Xihua He - — X.H

Brian K. Dearby - - BKD

WALTER J. MACHOWSKI WJM

Project #: 06002.01.322
06002.01.212

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Initial Entries for Under-salt Corrosion Tests
Part A. Effects of Dusts on Corrosion Behavior of Carbon Steel under Salt Deposits in Simulated Dry Repository Environments

Title: Effects of Dusts on Corrosion Behavior of Carbon Steel under Salt Deposits

Names of the individuals performing the activity:
Xihua He, Leitai Yang, Miriam Juckett, Bobby Pabalan, Brian Derby (Div. 18)

Objectives:
Determine the effect of the presence of dust on corrosion by deliquescent salts at different relative humidities

Proposed approach for achieving the objectives: Install carbon steel multielectrode array sensor (MAS) probes in a humidity chamber with controlled humidity. Place mixture of salt powders and dusts with different ratios above the sensing electrodes. Monitor current from corrosion of carbon steel

Equipment: Multielectrode array sensor, humidity chamber, Keithley nanovolt meter and Keithley 7001 Maniframe Switch to measure signal from MAS. Calibration and due dates are provided in data sheets for each test

Software: In-house developed visual basic code was used to control the two Keithley meters and to store data in a computer hard drive. The visual basic code was verified (see Page 45, Scientific Notebook #423)

Materials: G1008 carbon steel, dust, silicate

Measurement parameters: Humidity, Ratio of salts to dust, Current, Temperature

Required level of accuracy: Temperature ±3°C, Currents: ±10 nA

Potential source of uncertainty: Noise from power line of nearby equipment may affect readings from the probes. Pumps and heaters should not be close to the test.

Special personnel training or qualification requirements: None

Xihua He 1/24/06

Information on Quartz used in the tests

From: Bobby Pabalan [rpabalan@cnwra.swri.edu]
Sent: Wednesday, June 14, 2006 1:49 PM
To: xhe@cnwra.swri.edu
Subject: RE: quartz

This quartz material was used previously in uranium sorption experiments. The raw material was obtained as quartz sand (commercial name Wedron #510) from Wedron Silica Co. (Wedron, IL). The quartz sand was sieved to isolate the 60 to 100 mesh fraction (250 to 150 microns). Soluble salts and carbonates were removed by washing the sand in deionized water and in buffered (pH 5.0) acetic acid solution, then washed in sodium citrate-dithionite-bicarbonate solution to remove iron oxides. Other minerals and grains (e.g., those with pyrite inclusions) with densities above that of quartz (2.65 g/cm^-3) were removed by density separation using heavy liquid (Na-polytungstate, Geoliquids). The uranium sorption experiments and results are presented in the reference:

Pabalan, R.T., Turner, D.R., Bertetti, F.P., and Prikryl, J.D. (1998) Uranium(VI) sorption onto selected mineral surfaces. In E. Jenne, Ed. Adsorption of Metals by Geomedia, p. 99-130. Academic Press, San Diego, CA.

After the uranium sorption experiments, the quartz material was recovered, washed with dilute acid, rinsed with deionized water and filtered and dried.

-----Original Message-----
From: Xihua He [mailto:xhe@cnwra.swri.edu]
Sent: Wednesday, June 14, 2006 1:28 PM
To: Roberto Pabalan
Subject: quartz

Information on the label:

W510 [Wedron#510 sand] *60/100 [60 to 100 mesh size] *UC [ultrasonically cleaned] *RC [removed carbonates]
*RFe [removed iron oxides] *HL [heavy liquid separation]
Used-Cleaned-Filtered

Xihua He
6/14/06

Xihua He
Southwest Research Institute
6220 Culebra Rd.
San Antonio, TX 78238
Phone: (210) 522-5194
Fax: (210) 522-5184

January 24, 2006

Bill Scorzo
Staveley Services Materials Testing
192 Internationale Blvd.
Glendale Heights, IL 60139
Tel: 800.537.4012
Fax: 630.871.5520

Letter sent to Staveley with carbon steel 1008 wire for composition analyses

Dear Mr. Scorzo,

I am sending you the **1008** carbon steel wire for chemical analyses. Per our previous phone conversation I need to have the specimen analyzed for Fe, C, Mn, P, and S. The chemical composition (wt.%) of 1008 carbon steel, specified in ASTM A510-03 is provided below.

