A introduction to lithium commerce essay

Lithium is the lightest of all metals it has the greatest electrochemical potential and provides the largest energy density for weight. Rechargeable bateries using lithium metal as an electrode are capable of providing both high voltage and excellent capacity which results in an extraordinary energy density. A cell of a lithium-ion battery consists of a carbon-based anode, a lithium transition metal oxide cathode and a liquid electrolyte which consist of lithium salts, such as LiPF6 or LiClO4 in an organic solvent such as ethylene carbonate (galvanic reaction). When charging the cell is undergoing electrolysis and lithium ions are being extracted from the anode material and inserted into the cathode material, his process can be seen in figure 1, 2, 3 (R. Pierre, 2009).

Figure 1: How a Lithium Ion Cell Works

e-

V

Anode

LiC6

(-ve)

Cathode

LiMn2O4

(+ve)

¬Li+

¬Li+

¬Li+

Electrolyte

(Such as LiClO4 in an organic solvent, such as ethylene carbonate.)

Cathode: LixC6 → xLi+ + 6C + xe- Anode: xLi+ + Mn2O4 → LixMn2O4

Overall: LixMn2O4 + 6C → LixC6 + Mn2O4

Figure 2: Lithium Ion Cell Diagram (Electrochemical)

Note: Cell must be sealed, Lithium is highly reactive with air/water

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(+ve)

e-

e-

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(-ve)

Li+®

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Cathode: xLi+ + 6C + xe-→ LixC6 Anode: LixMn2O4→ xLi+ + Mn2O4

Overall: LixC6 + Mn2O4→ LixMn2O4 + 6C

Figure 3: Lithium Ion Cell Diagram (Electrolysis)

Note: Cell must be sealed, Lithium is highly reactive with air/water

Most lithium-ion batteries for portable applications are cobalt-based. The system consists of a cobalt oxide cathode and a graphite carbon in the anode. One of the main advantages of the cobalt-based battery is its high energy density. However there are a number of different Lithium ion cells which are used when different discharge properties are required as can be seen in Table 1.

Table 1: Most common types of lithium-ion batteries. (I. Buchmann, 2006)

http://www. batteryuniversity. com/images/partone-5a. gif

Lithium-ion batteries have a very high energy density as can be seen in Figure 4 and Table 2. They are the only battery that can be used practically in high power but small devices such as cell phones,

mp3 players, laptop computers, etc. They are also attractive for use in electric cars, for the same reasons. Portable devices are being fitted with these batteries for a reliable upkeep. Electric automobiles and many other serious industries are employing these rechargeable lithium batteries as their power source because it is a stable and effective method that they can rely on.

http://www. batteryuniversity. com/images/partone-5a-2. gif

Figure 4: Energy densities of common battery chemistries. (I. Buchmann, 2006)

Advantages

High energy density with potential for yet higher capacities.

Does not need prolonged priming when new. One regular charge is all that is needed.

Relatively low self discharge, self-discharge is less than half that of nickel-based batteries.

Low Maintenance there is no need for periodic discharge is needed; there is no memory.

Specialty cells can provide very high current to applications such as power tools.

Limitations

Requires protection circuit to maintain voltage and current within safe limits.

Subject to aging, even if not in use.

Transportation restrictions, shipment of larger quantities may be subject to regulatory control. This restriction does not apply to personal carry-on batteries.

Expensive to manufacture, at about 40 percent higher in cost than nickel-cadmium.

Not fully mature, metals and chemicals are changing on a continuing basis due to improving technology.

Disadvantages

Lithium is a rare metal, with about 80% of the world’s total reserve being found in South America.

The locations where it is found are fragile ecosystems that would be destroyed by the extraction of the mineral.

The demand for lithium, especial if it is used in the batteries of electric vehicles may cause demand to outstrip supply.

There are concerns that world lithium supply is very limited and our increasing demand for may exhaust this supply very quickly.

There are potential alternative which may have less of an impact on the environment such as the zinc-air battery and the zebra sodium nickel chloride battery. There are also greater world reserves for these elements.

(I. Buchmann, 2006)

Below is a summary of the strength and limitations of today’s popular battery systems.

Table 2: Characteristics of commonly used rechargeable batteries (Low Cost Batteries, 2010)http://www. gmbattery. net/images/battery. png

History

Pioneer work with the lithium battery began in 1912 under G. N. Lewis. However it was not until 1970 that lithium ion batteries were created by M. S. Whittingham from the Binghamton University, Exxon. He used titanium sulfide and lithium to power a battery. The use of metallic lithium worked fine for the batteries as far as power was concerned but they posed certain safety issues and concerns and could not be made commercially unless some safer solution was found.

(Delaney, D. 2010)

Attempts to develop rechargeable lithium batteries failed due to safety problems. This is because of the inherent instability of lithium metal, especially during charging, research shifted to a non-metallic lithium battery using lithium ions. Although slightly lower in energy density than lithium metal, lithium-ion is safe, provided certain precautions are met when charging and discharging.

(Buchmann, I. 2006)

Experimentation was done with the of the intercalation technique using lithium’s electrochemical properties and graphite in 1980 by Rachid Yazami who published a work in a year or two which indicated that lithium

intercalation in graphite was indeed a reversible reaction and could be used in the making of rechargeable lithium batteries. Stability, safety, cost and performance are the few major aspects of developing this battery further.

