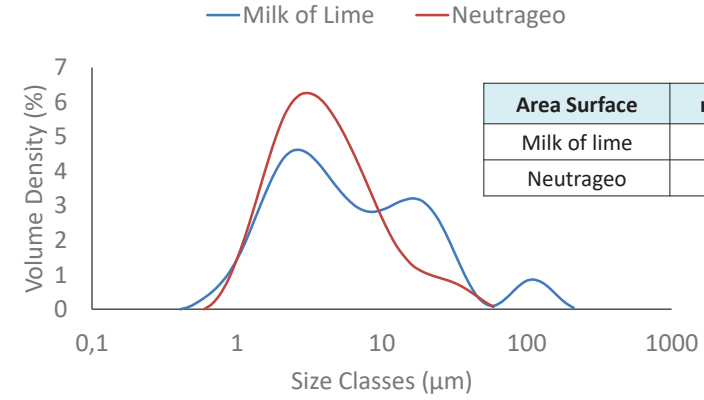




Milk of lime

Neutrageo




| Area Surface | $m^2/kg$ |
|---|---|
| Milk of lime | 1670 |
| Neutrageo | 1870 |

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# Methodology nº3

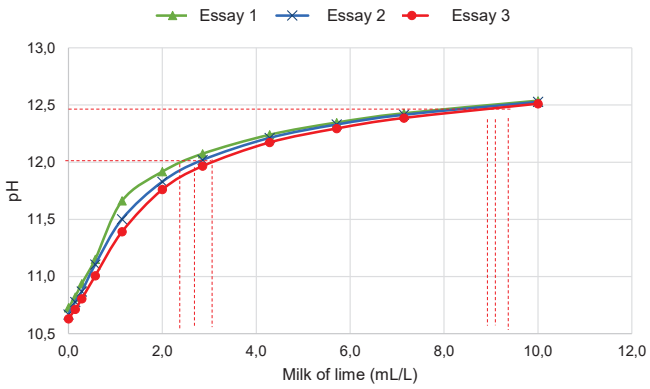
- **Under Flow Slurry Supernatant**

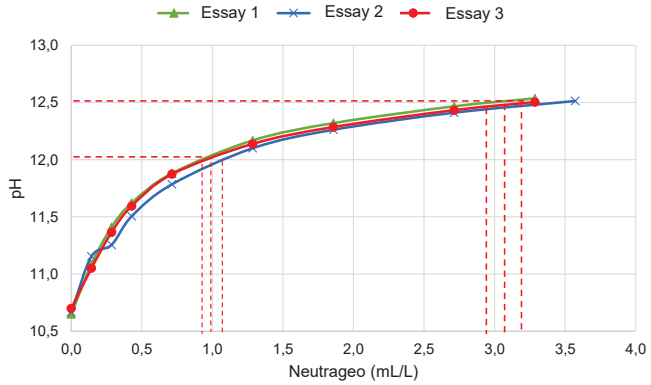
✓ Closed vial with synthetic air bubbling to avoid $CO_2$
✓ Temperature control with thermostatic bath
✓ Sample volume: 350 mL
✓ Sample agitation: 500 rpm

- **Milk of Lime and Neutrageo**

✓ Mechanical agitation to homogenize
✓ Measuring using a micropipettor

# Methodology nº2 – Results



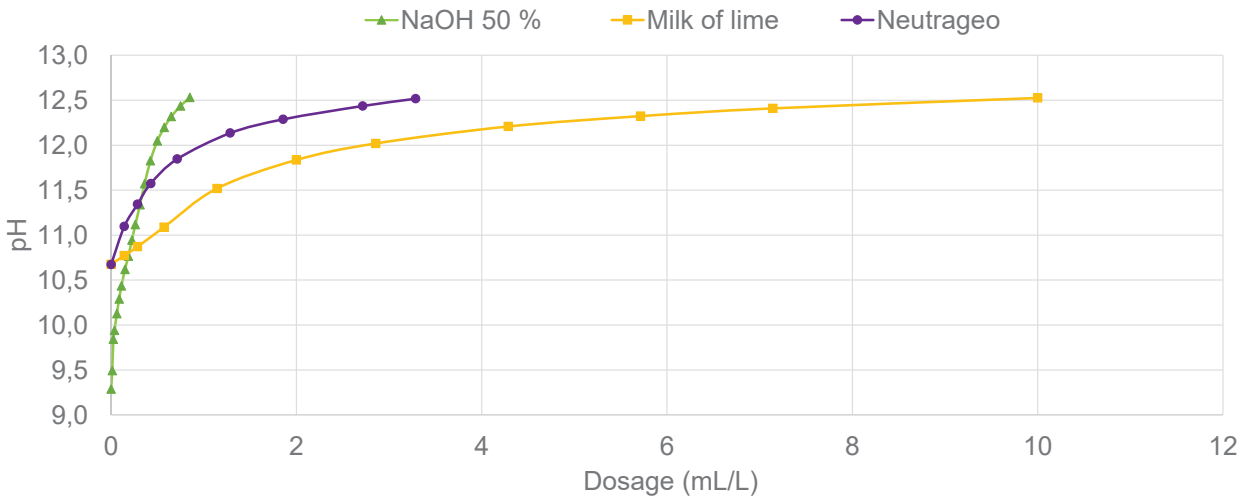
# Methodology nº3 – Results

**Table 3** – Consumption of alkaline reagent to adjust the pH of water and slurry – Methodology 3.

| Fluid | Reagent | Essay | Dosage mL/L. pH=12.0 | | Dosage. pH=12.5 | |
|---|---|---|---|---|---|---|
| | | | Values | Mean (St. Dev.) | Values | Mean (St. Dev.) |
| Under Flow Slurry | Milk of Lime | 1 | 2.42 | 2.70 (0.36) | 8.89 | 9.04 (0.52) |
| | | 2 | 2.68 | | 8.61 | |
| | | 3 | 3.13 | | 9.61 | |
| Under Flow Slurry | Neutrageo | 1 | 0.93 | 0.99 (0.09) | 2.98 | 3.20 (0.20) |
| | | 2 | 1.09 | | 3.41 | |
| | | 3 | 0.95 | | 3.19 | |

**Reference**: Corrosion and Protection Laboratory - IPT

## Results and discussion



## Conclusions

Compared to milk of lime and Neutrageo. sodium hydroxide requires less volume to reach pH levels of 12.0 and 12.5.

It was determined that Neutrageo has smaller particles than milk of lime. This favors faster solvation and allows it to reach high pH levels more quickly.

The reproducibility of the tests was determined by temperature.

Neutrageo is the best alternative for achieving pH balance in a shorter period of time.

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# Thanks for your attention!

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