Journal of Advanced Engineering Trends
ISSN : 2682 - 2091

Vol.42, No.2. July2023

http://jaet.journals.ekb.eg

PREPARATION OF POTASH ALUM FROM GARPAGE WASTES OF ALUMINUM ORIGIN

Basma M. Seif Elnasr[1], Lamiaa A. Mohammed[2], Ahmad M. Tony[3],Eman A. Ashour[4] and M. Zakaria Abdel Wahhab[5]

[1،3،4،5] Faculty of Engineering, Minia University, Minia, Egypt.
[2] Faculty of Engineering, Beni-Suef University, Beni-Suef, Egypt.

1- ABSTRACT:

Aluminum – base containers were gathered from different waste stores, cleaned, cut into small pieces and treated chemically to produce potash alum. The liquid potash alum was changed to crystals of potash alum. The product was subjected to verifying and validity tests to prove the potash alum percentage, its purity and its possible action in the sedimentation process carried for producing potable water from the Nile river stream. These tests contain instrumental methods of analysis, proofing tests for the validity of the sedimentation process in addition to tests carried out by nano-made crystals from the potash alum produced. The prepared alum from wastes proved to be accepted technically and environmentally as a controlling factor.

2- INTRODUCTION:

The aluminum –base cans are usually used for preservation of edible liquids, and/or, solids of different classes of food matter. They are, thus, a source of essential pollutants of daily origin in garbage lots. One of the objectives of the present investigation is to remove such a waste by changing to a useful material, either industrially or for other day life objectives. The potash alum is one of the important materials used for purifying Nile muddy water to pure potable one in water purification factories by separation of these suspensions by sedimenting agents, such as the potash alum. The ease by which this material can be made, from a chemical point of view, encouraged researchers and industrial responsibilities to activate memories about the factors affecting the production of alums in the form required industrially or for daily home requirements. [1-3]

Within the scope of the present investigation, waste cans, and other waste materials of aluminium origin, were gathered from different waste stores, cleaned and treated chemically to be changed to an alum. The potash alum had been chosen to be the type produced, since field studies proved this type to be of the largest consumption by the Egyptian population and factories. [4, 5]

The produced alum is subjected to instrumental analyses to prove its quality and purity and found to be of acceptable quality for use, although it contains some impurities, if removed, better quality with higher efficiency will be obtained [6].

Revised:27 October, 2021, Accepted:14 December , 2021

3- PREPARATION OF ALUM:

3-a. Preparation of Waste Cans for Treatments

Waste cans, of the same type, were obtained from waste storage sites. They were subjected to mechanical removals of their upper and lower circular surfaces, being of different metallic composition than the material of the rotating sides of the cans which are made of an aluminum base metallic composition. This last action decreases the impurities inclusions in the after- produced product of alum. The remaining cylinder of each can is cut, to be stretched manually to from a straight rectangle, each side of which was pre-treated either by an internal layer of a preservative material from the corrosive actions of the metallic side on the food which may be put in the can, or pre-treated externally by information about the internally contained solid or liquid and also by reclamative information.

The stretched straight rectangles are cleaned from both sides manually by rough emery papers, cleaned by water, and then soaked in an aqueous mixture of sodium carbonate, citric acid and lemon salt for half an hour [1]. The rectangles are then washed with water, re-treated manually by emery papers from both sides and finally washed with water.

For safety condition, chemical treatments was made in small batches to minimize the effect of the evolution action of the gases evolved, if any [2]. Manually, the rectangle pieces were cut into small pieces to activate reactions, which are then taken into small batches (about one gram), treated with 50 ml of potassium hydroxide (of molarity 4M) and heated. Gases were seen to be evolved. At the end of gas evolutions, and the disappearance of the metallic pieces from the reaction vessel, the cold, dark liquor and its suspensions are subjected to simple filtration through a funnel, where, the colourless liquor separates through the filter paper, while the dark residue remains on it [3].

The cold colourless liquor is subjected to a reaction with sufuric acid (10 ml for each 1 gram of scrap cans) of 10 molarity. The acid is carefully added, pit-a-pit, with stirring. The temperature rises while a thick gelatinous precipitate is formed. By addition of more acid (10 M) the precipitate dissolves again. It may become required to warm the solution again, gently and by continual stirring. The solution is boiled to evaporate any excess of water, then left, un-disturbed, overnight [7]. The day after (20 hours at least), the cold solution is filtered to separate the formed alum crystals of potash alum [6].