Fe: balance
C: 0.10 max
Mn: 0.30 to 0.50
P: 0.040 max
S: 0.050 max

The chemical analyses performed by Staveley Materials Testing should provide the chemical composition of the material. The analyses should conclusively determine if the material submitted are within the specifications listed in ASTM A510-03. Any discrepancy between the chemical analyses performed by Staveley Materials Testing and the specifications of ASTM A510-03 should be clearly identified.

Please call me or email me if you have any questions. Thank you for your assistance.

Sincerely,

Xihua He 1/24/06

SOUTHWEST RESEARCH INSTITUTE®
6220 CULEBRA • SAN ANTONIO, TX 78238-5166
(210) 684-5111

P.O# 686333J

(FOR SHIPPING DEPT. USE ONLY)
DATE SHIPPED:
SHIPPING TICKET NO. 442345
(THIS IS NOT A P.O. NO.)
DATE: 01/24/2006

PRIOR TO REPAIR OF ANY ITEM MENTIONED BELOW, PLEASE CONTACT (210) 522-3074 WITH ESTIMATE AND FOR P.O. NO.

SHIP TO
COMPANY NAME: STAVELEY SERVICES/MATERIAL TESTING
ATTN: BILL SCORZO
STREET ADDRESS: 192 INTERNATIONALE BLVD.
CITY/PROVINCE: GLENDALE HEIGHTS, STATE/COUNTRY: IL ZIP CODE: 60139
VENDOR PHONE NO.: 800 537 4012 FAX: R.M.A. NO.:

Please check box for method of shipment to and from Vendor
Circle specific method of shipment

SHIP VIA	TO VENDOR	RETURN TO SWRI
MOTOR FREIGHT	☐	☐
AIR FREIGHT (PRIORITY AIR / GENERAL CARGO)	☐	☐
UPS (1 day, 2 day, 3 day or 7-10 days)	☐	☐
FedEx (1 day, 2 days) or FedEx Ground	XX	☐
SATURDAY DELIVERY	☐	☐
AIRBORNE (1 day, 2 day)	☐	☐
OTHER FEDEX 2-DAY	☐	☐
SwRI DRIVER	☐	☐

PPD XX COLL ☐ 3rd Party ☐ | TOTAL VALUE | DECLARED VALUE | GOVT. PROJ. ☐ | ORG. 20 | BLDG. NO. 57 | PURCHASE ORDER NO.

AIR BILL OR W/B NO.: 7924 9715 4680
ACCOUNT OR PROJECT NO.: 20.06002.01.322
SWRI REQ. NO.:
SENDER'S NAME: XIHUA HE EXT.: 5194

PERSON TO BE CONTACTED FOR PICKUP IS: AT BLDG.: EXT:

QUANTITY	DESCRIPTION & SERIAL NO.	ORIGINAL P.O., S.O., R.O., C.O.D./REQ. NO. B/O
1 PKG	WIRE METAL SAMPLE	

Engines Purged ☐ YES ☐ NO
S.W.R.I. BUYER | EXT. | BUYER NOTIFIED ☐ | Please indicate if items are HAZARDOUS MATERIAL ☐ YES ☐ NO
NO. OF PACKAGES | TYPE OF PACKAGE ☐ BOX ☐ CRATE ☐ DRUM ☐ PALLET ☐ OTHER | WEIGHT | DIMENSIONS (Length x Width x Height)

REASON FOR SHIPMENT AND/OR REMARKS
☐ REPAIR (INDICATE PROBLEM IN REMARKS AREA) ☐ WARRANTY ☐ CREDIT ☐ CREDIT LESS RESTOCKING CHG. ☐ EXCHANGE ☐ OTHER (EXPLAIN IN REMARKS AREA)

REMARKS

DATE SHIPPED | VENDOR RECEIPT BY: | Dept. Approval Signature

THIS FORM TO BE USED FOR ANYTHING SHIPPED FROM S.W.R.I.

