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Influence of the Impeller Speed on Phosphate Rock Flotation

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INFLUENCE OF THE IMPELLER SPEED ON PHOSPHATE ROCK FLOTATION

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Why study this???

- Is it ***impeller*** important to flotation? YES!
- Why is it? ?
- Is it the impeller ***speed*** important? YES!
- What is the correct/optimal impeller speed, profile, etc.? ???

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Introduction

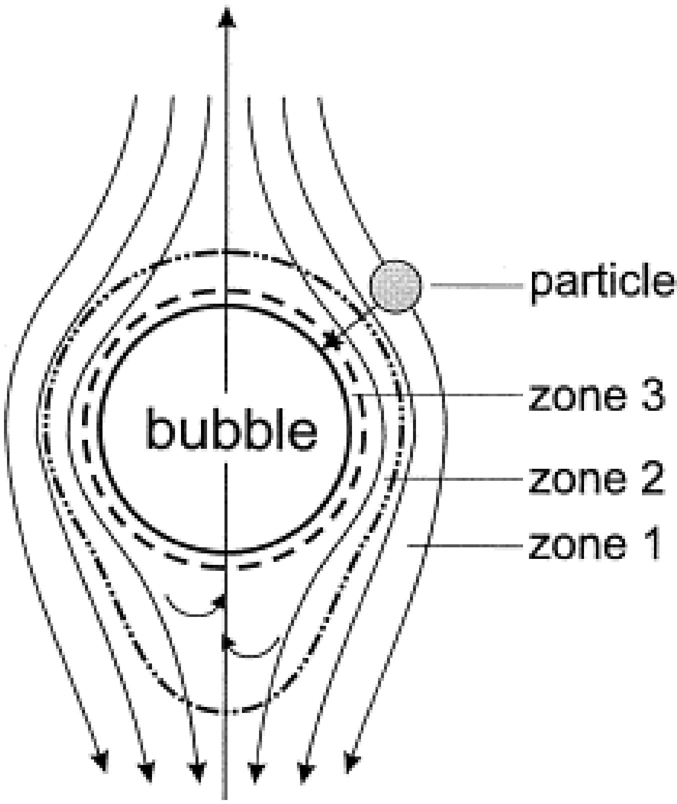
- Impeller rotation supplies the flotation system with ***air*** (by suction), produces ***bubbles*** on the base of the cell, and ***stirs*** the pulp.

- By keeping the mineral particles in movement, the impeller rotation avoid ***fast sedimentation*** of the particles and gives the ***energy*** required for the particles ***attach*** themselves to the bubble.

Introduction

- Although the impeller rotation has very high importance to the flotation, it also has a negative action on the system since it is one of the greater producer of ***turbulence*** in the flotation cell.

- ***Finer particles*** are likely to be found at the upper part of the cell (and even to be dragged to the froth layer, a phenomenon referred as ***hydraulic entrainment***), whereas ***coarser*** particles are likely to be found close to the ***bottom*** of the cell.



Ralston J, Fornasiero D & Hayes R (1999): Bubble–particle attachment and detachment in flotation. International Journal of Mineral Processing, v. 56, n. 1–4, pp. 133-164.

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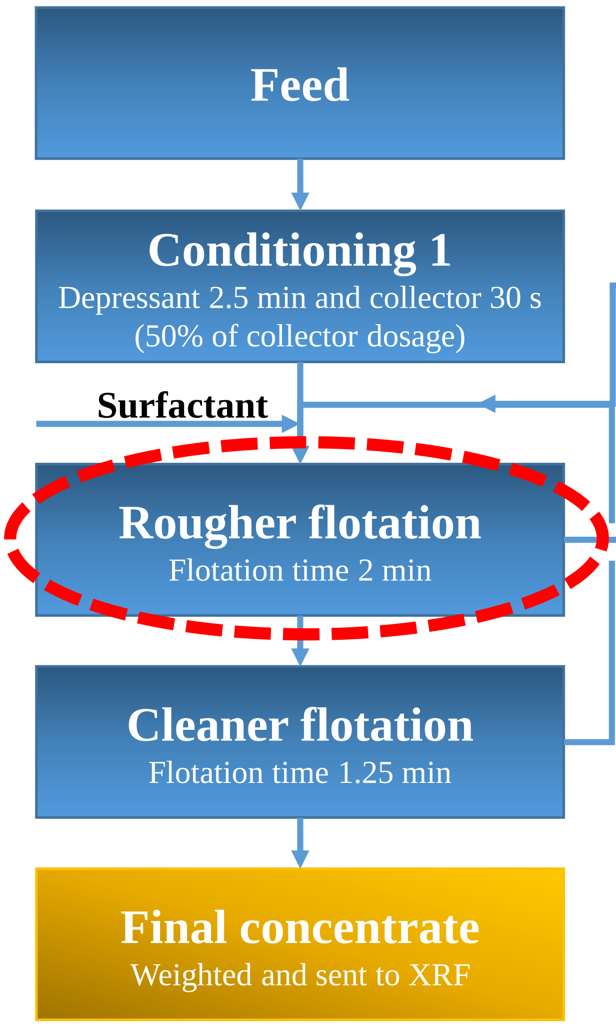
Phosphate rock processing flowsheet at Copebras/CMOC in Brazil

