The American Journal of Applied sciences
(ISSN – 2689-0992)
VOLUME 04 ISSUE 04 Pages: 11-19
SJIF IMPACT FACTOR (2020: 5. 276) (2021: 5. 634) (2022: 6. 176)
OCLC – 1121105553 METADATA IF – 7.987
Publisher: The USA Journals

Journal Website: https://theamericanjournals.com/index.php/tajas

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Research Article

RESEARCH TECHNOLOGY OF EXTRACTION OF GOLD FROM A PRODUCTIVE SOLUTION UNDER LABORATORY CONDITIONS

Submission Date: April 09, 2022, Accepted Date: April 17, 2022,
Published Date: April 30, 2022 |
Crossref doi: https://doi.org/10.37547/tajas/Volume04Issue04-03

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ABSTRACT

The paper considers the most effective leaching solution for extracting gold; it was decided to test different reagents using the IW method from spent uranium gold wells. And also Scientific experiments were carried out to extract gold from a productive solution in laboratory conditions, the sorption process was carried out on various grades of activated carbon to determine a promising sample. In order to saturate the sorbent with a solution from a productive solution, studies were carried out with the following types of activated carbons: AG 3, AG 5, AG-95. The sorption process was carried out with a productive solution supplied from the bottom up and consisting of a pressure column, with a dense layer of activated carbon 3 kg.

KEYWORDS

Well, gold, productive solution, sorption, desorption, leaching.

INTRODUCTION

The performance of laboratory studies ultimately makes it possible to obtain geotechnological data that are used as initial results for conducting a pilot test for the extraction of gold by in-situ leaching from depleted uranium wells.

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Laboratory studies on core material were carried out in order to determine the permeability of the medium and the nature of its change in the leaching process, clarify the geotechnological regime and solve some special problems associated with the subsequent use of the results in natural conditions. The research is based on the method of studying fluid filtration in a porous medium, known in the practice of laboratory hydrogeological work.

The technique, with some changes and taking into account the characteristics of the chemical process, has found wide application in laboratory studies of underground leaching of metals from loose sandy deposits. In the future, the obtained laboratory data are refined at the semi-industrial site of the deposit during tests for metal mining.

Numerous variables associated, in particular, with the heterogeneity of the environment, are stabilized, for example, the natural mineralogical and filtration heterogeneity of rocks and ores can be reduced to a simplified scheme with some average material composition and specified filtration properties [5].

To determine the mineralogical and material composition of the core material will be analyzed in the following methods:

- Full chemical analysis of ore, including gold, REE, scandium and germanium;
- Phase and X-ray fluorescence analysis of core material;
- Granulometric analysis of ore by different size classes;
- Conducting campaign experiments;
- Chemical analysis of solutions after agitation for gold and REE.

Before performing analytical work aimed at examining the core material for gold content, a stage of sample preparation for subsequent analyzes was carried out.

Sample preparation:

Processing of the core material was carried out in the following order:

1. taking the original sample;
2. measurement of a sample for radioactivity;
3. sample drying;
4. sample weighing;
5. sample mixing;
6. quartering and sampling for abrasion (100–150 g)

on vibrating grinders type IV.

The crushed samples are sent for X-ray fluorescence, assay and atomic absorption analysis of gold. Sampling of technological samples for chemical analysis of REE, scandium, germanium, uranium, granulometric composition, mineralogy and agitation[6];

To select the most effective leaching solution for extracting gold, using the IW method from depleted uranium wells, based on world experience in gold leaching, it was decided to test solutions of the following compositions:

1) I (iodine);

2) H_2SO_4 + NaClO; (mixture of sulfuric acid and sodium hypochlorite);

3) NaClO; (sodium hypochlorite);

4) $CS(NH_2)_2$ (thiourea);

Studies on gold leaching in filter columns.

The studies were carried out using a special setup. The stand consists of a plexiglass filtration column, which is installed in a vertical position in a metal frame[7].