IMPORTANT
PACKING LIST (PINK COPY) SHOULD BE ATTACHED TO THE OUTSIDE OF THE CONTAINER, REMAINDER OF SHIPPING TICKET SHOULD BE SENT TO SHIPPING. PART 5 (GOLDEN COPY) WILL BE SENT TO YOU FOR DEPARTMENT RECORDS.

Xihua He 2/1/06

Results of Independent Chemical Analyses

ACCREDITED
Certificate # 286.01
Certificate # 286.02

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TEST REPORT

SOUTHWEST RESEARCH INST. 7010
6220 CULEBRA RD
P.O. DRAWER 28510
SAN ANTONIO TX 78284
XIHUA (SHEWA) HE, PH.D.

P.O.# 686333J
DESCR 01-24-06
ASTM A510-03

REPORT DATE: 01/27/2006

LAB NO: 0126-005 / 01 RECEIVED DATE: 01/26/2006 JOB NO:

1008 CARBON STEEL WIRE

CHEMICAL ANALYSIS

Si	.18	Mn	.45 ✓	C	.10 ✓
P	.005 ✓	S	.009 ✓	Ni	.07
Cr	.07	Mo	.01	Cu	.14
Al	<.01	Pb	.001	V	<.01
B	<.0005	Fe	REMAINDER	Cb	<.01

THE ABOVE CHEMICAL TEST RESULTS CONFORM TO ASTM A510-03 GRADE 1008

TEST METHODS: ASTM E-1024-97* ; ASTM E-1019-03* ; ICP* ;

Meets compositional specification requirements for UNS G1008 as specified per ASTM A510-03.

Q.A. INSPECTOR

ALL CHEMICAL TEST RESULTS ARE REPORTED IN WEIGHT PERCENT UNLESS OTHERWISE NOTED.

PAGE 1 OF 1

SAMPLE RESULTS RELATE ONLY TO THE SAMPLE TESTED

*THIS TEST RESULT IS NOT COVERED BY OUR CURRENT A2LA ACCREDITATION
THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL WITHOUT THE WRITTEN APROVAL OF STAVELEY SERVICES MATERIALS TESTING.
KNOWINGLY OR WILLFULLY FALSIFYING OR CONCEALING MATERIAL FACT ON THIS FORM, OR MAKING FALSE, FICTITIOUS OR FRAUDULENT STATEMENTS OR REPRESENTATIONS HEREIN COULD CONSTITUTE A FELONY PUNISHABLE UNDER FEDERAL STATUTES.

Xihua He 2/1/06

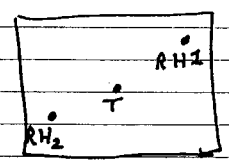
Information on page 6 contains copy of ASTM standard from the American Society for Testing and Materials (Nonresulfurized Carbon Steel Case or Heat chemical Ranges and Limits) that is copyright information and are therefore not included in this file.

Proof

Performance Verification of Humidity Chamber

ESPEC Humidity chamber ETH2 SN 406054
w/ WATLOW F4 Controller

A performance check of the humidity chamber was performed by placing a calibrated temperature probe and two calibrated humidity sensors inside the chamber.
The temperature was set and several humidity settings were checked. The probes were placed as such:



The data table on the following page (p. 8) tabulates the set points vs. the calibrated probes

EQUIPMENT: Fluke 54II Thermometer
SN 90810070 cal 4/17/06 due 4/17/07
probe SN 12159
cal 4/27/06 due 4/27/07

Vaisala Humidity Meter
SN Z0720015 cal 4/11/06 due 4/11/07
Probe #1 SN Z0750006 cal 4/11/06 due 4/11/07
Probe #2 SN Z0750005 cal 4/11/06 due 4/11/07

Walter J. Machowski
5/5/06

Performance Verification Data

Set Point T	Set Point Humidity	Temp Actual	Humidity Actual Probe #1	Humidity Actual Probe #2
70.0°C	20.0%	69.3°C	15.14%	16.95%
70.0°C	23.0%	69.5°C	18.32%	19.69%
70.0°C	40.0%	69.6°C	37.21%	39.28%
70.0°C	41.5%	69.6°C	38.91%	40.94%
70.0°C	55.0%	69.7°C	53.31%	55.60%
70.0°C	56.0%	69.8°C	54.36%	56.55%
70.0°C	68.0%	69.9°C	66.57%	68.84%
70.0°C	69.0%	69.9°C	67.59%	69.53%
70.0°C	80.0%	70.0°C	78.49%	79.65%
70.0°C	81.0%	70.0°C	79.43%	81.03%

Walter J. Machowski
5/5/06

First test series is NaCl plus Quartz. The NaCl and Quartz were thoroughly mixed together using a ball mill shaker w/out the grinding balls. Each batch was shaken for 5 (five) minutes.