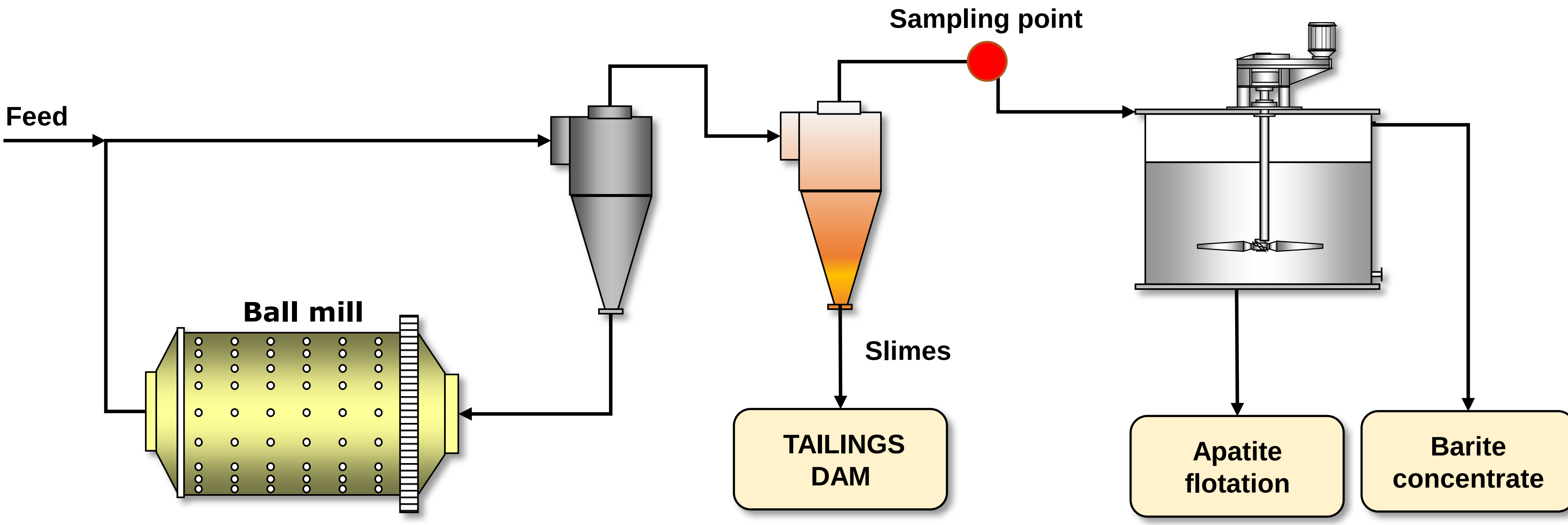


Operational parameter	Value
Starch (g/t)	500
Lioflot 567 (g/t)	320
Flotinor 071 (g/t)	20
pH	10
Impeller speed (rpm)	1450
Solids (%)	
Conditioning	50
Flotation	35
Conditioning (min)	
Depressor	2.5
Collector – rougher	0.5
Collector – scavenger	0.5
Flotation (min)	
Rougher	2
Cleaner	1.25
Scavenger	1.5

Copebras/CMOC internal procedure

Materials and methods

- Samples from phosphate rock were collected at Copebras mineral processing ***plant 47*** after the ***desliming*** and before the pulp conditioning for ***barite flotation***.



Materials and methods

- ***No chemicals*** added to the samples at Copebras.
- The bench tests was performed as ***apatite rougher*** stage
- ***No barite*** flotation.
- The chemical by XRF.

Phosphate rock flotation at Copebras

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Materials and methods

Flotation tests operational parameters

Operational parameter	Adopted value
Solids percentage (%)	35
pH	9
pH regulators	HCl (5 mol/L) and NaOH (50%)
Depressant	Cornstarch (Cargill) @ 600 g/t
Collector	Lioflot 502-A (Miracema-Nuodex) @ 500 g/t
Conditioning time (minutes)	3 (depressant) and 2 (collector)
Flotation time (minutes)	8 - 15
Flotation cell	Denver mechanical flotation cell with 3.0 L
Impeller speed (rpm)	1000, 1150, 1300, 1450*, and 1600

* Speed adopted at Copebras

All tests were performed in triplicate.
Tap water was used throughout the experiments.
All operational parameters were adopted in order to match the industrial values adopted in the Copebras

