Index Copernicus
IC 5.09

NAAS Rating
1.3

Received on:
16th March 2013

Accepted on:
26th March 2013

Revised on:
16th April 2013

Published on:
1st June 2013

Volume No.
Online & Print
6(2013)

Page No.
01 to 06

Life Sciences Leaflets is an international open access print & e journal, peer reviewed, worldwide abstract listed, published every month with ISSN, RNI Free-membership, downloads and access.

APPLICATION OF ALGAL BIOMASS FOR THE REMOVAL OF SILVER FROM WASTE

M.F.MANSURI [1] AND K.C.PATEL[2]

[1]MICROBIOLOGY DEPARTMENT, SMT. S. M. PANCHAL SCIENCE COLLEGE, TALOD, GUJARAT, INDIA, 383215.

[2]BOTANY DEPARTMENT, SMT. S. M. PANCHAL SCIENCE COLLEGE, TALOD, GUJARAT, INDIA, 383215.

* yasinfff@yahoo.com

ABSTRACT:

Silver, one of the heavy metals, is rare but naturally occurring, often found deposited as a mineral ore in association with other elements. Silver has been used for ornaments and utensils for almost 5000 years and as a precious metal, a monetary medium and a basis of wealth for more than 2000 years. Extensive use of silver has led to serious problems of contamination of terrestrial and aquatic ecosystems. Disposal of silver waste to surface and subsurface waters pose unacceptable health risks. The chief source of silver contamination of water is silver thiosulfate complexes in photographic developing solutions that photofinishers discard directly to sewers. Silver complexed with thiosulfate is difficult to remove from photographic waste. Thus a two stage removal approach was used. Thiosulfate oxidizing bacteria ware initially applied to breakdown the silver thiosulfate complex. The liberated silver is then removed using algal system. Algal Species of *Mougeotia*, *Spirogyra* and *Chara* were employed for this. As much as 70% removal of silver is reported here. These findings can help in the development of a green economic process.

KEY WORD: *silver remediation, silver waste, thiosulfate oxidising bacteria.*

INTRODUCTION:

Emissions from smelting operations, manufacture and disposal of certain photographic and electrical supplies, coal combustion, and cloud seeding are some of the anthropogenic sources of silver in the biosphere (Eisler, 1997).

Most of the silver lost to the environment enters terrestrial ecosystems, where it is immobilized in the form of minerals, metal, or alloys; agricultural lands may receive as much as 80,000 kg of silver per year from photo-processing wastes in sewage sludge. An estimated 150,000 kg of silver enter the aquatic environment every year from the photographic industry, mine tailings, and electroplating (Smith & Carson, 1977). The atmosphere receives 300 000 kg of silver each year from a variety of sources. The natural environment is not able to support the increasing exposure to chemical products caused by this development (Gorsuch *et al.*, 1998). Presence of silver is a serious threat to human health. There is a highly toxic effect of silver on several on several parts of cells, such as proteins, nucleic acids and riboflavin (Eisler, 2000).

This has led to the development of technology for its removal from waste. Silver complexed with thiosulfate is difficult to remove from photographic waste. A two stage removal of silver from such waste is reported here. Thiosulfate oxidizing bacteria were initially applied to break down the silver thiosulfate complex. The liberated silver is then removed using algal system. A common algal Species of *Mougeotia*, *Spirogyra* and *Chara* were employed for this.

MATERIALS AND METHODS:

Organisms, growth and harvesting of biomass

Thiosulfate oxidizing bacteria isolated previously and maintained on Starky's medium were grown on Starky's medium for 5 days on a rotary shaker. The organisms were found to be tolerant to 200 mgl^{-1} silver as evidenced from its growth in a medium supplemented with silver nitrate (200 mg silver l^{-1}) (Starkey RL., 1935).

Algal biomass was collected from a local pond (Labhor) in the town near the Talod science college, identified as species of *Mougeotia*, *Spirogyra* and *Chara*, washed thoroughly with de-ionized distilled water and granulated.

Photo film processing Waste Water

Used photographic film fixer solution *i.e.* UFFS was procured from a local film processing unit. It contained very high amount of silver up to 1.6gl^{-1} and thiosulfate concentration was 21.2gl^{-1}. The UFFS was diluted 1:10 times so as to bring the thiosulfate concentration in a range suitable for growth of thiosulfate oxidizing bacteria.