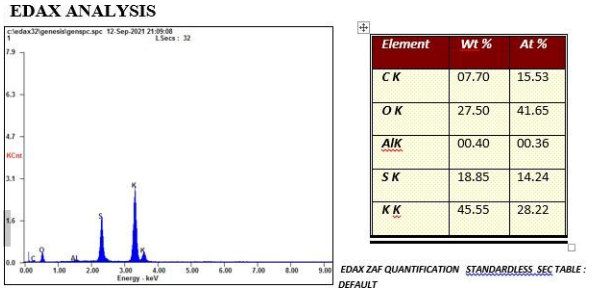
3-b. Methodology – Treatment Notes

Following the steps made by references of inorganic analytical chemical analysis [4, 8], the procedure for potash alum (kalinite) was performed. Notes on the steps of treatment to be followed are [9, 10]:-

- Treatment is to be made in beakers and glass utilities.
- The treatment is to be done in batches of one to two grams of aluminum base wastes.
- Treatment is to be done by batches, for instantaneous use and not for storage.
- Each batch, is to be analyzed to ensure the percentage of alum formed.
- Samples taken are to be preserved in dark bottles, out of direct light and sun rays, and marked by its important labels.
- Analysis is to be done as early as possible after the day of its preparation.
- Commercial alum samples are to be prepared for analysis, and compared with the prepared waste samples, [5, 9].

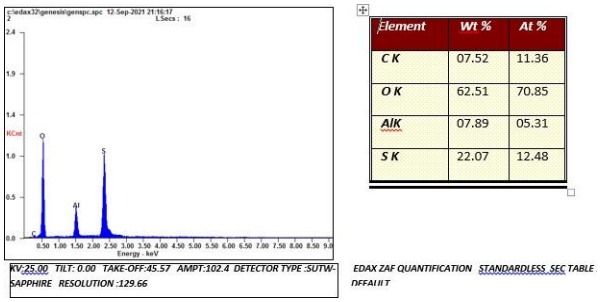
4- VERIFICATION OF THE PREPARED POTASH ALUM

4-a. The Energy Dispersive Analysis X-Ray (EDAX) Test



Element	Wt %	At %
C K	07.70	15.53
O K	27.50	41.65
AlK	00.40	00.36
S K	18.85	14.24
K K	45.55	28.22

Fig (1), sample (1), waste kalinite, WKL



Element	Wt %	At %
C K	07.52	11.36
O K	62.51	70.85
AlK	07.89	05.31
S K	22.07	12.48

Fig (2), sample (2), commercial kalinite, CKL

Solid samples of the prepared alum was analyzed instrumentally by an AMETEK micro analyzer instrument type SUTW-Sapphire resolution with an AMPT detector. Figure 1 and Figure 2 give the EDAX analysis at a resolution of 129.66.

The potash alum (kalinite) produced from waste aluminum cans by chemical treatments is given the nomination (w.kalinite), while the reference commercial potash alum is given the nomination (C. kalinite). W. kalinite is given the number 1, while C. kalinite the number 2.

- Both samples (1 and 2) contain impurities of organic origin.
- The commercial kalinite (sample 2) contains a percent of sulfer (22.07 %), and sample 1 contain 18.85 %, i.e. both samples, waste and commercial contain sulfur.
- The aluminium percent is higher in C. kalinite than the W. kalinite.
- The aluminium –potassium combination in W.kalinite is only 0.4 % by weight, and only 0.36 % by atoms.

Thus, it may be important to conclude that the prepared potash alum was not highly cleaned from the contaminations of paints and varnishes. The presence of two types of the potassium, having free energies between 3 keV and 4 keV may become a source of side reactions, which decrease the formation of the potash alum, and thus give a decrease in its percentage weight and atoms.

4-b. The Technical Sedimentation Test

Solutions were made from both kalinite types, W. and C., by the same concentration. The sedimentation test, usually is carried for examining the activity of alums in the separation of suspended solids from solutions and liquids and was done for a sample of fine clay suspension in water. The test was carried in two similar measuring cylinders. The same mass of clay, same volume of water and using stop watches. The samples were shaken after adding same volume of the kalinite prepared from waste and the other commercially obtained, each in one of the measuring cylinders.

