EG0800323
A new Leaching System, Sheta Extractor

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ABSTRACT

Moving of crushed solid ores against leaching solution in a continuous countercurrent arises a true technical problem. This invented system introduces a practical solution for such problem. Inside the system, the crushed ore is driving against gravity, whereas the leaching solution moves in the opposite direction. Contact between the two phases occurs with gentle stirring. After contact, discharging of the processed phases takes place automatically out the system. The system was investigated for uranium leaching from a coarse grained fraction (+2 ----- -30 mm) of uranium mineralized granite sample. Uranium leaching percent reached to nearly 50% using sulfuric acid.

Key words: countercurrent leaching /coarse gained crushing /leaching solution

INTRODUCTION

Leaching is the preferential dissolution of one or more constituents of a solid mixture by contact with a liquid through a fixed bed of the solid, but now leaching describes the operation generally by whatever means it may be done [(1)]. Most useful minerals occur in a mixture with large proportions of undesirable gangue and leaching of valuable materials is a separation method which is frequently applied. Leaching may involve simple washing of the solution from the surface of a solid or dissolving of a solute from a matrix of insoluble matter [(2)].

Crushing and grinding of such solid will greatly accelerate the leaching action, since the soluble portions are made more accessible to the solvent. Fine grinding is more costly but provides more rapid and possibly more through agitation leaching. Its disadvantage is represented in large volumes of liquid associated with settled solid in addition to that required for washing which produces dilute solution. Coarsely grounded particles leach more slowly and possibly less thoroughly but on the draining may retain relatively little solution require less washing and thus provide more concentrated final solution. The ability to use a coarse ore not only reduces the grinding costs but also makes subsequent separation of the pregnant leach solution from the leach residue easier [(3)]. Coarse solid particles are usually treated in fixed beds by percolation method which suffers from poor recovery (Fig.1), whereas for finely divided solids, agitation leaching can be applied [(4)].

The strongest leaching solution (most concentrated) will result if a countercurrent scheme is used, wherein the final withdrawn solution is taken from contact with the freshest solid and the fresh solvent is added to solid from which most of the solute has already been leached or washed. In order to avoid moving the solids physically from tank to tank, six tanks are arranged schematically in what is called Shanks system, (Fig.2) [(5)].

Many ingenious devices have been used for moving the solids continuously through a leaching device so that countercurrent action can be obtained. Coarse solids can be leached or washed free of solute in some types of machinery used in the metallurgical industries. Dorr classifier for washing coarse solid according to particle size is an example [(6)]. Within this system, the solids are

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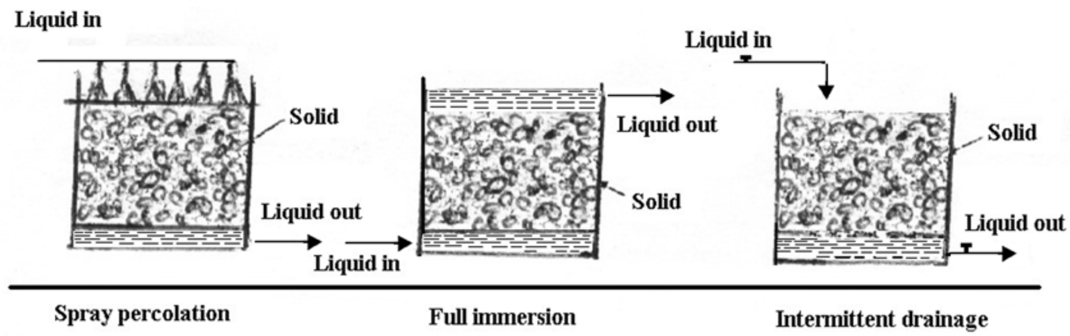

