

Coke-Based Carbon Sorbent: Results of Gold Extraction in Laboratory and Pilot Tests

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Table S1. Laboratory desorption results of gold from the CBCS.

Eluant volume, cm ³	Desorption time, min	Gold concentration in the eluate, mg dm ⁻³	Gold content in the eluate, mg	Gold extracting degree, %
100	30	100.08	10.008	35.93
100	30	58.00	5.80	20.82
100	30	31.37	3.137	11.26
100	30	20.67	2.067	7.42
100	30	14.80	1.480	5.31
100	30	11.67	1.167	4.19
100	30	8.18	0.818	2.94
100	30	5.01	0.501	1.79
100	30	3.95	0.395	1.42
100	30	4.80	0.480	1.72
100	30	4.17	0.417	1.497
100	30	4.56	0.456	1.64
100	30	2.86	0.286	1.03
100	30	2.01	0.201	0.72
100	30	1.65	0.165	0.59
100	30	1.20	0.120	0.43
100	30	0.98	0.098	0.35
100	30	0.91	0.091	0.33
100	30	0.84	0.084	0.30
100	30	0.82	0.082	0.29

Table S2. The results of metal removal from the production solution by the CBCS in the pilot test.

Day	V ¹ , dm ³	Au			Ag			Cu			Zn			Fe			As		
		C ₁ ²	C ₂ ³	R ⁴	C ₁ ²	C ₂ ³	R ⁴	C ₁ ²	C ₂ ³	R ⁴	C ₁ ²	C ₂ ³	R ⁴	C ₁ ²	C ₂ ³	R ⁴	C ₁ ²	C ₂ ³	R ⁴
1	30	2.6	0.03	99	0.42	0.02	95	490	490	0	5.40	5.50	-2	71.00	73.15	-3	0.96	0.83	14
2	30	2.6	0.07	97	0.42	0.20	52	490	500	-2	5.40	5.67	-5	71.00	71.15	0	0.96	0.74	23
3	30	2.6	0.21	92	0.42	0.32	24	490	480	2	5.40	5.70	-6	71.00	71.65	-1	0.96	0.68	29
4	30	2.6	0.45	83	0.42	0.30	29	490	500	-2	5.40	5.53	-2	71.00	71.85	-1	0.96	0.76	21
5	21	2.6	0.73	72	0.42	0.40	5	490	500	-2	5.40	5.40	0	71.00	71.35	0	0.96	0.68	29
6	8	2.6	0.07	97	0.42	0.22	48	490	490	0	5.40	4.63	14	71.00	56.50	20	0.96	0.62	35
7	9	2.6	0.13	95	0.42	0.26	38	490	480	2	5.40	5.93	-10	71.00	70.35	1	0.96	0.73	24
8	15	2.6	0.14	95	0.42	0.26	38	490	480	2	5.40	5.60	-4	71.00	71.50	-1	0.96	0.76	21
9	13	2.6	0.29	89	0.42	0.34	19	490	500	-2	5.40	5.47	-1	71.00	71.85	-1	0.96	0.75	22
10	12	2.6	0.41	84	0.42	0.39	7	490	490	0	5.40	5.47	-1	71.00	72.00	-1	0.96	0.79	18
Total/average	198			90			39			0			-3			0			23

¹ V – the volume of the production solution passed through the sorption cascade. ² C₁ – the metal ions concentration in the solution before sorption, mg dm⁻³. ³ C₂ – the metal ions concentration in the solution after sorption, mg dm⁻³. ⁴ R – metal removal, %.

Table S3. The dynamics of changes in the concentration of gold in the solutions after sorption for the day shift on each column during testing at the pilot unit.