(Delaney, D. 2010)

Lithium ion batteries so far have become quite popular for their safety mechanisms and long lasting durability and reliability in terms of performance. The development of lithium ion batteries was driven by the need for more cost effective and safe alternatives to the lithium cobalt oxide as well as improved performance. One of the materials that were developed was lithium iron phosphate developed in 1996 by the scientists Akshaya Padhi and John Goodenough.

(Delaney, D. 2010)

There is continuing research and development going on in regards to lithium ion batteries, both to further enhance their efficiency i. e. the amount and type of materials they use and improved performance and longevity.

Impact and Issues

Lithium is a relatively rare metal. There are concerns that lithium supplies will not be able to support continuing expansion of lithium-ion battery use, for example in electric cars. Analysis of Lithium’s geological resource base shows that there is insufficient Lithium available in the Earth’s crust to sustain Electric Vehicle manufacture in the volumes required, based solely on Lithium Ion batteries. Depletion rates would exceed current oil depletion rates and switch dependency from one diminishing resource to another.

Concentration of supply would create new geopolitical tensions, not reduce them. (T. William 2006)

Their use is limited by their cost and a lifespan of a few years or less. The batteries are recyclable but the amount that are recycled and the infrastructure need to do this would be costly. Also 100% recovery will never be possible and growth in automobile demand will continue. Another problem with these batteries is related to their high energy density if damaged or if there are defects that are introduced in manufacturing, they may catch fire or explode. Many laptop batteries have been recalled due to this issue. These are rare occurrences and lithium ion batteries are considered to be safe. (Buchmann, I. 2006).

Figure 5: Global Lithium Reserve Base Figure 6: Global Lithium Production (Metal Equivalent)

As can be seen in Figures 5 and 6 South America dominates the total lithium reserve base, this may have a lot of unseen consequences. Already there is antipathy between local communities in Argentina and international mining companies. This has in effect spilled over into a social revolution in Bolivia where many foreign mineral extraction companies are seeing their assets nationalised. The Bolivian government may not permit the wholesale industrialisation of the Uyuni salt flats, a unique and ancient ecosystem, just to provide lithium to the developed world. One major issue of South America holding so much of the world's lithium reserves is that if the world does come to rely on lithium, the way it does oil then it would be like handing over control of the world oil supply to South America. According to Meridian

Research Institute (2008), Everywhere in South America, the people are demanding accountability much greater return from the exploitation of their immense mineral wealth by foreign companies and the protection of the environment.

Another aspect to the political side of this is the need for government to appear to be doing something about the environment, taking care of it and making sure that we as humans do not destroy it. The development of eco friendly solutions is of strong political importance because the world is waking up to the impact that people are having on the planet. Cars are considered to be one of the main polluters and the auto industry is under pressure come up with less environmentally damaging and more efficient ways for use to get around easily. Petrol costs a lot more now than it did a few years ago this is also driving a need for cars to be more efficient using it or not using petrol at all, one solution to this is to use electric cars which need somewhere to store their energy one battery type that may be suitable is Lithium ion.

As with all mining and mineral extraction the process of obtaining lithium can have a major impact on the environment. The two areas in which lithium is found in significant quantities are also two of the most remote, unspoiled and fragile ecosystems in the world, the Andes and Tibet. To extract the amounts of lithium that are likely to be required in the future by both the automotive and electronics industries will do irreversible and widespread damage to these environments (Meridian Research Institute, 2008). These environmental impacts have to weighed against the possible benefits of not using oil to power cars. There is still a lot of debate going on about global

warming and it effects, one thing for certain is that we will eventually need to find an alternate source to power automobiles. Lithium ion battery power cars are just one possible solution to this.

Already the world has come to rely on the lithium ion battery to power most of our mobile electronic such mobile phones, mp3s, laptops etc. The social and cultural impact of lithium ion batteries can be seen to go hand in hand with the impacts the modern technology is having on the world. People's lifestyles and the way they live have changed dramatically from just 20 years ago. Generation Y and younger children now have greater lateral thinking ability and have a seemingly natural talent with technology that their parents don't have. There social interactions have change, no longer is there the need to talk face to face or even physical talk this can be interpreted as younger people being antisocial. It is also perceived as them losing some abilities that help them when they are put in a social situation, they don't have the ability to intercept body language or use correct English. However looking at this from the side of those using the technology they see themselves as being more social and having a wide array of contacts and friends.

The increasing demand in the world for portable electronics, with adequate battery time means an increase in the demand for lithium ion batteries. Combining this with emerging ' Environmental Friendly Car' market which if it continues to use lithium ion battlers as it has done will cause the demand for lithium, specifically lithium carbonate to far outstrip current supply. Also the amount of lithium in the world is not clear and as is the issue if it will be

enough to meet future demand. At the current time there is no clear answer on this.

The lithium ion battery has had a major impact on society and the economy on countries all around the world. These days we cannot imagine living without the portable technology that is powered by these batteries. It has opened up the world making information accessible from anywhere and we have the ability to speak to people via text, phone or the internet. The world has become a smaller more interconnected place because of this. The environmental impacts of lithium itself are little as it is nontoxic substance. However the processes that are used to obtain, refine and get it to us all have a negative impact on the environment just as any mining and manufacturing process does. This effect can be minimised and controlled. The lithium batteries are recyclable however most people just throw them out and do not recycle them. If the batteries are used to power cars then they will be having a positive impact on the environment but this must be weighed against the negatives of mining and production. Lithium has had a major impact on society and will continue to do so into the future, weather this is a positive or negative it is hard to predict. However based on what has happen so far the positives will outweigh the negatives.