ADVANCED PROCESS SOLUTIONS

EKATO



HPAL Review / History

- EKATO supplies agitators for HPAL Autoclaves for more than 20 years
 - > 300 agitators installed
 - performed many optimizations related to the process performance
- Valuable feedback for many of the projects we were involved in (impellers, photos, onsite information and other data)
 - process results
 - power draw agitators
 - lifetime of the mechanical seal
 - lifetime of the impeller (abrasion)
 - HPAL geometric setups differ (baffles, compartment length, overflow weir geometry)
 - scale formation at impellers and other autoclave wetted surfaces
- Other activities
 - multiple CFD simulations

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EKATO - HPAL Autoclave for Mineral Processing

Year	Type	Qty.	Product	Application	Country	P [kW]	V [m3]	Material	P (bar)	TPC
2023	HML 2160 NV	6	Nokel	HPAL Autodave	Indonesia	160	2 x 154	Teanium G 12	61	270
2023	HML 2160 NV	15	Noted	HPAL Autoclave	Indonesia	132	5 x 150	Titanium G 12	61	270
1222	HWL 2140 NV	2	Nickel	HPAL Autoclave	Indonesia	75	2×77	Tenium G 12	61	270
2023	HWI 2140 NV	4	Notel	HPAL Autoclave	Indonesia	75	4×77	Terrium 0 12	61	270
2023	HWL 2140 NV	1	Notel	HPAL Autoclave	Indonesia	75	1 x 77	Titanium G 12	61	270
2023	HWL 2160 NV	8	Notel	HPAL Autoclave	Indonesia	160	2 x 154	Titanium G 12	61	270
2023	HML 2160 NV	20	Nickel	HPAL Autoclave	Indonesia	132	5 x 150	Titanium G 12	61	270
2023	HWL 2160 NV	6	Nickel	HPAL Autoclave	Indonesia	132	2 x 154	Titanium G 12	60	270
2023	HWL 2100 NV	15	Nickel	HPAL Autoclave	Indonesia	110	5 x 150	Titanium G 12	60	270
2022	HML 2160 NV	12	Notel	HPAL Autoclave	Indonesia	160	2 x 154	Titanium G 12	61	270
2522	HWL 2160 NV	32	Noted	HPAL Autoclave	Indonesia	132	5 x 150	Tanium G 12	61	270
2022	HML 2160 NV		Noted	HPAL Autoclave	Indonesia	132	2 x 136	Titanium G 12	61	275
2022	HWL 2160 NV	15	Noted	HPAL Autoclave	Indonesia	110	5 x 130	Terrium G 12	61	275
2021	HML 2160 NV	12	Noted	HPAL Autoclave	Indonesia	160	2 x 154	Teanium 0 12	61	270
2021	HWL 2160 NV	32	Nobel	HPAL Autoclave	Indonesia	132	5 x 150	Tenium G 12	61	270
2019	HWL 2140 N	2	Nokel	HPAL Autoclave	Indonesia	75	2×77	Terrium G 12	61	279
2012	HW12140 N	4	Noted	HPAL Autoclave	Indonesia	75	4 x 77	Tenium G 12	61	270
2019	HWL 2160 N		Nokel	HPAL Autoclave	Indonesia	132	2 × 117	Titerium G 12/G 7	61	270
2019	HWL 2160 N	20	Nickel	HPAL Autoclave	Indonesia	110	5x 115	Titenium G 12/G 7	61	270
20.48	1000 2160 N	4	Mobile	MPM Autorizan	Interests	110	2 4 117	Theorem 0.12/0.7	61	100
	1000 2160 M	-	No.	HDM Autocines	Introneia		6	Theology G 12 / G 7	41	100
2012	HAN STERN		Man	HDM Autoritan	Techny	25	100×2	Taxing 0.12		155
	1000 0140 M		New	white Automation	Table		100 + 4	Taxing 0.12		265
20.45	LINE STERN		Man	UPU Autoritan	Delegan	110	120 4 4	Theorem 0.12/0.7		345
10.12	HIM THEOR		Maker	MRM Autoritan	Delegence		120.4.10	Tanan 0 12/07		245
2008	HWL 2160 N	6	Notel	HPAL Autoclave	Papua New Guinea	90	80 x 15	Tanium G 12	53	255
802	HWL 2140 N	15	Nickel	HPAL Autoclave	Papua New Guinea	75	80 x 6	Titanium G 12	53	255
2005	HWL 2160 N		Nickel	HPAL Autoclave	Drazil	55	105 x 4	Titanium G 12	51	255
2006	HWL 2160 N	4	Nickel	HPAL Autoclave	Drazi	75	110 x 8	Titanium G 12	51	255
2005	HWL 2160 N	9	Nickel	HPAL Autoclave	New Caledonia	75	62 x 6	Titanium G 12	64	278
2005	HWL 2160 N	9	Notel	HPAL Autoclave	New Caledonia	75	62.16	Tenium G 12	64	278
2004	HWL 2125 DN	12	Notel	PAL Autodave	Australia	45	75 x 6	Tanium G 12	45	250