Day shift	C ₁ ¹	C _{2 k-d} ²	R _{k-d} ³	C _{2 k-d} ²	R _{k-d} ³	C _{2 k-d} ²	R _{k-d} ³	C _{2 k-d} ²	R _{k-d} ³	C _{2 k-d} ²	R _{k-d} ³	R _{calc d} ⁴
1		C _{2 1-1}	R ₁₋₁	C _{2 2-1}	R ₂₋₁	C _{2 3-1}	R ₃₋₁	C _{2 4-1}	R ₄₋₁	C _{2 5-1}	R ₅₋₁	R _{calc 1}
		1.4	46	0.68	51	0.28	59	0.06	79	0.01	83	100
2		C _{2 1-2}	R ₁₋₂	C _{2 2-2}	R ₂₋₂	C _{2 3-2}	R ₃₋₂	C _{2 4-2}	R ₄₋₂	C _{2 5-2}	R ₅₋₂	R _{calc 2}
		1.77	32	0.99	44	0.41	59	0.12	71	0.04	67	98
3		C _{2 1-3}	R ₁₋₃	C _{2 2-3}	R ₂₋₃	C _{2 3-3}	R ₃₋₃	C _{2 4-3}	R ₄₋₃	C _{2 5-3}	R ₅₋₃	R _{calc 3}
		2.1	19	1.82	13	1.43	21	0.92	36	0.51	45	80
4		C _{2 1-4}	R ₁₋₄	C _{2 2-4}	R ₂₋₄	C _{2 3-4}	R ₃₋₄	C _{2 4-4}	R ₄₋₄	C _{2 5-4}	R ₅₋₄	R _{calc 4}
		2.24	14	1.92	14	1.54	20	1.07	31	0.64	40	75
5		C _{2 1-5}	R ₁₋₅	C _{2 2-5}	R ₂₋₅	C _{2 3-5}	R ₃₋₅	C _{2 4-5}	R ₄₋₅	C _{2 5-5}	R ₅₋₅	R _{calc 5}
		2.19	16	1.96	11	1.64	16	1.23	25	0.86	30	67
6		C _{2 3-6}	R ₃₋₆	C _{2 4-6}	R ₄₋₆	C _{2 5-6}	R ₅₋₆	C _{2 1-6}	R ₁₋₆	-	-	R _{calc 6}
		1.52	42	0.72	53	0.38	47	0.13	66	-	-	95
7		C _{2 3-7}	R ₃₋₇	C _{2 4-7}	R ₄₋₇	C _{2 5-7}	R ₅₋₇	C _{2 1-7}	R ₁₋₇	C _{2 2-7}	R ₂₋₇	R _{calc 7}
		1.17	55	1.01	14	0.75	26	0.64	15	0.25	61	90
8		C _{2 4-8}	R ₄₋₈	C _{2 5-8}	R ₅₋₈	C _{2 1-8}	R ₁₋₈	C _{2 2-8}	R ₂₋₈	-	-	R _{calc 8}
		1.48	43	0.8	46	0.4	50	0.17	58	-	-	93
9	2,6	C _{2 4-9}	R ₄₋₉	C _{2 5-9}	R ₅₋₉	C _{2 1-9}	R ₁₋₉	C _{2 2-9}	R ₂₋₉	C _{2 3-9}	R ₃₋₉	R _{calc 9}
		1.79	31	1.13	37	0.68	40	0.4	41	0.22	45	92
10		C _{2 4-10}	R ₄₋₁₀	C _{2 5-10}	R ₅₋₁₀	C _{2 1-10}	R ₁₋₁₀	C _{2 2-10}	R ₂₋₁₀	C _{2 3-10}	R ₃₋₁₀	R _{calc 10}
		2.18	16	1.72	21	1.31	24	0.88	33	0.41	53	84

¹ C₁ – the gold ions concentration in the solution before sorption, mg dm⁻³. ² C_{2 k-d} – the gold ions concentration in the solution after sorption on the column (k) for the day shift (d), mg dm⁻³. ³ R_{k-d} – the gold removal degree by the sorbent on the column (k) for the day shift (d), %. ⁴ R_{calc d} – the calculated gold removal degree in the cascade for the day shift (d).

Table S4. The metals content on the surface of the CBCS after sorption and desorption during testing at the pilot unit.

Column	Au ¹ , g t ⁻¹	Au ² , g t ⁻¹	Ag ¹ , g t ⁻¹	Ag ² , g t ⁻¹	Cu ¹ , %	Cu ² , %	Fe ¹ , %	Fe ² , %	Zn ¹ , %	Zn ² , %	As ¹ , %	As ² , %	Au + Ag proportion after sorption, %	Au proportion after sorption, %	Au extracting degree, %
1	2776.2	283.2	133.2	289.9	-	-	-	-	-	-	-	-	-	-	90
2	2690	251	137.1	72	-	-	-	-	-	-	-	-	-	-	91
3	2700	183	135.1	83	-	-	-	-	-	-	-	-	-	-	93
4	2883.4	767.5	168.3	112.5	0.096	0.09	0.069	0.086	0.005	0.009	0.001	<0.001	99.99	94.48	73
5	2358.4	446.7	208.3	115	0.098	0.115	0.081	0.144	0.005	0.009	0.001	<0.001	99.99	91.88	81
1 ³	2324.3	1325.8	116.7	130	0.136	0.115	0.07	0.096	0.017	0.009	0.001	<0.001	99.99	95.21	43
2 ³	2370	1294	114.3	126.8	0.13	0.117	0.072	0.094	0.007	0.01	0.001	<0.001	99.99	95.39	45
3 ³	2273.3	1198.3	140	72.5	0.141	0.087	0.098	0.111	0.009	0.008	0.001	<0.001	99.99	94.19	47

¹ The metal ions content after sorption. ² The metal ions content after desorption. ³ After reuse.