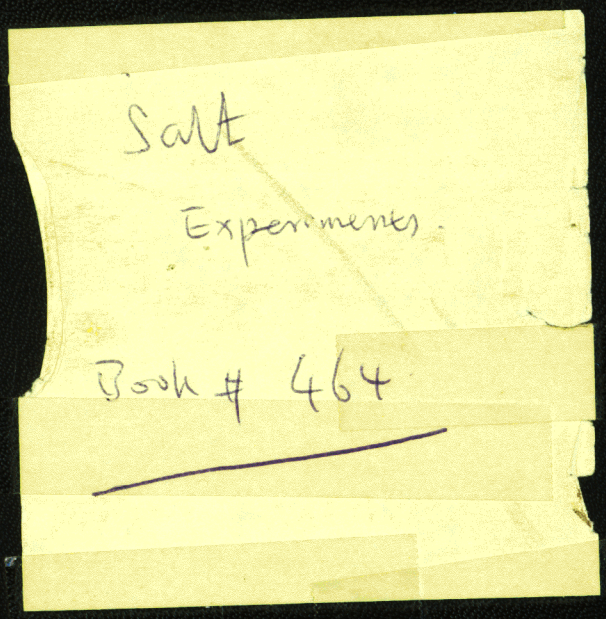
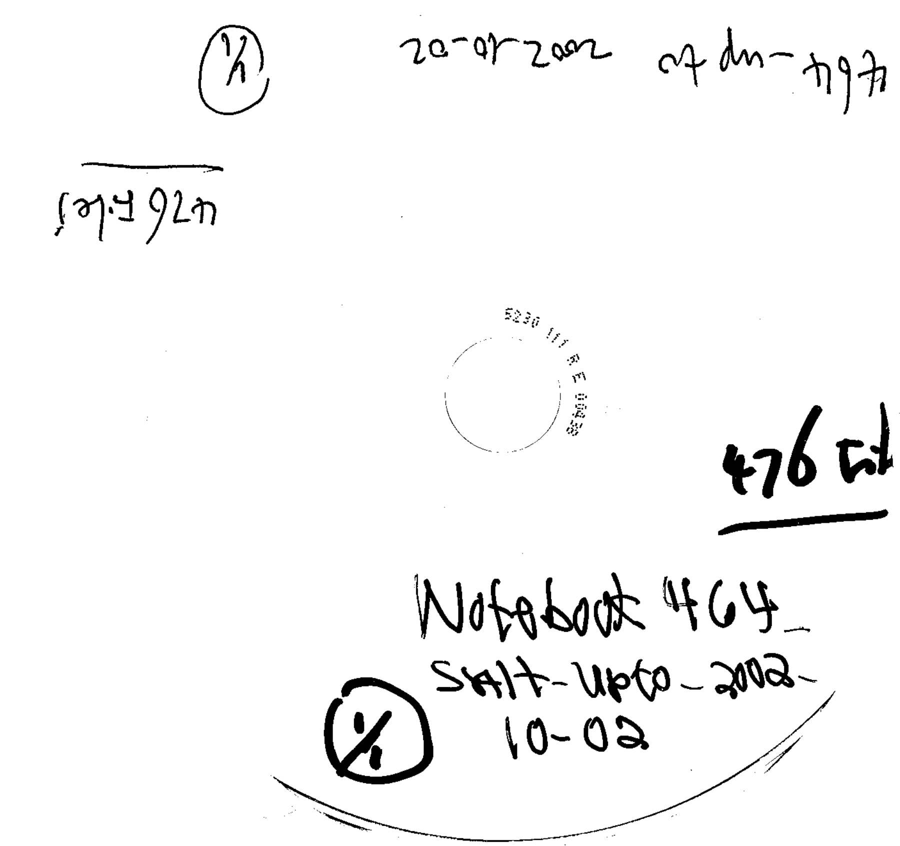
CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES



Project # 20.1402.561

Justin Landry Justin Landry JPL
Lietai Yang Lietai Yang. L.Y.



Initial Entries. 05/24/01

Project # 20.1402.561 Initial Entry.

Proposed Experiment to Understand the Deliquescence Behavior of the Salt Mixtures From YM Waters

April 19, 2001

All data files are stored in NoteBooks/NoteBook 464-Salt J. Wyss 11/17/03

BACKGROUND

Critical relative humidity (CRH) is an important parameter in predicting the life of the WP or DS. If the drift humidity is lower than the CRH, only dry air oxidation occurs; if the drift humidity is higher than the CRH, aqueous corrosion would occur. According to DOE's analysis, NaCl, $NaNO_3$ and KNO_3 would be the most dominant salts present in the evaporated water in the drift and, within the temperature range predicted for the drift, $NaNO_3$ is the most hygroscopic salt and has the lowest deliquescence relative humidity (50%). Therefore, DOE has considered 50% to be the CRH. This consideration may not be valid because it is based on the properties of pure salts. A mixture of the salts would have an even lower relative humidity. For instance, the hand book value for the NaCl-$NaNO_3$-KNO_3 saturated solution is only 30% at 16.4°C. If this is true for all the temperature ranges predicted for the drift, the dry air oxidation period would be significantly shorter and the aqueous corrosion period would be significantly higher than what the DOE has considered. Therefore, there is a need to determine the deliquescence behavior of the mixture of salts that are expected to be dominant in the drift.

OBJECTIVES

Experimental measurement will be conducted in this study to determine the deliquescence humidity of the mixtures of the dominant salts that would be present in the drift after evaporation. This work will also provide useful data for the modeling analysis for more complicated salts

EXPERIMENT

Methods:

A gravimetric method is a widely used method for studying the deliquescence behavior of salts. However, the gravimetric method requires a microbalance which is not available at CNWRA at the present time.. An electrochemical method will be used in this study. Figure 1 shows the proposed experimental set-up. The experiment will be conducted in a humidity chamber and a conductivity probe will be employed to determine the deliquescence humidity. Figure 2 shows the modeling result for the relative humidity of saturated NaCl-$NaNO_3$ mixtures. Figure 3 shows the modeling results of the electrical conductivity and the weight of a NaCl-$NaNO_3$ composition (NaCl fraction being 0.3061) at different relative humidities. Clearly both the gravimetric and the conductivity methods are highly sensitive to the changes of relative humidity near the mutual relative humidity (0.6646, see also Figure 2). At the mutual relative humidity, the changes are from 756g to 1562g for weight and from infinity to 0.2323 1/cm-ohm for conductivity respectively. Figure 3 also shows that both the weight vs RH and the conductivity vs RH curves can be used to determine the saturation relative humidity (0.6730, also see Figure 2).

