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Value Proposition of Efficient Chemical Working

Kimberlite Additives: A Novel Solution for Humate Removal from Bauxite Ore in Bayer's Process

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Content

Introduction

"Bauxite: Leading the Way in Aluminium Production"

Source: https://depositphotos.com/photo/bauxite-26234323.html

- High Aluminum Content:

  Typically containing 40-50% Aluminium oxide.

- Global Availability: 3rd most abundant element.

  Major Al producers : Australia, China, and India.

- Bauxite is a reddish-brown to white sedimentary rock, rich in Aluminium oxide ($Al_2O_3.3H_2O$).

- Impurities : Iron oxide, Silicon, Titanium oxides and Humate.

The Process of Transforming Bauxite into Aluminium:

Mining-Bauxite ($Al_2O_3.3H_2O$)

- Open Pit Mining

Ore Beneficiation/Dressing

- Crushing
- Grinding
- Pre-Treatment (Optional)

Hydrometallurgy / Bayer's Process

- Digestion
- Liquid Solid Separation
- Precipitation → Alumina Hydrate
- Calcination → 99.6% Alumina (Al_2O_3)

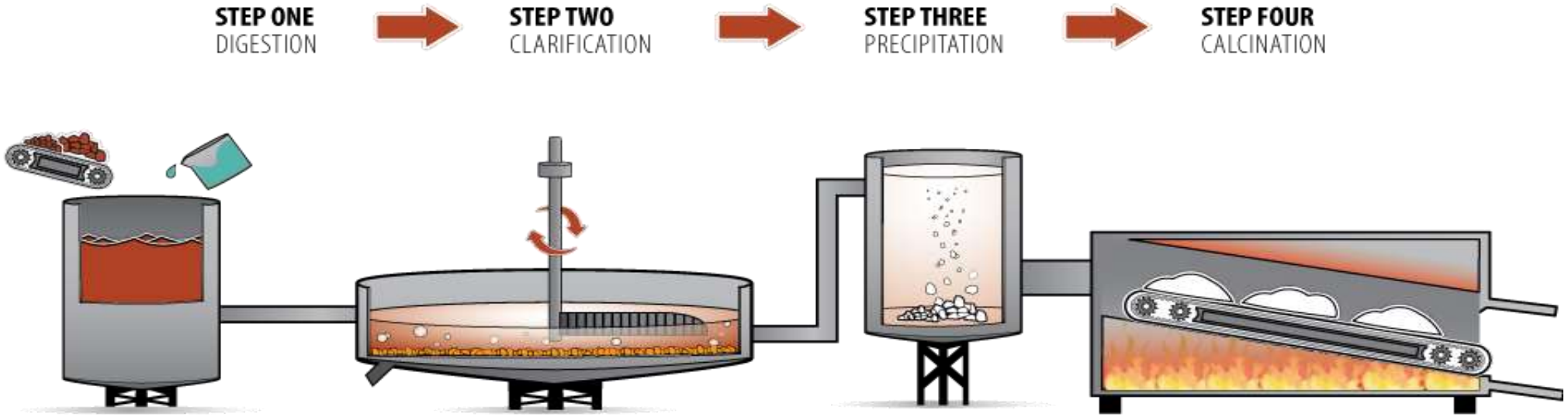
Electrometallurgy / Hall-Heroult Process

- Elelctrolysis of Alumina → >99.5% Aluminium (Al)

Bayer's Process Overview

- In the 1890s, Austrian chemist **Carl Josef Bayer** invented a revolutionary process for extracting alumina from bauxite.
- Some **90%** of alumina refineries still use the *Bayer process* to refine bauxite.