30% NaCl // 70% quartz
3.222 g NaCl Lot # 052761
7.063 g quartz

10% NaCl // 90% quartz
1.084 g NaCl Lot # 052761
~~7.063 g~~ quartz
wJM 5/8/06
9.906 g quartz

1% NaCl // 99% quartz
0.103 g NaCl Lot # 052761
9.916 g quartz

100% NaCl 10.020 g Lot # 052761

Information on Quartz:

~~pages~~ page 2
X.H
6/14/06

Xi'hua He 6/14/06

Walter J. Machowski
5/5/06

1. Verification of resistance of resistor in Keithly Electrometer which is used to measure current
Readings from each pin to COM:
1.002 – 1.009 kΩ

Measured with
Keithley 614 electrometer
SN: 055368
Cal: 3/2/06, Due 9/1/06

2. The MAS unit operation was verified by applying known voltages to various pins and comparing these inputs to the readings on the software and an electrometer

Voltages were checked in the two voltage inputs, and on the 1st and last pin of each sensor plug.

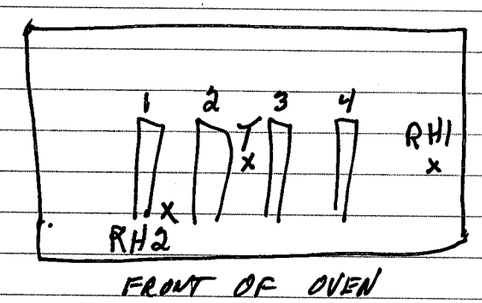
apparatus: OMEGA CL-477 calibration indicator
SN 96010330
cal 1/24/06 due 1/24/07

Keithly 614 Electrometer
SN 0555368
cal 3/2/06 due 9/1/06

Walter J. Mackowski
5/12/06

	Omega input (mV)	Keithly 614 Reading (mV)	Software display (mV)
Voltage input #1 (ch 33)	9.99	9.99	9.99
(ch 34)	9.99	9.99	9.99
Voltage input #2 (ch 73)	9.99	9.99	9.99
(ch 74)	9.99	9.99	9.99
Sensor #1 Pin #1	99.2	9.99	9.89
" " #16	99.3	9.99	9.87
Sensor #2 Pin #17	10.0	10.06	9.99
" #24	10.0	10.0	9.99
Sensor #3 Pin #41	10.0	10.0	9.99
#48	10.0	10.0	9.99
Sensor #4 Pin #57	10.0	10.0	9.99
" #64	10.0	10.0	9.99

* note channel #31 and #32 are reversed
i.e. #31 display is #32
#32 display is #31



RH1 + RH2 Vaisala probe

T Fluke temperature probe

Walter J. Mackowski
5/12/06

Test started @ 2:39 PM 5/12/06
data file c:\Xihua He\Quartzsalt11000.txt

test mixtures

	#1	#2	#3	#4
% NaCl	100	30	10	1
% Quartz		70	90	99

Humidity changed to nominal 40%
@ cycle 912 @ 8:55 AM 5/16/06

While Sterby was working w/ computer, the data collection program aborted. A restart of the program was initiated @ 5/16/06 9:05AM

Restarted again after 2nd abort. disconnected other computer so there would be no GPIB interference

Restart: 5/16/06 9:19AM
data file c:\Xihua He\Quartz Salt 51600.txt

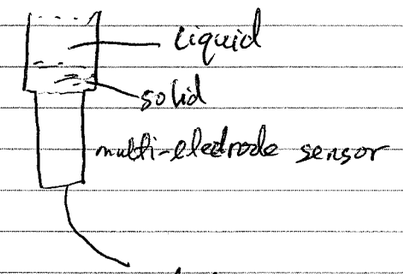
5/19/06 Raise RH to 55% same file ↑ cycle 731
@ 9:20AM

