UDC 546.34.553.677.4

GLOBAL DEMAND, APPLICATION, PRODUCTION SCALE OF LITHIUM COMPOUNDS

[1]Murodjon Samadiy, [2]Shafoat Namazov, [3]Dilbar Ramazonova, [4]Sitora Kayumova

[1] Yangiyer Branch of Tashkent Institute of Chemical Technology, Deputy Director for Scientific Affairs, PhD, associate professor

[2]Institute of General and Inorganic Chemistry of the Academy of Sciences of the Republic of Uzbekistan

[3]Student of Yangiyer branch of Tashkent Institute of Chemical Technology

https://doi.org/10.5281/zenodo.8101624

Abstract. *Demand for lithium is growing rapidly as its use increases in a variety of applications such as rechargeable batteries, light aircraft alloys and fusion. Demand for lithium is expected to triple by 2025 at the expense of batteries, especially those used in electric vehicles. To meet the growing consumption of lithium, it is necessary to increase the production of lithium from various resources. The reserves of lithium resources in salt water of salt lakes, sea and geothermal water are 70-80% of the total, which are excellent raw materials for lithium extraction. Compared with minerals, the recovery of lithium from water resources is promising because this water recovery of lithium is more common, more environmentally friendly, and cost effective. There are many ways to extract lithium from water resources. Among the existing methods, the adsorption method is more promising in terms of production method. Therefore, important advances in the field of ion-exchange-adsorption methods for extracting lithium from water resources have been studied in detail.*

Keywords: *lithium recovery, saline likes, adsorption, lithium-ion sieves.*

INTRODUCTION

Lithium and the derivatives obtained from Lithium are widely used in the production of glass, refrigerants, ceramics, lubricants, batteries, chemicals and other industries. World reserves of lithium are about 14 million tons, mainly 70-80% of the reserves are in salt lakes, geothermal waters and solids contained in lithium ore. At present, many of the researchers are providing much attention to explore the 2600 billion tons of lithium-containing sea waters, which is about 15×10^3 times higher than solid Li ores [1].

Figures of Li and its reserves are varied considerably by the available source, though there is a trusted consensus available which is stated that Li resources are much greater available in the brines than in rock. The recent USGS data show a total Li resource (brine and rock) of 54.1 Mt. Approximate minimum and maximum lithium resources in hard rock are 12.8 and 30.7 Mt, respectively. The field data for brines were having the minimum value of 21.3 Mt while having the maximum value of 65.3 Mt [2-3].

Lithium is used in many ways, but its abundance of Li in nature is 1.8×10^{-3} % [4]. The use of lithium in Li-enriched ceramics is up to 15% for use in tritium production [5]. In addition to that, enriched Li is available in the market which is very expensive, which is commensurate with the cost of gold. Therefore, it is necessary and very important to recover and process the lithium which is available in the solid waste raw materials. Thus, the wider use of Li and its derivatives in various fields. There are many studies have been carried out on the extraction of lithium from various sources.

The demand for the Li is expected to rise dramatically and steadily in future because there are various forms and types of Li containing batteries are available and produced to supply power to hybrid and electric vehicles [6-7]. Li containing batteries with so many technologies are available in the market including Li ion and some of the emerging technologies by having Li sulfur and lithium air. [8-9].

The demand of the Li is expected to increase by 60% from $102x10^3$ tons to $162x10^3$ tons of lithium carbonate equivalent over the next 5 years, with a huge percentage of this growth coming from battery applications [10-11]. Current lithium resources in continental and salar brines were reported to be approximately 52.3 Mt lithium equivalent, mainly in Chile, Argentina and Bolivia, of which is around 23.2 Mt could be recovered [12]. On the other hand, lithium from minerals is around $8.8x10^5$ tons, where the US, China and Russia are having the highest percentages. The estimated amount of the reserves and also the recoverable Li resources is around $29.79\ x10^5$ tons [13].

The general public are utilizing the Li resources associates batteries for the purpose of portable electronics, hybrid and electric vehicles. High-capacity Li batteries are also a leading candidate for a possible energy. The storage solution used in electric grid, smart grid, need high-capacity storage batteries green energy, wind that eats the sun and waves, all of which are inherently intermittent sources of energy [14-15]. Nowadays, in the struggle to obtain much percentage of high-capacity energy banks or batteries, green energy are important. Essentially, if we want our energy matrix to be heavily dependent on renewable energy sources in the near future, energy reserves or banks are needed to ensure that energy is continuously fed into the grid while these intermittent energy reserves or sources are either not fully operational (without wind) or offline. After all, in addition to being a source of energy, high-capacity batteries are also there should be an alternative way of storing the energy when there is a low demand, and it is allowing to reintroduced the excess energy to the grid when there is a peak demand for energy.