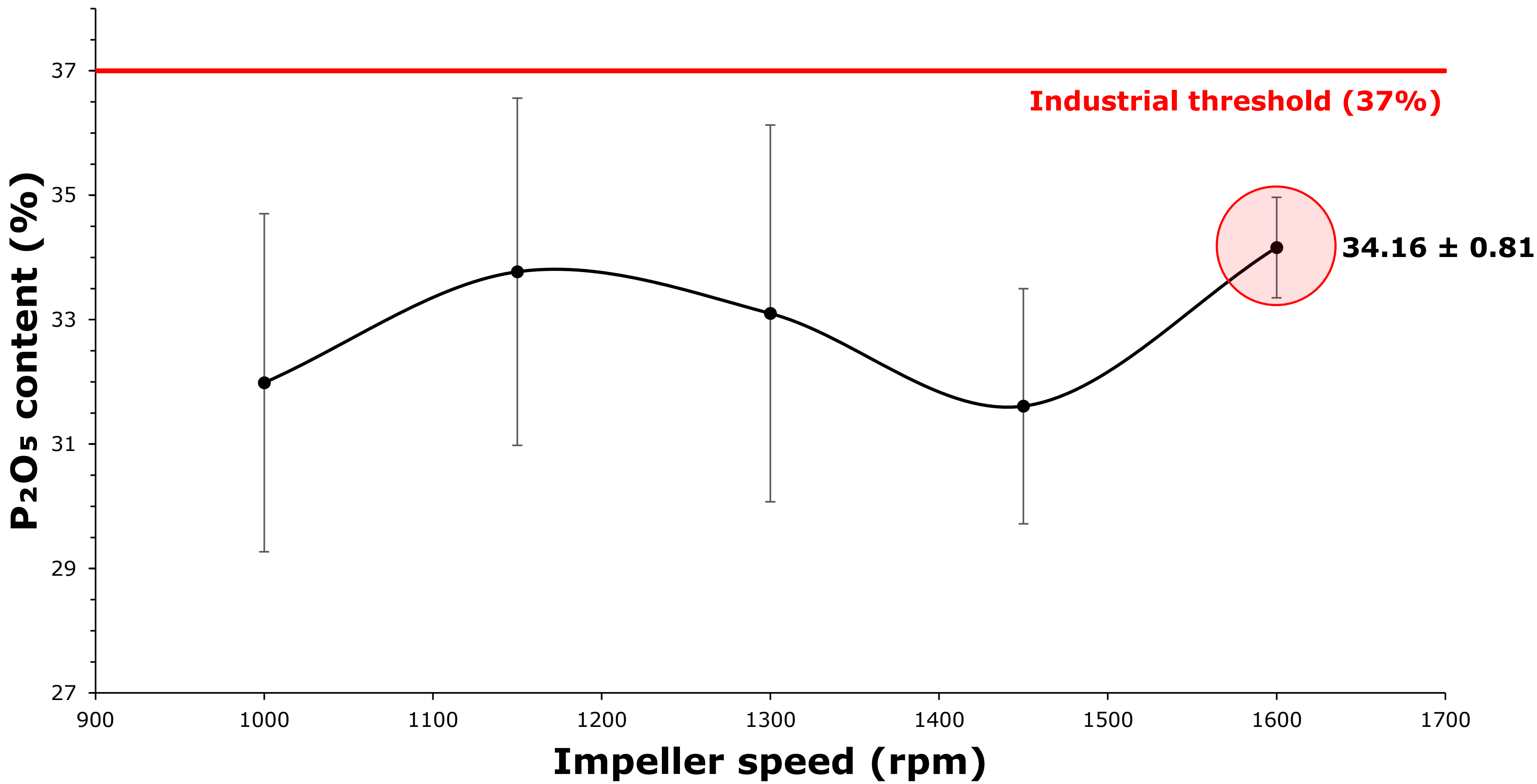
Results and discussion

Chemical results for ROM, apatite flotation feed, and industrial threshold

Oxide (%)	ROM (Reference)	Apatite flotation feed (Reference)	Industrial threshold (F.C.)
P_2O_5	12.76	20.34	≥ 37.00
CaO	17.08	25.79	-
Al_2O_3	0.93	0.43	≤ 0.82
Fe_2O_3	30.50	17.25	≤ 2.90
SiO_2	13.05	25.35	≤ 3.00
MgO	3.47	0.63	≤ 0.50
BaO	4.44	0.61	≤ 0.50
Nb_2O_5	0.64	0.33	-
Others	17.13	9.27	-
CaO/P_2O_5	1.34	1.27	≤ 1.32

Results and discussion

Influence of the impeller speed on the P_2O_5 content in the rougher concentrate



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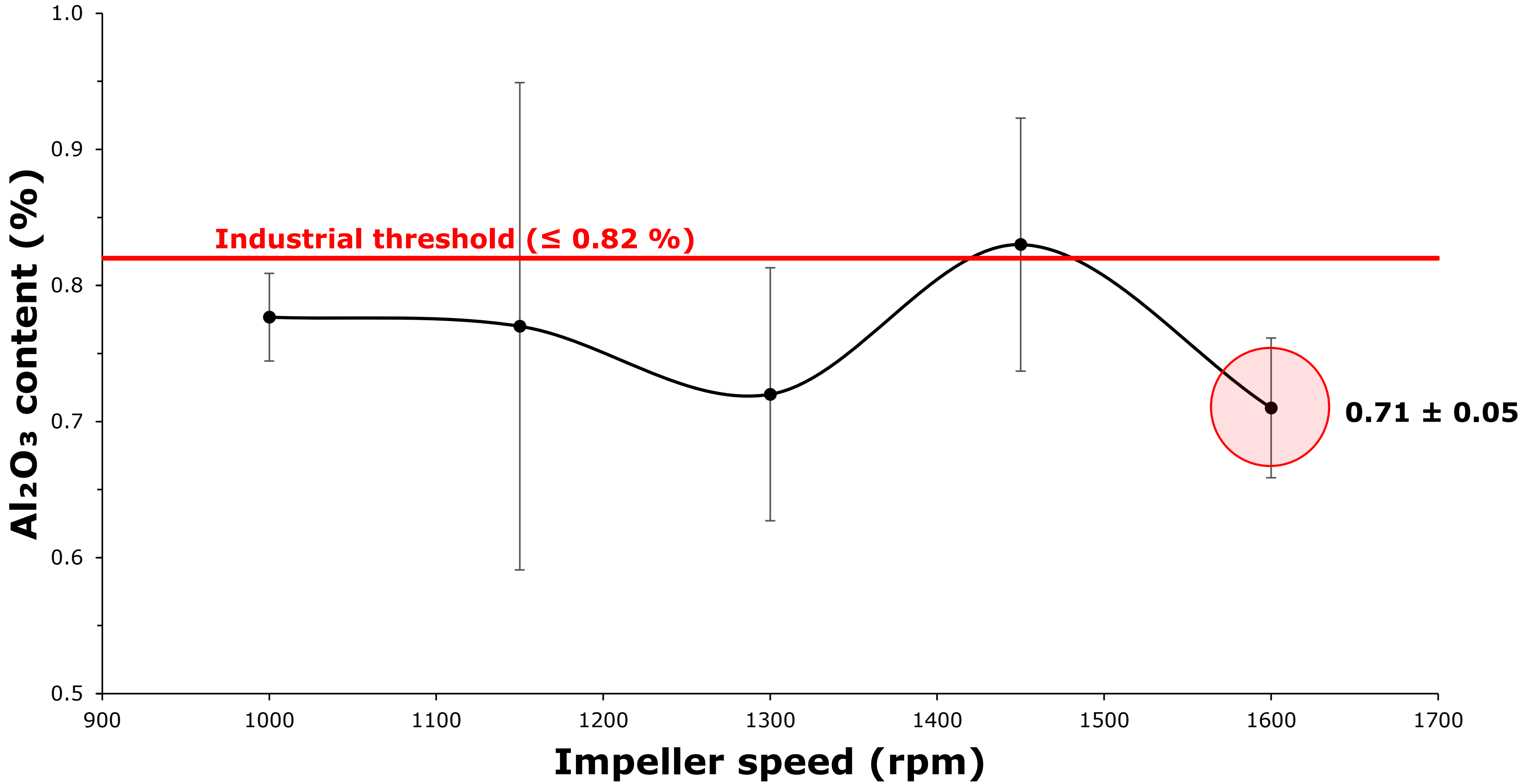
Results and discussion

