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Study the effect of anhydrous Cupric Sulphate on eutectic mixture of Lithium Chloride - Potassium Chloride.

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ABSTRACT

The change effect of eutectic mixture in Magnesium thermal cell using anhydrous cupric sulphate have been studied. Different weight ratios have been added into eutectic mixture. The activity of new eutectic mixtures have been examined relatively to the ambient temperatures and the voltage production of electrochemical systems. Optimized ratio of new eutectic mixture have been choice relative to minimum ambient temperatures, compares to the original eutectic mixture. Optimized weight of depolarizer in eutectic mixture of new Magnesium thermal cell have been studied. Anhydrous Cupric Sluphate additions give up high impact on the thermodynamic and conductivity activity of eutectic mixture, since the optimized weight ratio of new eutectic mixture Lithium Chloride: Potassium Chloride: anhydrous Cupric Sluphate is consisted from 5.5:4.5: 1.5 ratio .Operating temperature is 400̊ C, Open system cell produced 2.4 volte in presence 0.3 optimized weight ratio of depolarizer relative to weight ratios of new eutectic mixture components. The new thermal cell is sensitive to ambient temperatures and produce electrical energy when ambient temperature raise from 35 into 350̊ C by voltage range from 0.55 into 2.2 volte respectively. Electrical discharge of open circuit occurs in 150̊ C by eight minutes.

Keywords: Magnesium thermal cell, Eutectic mixture, Open thermodynamic system, Open Cup cell, Anhydrous cupric Sulphate.

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INTRODUCTION

Thermal batteries are electrochemical systems depend on molten salts as axillary electrolytes, were first developed in Germany in the 1940s [1]. It is classify into primary battery and secondary battery, which the solid electrolyte is inert (not conductance) at the room temperature .This device becomes electric energy production at elevated surrounding temperature [2,3]. Thermal batteries are used for high power applications that requiring runtimes from a few seconds to a few hours, and these batteries are used for air application and also are typically used to provide power for son buoys, mines, missiles, guided artillery, countermeasure devices, and guidance systems [4]. All batteries are composed of two electrodes connected by an ionica conductive material (eutectic mixture) electrolyte. The two electrodes have different chemical potentials. When these electrodes are connected by means of an external device, electrons spontaneously flow from the more negative to the more positive potential. Ions are transported through the electrolyte, and electrical energy can be tapped by the external circuit. In secondary, or rechargeable batteries, a larger voltage applied in the opposite direction can cause the battery to recharge [5]. Magnesium batteries is the luckiest technology in order to achieve substantially greater energy density than Li-ion. Because of the divalent nature of Mg^{2+} and the use of a magnesium metal anode, magnesium batteries can obtain higher energy density (energy per unit volume) and specific energy (energy per unit weight) than state of the art lithium batteries. A magnesium metal anode has a greater volumetric capacity than graphite or lithium metal and it's inexpensive, environmentally friendly and safe to handle [6-8]. In this work, study the chance of eutectic mixture composition through the effect of anhydrous cupric sulphate. Mole fraction of new eutectic mixture and their optimized conditions are investigated with their reliable properties of new magnesium cell.

EXPERIMENTAL

The preparation of molten salts

The molten salts were prepared by mixing different percentages of anhydrous cupric sulfate with the original fixed percentage of potassium chloride and lithium chloride that includes (LiCl: KCl: 45:55) [9]. The constant weight of depolarizer V_2O_5 have been used for each experiments that conducted up to get the optimal weight for the anhydrous cupric sulfate salt. In each experiments the mixture was crushed to a powder and then moved to the furnace whose temperature had been raised from 35 to 600 C̊ till get melted the powder and it becomes a solution, The furnace get turn off and leave it until gets cool down to 100, then the mixture moves to a dry box and leave it there until it gets cool down to solidifies then grind to a powder again and get used for electrical measurements.

Determination of the weight percentage of depolarizer

After choosing the best of weight ratio for (anhydrous cupric sulfate) that it was added to the molten salts that it has formed from the two salts (potassium chloride and lithium chloride) with the fixed ratio of depolarizer V_2O_5, it adds variety of weight ratio from depolarizer substance V_2O_5 and observe its effect on the molten salts and choose the best ratio for this substance, what it gives the highest voltage for the mixture.

Operation of the thermal cell

After determine the best ratio for the molten salts and depolarizer, the mixture was transferred to the pottery basin, and put it inside the furnace and connected the two electrodes of this cell to the voltmeter. The temperature suitable for the cell operation was determine by raising the temperature from 35 to 600̊ C.