- **The four key steps of Bayer's Process:**



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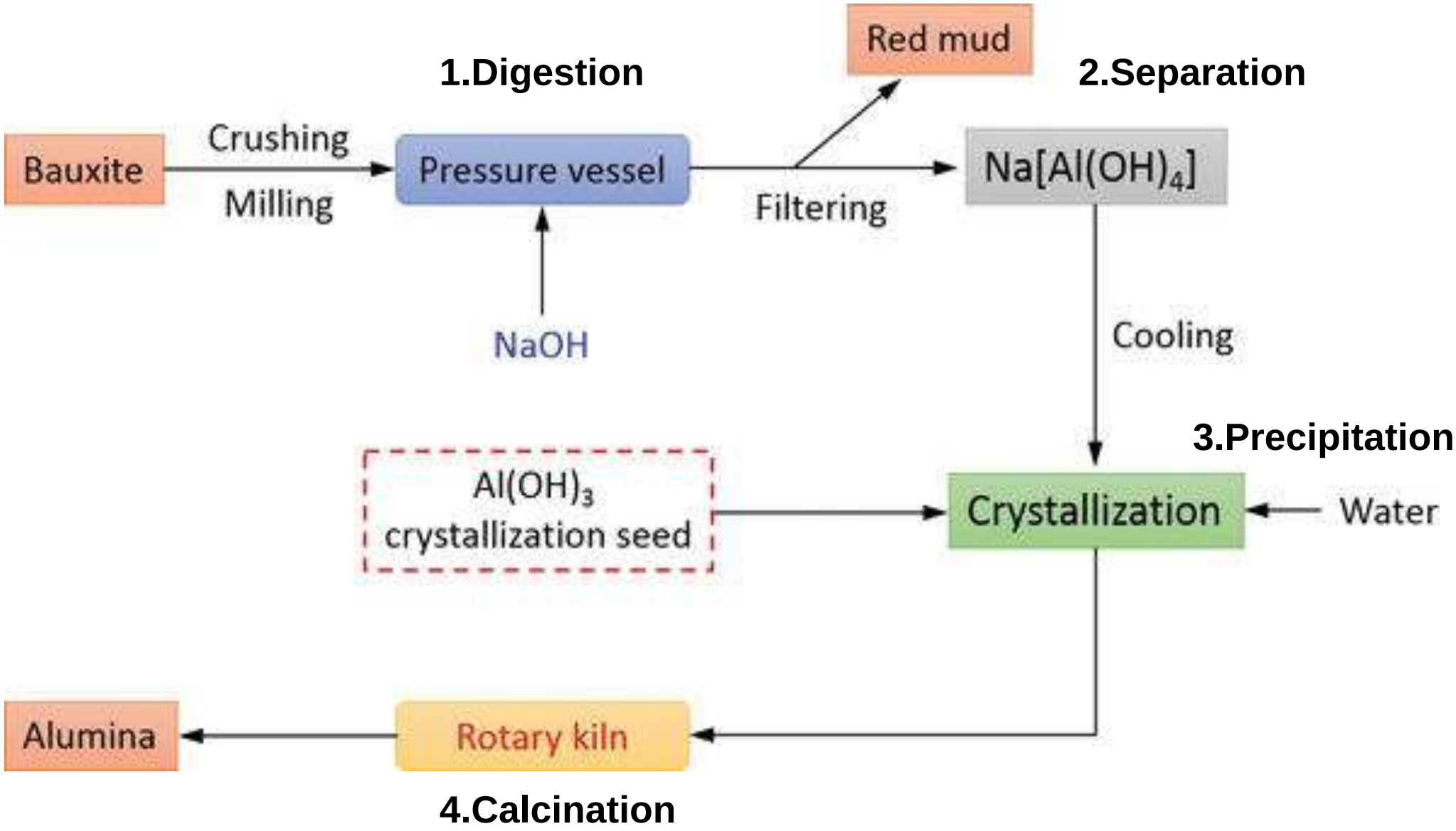
Schematic Flow Sheet of Bayer's process



Challenges with Humate Impurities

- Bauxite ore naturally contains organic materials (Humate).

- The presence of humate in the Sodium aluminate liquor adversely affects the brightness and fineness of the precipitated alumina hydrate.

Unwanted Colouration in Alumina Hydrate

Desired Alumina Hydrate Colour

Kimberlite's Solution

Importance of the humate removal:

Improved Alumina Hydrate Quality

- **Whiteness**
- **Fineness**

Enhanced Processing Efficiency

- **Precipitation**
- **Filtration**

M/s Kimberlite has developed an additive that effectively removes soluble humate material from the sodium aluminate liquor without impacting liquor productivity.