The conductivity will be measured using a Solartron AC Impedance System in conjunction with an in-house developed Visual Basic software. All equipment and software are presently available in the corrosion laboratory at CNWRA.

J. Wyss 7/17/02

Test Conditions:

Subject to the limitations of the humidity chamber in the corrosion laboratory, The test ranges will be from 20% to 90% for relative humidity and 45 to 75°C for temperature.

Salts and Salt Mixtures:

Initial tests will be conducted with several pure salts of known relative humidities for the purpose of method calibration. These salts include: NaCl, KNO_3, $CaCl_2$ and $MgCl_2$

Upon completion of the calibration tests, effort will focused on the NaCl-$NaNO_3$-KNO_3 system. The effects of Ca, HCO_3, and $MgCl_2$ salts may also be added to the test matrix if resource is available.

Schedule:

May through August, 2001

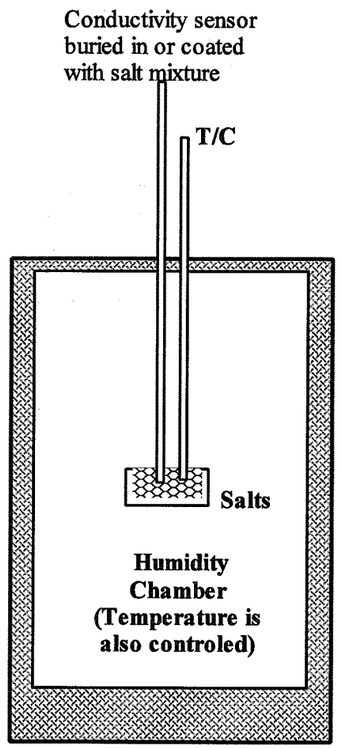


Figure 1 Proposed experimental setup to measure the deliquescence relative humidity of salt mixtures

Equipment

Conductivity measurement:

Solartron ~~Electrochemical System~~

~~1286~~ + 1280.
1287

J.yang. 10/21/01

Software: Zplot 2.0

Humidity chamber: see page. 35.

J.yang
7/15/02

~~Electrochemical cell~~. J.y. 06/12/01.

Soft wave:

Solartron 2.0 Zplot only allows manual operation. That is, the measurement can only be made for one humidity Point (varying frequency)

We need to make multiple or continuous measurement to detect the change in |Z| as a function of Relative humidity.

An Automation Program: "AUTOZPlot" is written to automatically start the Zplot program at a predetermined time interval. The automation program also save the data obtained after each run with Zplot into a file. It also display the |Z| calculated from $\sqrt{Z_{real}^2 + Z_{im}^2}$ on the screen. The |Z| values for different frequencies are also saved into another file.

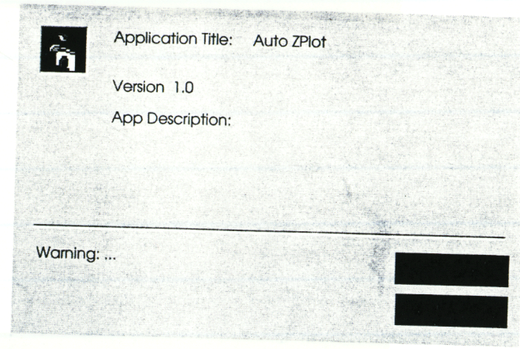
J.yang 06/12/01

Documentation of Auto ZPlot.

This is the splash screen. Codes associated with splash:

```
frmSplash - 1

Private Sub Form_Load()
    lblVersion.Caption = "Version " & App.Major & "." & App.Minor & "." & App.Revision
    lblProductName.Caption = App.Title
End Sub
```