Results proved that the separation was complete for both samples in nearly the same time, by a lag of three seconds for the W.kalinite sample. A result which is accepted in relation to the impurities already expected in the w.kalinite prepared.

4-c. Addition of Nano-alum to the W.kalinite Solution

Following the procedure of Anne Hahn and Stephen Barcikowski [11], and that procedure of Lijie Zhang and Thomas Webstar [12], in addition to the application done by Lamiaa A. Mohammed [13], it was possible to prepare

two types of nano- preparations, these are: the particulate and the fiber nano-alum. The third preparation (nano-tubes) was not easy to be prepared because of the absence of some important accessories which were not in hand. The obtained nano-shapes from the prepared alum were subjected to the TEM instrumental analysis to prove the nano-size of the samples as shown in figures 3 and 4.

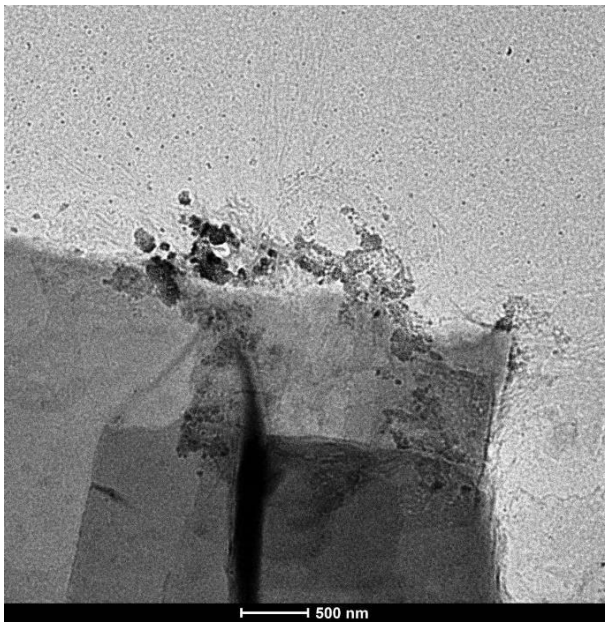


Fig (3) W.kalinite Nano particle

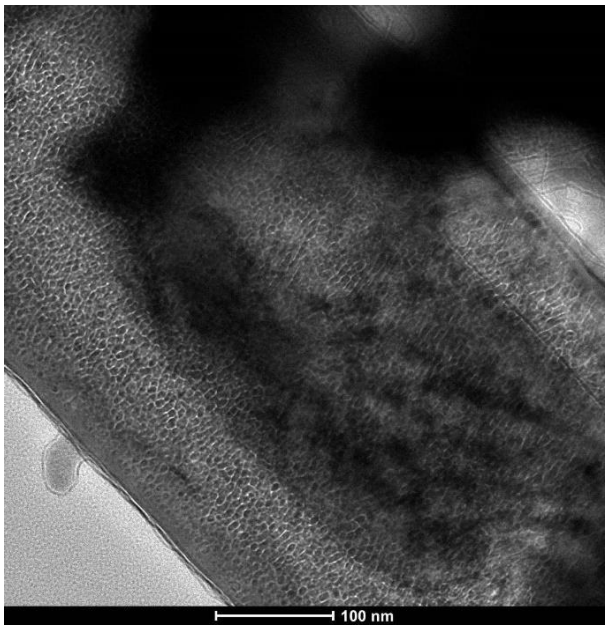


Fig (4) W.kalinite Nano fiber

The figures show that the transformation of the W.kalinite batch had not been completely transformed to the nano-size required, either the particulate or the fiber types, but the percentage, change of the fiber-type is much higher.

A mass of about 0.05 gram of the nano-sized W.kalinite was added to batches of W.kalinite solutions. It was easy to notice that the mass of seed crystal was increasing whether the nano-kalinite was in the particulate or in the fiber form, but with better enhancement from the fiber form. In addition, it was observed that a sudden large and continuous suspensions of crystals of different sizes were formed and finally falling down as a precipitate. These observations prove the increase of a new activity to W. kalinite solution contents, thus enhancing the action of forming clusters then embryos ending to nuclei, then crystals, a conclusion which needs detailed studies for these enhancement actions which increased the free energy (Δ F) of the population content of the solution to be ready to give increasing batches of precipitated crystals.