Experimental Studies

Three-Stage Digestion Process for Liquor Preparation:

Mixture of First Cycle:

- 200 grams of bauxite ore powder
- 200 ml of 50% caustic lye solution
- 400 ml of distilled water

Heating Stages:

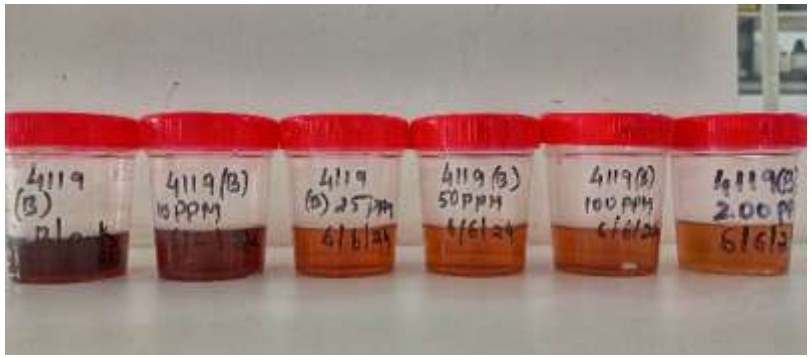
- 30 minute boil
- 1 hour simmer at 90°C

Second & Third Cycle:

- 200 grams of bauxite ore powder (Fresh)
- Previous Cycle Supernatant liquor

First Cycle Mixture

Filtration for Humate Removal:



Sample Preparation:

- 50 ml aliquots of filtered liquor were distributed into individual flasks.

Additive Dosing:

- Measured amounts of humate removal additive (0 ppm to 200 ppm) were added to each flask.

Heat Treatment:

- Flasks were placed on a hot plate set at 90°C for 15 minute to promote additive-humate interaction.

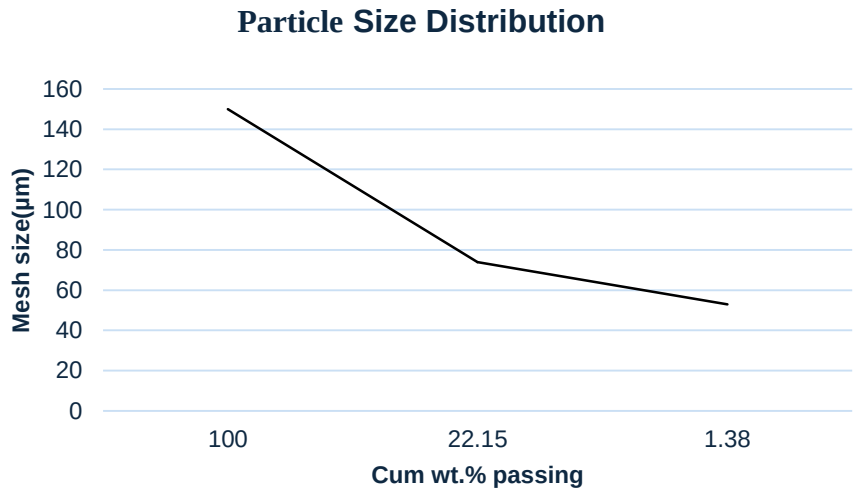
Filtration:

- After cooling, all treated liquors were refiltered using Whatman filter paper grade 42.
- The Filtrate absorbance was measured with a UV-visible spectrophotometer.

Result and discussions

Bauxite Ore Particle Size Distribution:

Mesh no	Mesh size (µm)	Cum wt.% passing
100	150	100
200	74	22.15
240	53	1.38



Characteristics of Bauxite ore

S no	Characteristics	Bauxite
1	Al_2O_3(t)%	44.56
2	Fe_2O_3%	24.83
3	Tio_2%	2.02
4	SiO_2%(t)	4.20
5	SiO_2%(r)	3.05
6	ATH%	39.4
7	Na_2O%	-
8	Org.C%	0.086
9	Min C%	0.184
10	P_2O_5%	0.088
11	V_2O_5%	0.062
12	CaO%	0.018
13	MnO%	0.096
14	K_2O%	0.042
15	ZnO%	0.0064
16	MgO%	Not traceable
17	LOI at 1000^0c	24.05

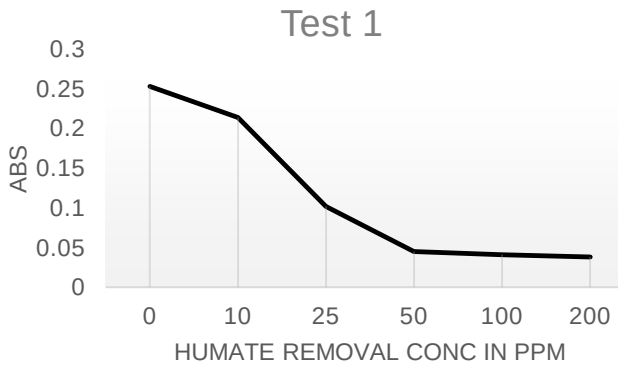
Characteristics of bauxite used for the preparation of synthetic aluminate liquor.