Fig. 1. Leaching in a filter column, close to the specific conditions of in-situ leaching

Dimensions of the filtration column, diameter 50 mm, length 1 m. During the experiments, solutions were tested and pH, Au, U, and REE were analyzed, and the reagent supply rate was controlled. Sample weight 3,2 kg (Fig. 1).

Liquid samples were taken once a day, it took 3 days for the leaching process, during the study, the levels of solutions were controlled to filter the solution at maximum speed at a constant pressure level j=1,0–2,0.

In the experiments, core samples from the well were used in the intervals of supra-ore, ore and sub-ore levels. The leaching was carried out under static conditions, at room temperature, in a laboratory setup. After a predetermined time, the solutions were filtered from the cake and sent for analysis of the gold content in it[8].

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Table 1.

The results of the analysis of gold leaching from core samples, obtained from a depleted uranium well

Sample No.	Leaching Solution Concentration, g/l	Name of solvents and quantity of products	Actual average values from test results	Note
I_2 pH=9,00 redox potential= 762				
1007	4	Gold concentration, mg/l	178	Surplus test ε= 92%
		Gold concentration, mg/l	180	
		Gold concentration, mg/l	184	
1026	4	Gold concentration, mg/l	18.1	Ore sample ε= 92%
		Gold concentration, mg/l	18.2	
		Gold concentration, mg/l	18.4	
1049	4	Gold concentration, mg/l	498	Ore sample ε= 92%
		Gold concentration, mg/l	505	
		Gold concentration, mg/l	515	
NaClO pH=3,00 redox sample = 1164,1				
1007	4	Gold concentration, mg/l	165	Surplus sample ε= 90%
		Gold concentration, mg/l	176	
		Gold concentration, mg/l	180	
1026	4	Gold concentration, mg/l	17.1	Ore sample ε= 90%
		Gold concentration, mg/l	17.7	
		Gold concentration, mg/l	18	
1049	4	Gold concentration, mg/l	495	Ore sample ε= 90%
		Gold concentration, mg/l	505	
		Gold concentration, mg/l	515	
NaClO+ acidic solution $H_2SO_{4(к)}$ pH=3,00 redox potential = 1150,8.				
1007	4	Gold concentration, mg/l	178	Surplus sample ε= 96%
		Gold concentration, mg/l	186	
		Gold concentration, mg/l	192	
1026	4	Gold concentration, mg/l	18.1	Ore samlpe ε= 96%
		Gold concentration, mg/l	18.6	
		Gold concentration, mg/l	19.2	

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1049	4	Gold concentration, mg/l	518	Ore sample ε= 96%
		Gold concentration, mg/l	525	
		Gold concentration, mg/l	537	
2CS $(NH_2)_2$ pH=3,5 redox sample = 500 мВ.				
1007	4	Gold concentration, mg/l	176	Surplus sample ε= 97%
		Gold concentration, mg/l	188	
		Gold concentration, mg/l	194	
1026	4	Gold concentration, mg/l	18,1	Ore sample ε= 97%
		Gold concentration, mg/l	18,7	
		Gold concentration, mg/l	19,4	
1049	4	Gold concentration, mg/l	527	Ore sample ε= 97%
		Gold concentration, mg/l	538	
		Gold concentration, mg/l	543	

The results in Table 1 and Fig. 2, Fig. 3., Fig. 4 indicate that gold dissolves in all tested solvents. The most pronounced results are shown by the solution in the well of the under-ore interval, in thiourea concentrations of 4 g/l. This is due to the fact that the core samples were acidified[9]. Additionally, it can be stated that the use of sodium hypochlorite together with sulfuric acid and the thiourea reagent showed the highest result of gold extraction, which amounted to 537 mg/l and 543 mg/l.