The operating temperature of thermal cell

The operating temperature temperature was determined by taken the pottery basin that container the best ratios of new eutectic mixture, and put it inside the furnace and connected to the voltmeter. The temperature was gradually raised from 35 to 600̊ C with recorded the temperatures with resulted voltage.

Effect of Temperature

The effect of temperature upon the voltage of the thermal cell could be showed by setting the pottery basin that container the best ratios from molten salts, and put it inside the furnace and connected to the voltmeter. The temperature raising from 35 to 150̊ C ,and when reach the temperature to the 150̊C, starts running the stopwatch and monitoring the voltages resulting with time up until utilized all supplied voltage of the cell .

RESULTS AND DISCUSSION

The components of the thermal cell

The thermal cell consists from the Mg anodes with thickness of 0.15-0.2 mm and width of 3mm where as it gets remove all the impurities that exist on the surface by washing it by nitric acid 1M, then get washed up by distilled water for several times, then dried well it get used. Metallic magnesium was a good candidate of anode material because of its high safety, low cost and abundance in nature [10]. Cathode of magnesium cell is composed from depolarizer (V_2O_5) with used the metal clip consisting of nickel, iron and chromium. It's cheap, low cost and available in the country markets. Metal clip a positive current collector. The eutectic mixture consist from the LiCl:KCl with ratio of 45:55 ,which wide used in the thermal cells electrolytes [1]. The purpose for addition of anhydrous cupric sulfate to the eutectic mixture to improving a new good properties of the eutectic mixture, to give the higher voltage value at ambient temperature than origin thermal cell of magnesium [11]. The components of the magnesium thermal cell put in the pottery basin that using for all experiments according to the open cell cup (open thermodynamic system). As the results show in both table 1 and figure 1.

Table 1: optimize weight ratio of anhydrous copper sulfate in the eutectic mixture of LiCl:KCl.

Temperature ˚C	wt. 1/ 0.25 gm.	wt. 2/ 0.5 gm.	wt. 3/ 0.75 gm.	wt. 4/ 1 gm.	wt. 5/ 1.25 gm.	wt. 6/ 1.5 gm.	wt. 7/ 1.75 gm.	wt. 8/ 2 gm.
50	0.1	0.1	0.1	0.2	0.1	0.15	0.1	0.21
100	0.15	0.15	0.11	0.25	0.2	0.2	0.1	0.24
150	0.27	0.2	0.25	0.3	0.24	0.3	0.33	0.4
200	0.32	0.3	0.33	0.56	0.4	0.95	0.45	0.5
250	0.35	0.38	0.45	0.8	0.56	1.8	0.8	0.75
300	0.45	0.5	0.75	1.3	0.95	2	1	0.8
350	0.51	0.82	1.1	1.7	1.5	2.1	1.4	0.82
400	0.55	0.7	0.88	1.5	1.3	2.3	0.9	0.5
450	0.6	0.42	0.52	0.96	0.75	1.3	0.65	0.25
500	0.42	0.4	0.2	0.54	0.25	0.75	0.25	0.2
550	0.1	0.1	0.15	0.3	0.15	0.21	0.1	0.15
600	0.1	0.1	0.1	0.25	0.1	0.2	0.1	0.11

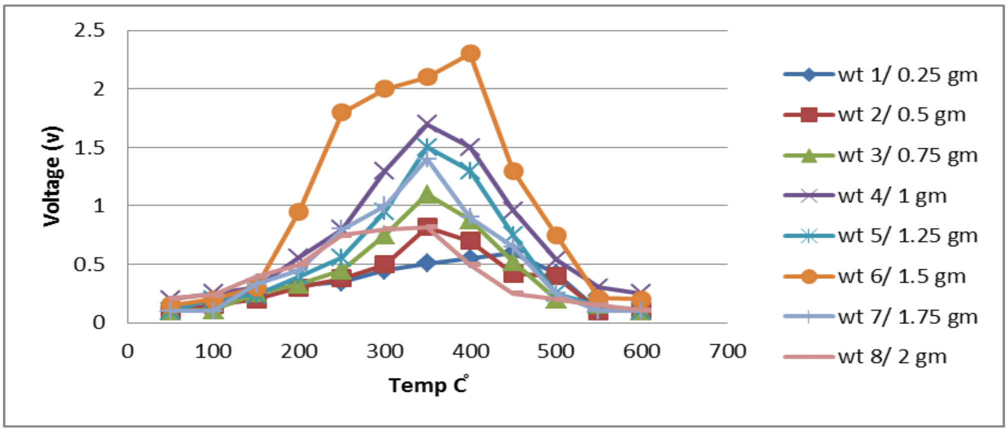

Figure 1: Voltages generate of open cup magnesium thermal cell according to different mole ratio of anhydrous copper sulfate.