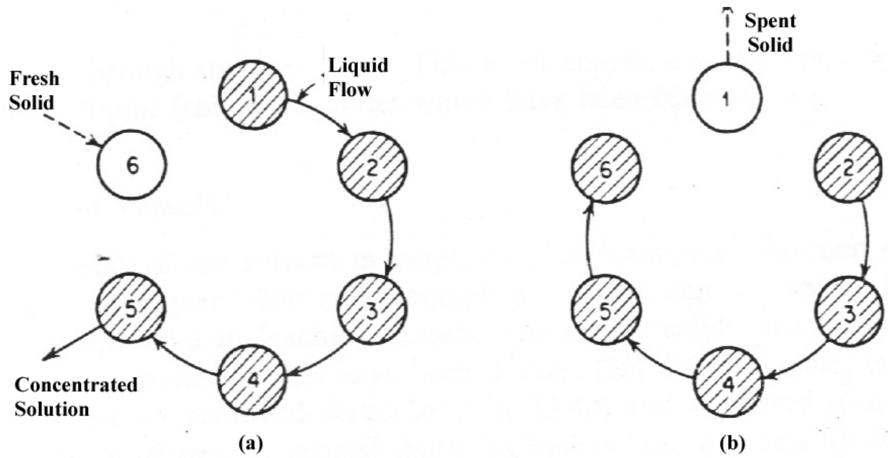

Fig.2, Countercurrent multiple contact, Shanks system

introduced into tank, made with slopping bottom and partly filled with solvent. The rakes, which are reciprocating and circular lifting motion by the driving machine, rake the solids upward along the bottom of the tank and out of the liquid. In the upper part of the tank solids are drained and discharged. The liquid over flows at the deep end of the tank as a result of the agitation by the rakes, so that the apparatus produces a single-stage action (Fig.3). Several classifiers can be placed in a cascade for continuous multistage countercurrent. This system stills the accredited system in this approach.

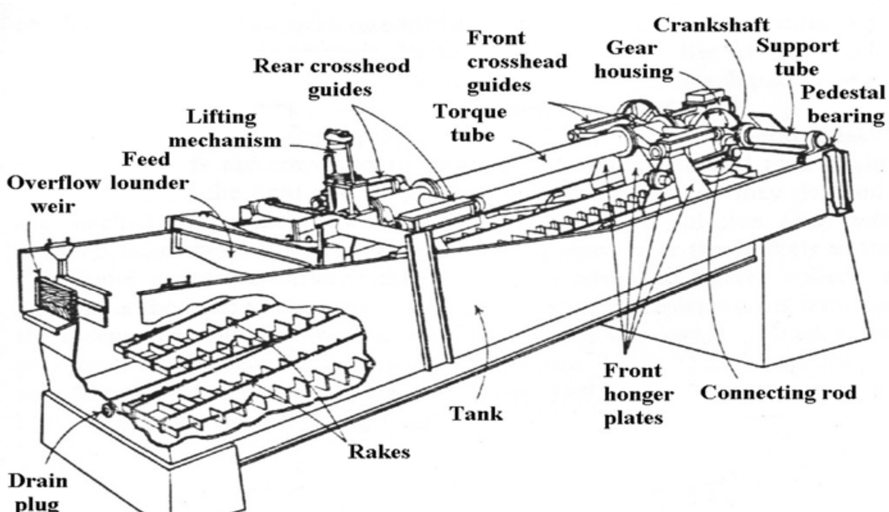

Fig.3, Single Dorr classifier for washing coarse solids

The Kennedy extractor,(Fig.4), is another stage wise device which has been in use since 1927 [7]. The solids are leached in a series of tubes and are pushed from one to the next in the cascade by paddles against gravity toward the upper end of the system. Perforations in the paddles permit drainage of solvent gravitationally toward the lower end of the system in countercurrent motion.

