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ENERGY STORAGE VIA ELECTROCHEMICAL GENERATION OF CARBON MONOXDE AS IN INTERMEDIATE PRODUCT

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The generation capacities of the largest resources of renewable energy, wind and solar, are weather- and time-dependent and most of the geographic areas best suited for harvesting these resources are remote from major population centers. Both these factors lead to the disproportionately large cost (>50%) of the infrastructure in the total cost of renewable-energy-based systems. This problem can be solved or largely alleviated if a reliable method for storing and transporting the harvested energy is found.

The conversion of CO_2 to CO by electrolysis of molten (Li_2CO_3 + Li_2O) was investigated. Using a cell comprising a Ti cathode, a graphite anode and a source of CO_2 allows the continuous electrolysis of the melt at 900°C. This process has a potential application for converting electrical energy into fuel. Stability of the molten (Li_2CO_3 + Li_2O) salt and the equilibrium between molten (Li_2CO_3 + Li_2O) and CO_2 were investigated.

Summary of the cathode and anode reactions is $Li_2CO_3 = Li_2O + 0.5O_2 + CO$. If the melt is fed with gas containing CO_2, then the CO_2 will react with Li_2O, reforming Li_2CO_3 and thereby stabilizing the melt. The net gas reaction is CO_2 decomposition to CO and O_2. Study of the electrode kinetics indicated that the overpotential of the anode reaction is below the detectable limit and the overpotential of the cathode reaction is below 0.5 V even for current density approaching 1 A/cm^2.

Experiments with the test cell showed that the Faradaic efficiency of the process remains close to 100±1 % for current densities in the range of 0.02-2 A/cm$_2$. We have also found that the decomposition potential of the reaction $Li_2CO_3 = Li_2O + 0.5O_2 + CO$ at 900°C is 0.87 V, whereas the isothermal potential of reaction $CO_2 = CO + 0.5O_2$ is 1.47 V. Therefore, the thermodynamic efficiency of electrolysis below 1.47V is close to 100%.

The developed technique has a number of features, favorably distinguishing it from the alternatives. The method does not use noble metals or other particularly expensive materials; does not use or produce environmentally hazardous materials; has a potential for continuous operation; can be modified to absorb CO_2 directly from air; produces CO that can be easily and potentially on-site converted into methanol for a direct use in internal combustion engines.