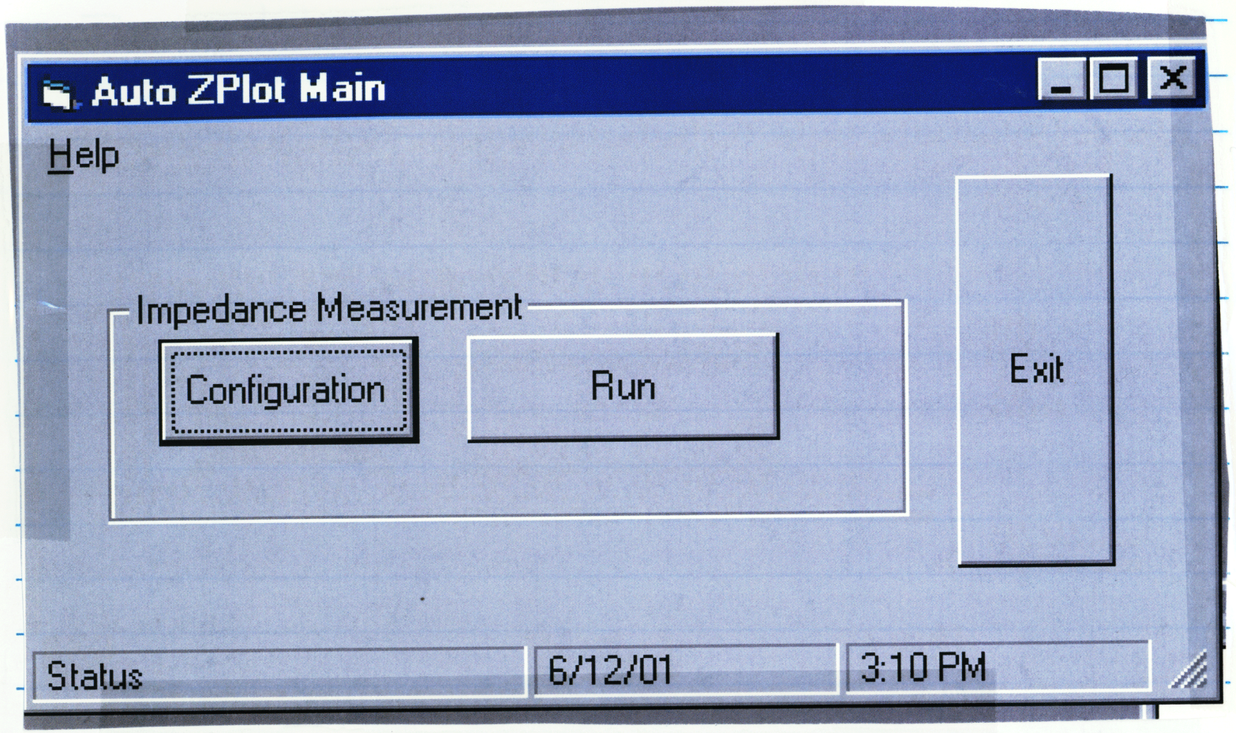
J. Yang 7/17/02



This is the about screen, displayed after clicking the Help Manual. Codes are not complete for the help. and therefore, the codes are not documented in this Book.

J. Yang 06/12/01

J. Yang 2/14/06



This is the Main Form. Clicking the Configuration Button takes the user to the Configuration Form. (see page 10)

Run Button takes the user to the Run Form (page 12)

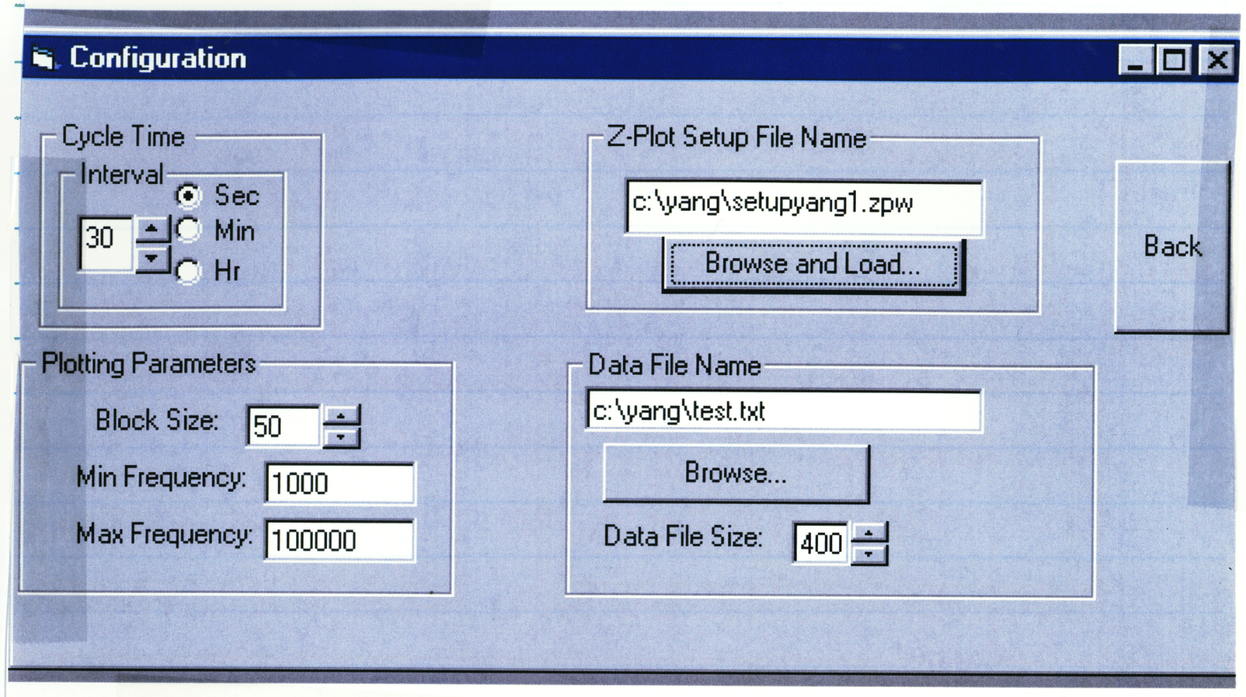
J. Yun 7/18/02

frmMain - 1 Codes For Main Form.

```
Private Declare Function OSWinHelp% Lib "user32" Alias "WinHelpA" (ByVal hwnd&, ByVal HelpFile$,
ByVal wCommand%, dwData As Any)

Private Sub cmdEISConfiguration_Click()
    If multiOption.Value = True Then
        frmConfigAC.Show
    Else
        frmConfigAC1.Show
    End If
    Me.Hide
End Sub

Private Sub cmdEISRun_Click()
    If (Not ConfigACDone) Then
        MsgBox "Please Setup the Configuration First"
        Exit Sub
    End If

    Me.Hide
    If multiOption.Value = True Then
        frmRunAC.Show
    Else
        frmRunAC1.Show
    End If


End Sub

Private Sub cmdExit_Click()
    Me.Hide
    End
End Sub
Private Sub Form_Initialize()
    ConfigACDone = False
End Sub

Private Sub Form_Load()
'    Me.Left = GetSetting(App.Title, "Settings", "MainLeft", 500)
'    Me.Top = GetSetting(App.Title, "Settings", "MainTop", 500)
'    Me.Width = GetSetting(App.Title, "Settings", "MainWidth", 4000)
'    Me.Height = GetSetting(App.Title, "Settings", "MainHeight", 4000)
End Sub
Private Sub Form_Unload(Cancel As Integer)
    Dim i As Integer
    'close all sub forms
    For i = Forms.Count - 1 To 1 Step -1
        Unload Forms(i)
    Next
    If Me.WindowState <> vbMinimized Then
        SaveSetting App.Title, "Settings", "MainLeft", Me.Left
        SaveSetting App.Title, "Settings", "MainTop", Me.Top
        SaveSetting App.Title, "Settings", "MainWidth", Me.Width
        SaveSetting App.Title, "Settings", "MainHeight", Me.Height
    End If
End Sub
Private Sub mnuHelpAbout_Click()
    frmAbout.Show vbModal, Me
End Sub

Private Sub mnuViewOptions_Click()
    frmOptions.Show vbModal, Me
End Sub

Private Sub mnuViewStatusBar_Click()
    If mnuViewStatusBar.Checked Then
        sbStatusBar.Visible = False
        mnuViewStatusBar.Checked = False
    Else
        sbStatusBar.Visible = True
        mnuViewStatusBar.Checked = True
```

There are other codes that are not related to the data functions. Thers are omitted.