Biodegradation of thiosulfate from UFFS

Culture of thiosulfate oxidizing bacteria (25 ml containing 10^7 cells/ml) was inoculated into 1:10 diluted UFFS (250 ml, pH 6.5) and incubated at ambient temperature (Ca 30 °C) at 120 rpm. After incubation of 5 days, the medium was centrifuged at 10,000 rpm for 20 min to remove bacteria and insoluble particulate matter (Bard *et.al.*, 1976).

The supernatant was analyzed for thiosulfate content, uninoculated UFFS was used as control in the experiment.

Analysis

Thiosulfate concentration was determined by iodometric method. Silver was estimated by atomic absorption spectrometry (ELICO SL-194) with air acetylene flame at λ =328.1 nm). After biodegradation of thiosulfate from UFFS any precipitated sulfur was removed by filtration and the supernatant used in silver biosorption experiment (APHA, 1992).

Shake flask experiment for removal of silver from UFFS.

Untreated and treated UFFS were further used for silver removal by biosorption using the algal biomass of *Mougeotia*, *Spirogyra* and *Chara*. Different concentration of biomass were added to 100 ml UFFS for varying contact periods in a rotary shaker at ambient temperature at 120 rpm (Pethkar *et.al.*, 2003).

After contact period, the biomass was removed by centrifugation at 10,000 rpm for 10 min. the silver content of remaining UFFS was determined.

RESULTS:

Thiosulfate was completely oxidized by thiosulfate oxidizing bacteria and no thiosulfate was detected in treated fixer solution (Fig-1).

No significant biosorption of silver from untreated UFFS was observed using the three algal biomass of *Mougeotia*, *Spirogyra* and *Chara* (Fig-2).

Biosorption of silver was observed from treated UFFS using the algal biomass. Among the three species used for the study *Chara* spp. showed highest biosorption of 70%. The species of *Mougeotia* and *Spirogyra* showed 60% and 66% biosorption respectively. (Fig-3).

Further analysis using the species of *Chara* showed the amount of biosorbent required for maximum silver biosorption was 2.5% as seen in (fig-4).

Further increase in the biosorbent concentration did not increase the biosorption efficiency.

The contact time required for silver sorption was 20min. (Fig-5).

DISCUSSION:

The experimental observation suggests that silver complexed with thiosulfate is very difficult to remove from photographic waste. A two-stage removal of silver from such waste is necessary for efficient recovery. A comparative evaluation of three species of algae showed that algae are a good potential for removal of silver from photographic waste like UFFS. Further up scaling it to a sufficient level can help in the development of a green economic process.

REFRENCES:

APHA, AWWA, WEF. 1992. Standard methods for the examination of water and wastewater. Washington DC, American Public Health Association. 1992.

Bard, C., Murphy, J., Stone, DL., Terhaar, C. 1976. Silver in photo processing effluents. Journal of the Water Pollution Control Federation. 48:389–394.

Eisler, R. 1997. Silver hazards to fish, wildlife and invertebrates: A synoptic review. Washington, DC, US Department of the Interior, National Biological Service. 44 pp. (Biological Report 32 and Contaminant Hazard Reviews Report 32).

Eisler, R. 2000. Silver. In: Handbook of chemical risk assessment. Health hazards to humans, plants, and animals. Volume 1.Metals.Boca Raton, FL, Lewis Publishers, pp. 499–550.

Gorsuch, JW., Klaine, SJ. 1998. Toxicity and fate of silver in the environment. *Environmental Toxicology and Chemistry*. 17(4):537-8.

Pethkar, AV., Paknikar, AM. 2003. Thiosulfate biodegradation-Silver biosorption process for the treatment of photo film processing waste water. *Process Biochemistry*. 3: 855-860.

Smith, I., Carson, B. 1977. Trace metals in the environment. Volume 2.Silver.Ann Arbor, MI, Ann Arbor Science Publishers. 469 pp.

Starkey, RL. 1935. Isolation of some bacteria which oxidize thiosulfate. Soil Science. 197-215.