(Some) Challenges



- Scale formation
 - nickel and cobalt are the target metals, but other reactions dominate
 - iron and aluminum undergo leach-precipitation reactions
 - I formation of e.g. Hematite and Alunite
 - majority forms in first compartments but in the entire autoclaves
 - regular cleaning required
 - not only process but mechanical impacts as well
- Remove / reduce number of inter-compartment walls and other internals
 - erosion near rat holes
 - reduced scale formation

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Concept Study HPAL Setup / Exploration

- Impact of the geometric setup
 - number and location of baffles
 - number and location of overflow weirs / compartment walls
 - over- and underflow
- Goal: reduce the size of the wetted surface area in the autoclave
 - reduce scaling
 - reduce Capex
 - easier maintenance
- EKATO Technical Center in Germany
 - □ lab study 500 liter
 - basis for comparison: standard design
 - comparison of RTD measured
 - solids suspension / flow pattern
 - mechanical impact: power input, radial forces



🎾 ALTA **Available Test Setups Test possibilities at EKATO Technical** Centre Scale-Up Scale-Up ~ 70 liters filling volume, 6 compartments 70 liter-scale for testing: - blending times ~ 1 m³ filling volume, - suspending behaviour 2 compartments - residence time distribution 1 m³ and 7 m³-scale for testing: ~ 7 m³ filling volume, - feed point locations - mechanical loads 2 compartments others - wear of e.g. impeller, baffles **EKATO** ADVANCED PROCESS SOLUTIONS



Test Setup

Our approach: 500 liters lab-trials – measurement of the residence time distribution







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Residence Time Distribution – Impact of Shaft Speed - Ideal n=1 -M2 - 150 / 100 - M3 - 300 / 250 - M4 - 250 / 200 - M27 - 200 / 150 Ideal n=2 1,10 1,00 0,90 0,80 □ increased shaft speed or power input results in short-circuiting 0,70 **E**(t/1) **B**(t/1) **B**(t/1) **B**(t/1) □ scale-effect and probably less distinct in full scale 0,40 0,30 0,20 0,10 0,00 0,0 0,5 1,0 1,5 2,0 2,5 3,0 3,5 4,0 dimensionless residence time t/τ (-)

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Residence Time Distributions



Kick-Off question:

Can a difference in the residence time distribution between over-flow and under-flow be observed?



Residence Time Distributions Compartment 6



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Residence Time Distributions Compartment 6







EKATO Concept study

Our approach: 500 liter – lab-trials



Mechanical impact: power input, radial forces

- Do the two (or more) agitators in one compartment influence each other ?
 - □ Yes, but not significantly !



Summary and Conclusions

Discussion

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- presentation for thought-provoking impulse / brainstorming
- concept might be worthwhile for some users or new autoclaves to be built
- comparisons as presented may allow to assess a possible impact on the leaching performance
- test scale to full scale: results in test scale considered to be conservative since absolute length scale important
- additional testing in our new 1 m diameter autoclave model with 3 compartments
- transfer concept to POX and similar applications
- CFD analysis after feedback
- new impeller type under development (compartmentalization ?)
- Looking forward to your feedback / input





Thanks to ...

EKATO ADVANCED PROCESS SOLUTIONS

- ... David White for the discussions and his input.
- ... Niels for his test and development work.

Thank you for your attention!



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 #process innovation stage
Monday June 10,02.00 - 02.30 pm Mixing in World Scale Plants

Meet me also at the EKATO booth in Hall 6.0 Booth C19

Schedule a meeting

ΕΚΑΤΟ