AEROSPACE ELECTRODE LINE

L. Miller
Eagle Picher

Let me just give you a little bit of history before I go directly into my paper.

For more than 20 years the Eagle Picher space-battery operations have been located in our Joplin, Missouri plant, and we have been procuring finished electrodes from our Colorado Springs facility. We consider this facility to be our commercial operation or high volume operation.

As of now, and at least starting about the last 6 months, we now have a new electrode facility in operation in our Joplin plant. We believe that this facility may be the first electrode-processing nickel cadmium and nickel hydrogen designed, developed, and dedicated solely to the production of electrodes for space-battery systems.

The facility offers production capacity for not only the chemical electrodes which we have been using for a great deal of time now, but also the newer electrochemical designs.

(Figures 6-15 and 6-16)

These are just a couple of vugraphs. I have a couple of more to give you an overview of the system. I might just comment on the production capability of the operation.

Right now, we are not really running at full capacity. We can produce about 150 square feet of plaque material in an eight-hour production shift. However, the design of the equipment is such that it is capable of handling three times this volume.

There are a number of unique design features that are specifically incorporated to produce a high-quality electrode. We have made these changes based upon our experience as part of the operation. Also, we are indebted to the recommendations and suggestions of Jerry Halpert and Floyd Ford.

Let me go through a couple of these items here.

1. A batch rather than a continuous operation mode was selected for better process control.

2. An independent equipment module design approach was taken to assure process solution isolation. In other words, electrode materials are themselves transferred from process tank to process tank, rather than the much easier and lower cost method of pumping in different process solutions into the same tank.

The benefits achieved here are elimination of the slow, but inevitable buildup of tank, plumbing, and solution reservoir contamination associated with partial solution mixing.

3. All equipment, even including the exhaust duct work, is constructed of stainless steel and all current carrying components such as buss bar and electrode process racks are constructed of pure nickel to prevent contamination.

4. Equipment design was easy and was designed for easy access to facilitate both internal and external cleaning.

5. Continuous in-line process monitoring and an analytical chemical laboratory dedicated to this operation assures achievement of the desired high degree of process control.

(Figures 6-17 and 6-18)

6. Each piece of 12 X 12 electrode material blank, and there is three per process rack, is connected to the process rack by four redundant, fusion welded nickel tab connections to ensure uniform current distribution within the parallel rack assembly.

7. In addition, each rack assembly offers an adjustable connection to the process tank buss bar, allowing fine tuning of current flow to achieve uniform current distribution through each parallel rack assembly.

8. During actual operation, process tank to reservoir solution recirculation provisions permitted the introduction of filtration and sedimentation steps to maintain ultra high solution purity levels.

9. The very important, final electrode material formation step, a unique high-voltage system was devised featuring multiple, series-connected small formation cells, again assuring uniform current distribution.

That's what you could see on your right over there if it were a better vugraph.

10. Each of the above formation cells is fixtured so as to permit frequent replacement of the electrolyte solution which, of course, always is heavily contaminated in this operation.

11. A special multistep cascade, deionized water washing technique followed by a vacuum dryin step, produces finished electrode materials exhibiting the desired physical stability and cleanliness characteristics.

12. A series step deionizing system which means we have two deionizers connected in series so we have pretreatment as well as final treatment to ensure a very high quality deionized water source for all operations of the system.

In addition to the formation there, we have what we call our final electrode carbonate treatment equipment. Basically, there are two systems in operation depending on the customer's preference.

One involves a multiflushing of the finished welded cell, and the other involves a hot caustic dip – it can be boiling caustic – just prior to final cell assembly for carbonate reduction purposes.

With respect to the results, as I say, we have only been in operation for six months. We don't have long-term data, but some of the initial observations based upon our previous source of electrodes – we used to only use about one-half of the electrodes that we procured. The attrition was either as a result of out-of-weight range plaques, or physical defects associated with the electrode materials. We now use more than 90 percent of the electrodes produced.

One thing that was somewhat of a surprise to us is that generally when we built some fresh cells, we needed, through a series of burn-in cycles, to develop their capacity, or at least stabilize their capacity.

We find now that cells built with electrodes on this new line exhibit a long-term capacity from the very first cycle.

One of our observations is that the activity in the electrode appears to have been improved to the point that we can operate a cell design to 15 to 20 percent more electrolyte and still measure lower internal pressures on cycling.

DISCUSSION

FORD: Lee, I don't remember you commenting on making the plaques themselves. Are you making those in Joplin?