J.Y. 06/12/01 7/14/02



Configuration Form.

Cycle Time is the time interval between each measurement.

Plotting parameters Block size is maximum number of measured data shown on plot (see the Run Form) page 12

Min & Max frequency gives the frequency window to be shown (page 12)

Z-plot setup file must be given before the Z-plot can be run.

J. Yang 7/17/02

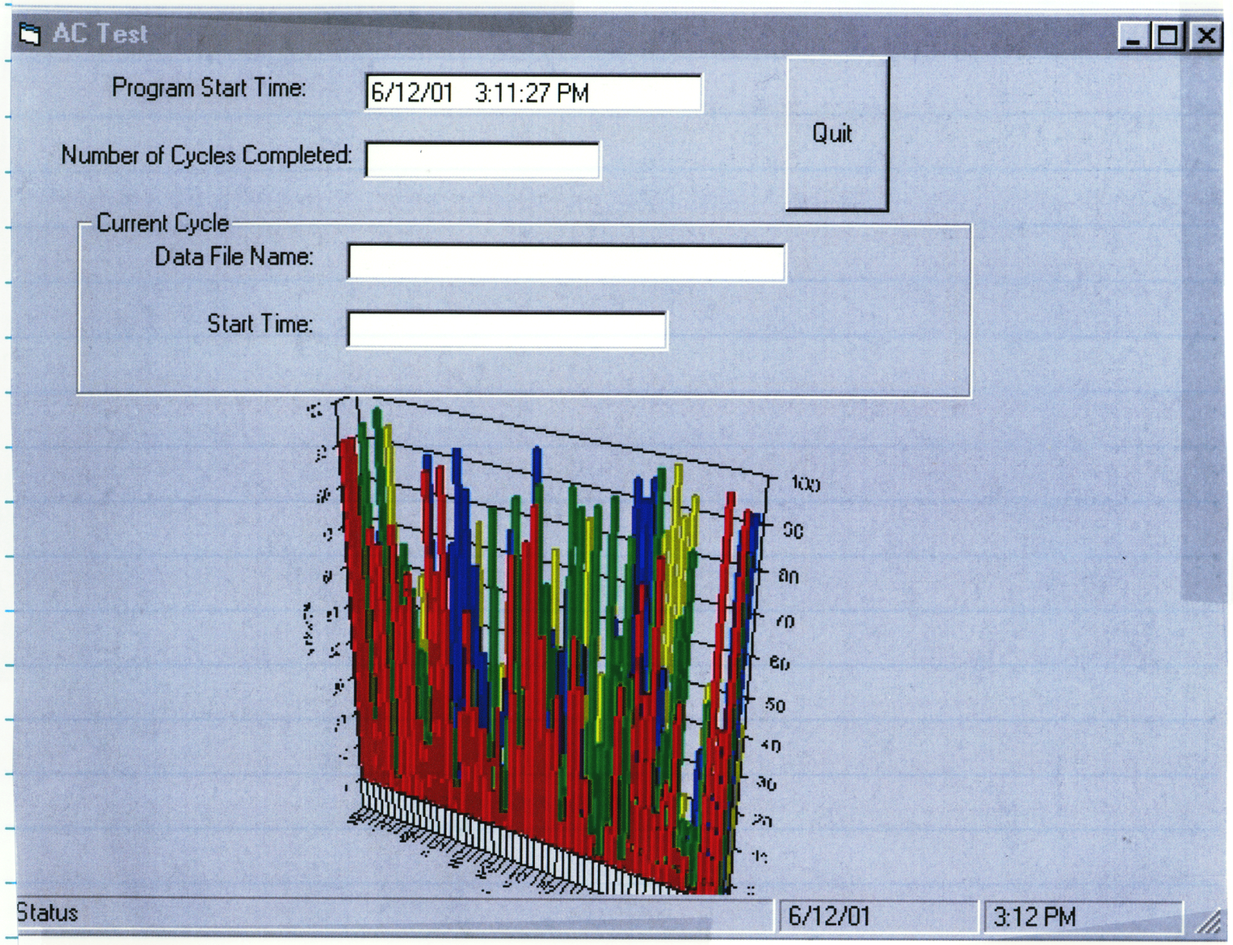
frmConfigAC1 - 1 for Configuration

```
Dim ScanIntAC1 As Integer ' not to the the ScanInt of the Global, too much headache

Private Sub ACSetup_Click()
    cdlGetACSetupFile.ShowOpen
    txtZplotSetup.Text = cdlGetACSetupFile.filename
    'txtConFile.Text = "C:\Yang\last.cfg"
End Sub

Private Sub cmdBack_Click()
    frmConfigAC1.Hide
    frmMain.Show
    ConfigACDone = True
End Sub

Private Sub cmdDataFile_Click()
    cdlGetDataFile.ShowOpen
    txtDataFile.Text = cdlGetDataFile.filename
End Sub

Function TimeToSec(asciiTIME$)
'**** convert time-ascii to integer-seconds ****
'DIM hrs, mint, sec
  TimeToSec = Val(asciiTIME$) * 3600 + Val(Mid$(asciiTIME$, 4, 2)) * 60 + Val(Mid$(asciiTIME$, 7,
 2))
End Function

Private Sub Form_Initialize()

   'for ScanInt initialization                ' Time interval for one cycle
    Call txtScanInt_Change
End Sub
            ' these Subs are dealing with the UPDown Properties for COunts

Private Sub Form_Load()
FileName0$ = txtDataFile.Text
End Sub

Private Sub optHour_Click()
    Call txtScanInt_Change
End Sub

Private Sub optMin_Click()
    Call txtScanInt_Change
End Sub

Private Sub optSec_Click()
     Call txtScanInt_Change
End Sub

Private Sub txtScanInt_Change()
    If Val(txtScanInt.Text) > 60 Or Val(txtScanInt.Text) = 0 Then
        MsgBox "the value is too big!", vbCritical, "Re-type"
        Exit Sub
    End If
    If optSec.Value = True Then
        ScanIntAC1 = txtScanInt.Text
    ElseIf optMin.Value = True Then
        ScanIntAC1 = 60 * txtScanInt.Text
    Else
        ScanIntAC1 = 3600 * txtScanInt.Text
    End If
    ScanIntAC_Global = ScanIntAC1
End Sub
Private Sub txtDataFile_Change()
    FileName0$ = txtDataFile.Text    'Initial filename to store data

    'FileName0$ = "C:\yang\data"
    DataFileTemp = txtDataFile.Text   'Base filename to store temperarty data

End Sub
```