The best weight ratios of anhydrous cupric sulfate were added to the original eutectic with the constant weight of the depolarizer (1. gm. for all these experiments) equal to 1.5 gm. that given the maximum value of voltage, 2.3 volt for the mixture in the 400 C . Addition of different amount of the depolarizer V_2O_5 to understanding what the suitable weight that's give up maximum production of voltage in magnesium thermal cell with best weight of anhydrous cupric sulfate. The V_2O_5 consider the best depolarizer that used in magnesium thermal cell. Table 2 and Fig 2, shows that the best weight of V_2O_5 is 0.3 gm added to the molten salts LiCl: KCl: $CuSO_4$: 45:55:1.5 to make higher voltage production by 2.1 volt for the mixture in 400 C̊.

Table 2: Optimize weight ratio of V_2O_5 in eutectic mixture open cup magnesium thermal cell.

Temp°C	0.1gm V_2O_5	0.2gm V_2O_5	0.3gm V_2O_5	0.4gm V_2O_5	0.5gm V_2O_5
50	0.3	0.2	0.13	0.25	0.1
100	0.35	0.4	0.25	0.36	0.25
150	0.5	0.65	0.42	0.55	0.43
200	0.85	0.98	0.71	0.81	0.75
250	2.5	1.3	1.5	1.3	1
300	3.5	1.55	1.8	1.7	1.23
350	3	1.9	2	1.9	1.5
400	1.7	2	2.1	1.4	0.98
450	0.65	1.2	1.4	0.84	0.51
500	0.5	0.6	0.8	0.66	0.45
550	0.45	0.3	0.15	0.4	0.4
600	0.3	0.2	0.1	0.35	0.15

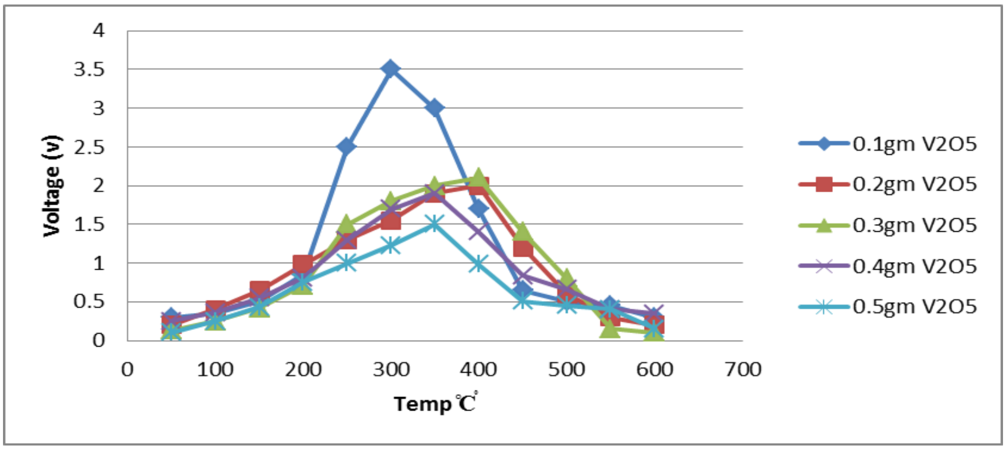

Figure 2: Voltages generate of open cup magnesium thermal cell according different weights of V_2O_5.

Operating temperature of magnesium thermal cell

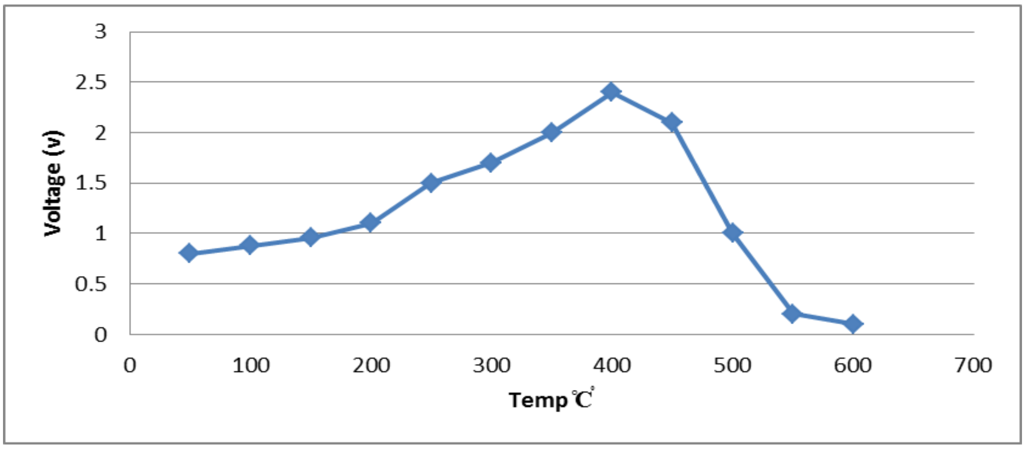

Figure 3: The operating temperature of the open cup magnesium thermal cell.