5/24/06 Raise RH to 68% same file ↑ cycle ?
@ 1:30 PM (no display)

6/5/06 Raise RH to 79.5% same file name cycle ?
@ 3:25 p.m (without display)
Xihua He 6/5/06

6/7/06 at 3:25p.m restart computer (computer is getting slower)
New data file c:\Xihua He\QuartzSalt607.txt

After raising the relative humidity to 79.5%, the salt/quartz mixture turns into aqueous solution and quartz mixture



6/14/06 Overflow observed from sensors 1 & 2 after relative humidity was raised to 85%

Xihua He 6/14/06

All original data files.

Quartzsalt #11000
QuartzSalt 51600
QuartzSalt51601
QuartzSalt60700
QuartzSalt60701
QuartzSalt60702

Xihua He 7/6/06

X.H. 7/14/08

Temperature and Humidity Log						
Date/Time	Set Temperature (°C)	Actual Temperature (°C) (Vaisala/Fluke)	Set Relative Humidity (%)	Relative Humidity #1 (%)	Relative Humidity #2 (%)	
5/12/06, 2:40p	70.8	65.0/67.3	23	21.74	20.78	
5/12/06, 3:00p	70.8	68.4/69.9	23	21.01	20.6	
5/15/06, 8:10A	70.8	70.4/70.6	23	19.42	19.62	
5/15/06, 3:20p	70.8	70.6/70.8	24	19.56	19.79	
5/16/06, 9:10A	70.8	70.4/70.6	43	40.38	40.62	
5/16/06, 1:30p	70.8	70.5/70.7	43	40.55	40.85	
5/17/06, 9:00A	70.8	70.4/70.6	43	40.66	40.76	
5/18/06, 9:10A	70.8	70.4/70.6	43	40.55	40.88	
5/18/06, 2:50p	70.8	70.6/70.8	43	40.74	41.07	
5/19/06, 9:25A	70.8	70.5/70.7	56.8	55.4	55.67	
5/19/06, 2:05p	70.8	70.6/70.9	56.8	55.54	55.78	
5/22/06, 9:15A	70.8	70.2/70.5	56.8	55.16	55.24	
5/23/06, 9:40A	70.8	70.3/70.5	56.8	55.23	55.29	
5/24/06, 9:45A	70.8	70.3/70.5	56.8	55.12	55.16	
5/24/06, 1:30p	70.8	70.4/70.2	56.8	55.35	55.31	
5/24/06, 1:40p	70.8	70.3/70.5	69.5	68.26	68.14	
5/25/06, 9:45A	70.8	70.2/70.5	69.5	68.43	68.1	
5/30/06, 9:15A	70.8	70.3/70.5	69.5	68.54	68.03	
5/31/06, 9:40A	70.8	70.1/70.4	69.5	68.55	68.07	
6/1/06, 9:40A	70.8	70.2/70.5	69.5	68.6	67.96	
6/2/06, 9:30A	70.8	70.2/70.5	69.5	68.67	68.18	
6/5/06, 8:40A	70.8	70.6/70.1	69.5	68.3	67.63	
6/5/06, 3:25p	70.8	70.7/71.1	79.5	79.14	77.8	
6/6/06, 8:40A	70.8	70.7/70.1	79.5	78.89	77.81	
6/7/06, 9:20A	70.8	70.1/70.5	79.5	78.86	77.63	
6/12/06, 9:58A	70.8	70.06/70.5	79.5	78.92	77.62	
6/14/06, 1:20p	70.8	70.15/70.6	79.5	79.05	77.8	