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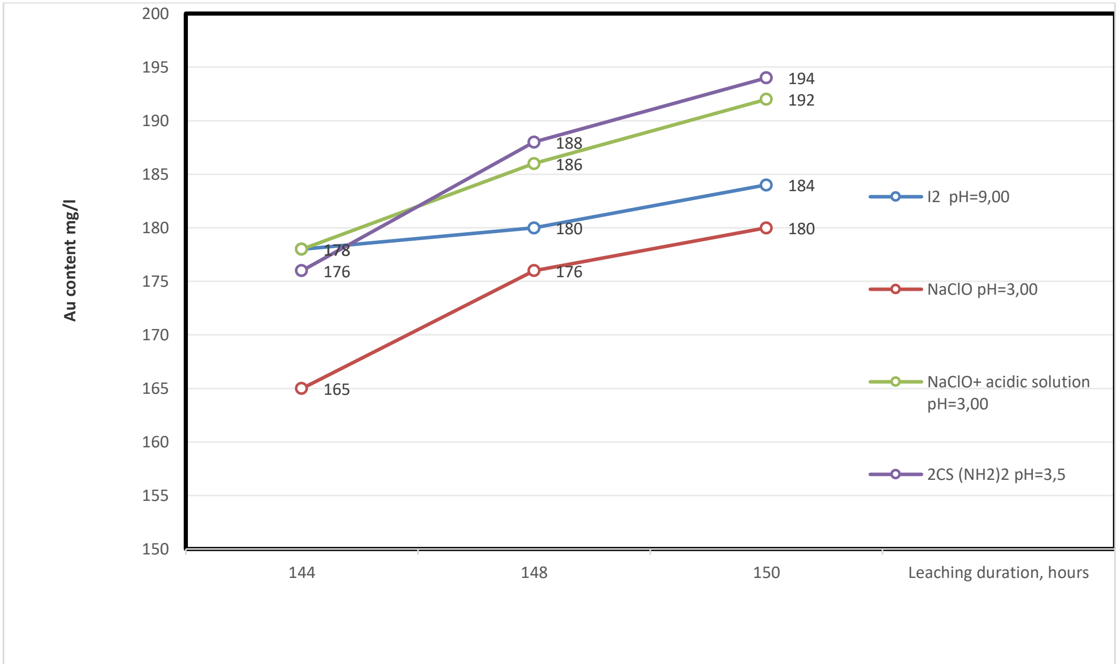

Fig. 2 Dependence of gold recovery from overore core samples by various reagents and time