Figure 3. Shows the temperature that which the thermal cell works with a maximum efficiency at 400 C, where the voltage is 2.4 volt. The temperature was raised from 35 to 600 C and the rising in the voltage was noticed from 0.8 volt at 50 C and continue to raise until reach the voltage to 2.4 volt at 400 C, this demonstrates the effectiveness of these thermal cell at the ambient temperature, after that observed the rapid falling in voltage that indicates the consumption one or all of the reactants in the thermal cell. the new fabricated magnesium cell has high sensitizing factor toward ambient temperature, since it has ability to produced electric energy when the ambient temperature raise than 50°C, as shows in figure 4. That explain the regularly electric discharge in the 150°C, with the lifetime was 8 minutes. The origin cell cannot produced energy until temperature raised to 400°C[12, 13]. this new phenomena can be used to fabricate thermal sensor of alarm system or in other air application system with low cost value.

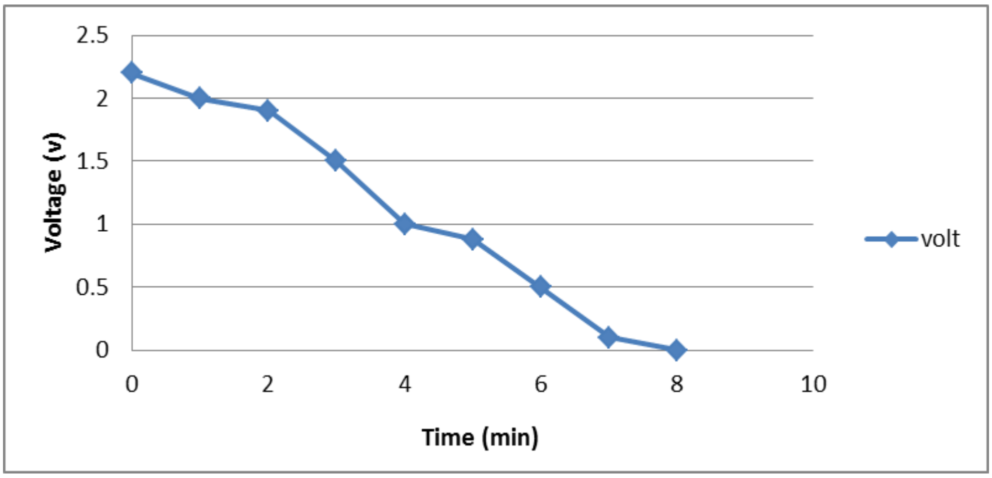

Figure 4: the sensibility of magnesium thermal cell toward ambient temperature.

CONCLUSION

The anhydrous copper sulfate has a significant effect on the properties and specifications of the eutectic mixture of magnesium thermal cell. Sensibility of voltage production at ambient temperature, low operating temperature value, and high economic cost value of fabricated due new simple raw materials have been used in new magnesium thermal cell.

REFERENCES

[1] David L. and Thomas B.R. "Handbook of Batteries". 3rd edition, McGraw-Hill Companies, USA, 2001.
[2] Abbas A-Ali Drea. Characterization study of Thermal Battery T-417, MSC Thesis, Babylon University, 2001.
[3] Abbas A-Ali Drea, and Hadi M-Ali Abbod. Natl J Chem 2004;13:15-25.
[4] Rebecca M. Thermal battery development project. American competitiveness institute, 2005.
[5] Armand M and Tarascon JM. Nature 2008;451:652-657.
[6] Lu Z, Schechter A, Moshkovich M and Aurbach D. J Electroanal Chem 1999;466:203-217.
[7] Aurbach D, et al. Nature 2000;407:724-727.
[8] David JB, Hojong K, Aislinn HCS and Donald RS. J American Chem Soc 2012;134:1895-1897.
[9] Vincent C A and Scrosati B. "Modern batteries", 2nd Edition, Edward Arnold, London, 1997;302.
[10] Aurbach D, et al. Adv Mater 2007;19:4260-4267.
[11] Abbas A-Ali Drea. Natl J Chem 2005;16:34-42.
[12] Abbas A-Ali Drea, Falah H. Hussein, and Hadi M-Ali Abbod. Natl J Chem 2006;24:488-510.
[13] Abbas A-Ali Drea, Falah H. Hussein, and Hadi M-Ali Abbod. Natl J Chem 2007;25:79-101.