Influence of the impeller speed on the Al_2O_3 content in the rougher concentrate



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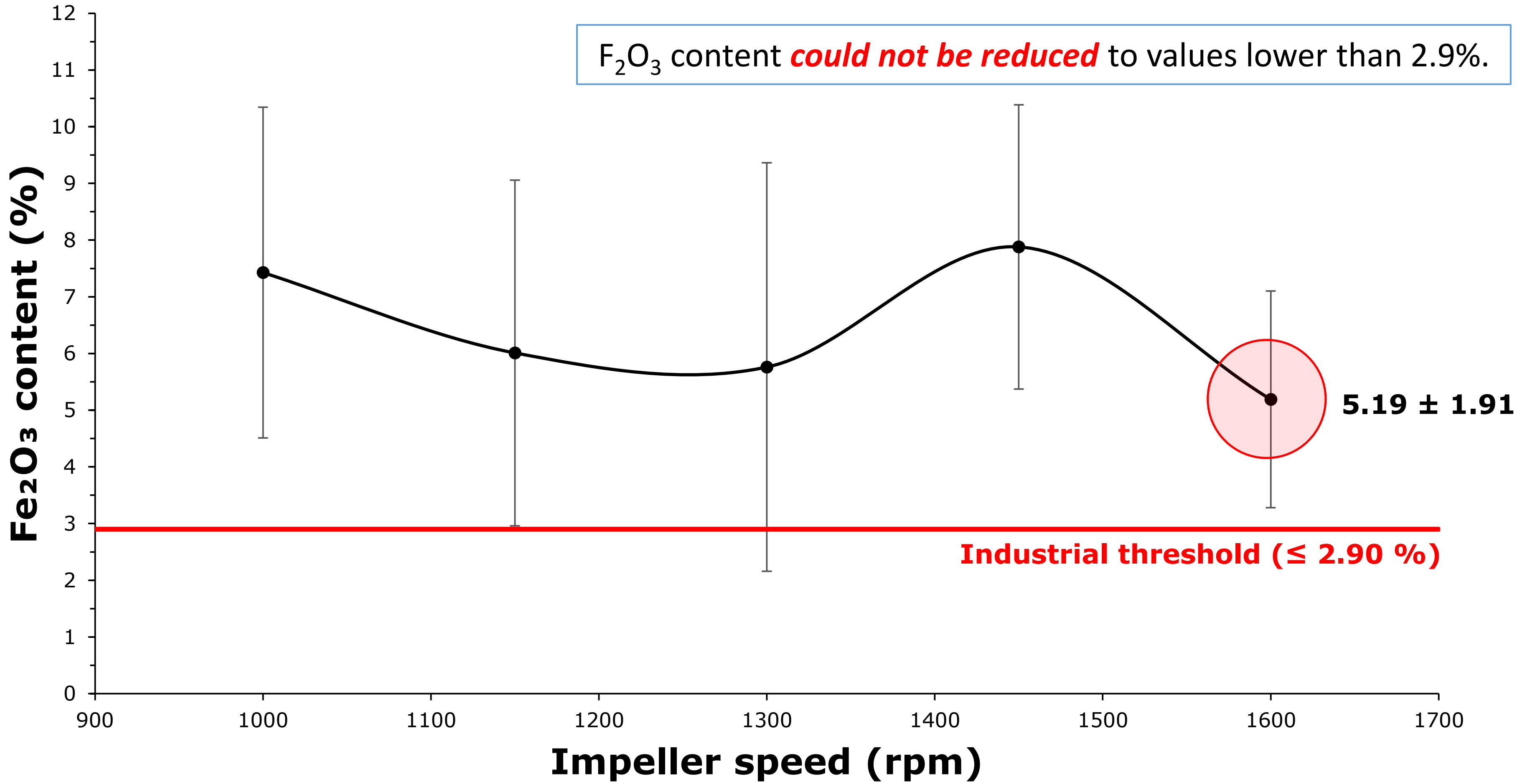
Results and discussion

Influence of the impeller speed on the Fe_2O_3 content in the rougher concentrate



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Results and discussion

- This result agrees with industrial results and explain the adoption of the WHIMS in the end of the phosphate rock concentration.