Organic Material:

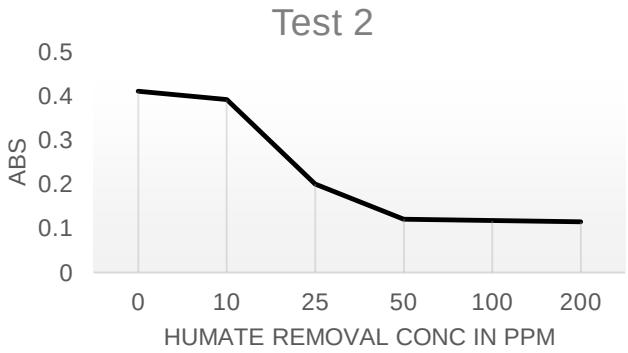
0.086% (Org. C) - Bauxite ore contain a problematic amount of organic carbon, which may come from decomposed plant matter trapped during formation.

Absorbance results:

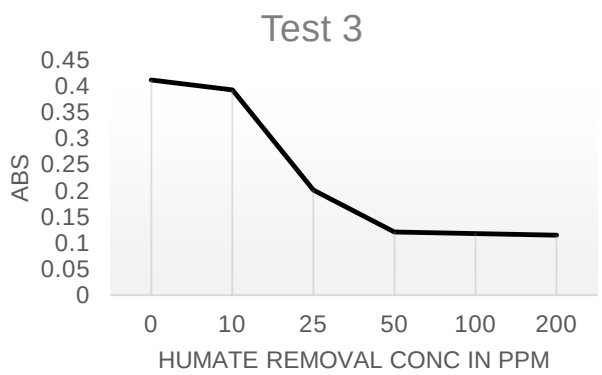
Test 1	
Humate Removal Conc. in PPM	Absorbance at 691 nm
0	0.158
10	0.15
25	0.053
50	0.028
100	0.025
200	0.019



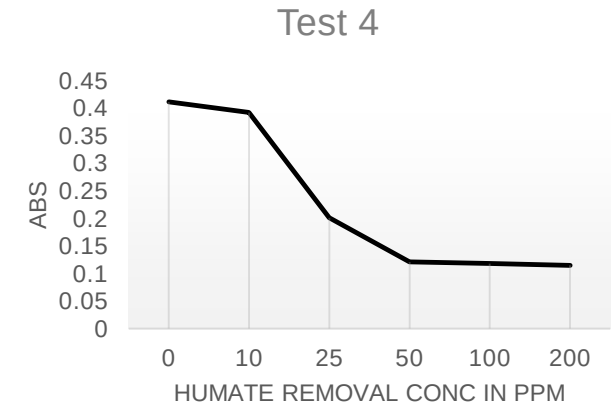
Test 2	
Humate Removal Conc. in PPM	Absorbance at 691 nm
0	0.253
10	0.214
25	0.102
50	0.045
100	0.041
200	0.038



Test 3	
Humate Removal Conc. in PPM	Absorbance at 691 nm
0	0.477
10	0.4
25	0.322
50	0.129
100	0.122
200	0.101