MILLER: At this time the raw sinter is still made in our Colorado Springs facility. There are plans to set up a new operation at Joplin for that, also.

FORD: Will you be automated with that, or are you going to use the old magnet technique?

MILLER: It is rather a tough decision right now. The dry sinter or the individual sintering process has certain advantages; the continuous or automated slurry has its own advantages. I would say right now the preference would be to probably go to the continuous slurry process.

GROSS: Lee, you indicated that it was determined that the batched process would be better than the continuous process.

Offhand, I would have guessed the other way around. Can you explain that a little bit further, please?

MILLER: Well, the batch process just lets you step into the middle of the process and make measurements more easily than a continuous process because it will be better control.

GROSS: The other point was, I have always felt that the electrochemical impregnation method had the potential to be a completely closed system, to be closed off from the atmosphere, and solved once and for all the problem of carbonates getting on the plates.

Apparently, you elected not to do that, or couldn't, and I wondered if you would explain why that happened.

MILLER: I am not sure what you mean by that, Sid. There is a great deal of gas evolution associated with the electrochemical process, more so than the chemical process.

GROSS: Yes, evolution. Would that mean gas would go out and you could have gas evolve without allowing atmospheric gases to get in?

MILLER: Maybe I don't understand your question. What do you mean by a closed system?

GROSS: Closed from the atmosphere, from the contamination of carbon dioxide and gas, which produces carbonates on the plates during manufacture.

MILLER: One thing you can do with the electrochemical process though is to finish the impregnation step in the acid state, so you don't have to be as careful as in the chemical process with respect to storage of plaques between operations.

Figure 6-15

Figure 6-16

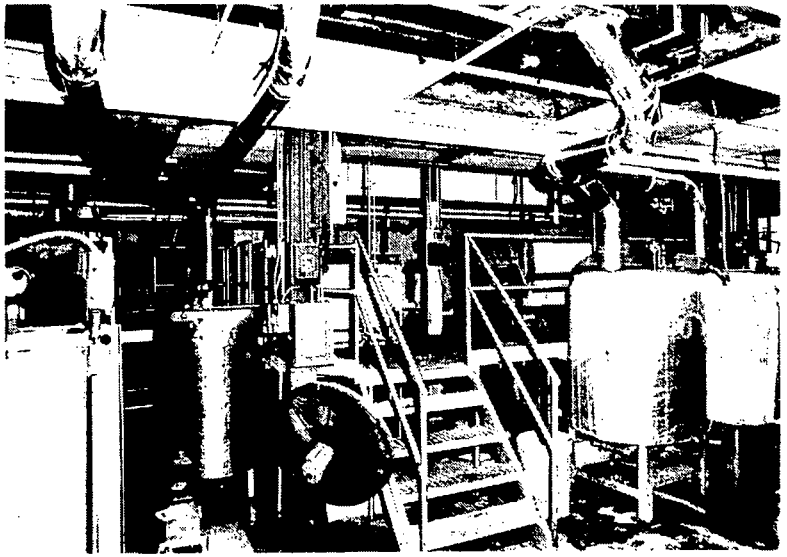

Figure 6-17

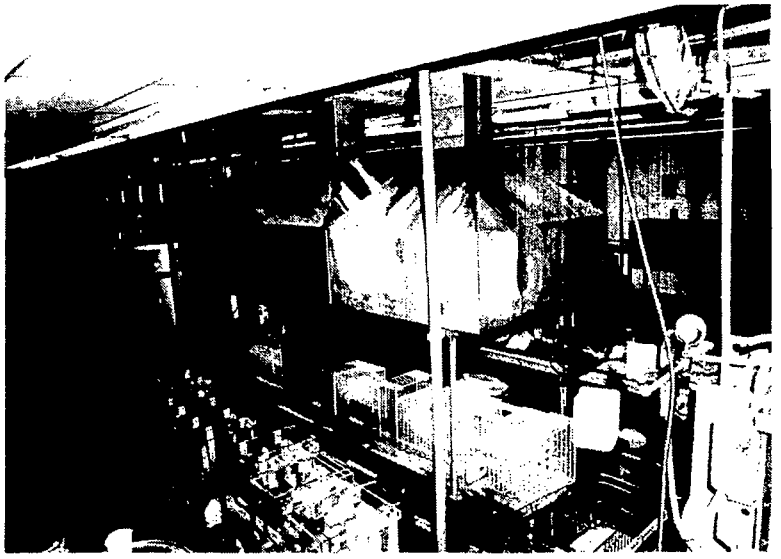

Figure 6-18