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SOME OBSERVATIONS ON BATTERY CHARGE CONTROL

NASA SPACE POWER WORKSHOP

NASA/MARSHALL SPACE FLIGHT CENTER, ALABAMA

11/17/93

G.J. METHLIE

NICAD CHARGE CONTROL -

GSFC TCVL

PROGRAM- SPECIFIC TCVL'S

V/T CHANGES WITH TIME

THINGS THAT CAN BE DONE

DELTA T VS "DIURNAL CYCLE"

- dE/dT

P & DELTA P

INTEGRAL I dt

RECHARGE RATIO CONTROL

1/2 BATTERY VOLTAGE DIVERGENCE

VOLTAGE "OR" DELTA T

GSFC TCVL CONTROL

TRADEOFF BETWEEN STATE-OF-CHARGE AND CELL DAMAGE

EARLY TCVL'S SET MOSTLY TOO HIGH

THERMAL PROBLEMS ABOVE ABOUT 30 CENTIGRADE

POSSIBLE HYDROGEN EVOLUTION AT 0 -10 CENTIGRADE

RECHARGE RATIOS OFTEN 120 - 160%

FLOYD FORD/GSFC & STEVE GASTON - 1972

EXTENSIVE WORK FOR OAO ESTABLISHED 8 TCVL'S

SAFT 20 AHr CELLS

C/2 LEO CYCLING FROM 10 - 30 CENTIGRADE

EARLY MODEL CONFIRMED IN BENCH TESTING AT GULTON

PARAMETER AND E DIVERGENCE CORRELATION LOW

RECHARGE RATIOS EFFECTIVE FROM 100 - 110 %

LESS DAMAGE WITH TIME/TEMPERATURE AND CYCLING

USED TO GENERATE NWSC/CRANE DATA BASE

G.E./NASA (STD) CELLS MOST RELIABLE

WORKED WELL WITH VERY DIFFERENT CELL DESIGNS

PROGRAM-SPECIFIC TCVL'S

CHANGED SLOPE OF E VS T FOR DIFFERENT MISSION T'S

SOME ELIMINATED TRICKLE IN LEO

SOME USED WITH VERY HIGH CHARGE AND DISCHARGE RATES

HENNIGAN - SEQUENTIAL CHARGING NOT ADVANTAGEOUS

WAS HELPFUL FOR VERY HIGH RATE MISSIONS

HIGHER RATE CHARGE - BETTER CAPACITY ON HIGH RATE DISCHARGE - MINIMIZE TRICKLE TIME

"BUILD IN" IR CORRECTION

RECONDITIONING DISCHARGE SHOWED "STAIR STEPS"

NEED REDUNDANT BATTERIES AND CELLS IN THEM

SOFT SHORTS (TEMPORARILY) ERASED

40,000 LEO CYCLES ACHIEVED (LIKE SOLAR MAX)

INTERACTION BETWEEN GS AND VEHICLE EXTENSIVE

EVENTUALLY MAINTENANCE TIME EQUALS OPERATING TIME OR SOMETHING ELSE ENDS MISSION

GSFC TCVL CONTROL (CONT'D)

ALSO EFFECTIVE IN GEO WITH STEP TO C/50-100 TRICKLE

SUPPORTED THE MAJORITY OF LEO & GEO PROGRAMS WELL

"ARRHENIUS" PLOT OF CYCLE LIFE VS DOD BETTER THAN NOW

V/T CHANGES WITH TIME/TEMPERATURE/CYCLING

CELLS DEGRADE

INTERNAL RESISTANCE RISES

HYDROLYSIS OF NYLON *

CORRELATION WITH DPA'S

PROPORTION OF CHARGED NEGATIVE INCREASES

ACTIVITY CHANGE SHIFTS Eo FOR NEGATIVE

HYDROGEN GENERATION & "PRESSURE CYCLING"

[KOH] FALLS FROM 31% TO 19% WITH 10% HYDROLYSIS

NICKEL ELECTRODE Eo SHIFTS WITH pH CHANGE

CAPACITY MEASURED IN R/D'S FALLS AT SAME TCVL'S

*- LIM, H.S., "STUDIES ON THE STABILITY OF NYLON SEPARATOR MATERIAL", 27th Power Sources Symposium, Atlantic City, N.J., 21-24 June, 1976, pp. 83-85.

THINGS THAT CAN BE DONE

WATCH BATTERY VOLTAGE TREND

WATCH BATTERY TEMPERATURES TREND

WATCH LOAD SHARING

APPLY LIM'S RATE CONSTANT TO TIME/TEMPERATURE PROFILE

ESTIMATE EXTENT OF HYDROLYSIS

ESTIMATE Ri BY CURRENT-STEP METHOD

CORRECT FOR Eo and Ri CHANGES

BEST TO CONFIRM WITH CELLS FROM MISSION SIMULATION TEST

REDUCE TASKING AND STAY WITH ORIGINAL TCVL'S

DESIGN FUTURE CELLS WITHOUT NYLON (i.e. "SUPERNICADS")

DELTA T VS "DIURNAL CYCLE"

COMPARE BATTERY TEMPERATURES WITH VEHICLE MODEL

INCREASE OR DECREASE CHARGE LEVELS TO ELIMINATE TREND

-dE/dT

AVOID -ROLLOVER CHARACTERISTICS VARY TOO MUCH

IN ONE TEST, 2/30 CELLS DID NOT EXHIBIT ROLLOVER

TRANSIENT LOADS CAN CAUSE PREMATURE CHARGE TERMINATION

P & DELTA P

CORRELATE WITH DELTA T & SOC

USED AS A "BACKUP" OR CHECK ON NICADS

MAIN APPROACH TO NICKEL/HYDROGEN

CAN BE APPLIED TO EOCP & EODP

PRESSURE GROWTH CORRELATED TO GRID CORROSION

INTEGRAL I dt

DIRECTLY DETERMINES RECHARGE RATIO

HIGHER PARTS COUNT & SEMICONDUCTOR FAILURE SUSCEPTIBILITY

ACCOUNT FOR "SOFT SHORTS:"

1/2 BATTERY VOLTAGE DIVERGENCE

RECENT MISSIONS MANAGED TO KEEP THIS DOWN

ADVERSELY AFFECTED BY "SOFT SHORTS"

DOES THIS "DRIVE" PROBLEMS?

VOLTAGE "OR" DELTA T

USED PRIMARILY TERRESTIALLY

VOLTAGE CUTOFF FIXED AT 1.515 V. +/- 10 mV/CELL

DELTA T AT 3 CENTIGRADE OVER BASEPLATE

SUPPORTED C RATE CYCLING WITH 10 C PEAK LOADS

WORKS FROM 5 - 60 CENTIGRADE