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Journal of Power Sources 64 (1997) 9–10

JOURNAL OF POWER SOURCES

The 1996 Gaston Planté Medal acceptance speech

K.R. Bullock

I would like to thank Professor Yakimoff, Scientific Secretary General of the Bulgarian Academy of Sciences, and Planté Medalist Professor Pavlov for this great honor. And I congratulate my friend and colleague Dr David Rand on his receipt of the medal.

I would like to acknowledge the support of my family, my husband Ken Bullock and my son Kevin who are here today and my daughter Kerry who was not able to be here because of her academic studies. I would also like to acknowledge John Devitt, who is here today. John is the person who first hired me into battery research and development, and he has been an ongoing source of encouragement to me throughout my career.

I would also like to acknowledge the many co-workers who have co-authored or co-edited technical works with me. They are listed in Table 1. I have been fortunate to work with many very fine scientists and engineers throughout my career. Professor Donald Smith was my graduate advisor at Northwestern University. Dr Donald McClelland, at The Gates Company, was a co-inventor with John Devitt, of the first commercially successful valve-regulated lead/acid battery with absorptive glass mat (VRLA AGM). He first introduced me to the field of electrochemistry and inspired me to go to graduate school in this field. My many co-authors during nearly fifteen years at Johnson Controls and five years at Lucent Technologies (formerly AT&T) Bell Laboratories are also listed, along with some co-workers in other organizations. I would especially like to mention my esteemed colleague Professor Detchko Pavlov, who co-edited the Proceedings Volume on Advances in Lead/Acid Batteries with me in 1984. Finally, I would like to thank the management of Lucent Technologies who sponsored the work I am going to present and gave me the opportunity to come to Bulgaria and receive this award.

The paper which I am going to present is based on the very first work I published on lead/acid batteries. In 1975, Dr McClelland and I published an extended abstract for a paper which I presented at the Electrochemical Society meeting in Toronto that year on a model of the self-discharge processes in VRLA AGM lead/acid batteries. The model presented in the paper was based on the earlier paper published in the *Journal of the Electrochemical Society* in 1958 by Planté Medalist Paul Ruetschi and R.T. Angstadt who had described the self-discharge processes in flooded lead/acid batteries. My paper with McClelland was published in the *Journal of the Electrochemical Society* in 1976 and has been cited in subsequent literature. But there was a formula in the extended abstract which is not as well known which can be used to calculate from measurement of the open-circuit voltage the percent state-of-charge of a VRLA AGM batteries. I derived this equation using the Nernst equation for the double sulfate reaction, based on the assumption that the capacity decrease in the cell during storage will be equivalent to the Ah/mole of acid used in the self-discharge reactions. The extended abstract also had a figure showing the calculated percent state-of-charge of the Gates cells as a function of storage time at four different temperatures which was based on open-circuit voltage measurements. At the time I published the paper, I had some data from another company on the actual discharge capacities of the Gates cell after varying storage times at room temperature. And these data points agreed well with the values calculated from the open-circuit voltages measured at room temperature. But since the data was limited, I decided not to include the formula and figure showing percent state-of-charge in the paper.

Recently, we have obtained some additional data at Lucent Technologies on VRLA AGM batteries which show that this formula for percent state-of-charge is quite accurate. The 12 V flat plate batteries which we used are quite different from the cylindrical, spirally wound Gates cells used in the 1975 study. Although these two designs represent the range of VRLA AGM designs which are on the market, the formula works quite well on both. In addition, we have taken the self-discharge model which I published with McClelland and extended it using statistical theory to determine the reliability of a population of batteries based on a limited amount of data on a sample of the population.

Table 1
Co-authors of technical works

Northwestern University, USA	
D.E. Smith	
The Gates Company, USA	
D.H. McClelland	
Johnson Controls, Inc., USA	
G.H. Brilmyer	B. Reichman
R.G. Burrow	J.L. Strebe
R. Hamann	J.S. Symanski
S.L. Haberichter	W.H. Tiedemann
W.H. Kao	G.M. Trischan
E.C. Laird	C.L. Wang
B.K. Mahato	G.L. Wierschem
B.L. McKinney	D.F. Wilkinson
J.R. Pierson	W.J. Wruck
Lucent Technologies, Inc., Bell Laboratories, USA	
J.R. Baldasty	R.H. Holland
C.S.C. Bose	K.A. Murugesamoorthi
G. Cadet	P.K. Ng
A.G. Cannone	T.V. Nguyen
D.G. Fent	J.L. Valdes
M.E. Fiorino	M.C. Weeks
CLEPS, Bulgarian Academy of Sciences, Bulgaria	
D. Pavlov	
Energizer Power Systems	
P.D. Bennet	
Sandia National Laboratories, USA	
M.A. Butler	
University of Western Ontario, Canada (IUPAC)	
J.W. Lorimer	