J. Yang 7/17/02

J.Y. - 06/12/01

Auto Zplot Run Form.



This the form displayed during the program run.

3-D plot:

Z — the impedance data log|Z|

Y — the frequency, from Min to Max

X — Data measured at different time

The plot will be refreshed when the number of measurement reaches the "Block size"

J.Yang 7/17/02

Codes for Run Form

```
frmRunAC1 - 1

 Dim quitflag As Boolean
 Dim loopFinished As Boolean
 Public ZplotObject As Object    ' can also be declared in a module
 Dim firstChannel As Boolean
 Dim GotoQuitAfterSweep As Boolean
 Dim ZplotFinished As Boolean
 Dim F(25) As Double 'keep track of frequency
 Dim Z(25) As Double  'Keep track of Impedance
 Dim ZCycleN As Integer
 Dim block As String
 Dim DataFileTemp As String   'File to temperary store the Zplot data for one cycle
 Dim FileName1 As String    ' File Name for data, with no extension name
 Dim FileNamePData ' File Name for Processed Data
 Dim newFile As Boolean 'track if the data is after the initial loop, need a heading
 Dim ScanIntAC1 As Integer ' not to the the ScanInt of the Global, too much headache


Sub LoadZplot()
    Dim IsOK As Boolean
    Dim gs As String
    Dim gb As Boolean

    'If the ISOK variable is "true", the function was succesful
    'If the ISOK variable is "False", the function failed

    'Load ZPlot                                  frmConfigAC1.   J.Y. 06/12/01

    Set ZplotObject = CreateObject("ZPlot.ZPlotApp")   'Windows knows where to start ZPlot
    gs = frmConfigAC1.txtZplotSetup.Text 'load the setup file for Zplot
    IsOK = ZplotObject.OpenSetup(gs)

    'self added:
    'I should get the data points and save my own files
    'I should use ZPlotObject.GetPoint(PointNo: Int)  VariantArray to get the AC imp. data
    ' no need, just do the cycle then pull the data out after the cycle

End Sub
Sub ZplotRun()
    Dim IsOK As Boolean
    Dim gs As String
    Dim gb As Boolean

    'If the ISOK variable is "true", the function was succesful
    'If the ISOK variable is "False", the function failed
    'Open a Setup File
''    gs = txtSetupFile.Text  ' to be set set such as "mysetup.zpw"

    ' Specify a data file for the experiment
''    gs = txtDataFile.Text  ' to be set set such as "mydata.z"

    DataFileTemp = FileName1$ + "Temp"
    gs = DataFileTemp   'temperary file name to store the Z plot data for one curve (one channel)
    gb = False 'append condition, True=append, False=overwrite

    ZplotFinished = False

    IsOK = ZplotObject.SetDataFile(gs, gb)

    'Clear the comment text, and add new text
    IsOK = ZplotObject.SetCommentClear
    'gs = "comment1"    'to identify channels
    'ZplotObject.SetCommentAdd (gs)
'    gs = "comment2"
'    ZplotObject.SetCommentAdd (gs)

    ' Start the sweep

    IsOK = ZplotObject.StartSweep

    PR = -1
```

J.Yang 7/17/02

frmRunAC1 - 2

```
    While PR <> 0
        DoEvents   'must have a mechanism to prevent timer call the Mainloop
        PR = ZplotObject.GetPointsRemaining
    Wend
'    MsgBox "After finished  PR= " + Str(PR)
    ZplotFinished = True

End Sub

' the following should be in a loop

Private Sub cmdCheck_Click()
    Dim PR As Integer
    'Check number of point to be measured
    PR = ZplotObject.GetPointsRemaining
    If PR = -1 Then
        'The instrument are being initialized to sweep
    End If
    If PR = 0 Then
        'The experiment is done
    End If
End Sub

Sub MainLoopInitialize()
    ZCycleN = 0
    txtProgStartTime.Text = Str(Date) + "    " + Str(Time)
    quitflag = False


End Sub
Sub MainloopFinish()
    Close #3                                    'close data file
End Sub
Sub MainLoop()
'**** MAIN LOOP ****
' to be fired by the timer tmrScanCycle
           'Check if this cycle data should be saved to the new sub file.
           'When the block number has been reached, data will be saved into a new file and heade
rs for the file will be created
    txtCycleStartTime.Text = Str(Date) + "    " + Str(Time)

'**** MAIN LOOP ****
' to be fired by the timer tmrScanCycle
           'Check if this cycle data should be saved to the new sub file.
           'When the block number has been reached, data will be saved into a new file and heade
rs for the file will be created


    If quitflag = True Then
           Call MainloopFinish
           Unload Me
           frmMain.Show
    End If


                                    'pass no Loop Scan No.
'     time1 = Time
'

       Call BlockCheck_for_NewFile(ZCycleN)
       loopFinished = False
       toExitafterSeep = False
       txtFileName.Text = filename$
       time1 = Now
       GotoQuitAfterSweep = False 'before the start of sweep
       ZCycleN = ZCycleN + 1
       Call ZplotRun
       time2 = Now

       Call Save_N_PlotData(time1, time2)
       txtCycleCompleted.Text = ZCycleN
```