- Previous tests performed at Copebras in order to remove iron bearing minerals by ***flotation*** showed ***low selectivity and poor apatite recovery*** when compared with a single stage of magnetic separation.

Phosphate rock flotation at Copebras

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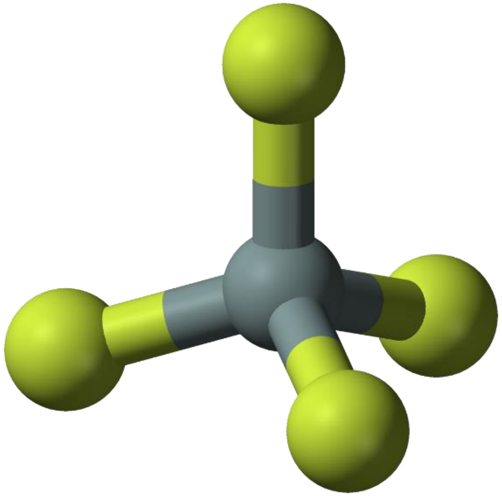
Results and discussion

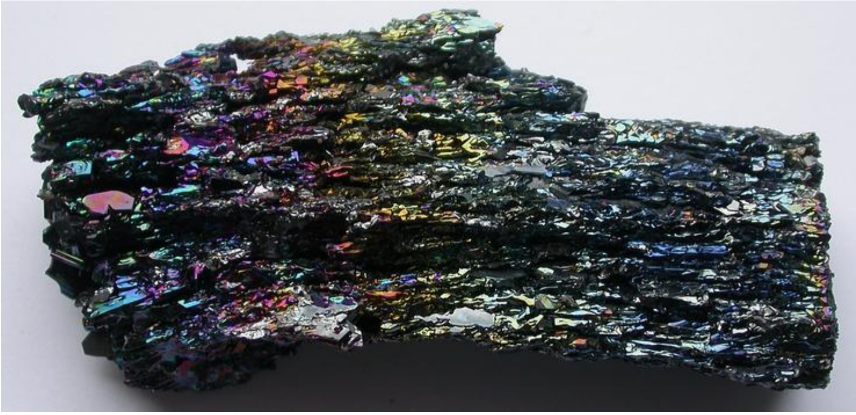
- The production of phosphoric acid is impaired by the presence of silicates (production of ***silicon tetrafluoride***, a highly flammable gas).

$$4HF_{(aq)} + SiO_{2(s)} \rightarrow 2H_2O_{(l)} + SiF_{4(g)} \uparrow$$

- Such gas must be directed to a gas scrubbing system, where it is absorbed by water generating liquid fluossilicic acid.

- ***Only at 1600 rpm*** was possible to reduce the SiO_2 content to 2.92 ± 0.24%





Silicon tetrafluoride

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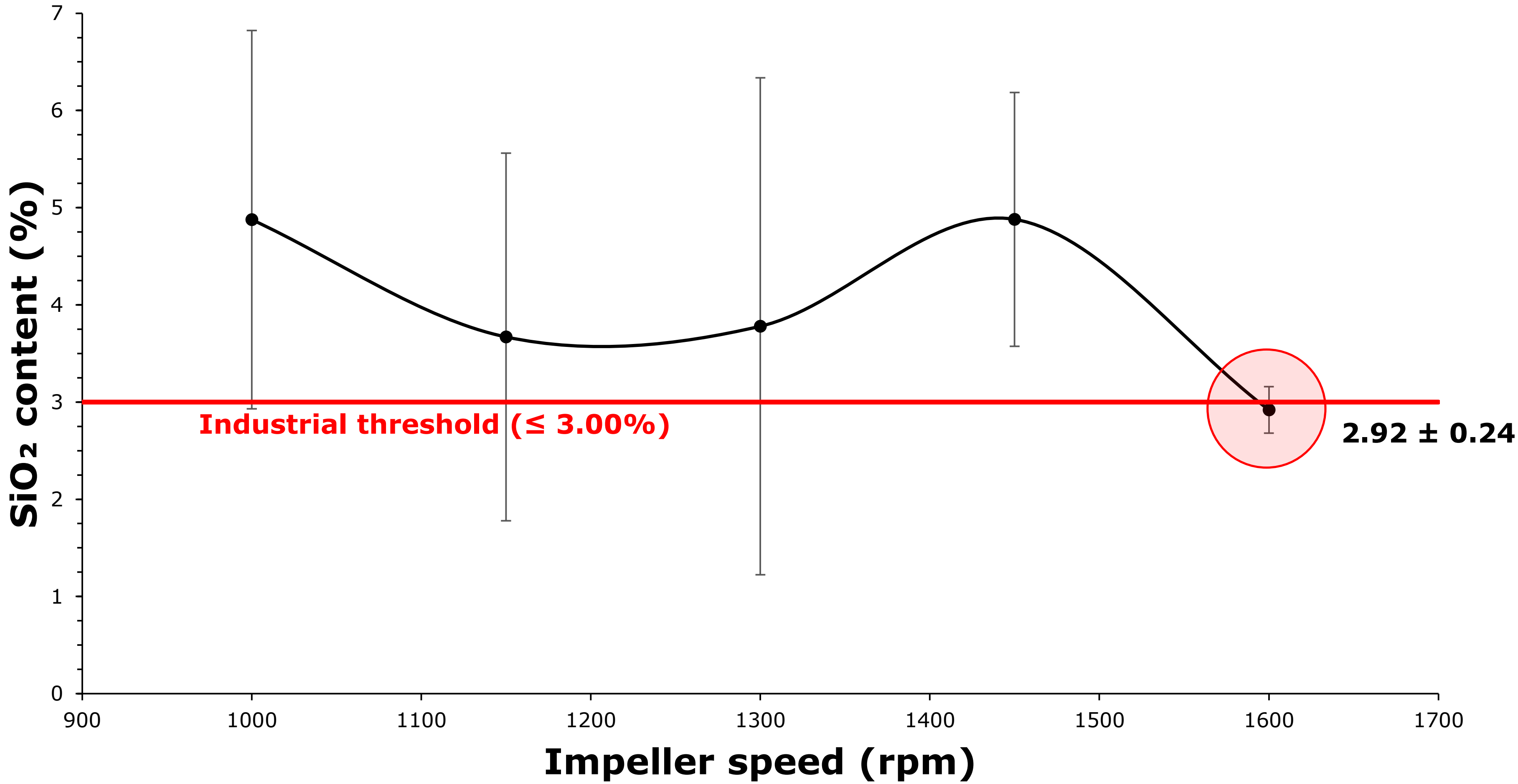
Results and discussion