The precipitates formed were followed in its formation to record the changes by time and masses of enhancing nano-batches added. This enhancement item gives an assurance that the preparation formed from waste batches of cans and aluminium base metallic wastes, is an alum. Also, it may conform the formation of a type of potash alum, and its transformation to the nano-size, as described, but does not give assurance of any new accurate ideas for the last precipitation actions.

The following figures give the registered data from the observations noticed. Each figure has its own data inside, from which different conclusions may be extracted.

The following are additional discussions extracted from the figures numbered (5) to (10), in order to declare some vague or possible nuclear differences which may become a means for misunderstanding :-

a) Comparing the two figures (6) and (7) may give the following understanding:-
   Due to the super saturation of the solution, precipitation of particles may occur in addition to the growth of the externally-added crystal which increases also in mass and size.
   After 4 hours the precipitate attained 5.4 grams without addition of any nano-sizes (whether particles or fiber) for enhancement. Within the same period of time (4 hours) and without changing any of the other conditions, the precipitate reached to a mass of 12.0 gram.
b) Addition of the prepared nano-particles (fig.5) in very small amounts (0.05g) for the solution, increased the mass of the crystal after 4 hours and at the same conditions as in item (a) above, to be 3 grams (i.e. 3 grams was added), since originally the crystal was of 0.25 grams, at zero time.
c) By the same conditions used in either item (a) or item (b), the precipitate (and, logically, also the growth of the original seed crystal) were observed to increase in mass, as shown in figures by addition of the nano-sizes prepared.
d) Figures (6) and (8), shows the results giving the amount of precipitate without adding the nano-sized alum prepared from waste garbage. Figures (6) gives the results using an agitation rate of 2 rpm, while figure (8) shows results of a double rating of agitation (4 rpm).
   After 4 hours the precipitate was noticed to be 5.4 grams (figure 6), while it is in figure (8), 4grams only. Thus, agitation at higher rates decreased the amount of precipitate.
e) On addition of nano-fibers (made from waste alumimum material, figure (6)), the amount of precipitate increased from 5.4grams (at 2 rpm agitation, fig.(6), to 10.3 grams using 6 rpm agitation in presence of nano-fibers.

The above five notes given above from(a) to (b) declare the additional enhancement given to the solids solubilized in the solvent (water) by adding very small amounts (0.05 grams) of nano-sized solids of the same type of solid in solution.

These notes given, thus justifies the proposal of giving an additional activation to the solids dissolved in solvent to the supersaturation conditions, by adding very small amounts of nano-sized particles or fibers, an observation which needs additional researches to discover their additional free energy (ΔF), which gave the high intensity for enhancement for same – quality solids having just a much more difference in size by a negative sign (i.e. lower in size and mass).