7/15/02

frmRunAC1 - 3

```
       If GotoQuitAfterSweep = True Then
           Call cmdQuit_Click
       End If
       loopFinished = True
    '**** end of main loop
End Sub

Sub Save_N_PlotData(time1, time2)

    Open DataFileTemp For Input As #6

    Open filename$ For Append As #3
    tim1 = Mid(Str(time1), 9, 8)
    tim2 = Mid(Str(time2), 9, 8)
    I1 = 1
    jj = 0
    Do Until EOF(6)
        Line Input #6, temp$
        If ZCycleN = 1 Then
           'For begining of file write everything in the Zplot file
            Print #3, "        "; ","; "       "; ","; temp$
        End If


         'write only the numbers. Note the first 2 lines after "Frequency in the Zplot file will
be ignored

        'test the first three character and see if they are numbers
        If (Val(Mid(temp$, 1, 3)) <> 0) Then
            jj = jj + 1
            If jj >= 2 Then
                'ignore the first 1 lines which are non-zero numbers
                If ZCycleN <> 1 Then
                   Print #3, tim1; tim2; temp$
                End If
                'to extraxct the values for f and Z to plot
                Call ExtractZ(temp$, Fr, Za, Zb)
                jj = jj + 1

                If Fr >= Val(frmConfigAC1.txtMinFreq.Text) Then
                    If Fr <= Val(frmConfigAC1.txtMaxFreq.Text) Then
                        F(I1) = Fr
                        Z(I1) = (Za ^ 2 + Zb ^ 2) ^ 0.5
                        I1 = I1 + 1
                    End If
                End If
            End If
        Else
            'ignor all descriptive lines
        End If
    Loop
    ' Update Processed Data File
    Print #3, ""  ' change the line at the end
    Close #6
    Close #3

    If newFile = True Then 'write the frequency headings
        Open FileNamePData For Append As #9
        Print #9, "Date  "; ","; "Time Started "; ",";
        For L = 1 To I1 - 1
            Print #9, F(L); ",";
        Next L
        Print #9, "" 'change line
        Close #9
        newFile = False
    End If

    'Printing the processed data to FileNamePData
    Open FileNamePData For Append As #9
    Print #9, Date$; ","; tim1; ",";
```

7/15/02

frmRunAC1 - 4

```
    For L = 1 To I1 - 1
        Print #9, Z(L); ",";
    Next L
    Print #9, "" 'change line
    Close #9

    'Update plotting

        With crt3DLine
    ' Displays a 3D chart with 8 columns and 8 rows
        ' data.

        ZBlock = frmConfigAC1.txtZBlockSize.Text

        'initalize the chart if the ZCycleN=0, first started
        If (ZCycleN = 1) Then   'refresh all data
            .ColumnCount = I1 - 1   ' every block, start again
            .RowCount = ZBlock
            For R = 1 To ZBlock
                .Row = R
                For C = 1 To .ColumnCount
                    .Column = C
                    .Data = 0
                Next C
            Next R
        End If


        R = (ZCycleN - 1) Mod ZBlock + 1
        .Row = R          'make sure scale back after reaching  block
        For M = 1 To I1 - 1
               .Column = M     'Plot the Frequency
               .Data = Log(Z(M)) / 2.303    'plot the Impedance
        Next M
        'clear zero for front data
        If R < ZBlock - 1 Then
            .Row = R + 1        'make sure scale back after reaching  block
            For M = 1 To I1 - 1
                  .Column = M    'Plot the Frequency
                  .Data = 0   'plot the Impedance
            Next M
        End If
    End With

End Sub

Sub ExtractZ(buffer$, Fr, Za, Zb)
    i = 0
    j = 0
    Flag$ = ""
    Size = Len(buffer$)
    'Scan until we run out of characters, or we hit the delimiter
    Do While (i < Size) And (j <= 6) 'until reaching end
        Do While (Flag$ <> ",")  'until hit ","
            i = i + 1
            Flag$ = Mid(buffer$, i, 1)   'return 1 char from ith position
        Loop
        '   found a ","
        j = j + 1
        Flag$ = 0 'reset flag
        If j = 1 Then
            FreqLen = i - 1
        End If
        If j = 4 Then
            ZaStart = i + 1
        End If
        If j = 5 Then
            ZaLen = i - ZaStart
            ZbStart = i + 1
```

J. Yang 7/18/02

frmRunAC1 - 5

```
            End If
            If j = 6 Then
                ZbLen = i - ZbStart
            End If
        Loop
        'Calculate the parameters. Ignore case for VarName$. Ensure there was
        '  actually data read
        If Size > 0 Then
            FValue = Mid(buffer$, 1, FreqLen)
            ZaValue = Mid(buffer$, ZaStart, ZaLen)
            ZbValue = Mid(buffer$, ZbStart, ZbLen)
        Else          'Blank line; ignore it
            ZaValue = ""
            ZbValue = ""
        End If
        Fr = Val(FValue)
        Za = Val(ZaValue)
        Zb = Val(ZbValue)
End Sub
'                       'Call the plotting program

'                       ' Asking user which frequency range to use for averaging
'
'                   End Sub
Sub BlockCheck_for_NewFile(ZCycleN):
    blockSize = Val(frmConfigAC1.txtBlockSize.Text)
    If (ZCycleN Mod blockSize = 0) Then  '
        newFile = True  'tracking whether file is new for writing the frequecy headings
        block0 = Int(ZCycleN / blockSize)       'get the block number
        block$ = Str(block0)              'convert to text
        If block0 < 10 Then
            Mid$(block$, 1, 1) = "0"  'change the space to "0"
        Else
            block$ = Right$(block$, Len(block$) - 1) 'leave out the space
        End If

        periodPosition% = InStr(FileName0$, ".")    'position of period in FileName$ to insert "x
x" at
        If periodPosition% <> 0 Then 'If period found
            Position% = periodPosition% - 1
            FileName1$ = Left(FileName0$, Position%)   'chop the extention name
            lengthExtention = Len(FileName0$) - periodPosition%
            FileName2$ = Right(FileName0$, lengthExtention) 'chop the extention name
            filename$ = FileName1$ + block$ + "." + FileName2$

        Else
            FileName1$ = FileName0$
            filename$ = FileName0$ + block$ + ".txt"
        End If
        FileNamePData = FileName1$ + block$ + "PData.txt"
        Close #3

        'Test if the Data File name is exist
        'This section is added May 24, 2001 L.Y.

        On Error Resume Next
        Err.Clear
        Open filename$ For Input As #13

        If Err.Number = 0 Then
            'there is no error, file already exist
            strMsg = "Data File already exist. Do you want to replace it? "
            Response = MsgBox(strMsg, vbYesNo, "Caution")
            If Response = vbNo Then
                End
            End If
        End If

        'Resume error tracking
        On Error GoTo 0
```