Xihua He 6/14/06

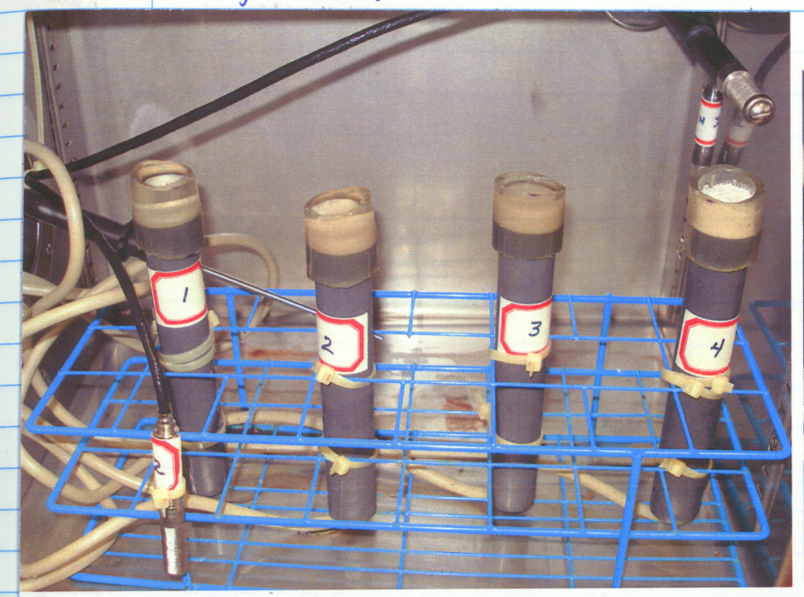
6/16/06 3:00p.m terminate tests

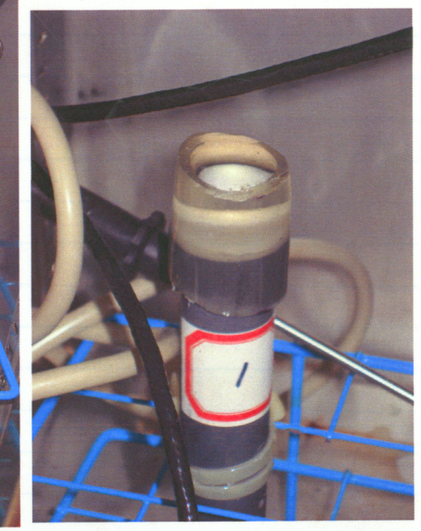
Xihua He 6/16/06

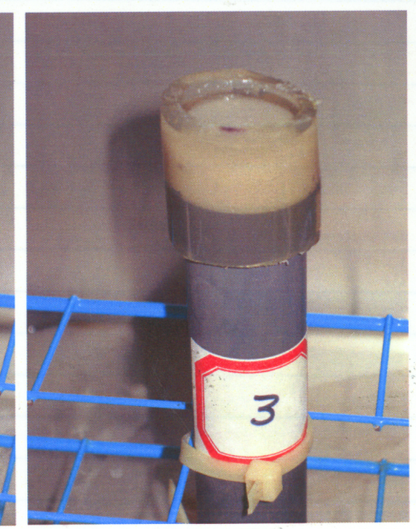
X.H 7/14/08

All data files:
QuartzSalt#11000, QuartzSalt51600, QuartzSalt51601, QuartzSalt60700, QuartzSalt60701, QuartzSalt60702

Sensors after tests:

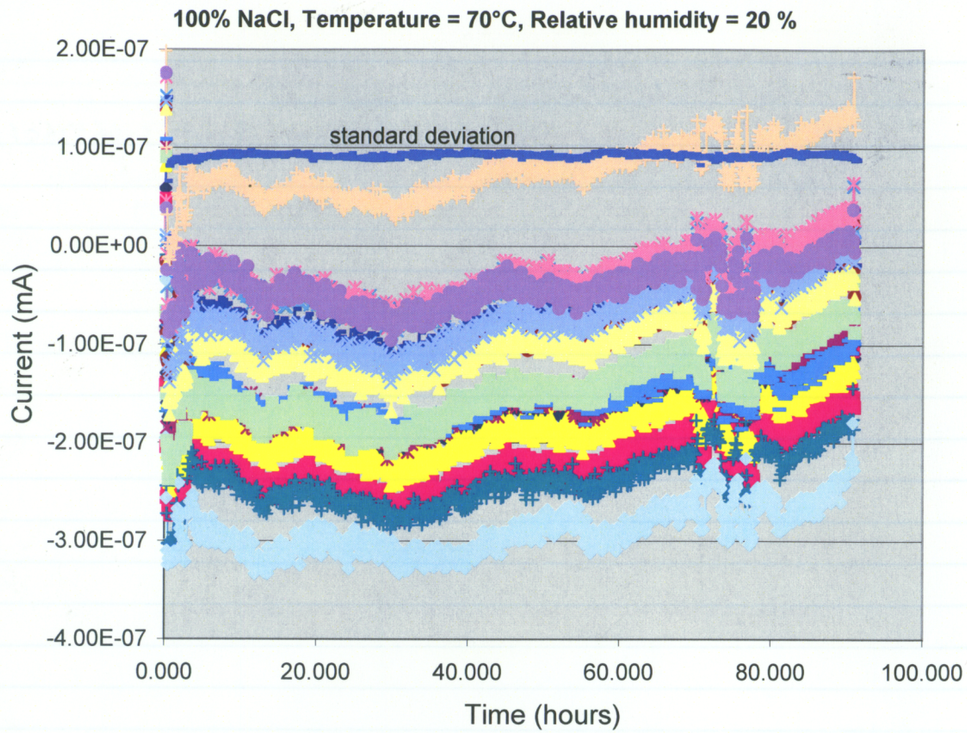


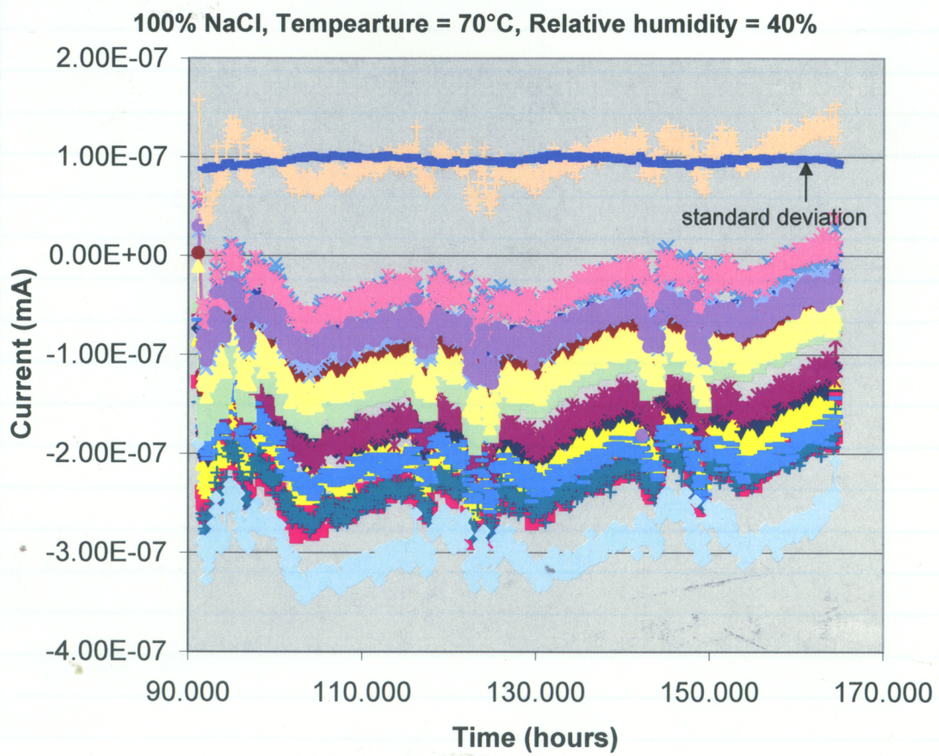




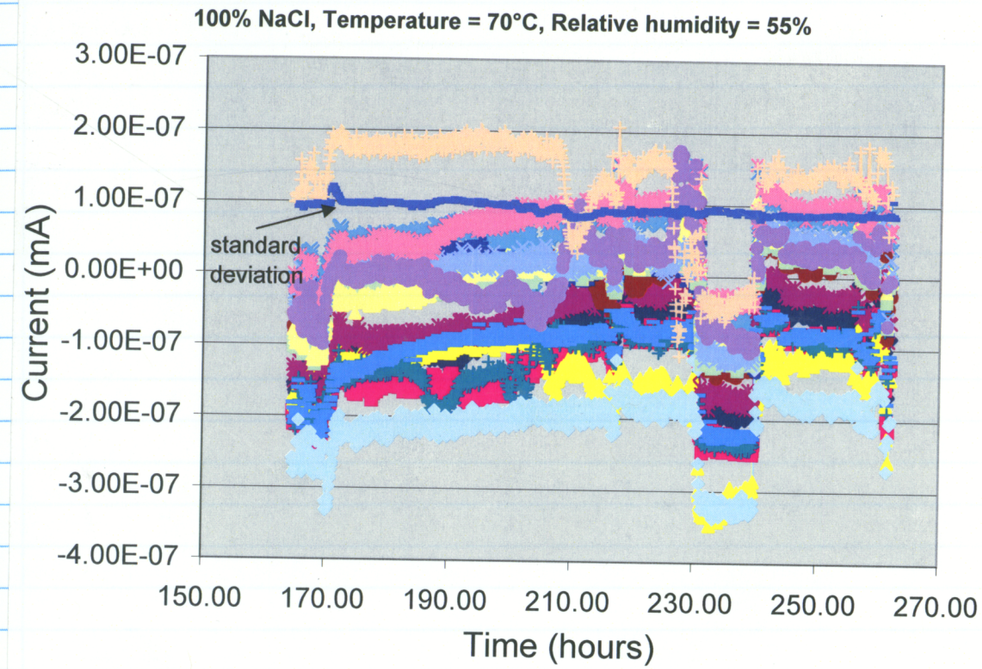
Xihua He 7/6/06