Influence of the impeller speed on the SiO_2 content in the rougher concentrate

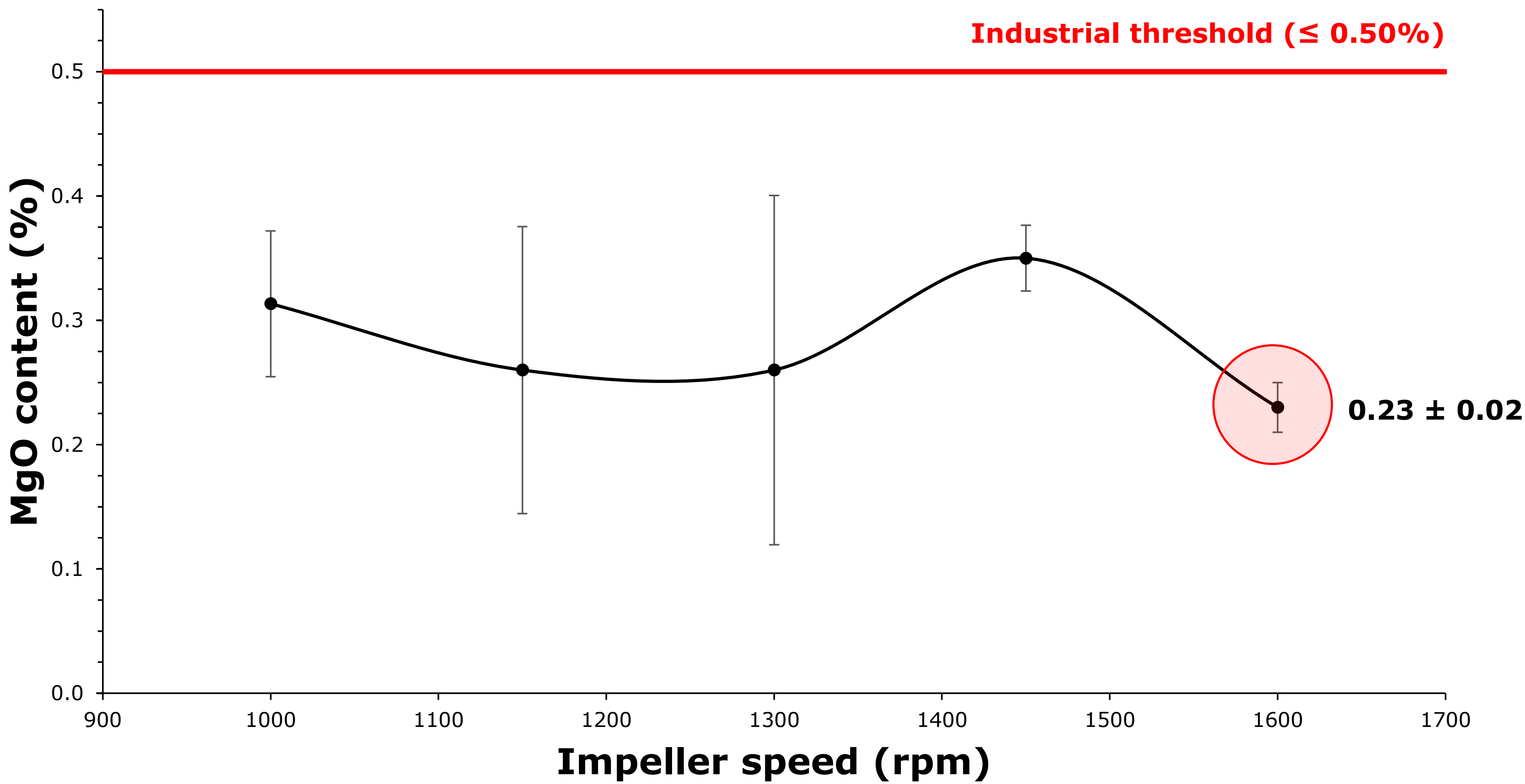


Results and discussion

The MgO content is a major concern. Copebras produces DCP for animal feed. ***Bull calves*** fed with 2 and 4% magnesium oxide presented Diarrhea. These dosages of magnesium ***reduced feed consumption and weight gains***.

