Assessment of Coal and Graphite Electrolysis

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Introduction

Hydrogen can be looked at as a promising option as a fuel and can be used for electricity generation. It is clean and abundantly available in nature. Depletion of the fossil fuels, especially petroleum makes hydrogen even more attractive for the future use. But the problem is that it is not present in directly usable form. Hence, it has to be extracted from its sources as water and other chemical compounds. However the processes demand large amount of energy consumption and often are not environmentally friendly.[1]

For a long time coal has been used for the production of energy. One of the advantages of using Coal is that it is one of the cheapest sources of energy and abundantly available. Conventional methods for producing hydrogen from coal involve the process which has to be carried at very high temperatures (800^{o}C). Also it produces harmful pollutants as SO_x and NO_x. Hence, hydrogen has to be separated from these gases. In 1979, Coughlin and Farooque[2] provided some fundamental understanding on the electrolysis of coal slurry to produce pure hydrogen at cathode and CO_2 at anode. The authors have also reported that the reversible thermodynamic potential of the oxidation of coal is only -0.21 when compared to conventional water electrolysis which is -1.23 V, hence making coal slurry electrolysis more competitive.

The authors also evaluated the performance of graphite which is the pure form of carbon. They found that the oxidation current for graphite was more than order of magnitude lower than for the coal. But the authors did not provide detailed study of the same. Evaluating the performance of graphite is important because it may provide an insight into the role of various factors which contribute towards the difference between the performance of coal and graphite such as chemical nature, morphology etc.

Within this context, the objective of this paper is to study the electro-oxidation of graphite and to evaluate the effect of different parameters (composition of slurry and particle size) on it. The intention is to adjust the composition of the slurry in order to mimic the electrochemical performance of coal. This research will lead to a better understanding of the electrochemical oxidation of coal.

Experimental

The electrodes, Pt, Pt-Ir, Pt-Ru , Pt-Rh were used as working electrodes and Pt-Ru was used as a counter electrode for the evaluation of Pittsburgh no.8 Coal and Graphite with particle size from 74-105µm. The experiments were carried out potentiostatically with the ARBIN potentiostat.

Coal and Graphite were characterized before and after any measurement was performed to determine: 1. Particle size, using sieving, and 2. Surface analysis, using Scanning Electron Microscopy (SEM) and X-Ray Diffraction (XRD). Iron content in the slurry solution was measured by Atomic Absorption Spectroscopy (AAS).

Results and Discussion

Figure 1 shows the potentiostatic study of coal and graphite slurries in water with concentration (0.12 g/ml) in acidic medium (1M H_2SO_4) using two different foil electrode materials (Pt-Ir and Pt-Ru) at 40º C. From the graph we observe that the current densities for graphite slurries are lower than that of coal slurries. Graphite slurries were further evaluated after adding Fe^{+3}, which is typically present in coal at different concentrations. Still the current densities were found to be lower than that of coal slurries. That means the other factors play an important role in the electrolysis of coal slurry.

Further analysis and results will be presented.

References

[1] Bisio A, Boots S, *Encyclopedia of energy technology and the environment*, vol. 3. New York: Wiley (1995).

[2] R. W. Coughlin and M. Farooque, *Fuel, vol.58, no.10*, 705(1979).

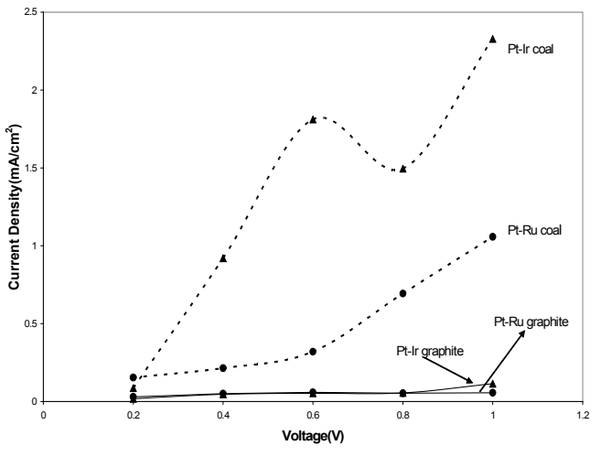

Figure 1: Comparison between electrolysis of coal and graphite slurries for Pt-Ir and Pt-Ru electrodes at 0.12 g/ml concentration and 40º C