UANIUM RECOVERY FROM COBALT LEACH SOLUTION IN THE DRC

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ABSTRACT

Clean TeQ water designs and supplies equipment for waste and process water treatment, impurity removal and metal recovery from process streams.

One of Clean TeQ Water core technology relies on Continuous Ionic Filtration (CIF). CIF provide both ion exchange and filtration equipment in which a packed bed of resins move downwards in counter flow to the liquid moving upwards. In such systems loaded resins are removed from the bottom and moved to the next column through airlifts.

The technology has been successfully applied for different types of water and process treatment throughout the world. This specific case focuses on the recent results from a large scale IX-CIF plant in the DRC for removal of Uranium impurities from a Cobalt stream. This Uranium polishing plant was designed and supplied by Clean TeQ Water in cooperation with Multotec, Clean TeQ's partner in Africa. The results from site show the Uranium concentration reduced from around 40 to around 4 ppm from a 20,000 m3 per day 1.5 pH raffinate stream. The next step is for the end-user to increase the pH of the incoming raffinate (as per design) such that the outgoing Uranium concentration will reach below 1 ppm.

Using such ion exchange CIF system provides a number of benefits compared to regular resin exchange systems including

- The ability to accept up to around 150 mg/l solids which is continuously filtered out and removed by the moving packed bed. This is substantially higher than would be acceptable for any fixed packed bed system which would require expensive pre-treatment.
- Limited space requirements and capex due to the combination of packed beds and counterflow. This is in contrast to fluidized or stirred reactors that require more space and potentially require long series of vessels to create similar counter flow results.
- Low output impurity levels and a highly concentrated waste stream (uranium strip liquor), making disposal or further processing easier.
- The ability to quickly adjust to changing feed flow or concentration conditions by adjusting the speed of resin flow.

Clean TeQ Water applies this technology not only for Uranium removal, but also for the recovery from process water and tailings of valuable metals (e.g., Ni, Co, Cu, Au), for the removal of other pollutants (e.g., Se, As, Sb) and for nutrient removal (P, N)

Keywords: Uranium, Ion Exchange, Cobalt, Impurity removal, polishing, Waste water treatment, Clean TeQ, Sunrise, DRC

- 1. Company Intro
- 2. CIF and IX
- 3. Project overview
- 4. CIF for other applications

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CLEANTEQ PATENTED TECHNOLOGIES

CIF ® – Continuous Ion Filtration

CleanBio® Lenses

NEX – Natural Evaporation Crystallization Technology

GO membranes and adsorbents (under development) Using a moving bed of resins to continuously filter waste water and remove pollutants from large amounts of water to meet water discharge standards or upgrade water for re-use

Using natural bacteria immobilized in a PVA gel, waste water treatment processes are accelerated with as a result a lower footprint, low power and less sludge production. This process is particularly applicable nitrification and denitrification

Using natural evaporation at low temperatures to treat highly polluted, high salinity (<5%) waste streams and produce distilled water and dry salts at low energy cost with limited issues from scaling and corrosion

Using graphene oxide as the active layer in membranes and as an absorbent, organic pollutants are effectively removed from waste water

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CASE EXAMPLES

- Over 50 moving packed bed plants around the world
- Mostly located in Kazakhstan
- Focused on Uranium and gold extraction
- Predominantly U-column design
- In operation since 1944

	Mine	Company	Location	Commodity	Start up	Process	Metal Produced (tpa)	Ore (tpa)
1	Eastern Moinkum	Mining Company LLP	Kazakhstan	Uranium	2006	ISR / CCIX	1,000	
2	Zarechnoye	Zarechnoye JV	Kazakhstan	Uranium	2006	ISR / CCIX	1,000	-
3	Inkai, Site 4	Betpak Dala JV	Kazakhstan	Uranium	2007	ISR / CCIX	2,000	-
4	Central Mynkuduk	Ken Dala kz JV	Kazakhstan	Uranium	2007	ISR / CCIX	2,000	
5	Budenovskoye, Site 2	Karatau LLP	Kazakhstan	Uranium	2007	ISR / CCIX	1,000	-
6	Kanzhugan, Kainarski Site	Mining Company LLP	Kazakhstan	Uranium	2008	ISR / CCIX	300	-
7	West Mynkuduk	APPAK LLP	Kazakhstan	Uranium	2008	ISR / CCIX	1,000	-
8	Kharassan 1	Kyzylkum LLP	Kazakhstan	Uranium	2008	ISR / CCIX	3,000	-
9	irkol	Semizbai-U LLP	Kazakhstan	Uranium	2008	ISR / CCIX	750	-
10	Semizbai	Semizbai-U LLP	Kazakhstan	Uranium	2009	ISR / CCIX	500	-
11	Budenovskoye, Site 1	Akbastau JSC	Kazakhstan	Uranium	2009	ISR / CCIX	1,000	-
12	Budenovskoye, Site 3,4	Akbastau JSC	Kazakhstan	Uranium	2010	ISR / CCIX	2,000	-
13	Kharassan 2	Baiken-U LLP	Kazakhstan	Uranium	2009	ISR / CCIX	2,000	
14	Southern Zarechnoye	Zarechnoye JV	Kazakhstan	Uranium	2010	ISR / CCIX	1,000	-
15	Krasnokamensk	ARMZ	Russia	Uranium	1975	cRIP/CCIX	2,900	2.5M
16	Navoi	NGMK	Uzbekistan	Uranium	1963	cRIP/CCIX	2,350	2.5M
17	Stepnogorsk	Kazatomprom	Kazakhstan	Uranium	1970	cRIP/CCIX	1,000	3.0M
18	Zheltiye Vody	VostGOK	Ukraine	Uranium	1960	cRIP/CCIX	800	1.0M
19	Kara Balta	Renova	Kirgizstan	Uranium	1965	cRIP/CCIX	500	2.5M
20	Dolni Rozinka	Diamo	Czech Rep	Uranium	1964	cRIP/CCIX	600	0.5M
21	Chkalovsk (closed)	Vostokredmet	Tadjikistan	Uranium	1964	cRIP/CCIX	2,000	2.5M
22	Bismuth (closed)	Wismut	Germany	Uranium	1964	cRIP/CCIX	1,000	2.5M
23	Bukhovo (closed)	Redki Metali	Bulgaria	Uranium	1964	cRIP/CCIX	1,000	1.0M
24	Muruntau	CMA	Uzbekistan	Gold	1968	cRIP	50	25M
25	Almalyk	AMMC	Uzbekistan	Gold	1961	cRIP	5	10M
26	Vasilkovskoye	VasGold	Kazakhstan	Gold	1979	HL/CCIX	0.9	1M
27	Matrosov	OJSC	Russia	Gold	1944	cRIP	10	10M
28	Aldanzoloto	OJSC	Russia	Gold	1961	cRIP	8	10M
29	Petropavlovsk Plant	Petropavlovsk Plc	Russia	Gold	2000	cRIP	20	4M