Due to the deterioration of Li ores, most of the recent studies have shown and discussed about the Li extraction from brine, seawater and geothermal water. The production of Li from the water resources are considered as very important due to ease of process, wide availability, and cost effectiveness when it is compared from the production from other resources.

METHODOLOGY

Many methods have been reported for extracting Li from brines, seawater and geothermal water: solvent extraction, including precipitation, liquid-liquid extraction, selective membrane separation, electrodialysis, ion-exchange adsorption, etc. [16]. The highest and more attention has been made to “ion-exchange adsorption methods” which is based on the Li-ion sieves because of their better selectivity for high adsorption properties and the Li ions [17]. Therefore, the cost and efficiency, the extraction of Li ions from solutions by the ion exchange adsorption is an important for these method of extraction [18].

DISCUSSION

In recent years, various methods have been proposed to remove lithium from water. Among them, adsorption has been proven to be an ideal way to recover lithium, offering significant advantages such as availability, lower cost, cost-effectiveness, efficiency, and ease of operation. Various lithium removal materials have previously been reported, including metal oxides, clay minerals, silicotitanates, and zirconium phosphate. The main attention of researchers was focused on adsorbents titanium-lithium-ion sieves manganese-lithium-ion sieves and aluminum salts aluminum salt adsorbents showed stable /55/and high selectivity for Li^+ with lithium uptake as low as 2-3 mg/g [19]. The authors synthesized nanosized H_2TiO_3 by a solid-phase reaction, and its lithium adsorption capacity reached 32 mg/g. Tang et al. (2015) and Zhang et al. (2016) synthesized H_2TiO_3 using various raw materials. Wang et al (2016) synthesized lithium-enriched β-Li_2TiO_3 with a maximum lithium uptake of 76.7 mg/g in alkaline LiOH solution. Despite the fact that the maximum absorption of Li^+ by the H_2TiO_3 adsorbent from a solution enriched with lithium reached 76.7 mg/g, the high cost of synthesis and the loss for the dissolution of the titanium ion are still an obstacle. Chitrakar et al. (2001) synthesized Li1 by a hydrothermal reaction. $6Mn_{1.6}O_4$ and Li^+ adsorption capacity 52 mg/g [20].) Synthesized Hydrogen oxides of manganese with a spinel structure, and found that the saturated adsorption capacity was around 42 mg/g [21]. Synthesized MnO_2 with maximum adsorption capacity reaching 46.34 mg/g in Lithium hydroxide solution (C0= 35 mg/l). The dismutation reaction during etching can lead to lattice distortion and manganese dissolution, which disrupts its cyclicity. Also, Li and Mg, processed salt-like brines can contain significant concentrations of K (potassium), Na (sodium) and B (boron) [22-24].

CONCLUSIONS

Lithium is one of the rarest metals, and the demand for lithium will grow with the growth in the production of electrical and electronic devices and hybrid electric vehicles.

Therefore, it is important to search for ways to obtain lithium from water sources. There are various methods for extracting lithium from brine, sea water, and geothermal water, including precipitation, solvent extraction, selective membrane separation, liquid-liquid extraction, ion-exchange adsorption, electrodialysis, and so on. The absorption method is promising for the future production of lithium compounds.

Scientists and manufacturers are faced with the challenge of solving several problems: the ion sieve has a relatively low ion exchange capacity and poor stability; lithium absorption reaches 16 to 26-28 mg/g, theoretical adsorption capacity 54 mg/g; dissolution of sorbents. Weight loss was observed in almost all sorbents; low stability during processing; the appearance of secondary waste in the regeneration of acids; the process takes a long time.

To solve these problems, scientists around the world have carried out a lot of scientific work to improve the stability of sorbents, increase the absorption capacity, selectivity, and accelerate the sorption time.

Many methods have been explored, including organic chemicals, synergies, binders, various composites. Lithium adsorption recovery may be an alternative option to meet future demand, energy sustainability, environmental protection and circular economy.