Results and discussion

Influence of the impeller speed on the MgO content in the rougher concentrate



Results and discussion

- Copebras uses Lupromim FP B 715 from BASF (40 - 100 g/t, depending on the ore).

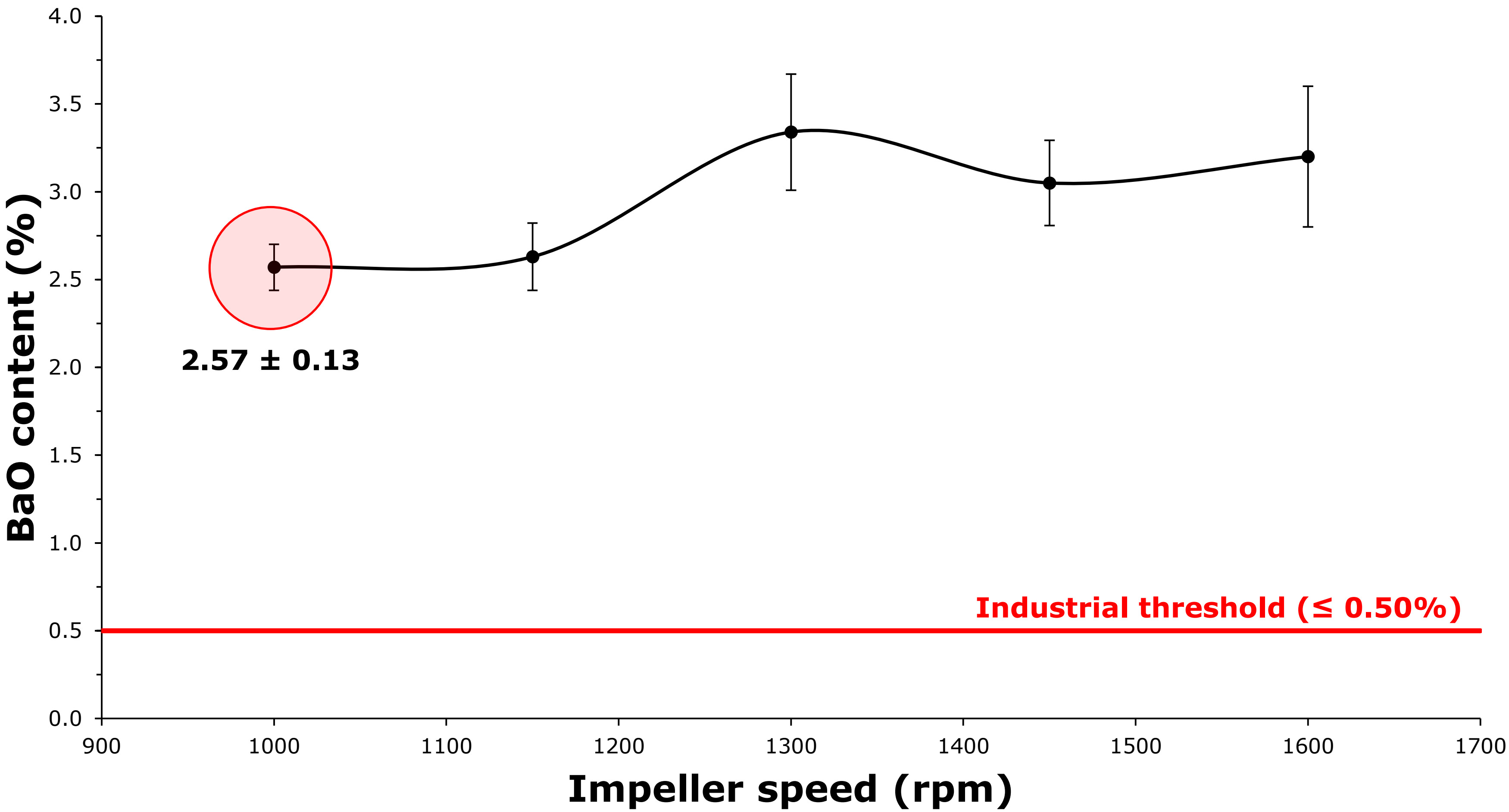
- As expected, the BaO content was above the industrial threshold for all tested impeller speeds, which justify the ***industrial adoption of the barite flotation***.

- For is oxide the best result was obtained at the ***lowest impeller speed***, 1000 rpm (2.57 ± 0.13%).