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SITE TEST RESULTS

- Data from initial stages of commissioning
- Not yet reaching <1:
 - Feed pH not in optimal range
 - Feed BEFORE Fe removal circuit

Feed			Treated A	Treated B	Treated C	Treated D	
рН	Co (mg/L)	U (mg/L)	U (mg/L)	U (mg/L)	U (mg/L)	U (mg/L)	
1.55	2,670	39.65	3.25	3.88	3.78	3.83	
1.49	3,090	39.65	7.21	6.93	5.57	6.32	
1.56	3,700	35.60	5.15	2.45	4.97	3.41	
1.55	2,390	37.23	5.31	5.47	5.63	5.64	
1.56	2,610	38.76	6.14	3.35	5.61	5.87	
	pH 1.55 1.49 1.56 1.55	PH Co (mg/L) 1.55 2,670 1.49 3,090 1.56 3,700 1.55 2,390 1.56 2,610	Peed U (mg/L) pH Co (mg/L) U (mg/L) 1.55 2,670 39.65 1.49 3,090 39.65 1.56 3,700 35.60 1.55 2,390 37.23 1.56 2,610 38.76	PGeQ PGQ PGQ <thp< td=""><td>pH Co (mg/L) U (mg/L) U (mg/L) U (mg/L) 1.55 2,670 39.65 3.25 3.88 1.49 3,090 39.65 7.21 6.93 1.56 3,700 35.60 5.15 2.45 1.55 2,390 37.23 5.31 5.47 1.56 2,610 38.76 6.14 3.35</td><td>pH Co (mg/L) U (mg/L) U (mg/L) U (mg/L) U (mg/L) U (mg/L) 1.55 2,670 39.65 3.25 3.88 3.78 1.49 3,090 39.65 7.21 6.93 5.57 1.56 3,700 35.60 5.15 2.45 4.97 1.55 2,390 37.23 5.31 5.47 5.63 1.56 2,610 38.76 6.14 3.35 5.61</td></thp<>	pH Co (mg/L) U (mg/L) U (mg/L) U (mg/L) 1.55 2,670 39.65 3.25 3.88 1.49 3,090 39.65 7.21 6.93 1.56 3,700 35.60 5.15 2.45 1.55 2,390 37.23 5.31 5.47 1.56 2,610 38.76 6.14 3.35	pH Co (mg/L) U (mg/L) U (mg/L) U (mg/L) U (mg/L) U (mg/L) 1.55 2,670 39.65 3.25 3.88 3.78 1.49 3,090 39.65 7.21 6.93 5.57 1.56 3,700 35.60 5.15 2.45 4.97 1.55 2,390 37.23 5.31 5.47 5.63 1.56 2,610 38.76 6.14 3.35 5.61	







MAIN BENEFITS MOVING RESIN BED ION EXCHANGE

- Ability to handle solids without system fouling through resin washing
- Flexibility to handle changing feed conditions by changing the resin flowrate
- Concentrated waste stream / tenors (uranium strip liquor) which are easier to dispose
- Minimised reagent and power consumption
- Minimised resin inventories reduced investment cost

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IX APPLICATIONS FOR METAL EXTRACTION

Number	Application	Target Elements	Resin Type	Regeneration
1	Valuable metals recovery	Cu, Ni, Co	IDA	H ₂ SO ₄
2	Uranium removal from leachates	U	SBA	H ₂ SO ₄
3	Scandium purification from leachates	Sc	AP	Na ₂ CO ₃
4	Precious metals recovery	Au, Ag	15% SBA, 85% WBA	SC(NH ₂) ₂
5	Molybdenum, Tungsten, Vanadium recovery	Mo, W, V	WBA	NH ₃

C	CLQ WATER SOLUTIONS FOR MINING						
•	<u>Recovery or trace metals</u> from process streams or tailings. For example: Cobalt, Nickel, Vanadium and Tungsten	IX					
٠	Removal of metal impurities from process streams or tailings. For example: Uranium, Selenium, Antinomy, Arsenic	CIF / IX	Precipitation				
٠	General process water treatment for disposal by removing salts, sulphates and heavy metals	CIF	Filtration Precipitation				
۰	<u>Clean water production and process water</u> <u>recycling</u> by a combination of Continuous Ionic Filtration with membranes and precipitation	HiROx (CIF + Biolenses	RO)				
•	Brine minimization and Zero Liquid Discharge	HiROx NEX	Filtration				



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