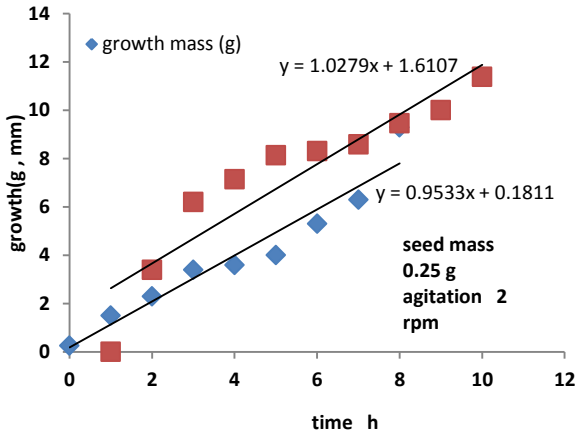


Fig. (5): Adding nano-particles (0.05) g

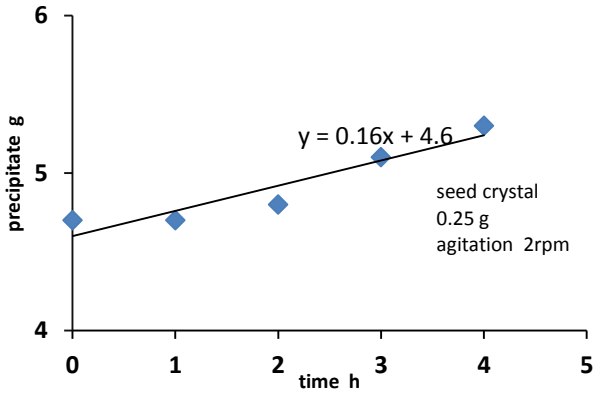


Fig. (6): precipitation without nano

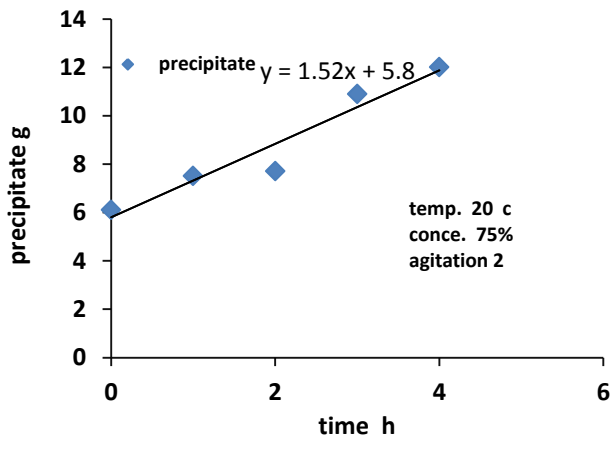


Fig. (7): addition of nano-fiber

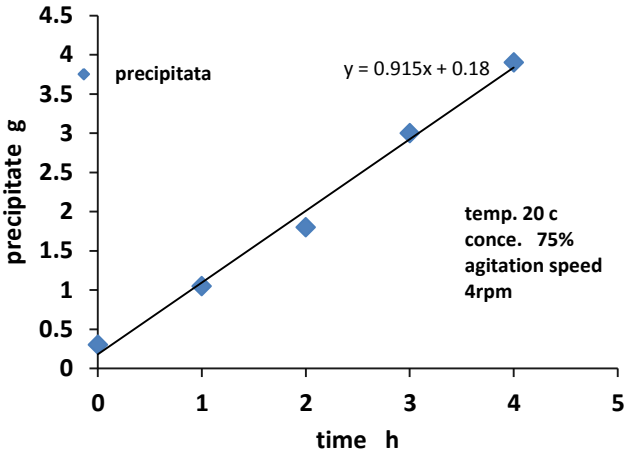


Fig. (8): 4rpm agitation without nano

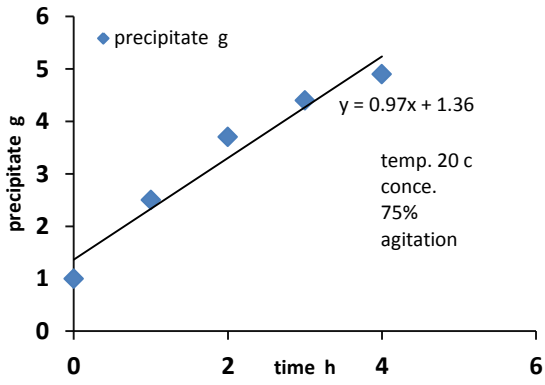


Fig. (9): 4rpm agitation + nano-fiber

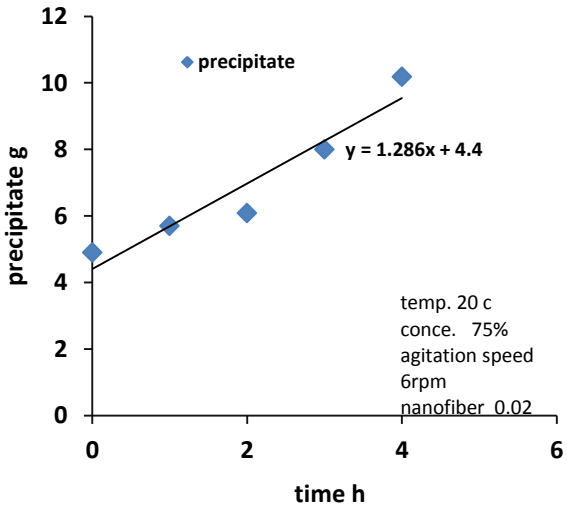


Fig. (10): 6rpm agitation + nano-fiber

5- CONCLUSIONS

- A batch of potash alum had been chemically extracted from waste

aluminum-base cans and allied containers and sheets.