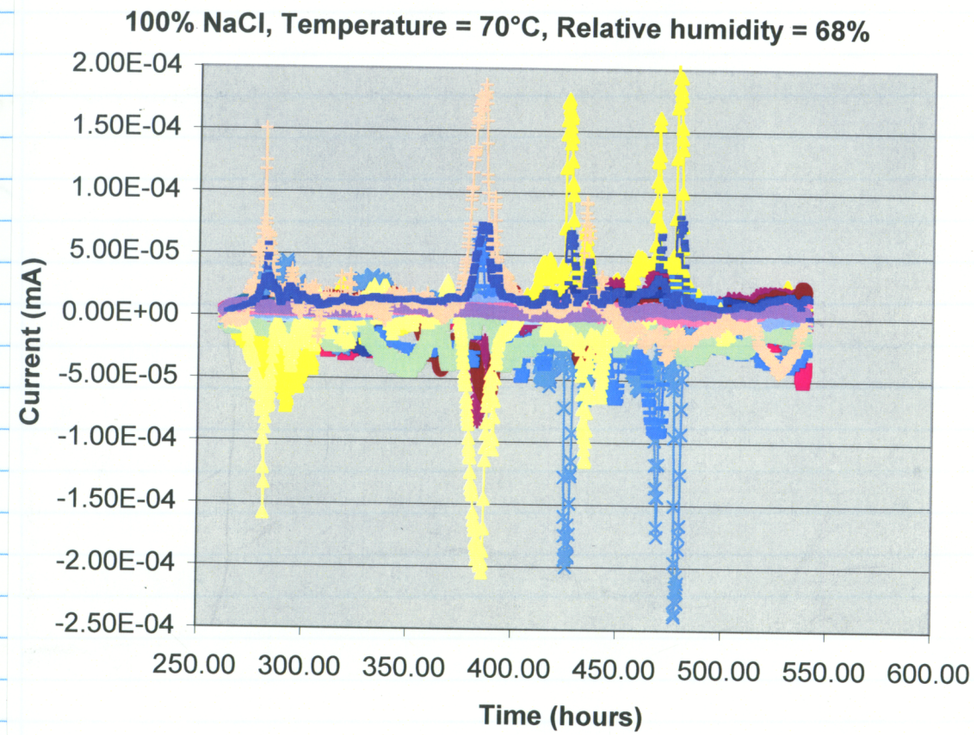
X.H 7/14/08





Xihua He 6/13/06





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