Barite flotation in Copebras

Results and discussion

Influence of the impeller speed on the BaO content in the rougher concentrate



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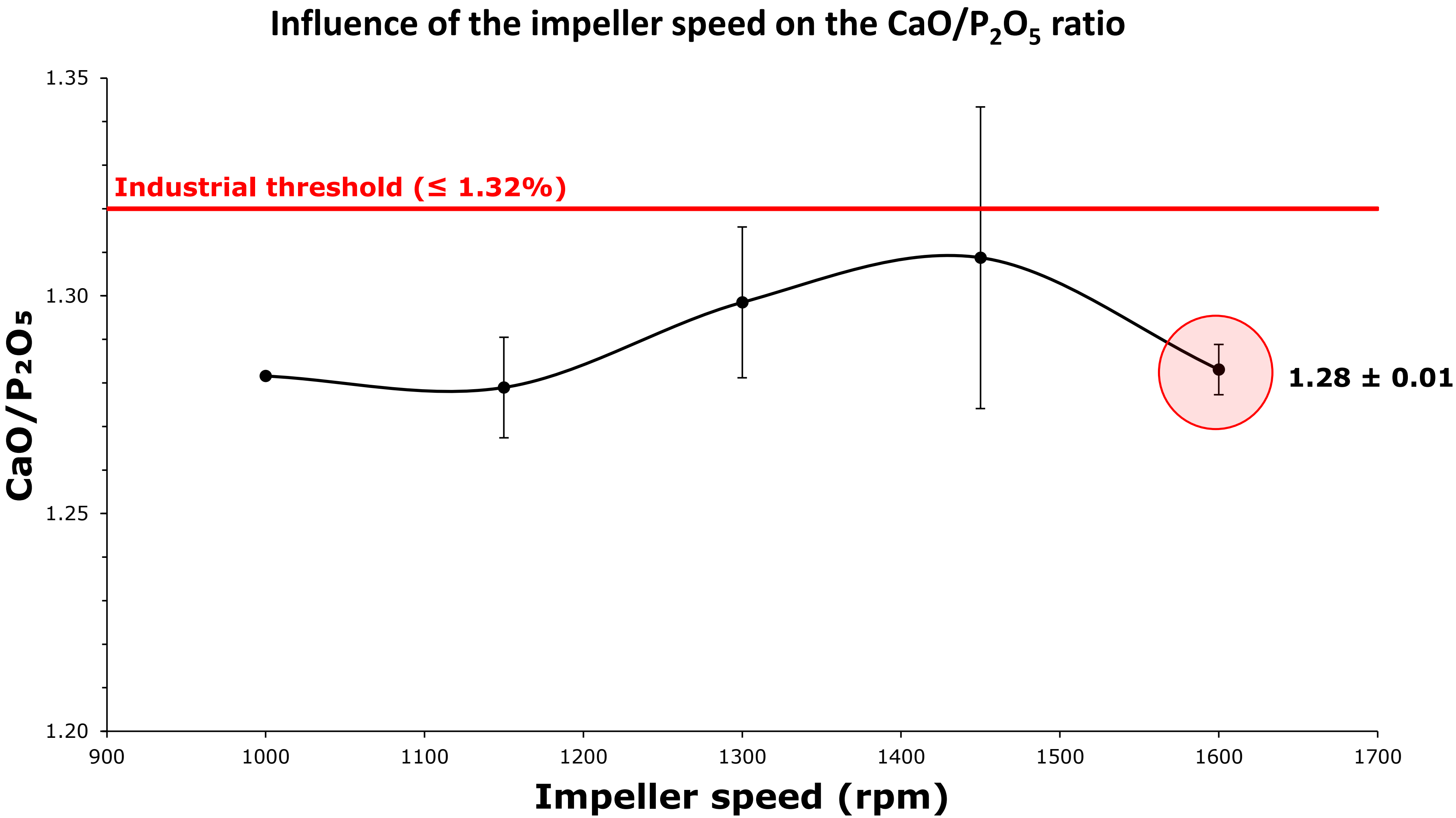
Results and discussion



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Results and discussion

Chemical results for ROM, flotation (feed and concentrates), and industrial threshold

Oxide (%)	ROM	Feed	Impeller speed (rpm)					Threshold
			1000	1150	1300	1450	1600	
P_2O_5	12.76	20.34	31.99 ± 2.72	33.77 ± 2.79	33.10 ± 3.03	31.61 ± 1.89	34.16 ± 0.81	≥ 37.00
CaO	17.08	25.79	40.99 ± 3.50	43.19 ± 3.33	42.98 ± 3.30	41.37 ± 1.50	43.83 ± 1.25	-
Al_2O_3	0.93	0.43	0.78 ± 0.03	0.77 ± 0.18	0.72 ± 0.09	**0.83 ± 0.09**	0.71 ± 0.05	≤ 0.82
Fe_2O_3	30.50	17.25	**7.43 ± 2.92**	**6.01 ± 3.05**	**5.76 ± 3.60**	**7.88 ± 2.51**	**5.19 ± 1.91**	≤ 2.90
SiO_2	13.05	25.35	**4.88 ± 1.95**	**3.67 ± 1.89**	**3.78 ± 2.56**	**4.88 ± 1.31**	2.92 ± 0.24	≤ 3.00
MgO	3.47	0.63	**0.31 ± 0.06**	**0.26 ± 0.12**	**0.26 ± 0.14**	**0.35 ± 0.03**	**0.23 ± 0.02**	≤ 0.50
BaO	4.44	0.61	**2.57 ± 0.13**	**2.63 ± 0.19**	**3.34 ± 0.33**	**3.05 ± 0.24**	**3.20 ± 0.40**	≤ 0.50
Nb_2O_5	0.64	0.33	0.21 ± 0.05	0.16 ± 0.09	0.17 ± 0.10	0.22 ± 0.05	0.16 ± 0.04	-
Others	17.13	9.27	10.85	9.54	9.89	9.81	9.60	-
CaO/P2O5	1.34	1.27	**1.28 ± 0.00**	**1.28 ± 0.01**	**1.30 ± 0.02**	**1.31 ± 0.03**	**1.28 ± 0.01**	≤ 1.32

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Conclusions

- Changes in the impeller speed produced an ***increase of 8% in the P_2O_5*** content and significant ***decreases*** in the ***contaminants*** content.

- The ***best results for 1600 rpm***, followed by 1150 rpm (P_2O_5 were at the highest and the contaminants content was low, in some cases even the lowest values).

Conclusions

- The most studied operational parameters in flotation nowadays are those of chemical order, such as changes in reagents (type or dosage), pH, and others.

- The present work demonstrates that ***physical variables also produce gains for the process***, since the attachment and the bubbles production, size, and stabilization, has severe influence on the concentrate quality.

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