REFERENCES

1. Murodjon Samadiy and Tianlong Deng. Lithium Recovery from Water Resources by Ion Exchange and Sorption Method. Journal of the Chemical Society of Pakistan. J.Chem.Soc.Pak., Vol. 43, No. 04, 2021 P. 406-416.
2. Bakhodir Abdullayev, Ilkham Usmanov, Murodjon Samadiy, Tianlong Deng. Lithium Recovery from Water Resources by Membrane and Adsorption Methods. International Journal of Engineering Trends and Technology. 2022, 70(9), P. 319-329.

3. Kesler SE, Gruber PW, Medina PA, Keoleian GA, Everson MP, Wallington TJ Global lithium resources: relative importance of pegmatite, brine and other deposits. Ore geol. 2012. Rev. 48, P. 55-69.
4. Glasstone S., Senonske A. Nuclear Reactor Engineering, 3rd Ed., CBS Publisher & Distributor, Delhi, India, 1986.
5. Tsuchiya K., Kawamura H. Fabrication and Characterizationn of 6Li-enriched Li_2TiO_3 Pebbles for a High Li-burnup Irradiation Tests, Japan Atomic Energy Agency, 2006.
6. Opitz A., Badami P., Shen L., Vignarooban K., Kannan. Can Li-Ion batteries be the panacea for automotive applications? Renew. Sust. Energ. 2017. Rev. 68, P. 685-692.
7. Evans RK Lithium's future supply, demand. North. miner. 2010. 96 (35), P. 11-12.
8. Winter M., Brodd R.J. What are batteries, fuel cells, and supercapacitors? Chem. Rev. 2004. 104 (10), P. 4245-4269.
9. Bruce P.G, Freunberger S.A., Hardwick L.J., Tarascon J.M. Li-O_2 and Li-S batteries with high energy storage. Nat. mater. 2012. 11 (1), P. 19-29.
10. Hykawy J. Looking at lithium: discussing market demand for lithium in electronics. mater. World Ceram. Lithium 2010. 18 (5), P. 34-35.
11. Siame E., Pascoe D. Extraction of lithium from micaceous waste from China clay production. miner. Eng. 2011. 24 (14), P. 1595-1602. doi:10.1016/j.min.eng.2011.8.013.
12. Yaksic A., Tilton JE Using the cumulative availability curve to assess the threat of mineral depletion: the case of lithium. resource. Policy 2009. 34, P. 185-194.
13. Evans J.K. An abundance of lithium. Accessed on 27 November 2011.
14. A.S. Brouwer, M. van den Broek, W. Zappa, W. C. Turkenburg, A. Faaij. 2016. Least-cost options for integrating intermittent renewables in low-carbon power systems. Appl. Energy 161, P. 48-74.
15. Pellow MA, Emmott CJM, Barnhart CJ, Benson SM Hydrogen or batteries for grid storage? A net energy analysis. Energy Environment. sci. 2015.8(7), P. 1938-1952.
16. Liu Q., Ai H. & Li Z. Potassium sorbate as an efficient and green catalyst for knoevenagel condensation.Ultrasonics Sonochemistry, (2011). 18(2) P. 477–479.
17. Ji Z.-Y., Yang F.-J., Zhao Y.-Y., Liu J., Wang N. & Yuan J.-S. Preparation of titanium-base lithium ionic sieve with sodium persulfate as eluent and itsperformance.Chemical Engineering Journal, (2017). 328, P.768–775.
18. Chitrakar R., Makita Y., Ooi K., & Sonoda A. Synthesis of iron-doped manganese oxides with an ion-sieve property: Lithium adsorption from Bolivianbrine. Industrial & Engineering Chemistry Research, (2014c). 53(9), P. 3682–3688.
19. Rjabtsev A.D., Kotsupalo N.P., Kishkan L.N. Method of Producing Lithium Hydroxide from Brines and Plant for Method Embodiment. 2003.
20. Chitrakar R., Kanoh H., Miyai Y., Ooi K. Recovery of lithium from seawater using manganese oxide adsorbent ($H_{1.6}Mn_{1.6}O_4$) derived from $Li_{1.6}Mn_{1.6}O_4$. Ind. Eng. Chem. Res. 2001. 40(9), P. 2054–2058
21. Chitrakar R., Makita Y., Ooi K., Sonoda A. Lithium recovery from salt-like brine by H_2TiO_3. Dalton T. 2014. 43 (23), P. 8933–8939.
22. Zhou ZY, Qin W., Fei WY Extraction equilibria of lithium with tributyl phosphate in three diluents. J. Chem. Eng. Data 2011a. 56 (9), P. 3518-3522.