Intra Company

August 24, 1970

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Subject: Monthly Highlights for August 1970, Chemical Engineering Dept.

Sodium-Sulfur Battery

Long term testing of sodium-sulfur glass cells has been started. Two cells with the 9.25% $Na_2O$, 0.25% $Li_2O$ ceramic have been put on test at 0.25 amp/$cm^2$.

The processing study aimed at the fabrication of the ceramic tubes from the single phase material at lower temperatures and pressures has continued. Samples with alkali contents of 11% and 12% $Na_2O$ and 0.75% $Li_2O$ have been prepared with acceptable density at 45°C below normal temperature and at 5000 psi. The 11% $Na_2O$ material is the more promising of the two on the basis of the short-term electrical test results. Sodium-sodium cells will be constructed to study the performance and life of the 11% $Na_2O$ ceramic.

Corrosion tests on stainless steel indicate passivation by a thick sulfide layer. The characteristics and protective properties of this layer under battery operating conditions are under investigation.

Lead Acid Battery

Improved Positive Active Material. The experimental work on a process for producing the active material paste is progressing well on the laboratory scale. Presently small plates are being prepared for cycling tests. Attempts by our personnel to produce the paste at the General Parts Division with their large scale equipment were not successful. More information on the effects of the various process variables is required before further large scale trials are made.

At a recent meeting with the Advanced Battery Development personnel it was agreed that if our small plates perform satisfactorily we will then make battery size plates for G.P.D. to test.

(G.P.D.'s) Maintenance Free Battery Program. Their program was

reviewed with Mr. R. Bennett. They have finalized on the lead-calcium-tin grid alloy and are running casting experiments with the assistance of Process Research Dept. They are encountering problems with separators, oxide material from Shreveport, and impurities in the acid and the water. We shall continue to assist them with problems as they arise. Presently we will look into the problem of the high level of impurities in the acid. So far it has been necessary to use distilled water and reagent grade acid.

Nickel-Zinc Battery

In a recent discussion with General Electric personnel it was indicated that they have extended the cycle life of nickel-zinc cells by reducing the shape change of the zinc electrode. They claim that little or no capacity loss was observed after 100 cycles at the C/5 rate and that after 200 cycles a 35% loss in capacity occurred. The cells are also supposed to be capable of discharge at the 20C rate and charged at the C rate. The improvements have been achieved, in part, by increasing the KOH, using a different binder and additives in the zinc electrode. The ultimate failure is still due to shape change. While the indicated improvement is interesting it is not sufficient as yet, to warrant our testing of the cells.

Bumper Task Force

Chemical Engineering investigation of the anodic and cathodic process in the brass plating process has shown that more uniform cathodic deposits and improved anode corrosion can be obtained by placement of the air agitation directly under the anodes rather than the cathode rack. The suggested change was incorporated in the Monroe high-copper brass pilot plant operation with improved results reported. The added suggestion of using larger anode bags is being evaluated by Monroe.

Aluminum-Finned Radiators

Engine and Foundry Division has requested assistance in suggesting procedures for the joining of aluminum fins to the conventional copper tubes, and in the evaluation of the final structure. Alstan treatment of the aluminum prior to soldering to the tubes has been suggested. Chemical Engineering will assist in the corrosion testing of the final assembly.

Phosphate Coatings-Chromic Acid Rinse

Due to the trend to more stringent requirements for treating effluents, Automotive Assembly is considering the use of a chromic acid-free rinse at the end of the phosphating operation. Scientific Research has been asked to assist in the evaluation of this procedure. A new rinse developed by Amchem is under consideration.

Non-Battery Applications for $\beta$-Alumina

A paper study of the possible application of $\beta$-Alumina in a process for the desulfurization of residual fuel oil has been made. Although there is an early patent literature pertinent to the problem, the exact chemical reactions

for sodium-desulfurization are not known. Our study was prompted by the interest shown by Esso in such an application.

In the assumed process the organic sulfur compounds in the oil would be reduced by sodium and the sodium and sulfur electrochemically regenerated from the resulting sodium sulfide in a two chambered cell divided by the β-Alumina. It is assumed that the major product of desulfurization will be $Na_2S$, but higher sulfides or deeper desulfurization are not excluded as possible. The expected features and costs of such a process are compared with the currently available hydrodesulfurization - catalytic reduction with hydrogen.

It is concluded that the sodium process may have the potential of operating at a somewhat lower cost for the main process consumables than does the hydrodesulfurization process. It is interesting to note that about 1.5 million square feet of β-Alumina would be required to furnish cell capacity to desulfurize to 0.3% sulfur the more than 1.7 million bbl/day of residual oil burned in the United States.

Friction Material Development

Sintered metallic friction materials, while having many desirable properties for brake linings, usually are noisy, have a tendency to score the cast iron rubbing surface, and exhibit variations of friction during the seating-in period. Special surface finish treatments with extended break-in periods are required to obtain satisfactory performance. Past attempts to overcome these problems by impregnating the sintered material with a phenolic-type resin have been only partially successful.

Preliminary evaluation of an experimental sintered metallic friction material, performed in cooperation with the Mechanical Research Department, shows that the addition of sodium fluoride substantially improves the wear life and tends to diminish the noise and scoring problems. The laboratory testing was done on a FAST machine using an experimental formulation developed by the Ceramics and Glass Department, now a part of the Process Research Department. A high-density iron powder was substituted for the 100 mesh iron used in the original formulation. This enabled the formulation containing sodium fluoride to be compressed to a higher green strength and sintered at lower temperature than is possible with 100 mesh iron. An invention disclosure on this concept has been submitted. Additional work is planned to investigate these kinds of systems further.

Engine Cooling

Part of the heat carried away by engine coolant is often transmitted by boiling of the coolant at localized regions of high metal surface temperature. At the onset of boiling, nucleate boiling generally occurs, and the heat transfer rate increases rapidly as the surface temperature increases. When a critical temperature is reached, called burnout, film boiling replaces nucleate boiling and the heat transfer rate decreases drastically leading to a further increase in surface temperature.

Cooling of the critical regions could be substantially improved if the

the limiting heat transfer rate at burnout were increased. There is evidence in the literature that the burnout point and heat transfer during nucleate boiling can be affected by additives to the coolant. In conjunction with the Mechanical Research Department, it is planned to investigate this phenomenon.

Honeycomb Catalyst Support

Car Systems Research is planning to evaluate honeycomb channel-supported catalysts for exhaust emissions control. The catalysts, to be tested in engine exhaust systems, will be supplied by Engelhard Industries. We are helping CSR to determine the best honeycomb channel size and reactor size and shape. This will require the preparation of a computer program to estimate the effects of reactor design on performance under various engine operating modes.

J. V. Petrocelli

Invention Disclosure

M. Weintraub, "Friction Additives for Sintered Metals", File No. 70-351

G. J. Tennenhouse, "Conductive Surface Coatings Resistant to Corrosion in Air, Sulfur, and Molten Alkali Polysulfides", File No. 70-353

G. J. Tennenhouse, "Surface Coatings Resistant to Corrosion in Air, Sulfur, and Molten Polysulfides", File No. 70-352

R. W. Minck, "Addition of $H_2S$ to Improve Sodium-Sulfur Cell Rechargeability".

R. W. Minck and R. P. Tischer, "Electrode Having Improved Mass Transport".

Technical Memorandum

Report No. SRM 70-23, R. L. Gealer, "Consideration of the Use of $\beta$-Alumina in a Residual Fuel Oil Desulfurization Process".