- The batch obtained is analogous, to a certain extent, to the alum present commercially in Egyptian markets.
- Instrumental and technical tests proved the utility of the produced alum for industrial and home daily uses.

6- RECOMMENDATIONS

- In addition to the aluminium dross thrown out as a waste from the Aluminum Production Company at Nag Hammady (Egypt), the aluminium obtained from waste cans and allied aluminum sheets can be a source for construction of a new line for potash alum in liquid or solid form. This will make an addition to the production facilities for the alum production companies at Alfayoum and other cities in Egypt.
- The enhancement facility made by addition of the nano-sized crystals to the crystallization bathes may promote new paths for the crystallization techniques.
- As a route for additional improvement in the daily stocks of garbage, the environmental responsible has to activate such a route of W. kalinite formation for decreasing the daily waste packages.

7-REFERENCES

[1] A.L.Adegumo, R.U.Uwolabi, S.A.Adebisi, W.A.Agbaje, M.A.USM-AN, "Synthesis Characterization and efficiency of alum produced from waste Aluminium cans for waste water treatment ", Journal of Engineering and Applied science, Vol (3) , Issue (2), November 2016 , PP (9 : 13)

[2] YMliew , Cheng Yong Heah, Mohd Mostafa Abdullah AlBakri , Kamarudin Hussin, Soo Jin, " characterization of Alum Crystals synthesized from waste Aluminium Beverage cans ", J.Material Science Forum , Vol (857), PP.(514-518), 2016.

[3] Yun Ming Liew, Cheng Young Heah, Mohd Mustafa AIBakri Abdullah, Kamarudin Hussin , " Synthesis of alum from discarded Aluminum beverage cans ", key Engineering Materials, Vol (660), pages (284-288), 2015.

[4] N.R.Ekere , J.N.Iheoha , Agwogie Aiyehirve Bright "Synthesis of potash alum from waste Aluminium foil and Aluminium scrap ", Int, J.Chi, Vol (12) , PP. (1145-1152),2014.

[5] J.W Mullin, S Zacek, "The precipitation of potassium aluminium sulphate from aqueous solution", J Crystal growth, Vol. (53), page (515-518), 1981.

[6] A.U.Birnin-Yauri, Musa Aliyu , " synthesis and analysis of potassium Aluminum sulphate (Alum) from waste Aluminum cans " , International Journal of Advanced Research in Chemical Science (IJARCS), Vol.(1) , PP(1-6), 2014

[7] Igorpritula, Keshra, Sargwal, " Hand book of crystal growth**:** Bulk crystal growth**:** Bulk crystal growth ", Second Edition, 2015.

[8] Do Yean Kim, Dae Ryook Yang, "A movel method for measurement of crystal growth rate ", J, Crystal growth, Vol. (373), PP. (54-58), 2013.

[9] Cai Y, Ma, Jian Wan, Xue [6, 7], Z-Wang, "Faceted growth rate estimation of potash alum crystals grown from solution in a hot stage

reactor", powder technology, Vol. (227), P. (96-103), 2012.

[10] Konuma, K Tsukamoto, I Sunagawa, "Measurements of surface super saturations around a growing K-alum crystal in aqueous solution ", J. Crystal growth, Vol. (98), page (377 – 383), 1989.

[11] Anne Hahn and Stephan Barcikowski, Production of bio-action nano-materials using laser generated nano-particles, J. of Laser Micro/Nano engineering, 4, P.41-54(2009).

[12] Lijie Zhang and Thomas J. Wabster, Nano-technology and nano-materials, Promisses for improved tissue regeneration, Nano Today, 4, 66-80 (2009).

[13] Lamiaa A. Mohammed., ph.D Thesis, "Preparation and characterization of bio-ceramics based on nano-technology for bio-medical applications, Fac. Of Engineering, Minia University, Minia, Egypt (2016).

bio-ceramics based on nano-