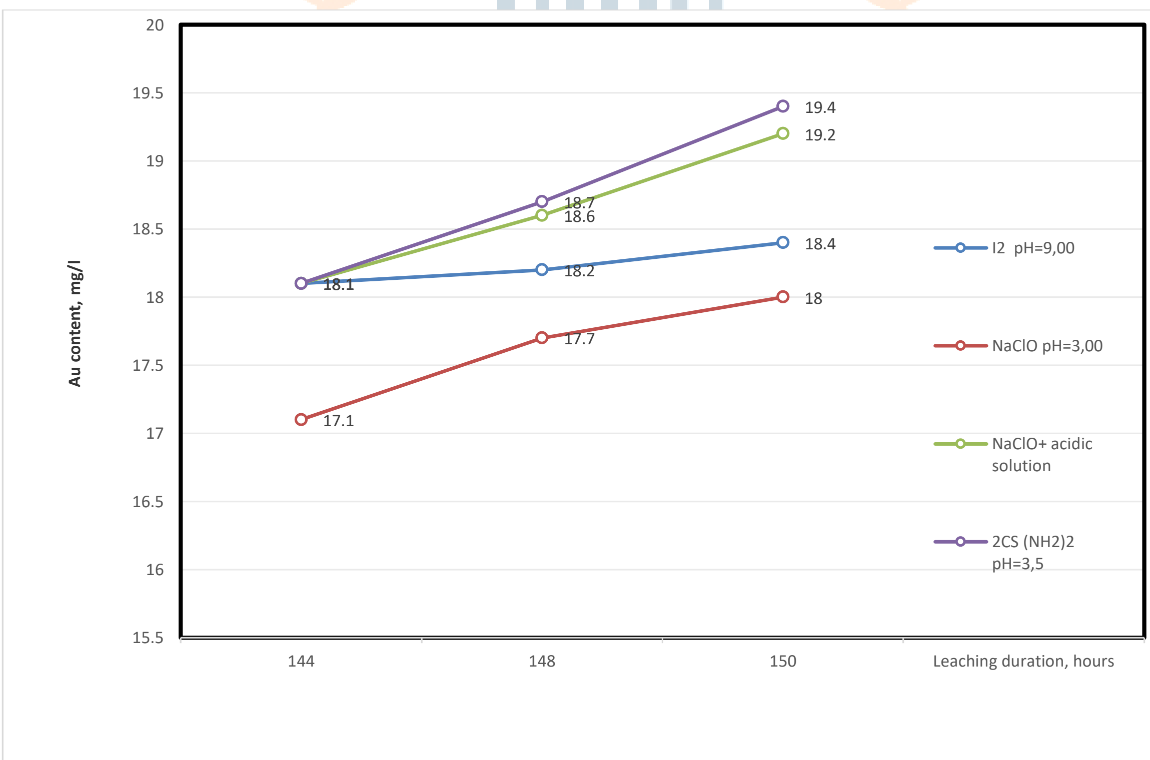

Fig. 3. Dependence of gold extraction from ore core samples by various reagents and time

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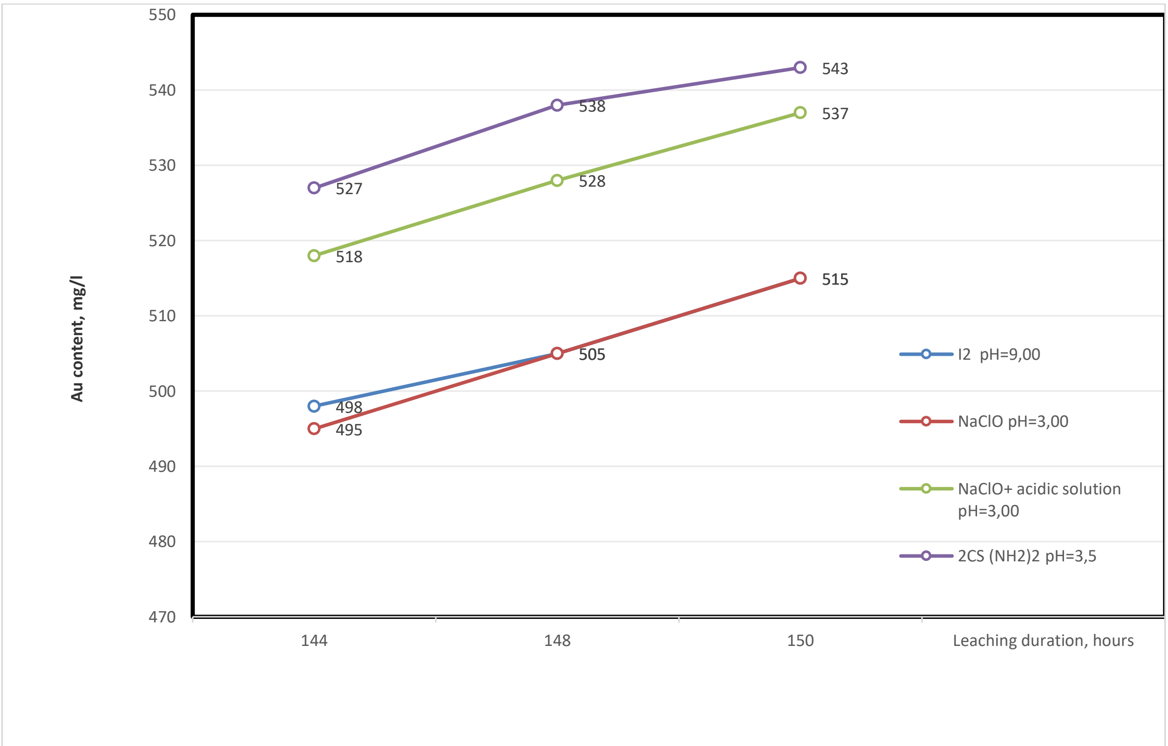

Fig. 4. Dependence of gold extraction from underore core samples by various reagents and time

Scientific experiments were carried out to extract gold from a productive solution in laboratory conditions, the sorption process was carried out on various grades of activated carbon to determine a promising sample. In order to saturate the sorbent with a solution from a productive solution, studies were carried out with the following types of activated carbons: AG-3, AG-5, AG-95. The sorption process was carried out with a productive solution supplied from the bottom up and consisting of a pressure column, with a dense layer of activated carbon 3 kg.