J. Yang 7/18/02

frmRunAC1 - 6

```
        Close #13
        Call DataFileHeading 'setup heading in the data file
    Else   'not to start new file
        Close #3  'each time close the file then open it, to be safe with data
    '    Open filename$ For Append As #3
    End If
    txtFileName.Text = filename$
End Sub

Sub DataFileHeading()
    '**** setup data file header ****
   Open filename$ For Output As #3
   Print #3, Date$
    ' Any Comments can be placed here

    'Print Out Configuration Infor
    Print #3, "Data File:                "; Chr$(9); filename$
    Print #3, "Zplot Setup File:         "; Chr$(9); frmConfigAC1.txtZplotSetup.Text
    Print #3, "Scan Interval:            "; Chr$(9); ScanIntAC1
    Print #3, " "   ' Space; line
    Print #3, "Start T"; Chr$(9); 'print the same thing to indet the headings with the contents
    Print #3, "End T"; Chr$(9);
    Print #3, "Z Plot Infor"; Chr$(9)  'the string from Z plot
    Close #3

  'For the Processed Data
  '**** setup data file header ****
    Open FileNamePData For Output As #9
    Print #9, Date$
    ' Any Comments can be placed here
    'Print Out Configuration Infor
    Print #9, "Data File:                "; Chr$(9); FileNamePData
    Print #9, "Zplot Setup File:         "; Chr$(9); frmConfigAC1.txtZplotSetup.Text
    Print #9, "Scan Interval:            "; Chr$(9); ScanIntAC1
    Close #9


End Sub

Private Sub Form_Load()
    'initialize the interval
    ScanIntAC1 = ScanIntAC_Global

    'set channels of instruments to channels in he program
'    Call Initial_Channels

    'set the timer
    tmrScanInt.Enabled = True
    If ScanIntAC1 <= 60 Then
        tmrScanInt.Interval = ScanIntAC1 * 1000
    Else
        tmrScanInt.Interval = 60000
    End If

    TimerReady = True 'for first measure, set timer at ready state
    Call MainLoopInitialize    'start the measure loop initilaization
End Sub

Private Sub tmrScanInt_Timer()
    Static ELTime
    II = Int(ScanIntAC1 / 60)
    If ScanIntAC1 > 3600 Then
        II = ScanIntAC1 / 3600
    End If
    If ELTime >= II Then
        Beep
        'MsgBox "time is up"
        'Time is ready, do the measurement
        If loopFinished = True Then
```

J. Yang 7/18/02

frmRunAC1 - 7

```
        ' make sure Mainloop not to be called even if the time is up
            Call MainLoop
        End If
        EITime = 0
    Else
        ELTime = ELTime + 1
    End If
End Sub


Private Sub cmdQuit_Click()
    '     ******************************
    quitflag = True

    If loopFinished = True Then

        'Disposing of the object closes ZPlot
        Set ZplotObject = Nothing
        Call MainloopFinish
             '    MsgBox "Waiting for the Logging Cycle to Finish and Data to be Saved Please Wait
!"
        'cmdStart.Enabled = True
        Unload Me
        frmMain.Show


        'End
    Else
        ' MsgBox "Please Wait for Zplot Sweep to Finish?", vbCritical
        Response = MsgBox("Do you want to quit without waiting to finish all channels?", vbYesNo,
"Channel Loop in Progress")
        If Response = vbYes Then
           If ZplotFinished = False Then
                Response = MsgBox("Do you want to Wait for Zplot to finish current sweep?", vbYes
No, "Zplot Sweep (for a Channel) in Progress")

                If Response = vbYes Then
                     '          wait for the current sweep to finish
                    GotoQuitAfterSweep = True
                    loopFinished = True  'Assume all channels has been done, ready to exit  at ne
xt call
                    Exit Sub  ' go back to finish sweep and Save Data then call this sub
                End If
            End If
            'Disposing of the object closes ZPlot
            Set ZplotObject = Nothing

            Call MainloopFinish
            '    MsgBox "Waiting for the Logging Cycle to Finish and Data to be Saved Please Wait!
"
            ' frmMain.Show
            Unload Me
            'cmdStart.Enabled = True
            frmMain.Show
        '    End
        Else
        'Continu to measure
        End If
    End If

End Sub


Private Sub tmrStart_Timer()
'This timer delay the start of the Mainloop just 0.25 Sec
loopFinished = True 'set this to let tmrScanInt pass
    tmrStart.Enabled = False
    'start the first cycle without waiting
```

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```
frmRunAC1 - 8

    Call LoadZplot
    loopFinished = True  'Allow timer to call the Maniloop for first cycle
    Call MainLoop 'start the first cycle without waiting
End Sub
```

Main module for Global variables.

```
mdlMain - 1

Global ConfigACDone As Boolean

Global fMainForm As frmMain
Global LpNum As Integer
Global PBlock   As Integer

Global buffer$
Global vvalues(2, 30) '?
Global ScanInt
Global ScanIntAC_Global
Global rparange$(10)  '?