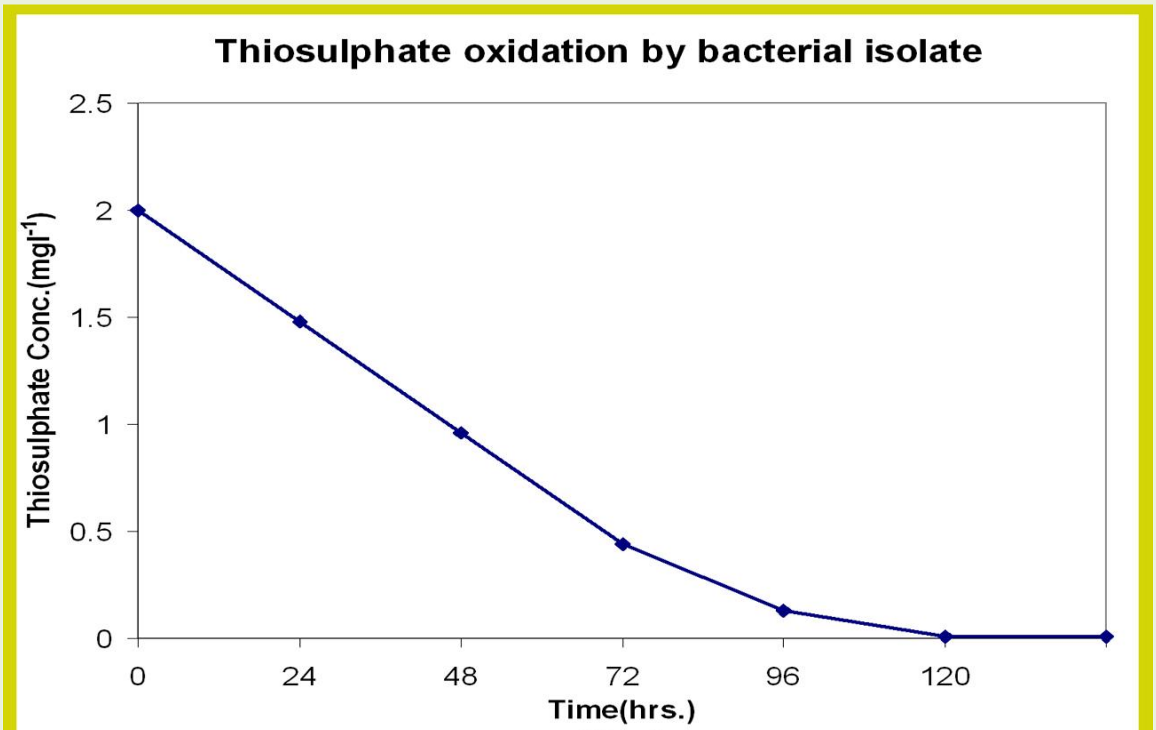


Fig. 1

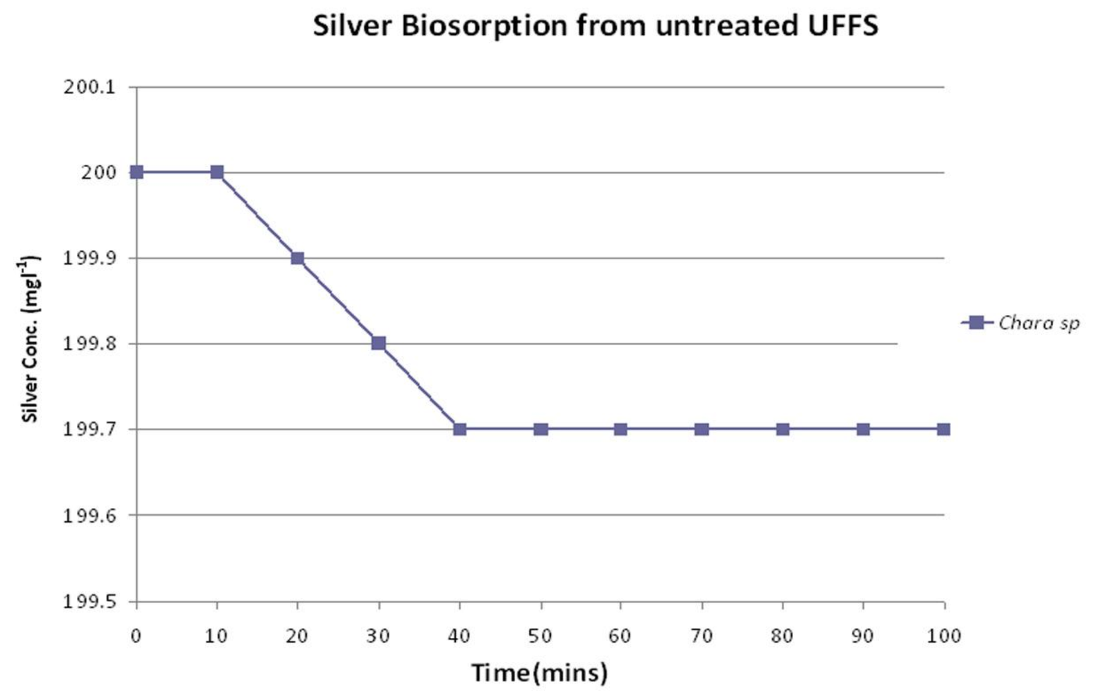

Silver Biosorption from untreated UFFS
200.1
200
199.9
199.8
199.7
199.6
199.5
Silver Conc. (mgl-1)
0
10
20
30
40
50
60
70
80
90
100
Time(mins)
Chara sp