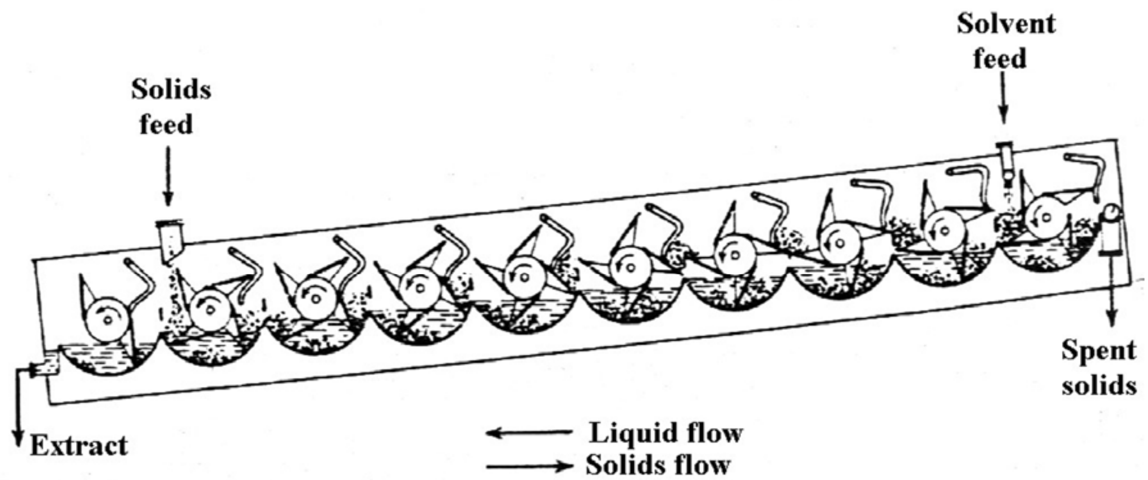

Fig.4, Kennedy extractor

SHETA EXTRACTOR

The system has been invented by Dr. Mohamed E.I. Sheta, Nuclear Materials Authority, Egypt, 2007 (Fig.5). The system is of a cylindrical form includes internal helix around a central narrow pipe as axis. All parts are made of chemically resistant material. The system employs gravity and spiral movement to occur contact between the crushed solids and leaching solution. Feeding by the crushed solid ore takes place through a gutter attached with a semi-cylindrical hopper and enters inside the system intermittingly by means of a ladle at the lower end of the helix. The solids are raised up against gravity by screw motion. The feeding by leaching solution occurs through pumping or under gravity effect from a suitable container at higher level through the upper end of the system. The leaching solution moves inside the system toward the lower end of the system under gravity effect. Countercurrent percolation leaching for the crushed ore takes place with slow agitation while it raises toward the upper end. After leaching, the tow processed phases get out the system automatically and separately. The solids are discharging from the upper end of the helix whereas the leach solution is drained from the lower end of the central axis. The system produces leaching action as a single stage. The recycling of leaching operation (for the same solids quantity using the same volume of leaching solution) for any times is available for excess leaching.

The system is carried on iron skeleton permits the desired slope. Slow revolving motion of the system is carried out by an electric motor supplied with speed reducing gearbox. Additionally adjusting of the speed is also done through a roller system of different diameters.

Engineering specifications:

The total length of the system is 3 meters, the helix length is 2 meters. The diameter of the helix is 20 cm. Its height is 80 cm. at the upper side and of 60 cm. at the lower side. The inclination angle

of the system is calculated as sin θ = helix diameter / helix length. The solid ore feeding rate equals 18 kg / hour. And leaching solution feeding rate equals 15 liter / hour. The revolving speed is 3 r.p.m. The trip time of a given ladle inside the system is 8 minutes. The most important advantage of the present system is its unlimited availability for up scaling.