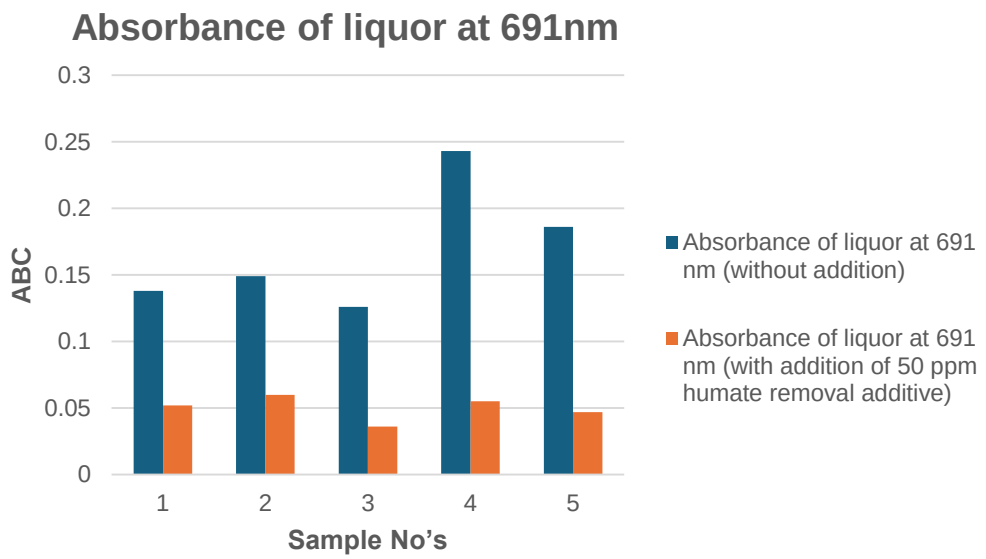
Test 4	
Humate Removal Conc. in PPM	Absorbance at 691 nm
0	0.411
10	0.392
25	0.201
50	0.121
100	0.118
200	0.115

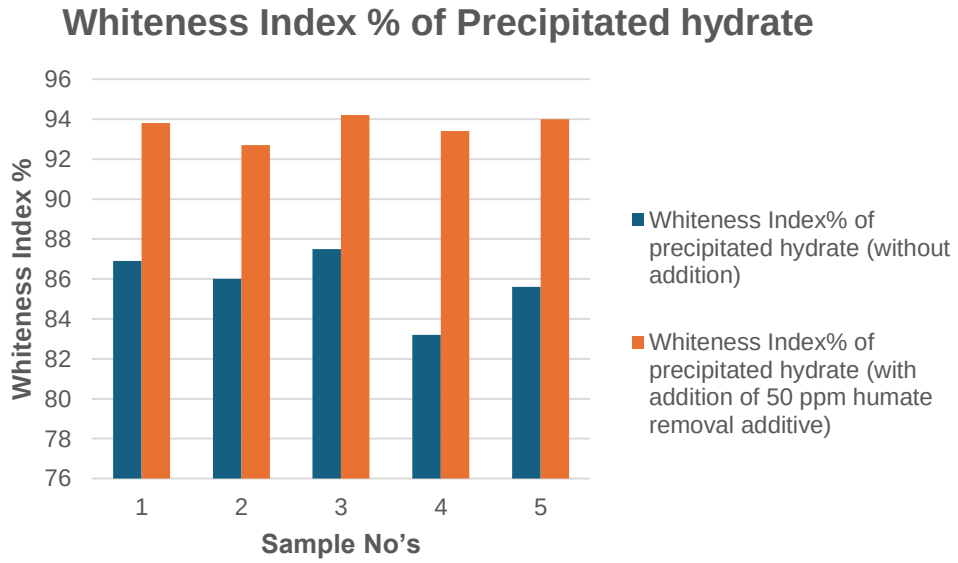


Lower Absorbance = More Removal

Whiteness Index Measurement

Sample No	Absorbance of liquor at 691 nm (without addition)	Absorbance of liquor at 691 nm (with addition of 50 ppm humate removal additive)	Whiteness Index% of precipitated hydrate (without addition)	Whiteness Index% of precipitated hydrate (with addition of 50 ppm humate removal additive)
1	0.138	0.052	86.9	93.8
2	0.149	0.060	86.0	92.7
3	0.126	0.036	87.5	94.2
4	0.243	0.055	83.2	93.4
5	0.186	0.047	85.6	94.0





Conclusion

- M/s Kimberlite's specialty chemical effectively reduces reddish brown colour in alumina hydrate caused by humate presence.

- Study results suggest a **50 ppm** dosage range for efficient humate removal.

- The addition of a humate removal additive resulted in a significant improvement in whiteness index, ranging from **6.9% to 11%.**

Acknowledgement

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Thank you

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