The processing time was 20 hours in the sorption column, the volume was 6 liters of the processed solution.The volume of processed solutions to the volume of the sorbent is shown in Fig.5. The results of the processing of solutions are presented, the amount of gold in coal was 515 mg/kg. The extraction of gold from solutions was 95%. [eight; pp.235-2478]. Table 2 shows the results of a study of 3 types of activated carbons in terms of sorption properties for gold.

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Table 2.

The results of studies on the sorption of gold from a productive solution using activated carbons of various grades

Measured parameter	Measure	Types of activated carbon		
		AG-3	AG-95	AG-5
Sorption time	ч	20	20	20
Volume of solutions	л	6	6	6
Average gold content in the productive solution	мг/л	543	543	543
The content of gold in the sorbent at the time of stopping the adsorber (3 kg)	г/кг	0,515	0,368	0,501

According to Table. 2 for the extraction of gold from the productive solution, the most promising sorbent is activated carbon grade AG-3.

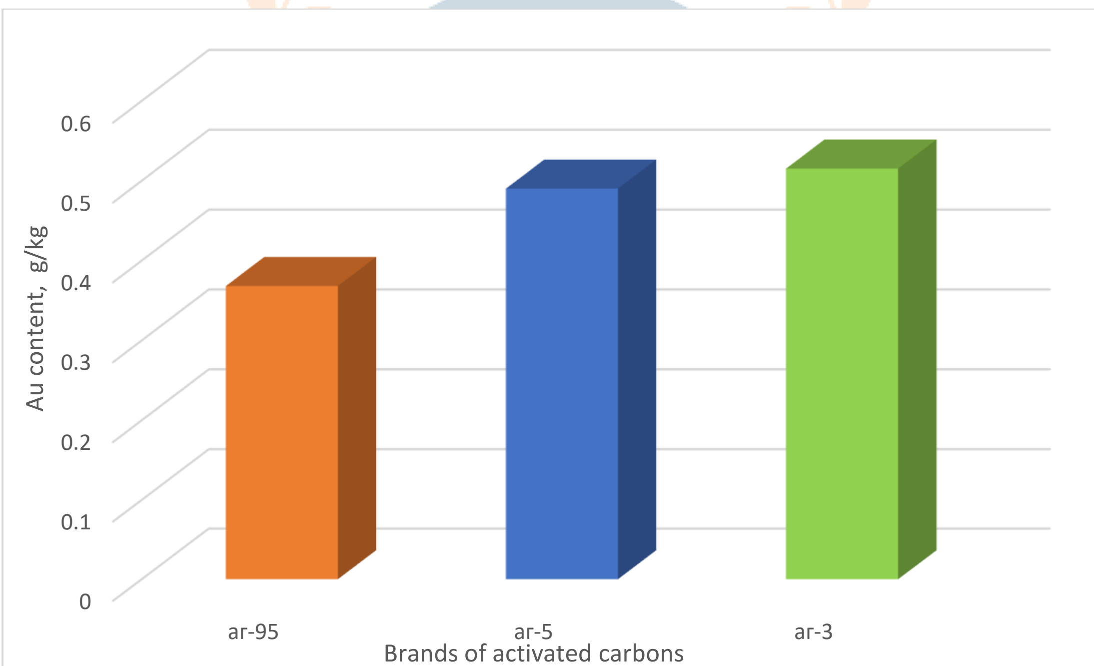

Fig. 5. Comparative analysis of the gold content in various types of activated carbon

Under laboratory conditions, studies were carried out on the sorption of gold from a productive solution using activated carbon grades AG-3, AG-95 and AG-5. The research results showed that the best extraction

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of gold (515 mg/kg) is achieved with a sorption duration of 20 h, while the degree of extraction of gold from the solution is 96%.

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