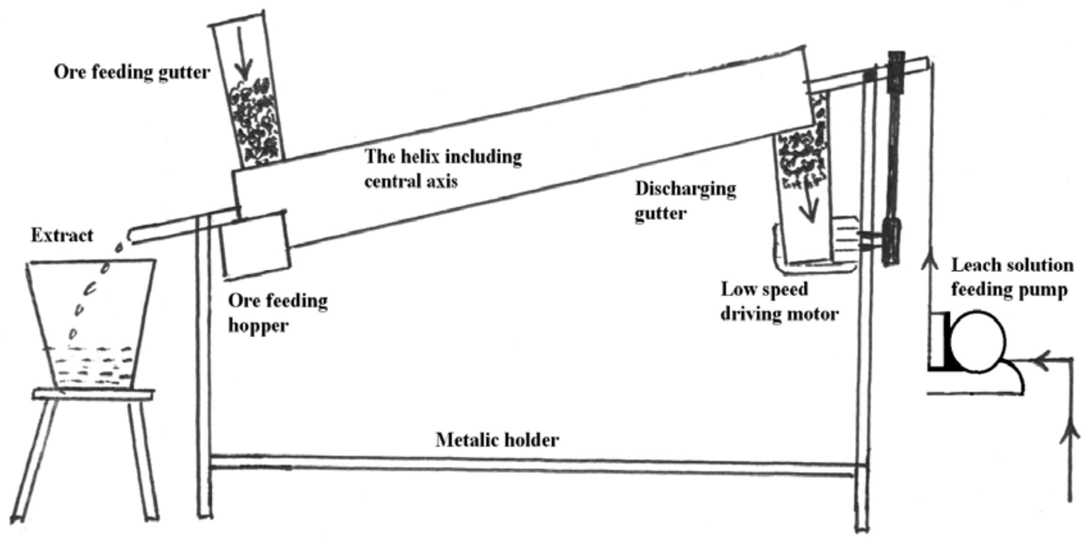

Fig. 5, Sheta Extractor

Testing of leaching ability:

Sheta extractor was practically tested as leaching system using a uranium mineralized granite sample. The sample was crushed by a jaw crusher machine to – 30 mm. grain size. The sample was fractionated into two fractions using a sieve of 2 mm. open size. The coarse fraction was of -30 mm to + 2mm. grain size representing 89% of the crushed sample weight whereas, the fine one was of – 2mm grain size representing 11% of the sample weight. The chosen fraction was the coarse one. The system was designed to treat only with coarse solids (+ 2 mm) because of fine grained may led to some technical problems.

Before leaching, a representative sample of coarse grained fraction was grounded finally to -200 mesh size. Complete dissolution for one gm was carried out for uranium analysis. Uranium concentration was defined as 3500 ppm.

A sample weighing 3.820 Kg of coarse grained fraction was used for uranium leaching experiments. Ten liters of sulfuric acid with concentration of 200 gm H_2SO_4/ liter were prepared for leaching purpose. The experiment was conducted by gradually feeding of the crushed ore against solution feeding rate of 15 liter/ hour. The taken time for one leaching cycle was 22 min. Leaching operation recycled for the same ore and the same solution for 4 times after the first one. An aliquot sample, 10 ml, was taken for uranium analysis after each leaching cycle. Uranium concentration after a given cycle expressed a cumulative value. The obtained results are givin in Table 1, and plotted on figure 6. Uranium analyses were carried out by titration and arsenazo III spectrophotometric analysis methods [8],[9]

Table 1, uranium analysis data
for uranium leaching

Cycle no.	U ppm
1st	390
2 nd	560
3 rd	624
4 th	640
5th	680

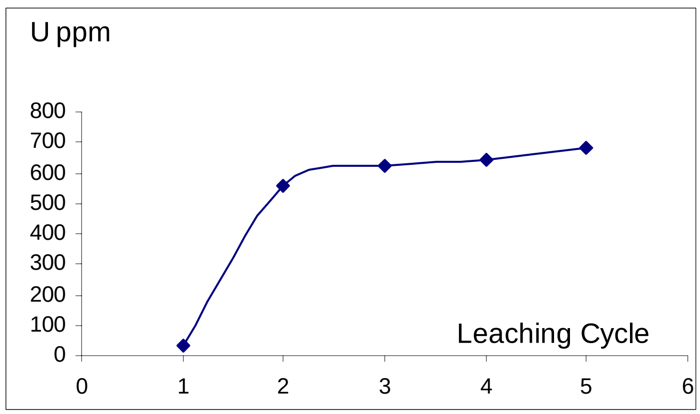

Figure 6, uranium leaching for 5 leaching cycles

The total processed leaching solution volume was 8 liters. The final obtained leach liquor was 7.6 liter which means that about 400 ml of the leaching acid were adsorbed on solid grains. Six liters of ordinary tap water were used for addition washing cycle. Uranium concentration in the obtained washing solution was 220 ppm.

Calculation of uranium balance:

To evaluate leaching efficiency carried out by sheta extractor, uranium mass balance for leaching operation is a logic base for evaluation. Uranium concentration in the processed fraction is 3500 ppm , uranium content in 3.820 kg equals 13.37 g U. The obtained leach liquor volume was 7.6 liter with uranium concentration of 680 ppm accordingly; uranium content in this liquor equals 5.17 g U. The washing solution volume was 6 liters with uranium concentration of 220 ppm and its uranium content equals 1.32 g U. The total leached uranium equals 6.49 g. The leached uranium percent equals 48.5.

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