Fig. 2

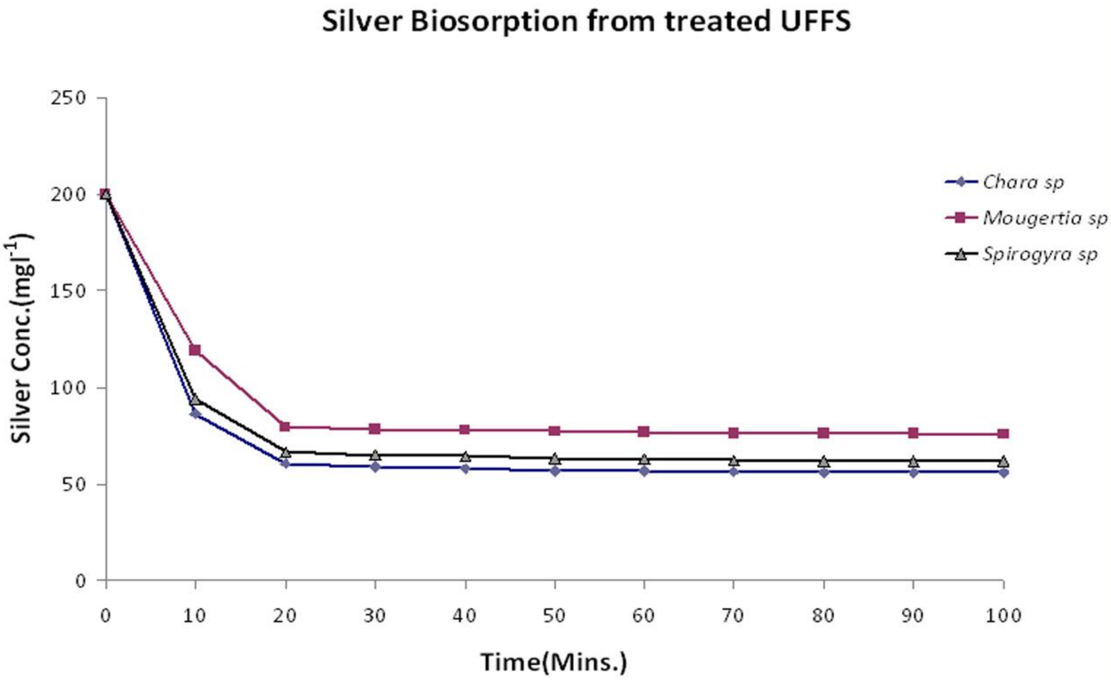
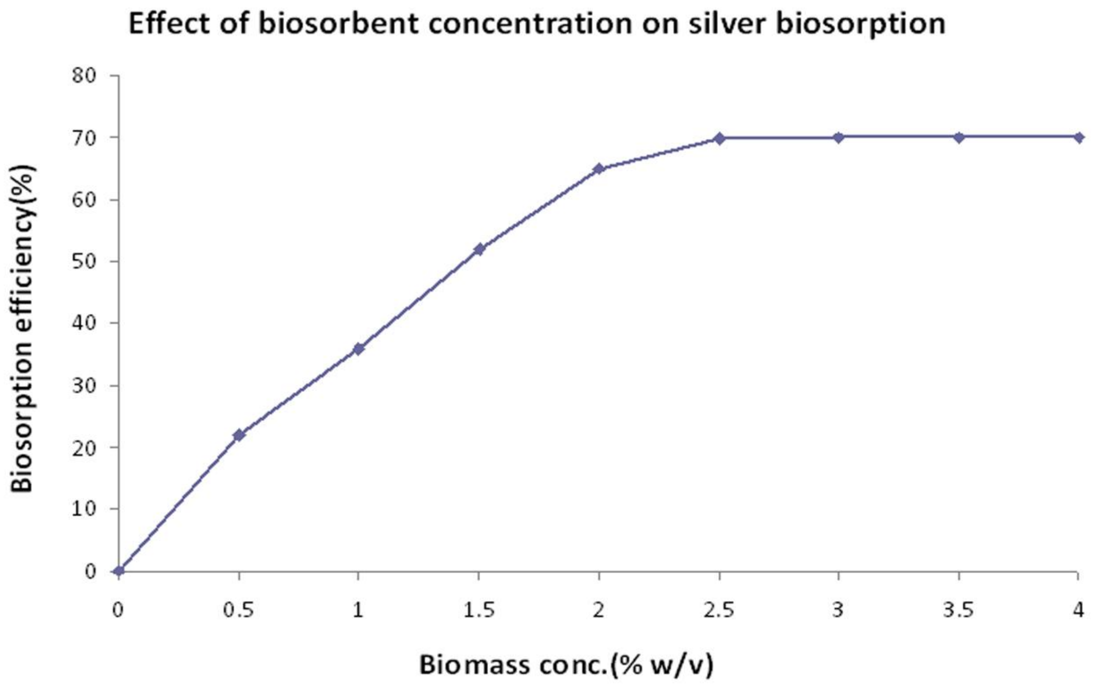
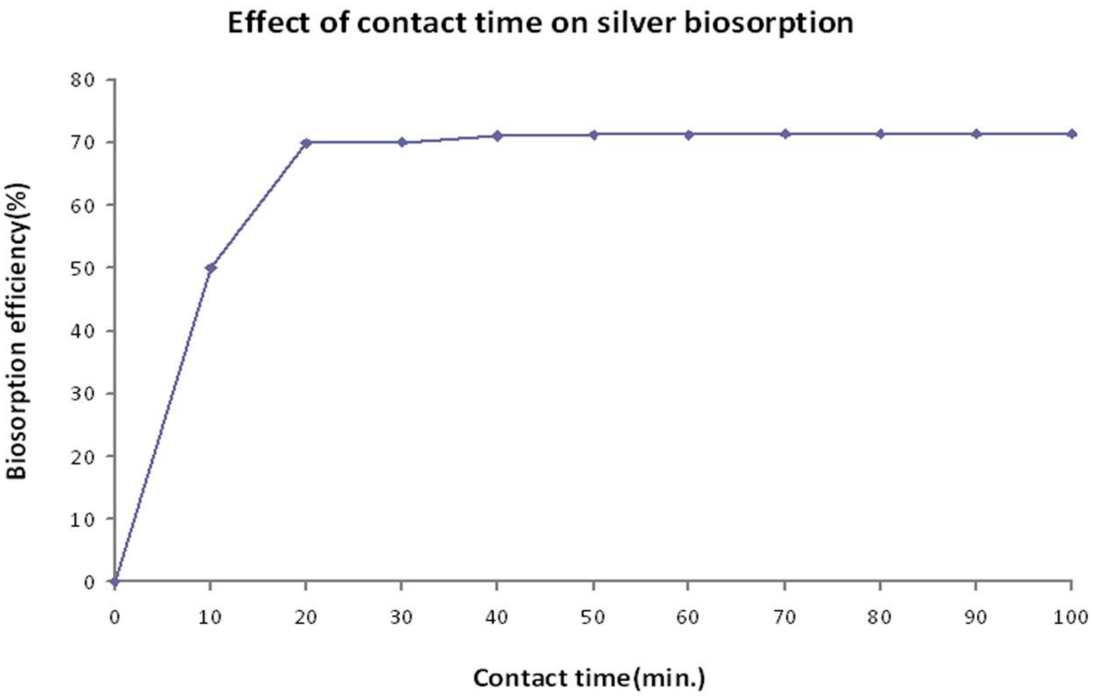

Silver Biosorption from treated UFFS
250
200
150
100
50
0
Silver Conc.(mgl-1)
0
10
20
30
40
50
60
70
80
90
100
Time(Mins.)
Chara sp
Mougertia sp
Spirogyra sp

Fig. 3


Effect of biosorbent concentration on silver biosorption
Biosorption efficiency(%)
0
10
20
30
40
50
60
70
80
0
0.5
1
1.5
2
2.5
3
3.5
4
Biomass conc.(% w/v)
Fig. 4


Effect of contact time on silver biosorption
Biosorption efficiency(%)
0
10
20
30
40
50
60
70
80
0
10
20
30
40
50
60
70
80
90
100
Contact time(min.)
Fig. 5