Global filename$
Global FileName0$
Global startTIME$, ScTime$
Global FiltN
Global CycleN
Global chgPROGI
Global CFGFile$
Global ConfigDon As Boolean
Sub Main()
    frmSplash.Show
    frmSplash.Refresh
    Set fMainForm = New frmMain
    Load fMainForm
    Unload frmSplash
    fMainForm.Show
End Sub
```

```
        'number of loops in one cycle
        'number of Cycles of data to save

'buffer for DMM 2182
   'values from last scan (readnum,voltage)
 ' Scan time interval in Seconds
          ' Scan time interval in Seconds for AC test
  'channel range

'filename to store data (name changed for every new block)
 'initial given name to store dat

'total number of scans per loop
 'total number of measurements since program started
'status for changing time interval
'Config file's name
```

J. Yang 06/12/01

Verification of the program.

Connected the equipment and the cells. The cell is filled with saturated KCl solution (about 1mm x 1mm slot, 30 mm length. two Pt electrode at each end).

Program configured to:

Scan interval = 2 sec.

plotting Blocksize: 3

Data file Size: 5

Data File Name: test0611a

Frequency Window: 10000 to 1000

Run for 10 data points.

test0611a00.txt should have the first 5 measurements data

test0611a01.txt should have the last 5 measurements data.

test0611a00PData.txt should have the processed data from the first 5 measurements. time and $|z| = \sqrt{z_{real}^2 + z_{im}^2}$ at frequencies from 1k to 0.1M

test0611a01PData.txt same as test0611a00PData.txt except for the last 5 measurement

test0611aTemp should have the original data for the 10th measurement (last one).

J. Yang 7/12/02

test0611a00.txt

06-11-2001
Data File: c:\yang\test0611a00.txt
Zplot Setup File: C:\Yang\setup_Yang_Salt1.zpw
Scan Interval: 2

Start T End T Z Plot Infor
, ,"ZPlotW Data File: Version 2.2"
, ,"Raw Data"
, ,"Sweep Frequency: Control Voltage"
, ,Date: 06-11-2001 Time: 11:21:53
, ,"Open Circuit Potential (V): 0.0091 "
, ,""
, ,"c:\yang\test0611aTemp"
, ,"Frequency"
, ,0,3,0,1,100000,1000
, ,7
, ," Freq(Hz) Ampl Bias Time(Sec) Z'(a) Z''(b) GD Err Range"
, ,1.000000E+05, 1.0000E-02, 9.1000E-03, 4.570000E+00, -4.4961E+05, -5.9232E+05, 0.0000E+00, 0, 5
, ,4.641589E+04, 1.0000E-02, 9.1000E-03, 8.100000E+00, -1.9071E+06, -6.9128E+05, 0.0000E+00, 0, 5
, ,2.154435E+04, 1.0000E-02, 9.1000E-03, 1.107000E+01, -5.4340E+06, -7.3760E+06, 0.0000E+00, 0, 6
, ,1.000000E+04, 1.0000E-02, 9.1000E-03, 1.183000E+01, -3.5795E+06, -4.2886E+07, 0.0000E+00, 0, 6
, ,4.641589E+03, 1.0000E-02, 9.1000E-03, 1.261000E+01, -2.2044E+05, -3.0648E+07, 0.0000E+00, 0, 6
, ,2.154435E+03, 1.0000E-02, 9.1000E-03, 1.559000E+01, 2.2551E+07, -8.4681E+07, 0.0000E+00, 0, 7
, ,1.000000E+03, 1.0000E-02, 9.1000E-03, 1.635000E+01, 1.1033E+08, -2.6423E+07, 0.0000E+00, 0, 7

1st (ohm) (ohm)

2nd measurement

11:22:1111:22:401.000000E+05, 1.0000E-02, -4.9200E-02, 4.580000E+00, -5.5239E+05, -6.1525E+05, 0.0000E+00, 0, 5
11:22:1111:22:404.641589E+04, 1.0000E-02, -4.9200E-02, 8.110000E+00, -1.3914E+06, -1.6430E+06, 0.0000E+00, 0, 5
11:22:1111:22:402.154435E+04, 1.0000E-02, -4.9200E-02, 1.108000E+01, -3.3036E+06, -7.2941E+06, 0.0000E+00, 0, 6
11:22:1111:22:401.000000E+04, 1.0000E-02, -4.9200E-02, 1.185000E+01, -4.8589E+07, 2.5259E+07, 0.0000E+00, 0, 6
11:22:1111:22:404.641589E+03, 1.0000E-02, -4.9200E-02, 1.262000E+01, -2.1200E+06, -1.5409E+07, 0.0000E+00, 0, 6
11:22:1111:22:402.154435E+03, 1.0000E-02, -4.9200E-02, 1.560000E+01, 4.8764E+07, -1.3461E+08, 0.0000E+00, 0, 7
11:22:1111:22:401.000000E+03, 1.0000E-02, -4.9200E-02, 1.637000E+01, -3.1213E+07, 3.3255E+08, 0.0000E+00, 0, 7

11:22:4211:23:111.000000E+05, 1.0000E-02, -6.0600E-02, 4.560000E+00, -5.2639E+05, -5.5051E+05, 0.0000E+00, 0, 5
11:22:4211:23:114.641589E+04, 1.0000E-02, -6.0600E-02, 8.090000E+00, -1.9177E+06, -5.2920E+05, 0.0000E+00, 0, 5
11:22:4211:23:112.154435E+04, 1.0000E-02, -6.0600E-02, 1.106000E+01, -4.2970E+06, -7.4879E+06, 0.0000E+00, 0, 6
11:22:4211:23:111.000000E+04, 1.0000E-02, -6.0600E-02, 1.182000E+01, 3.4666E+06, -1.6885E+07, 0.0000E+00, 0, 6
11:22:4211:23:114.641589E+03, 1.0000E-02, -6.0600E-02, 1.260000E+01, -2.0414E+07, 1.4467E+07, 0.0000E+00, 0, 6
11:22:4211:23:112.154435E+03, 1.0000E-02, -6.0600E-02, 1.558000E+01, 3.8405E+08, -9.8360E+07, 0.0000E+00, 0, 7
11:22:4211:23:111.000000E+03, 1.0000E-02, -6.0600E-02, 1.634000E+01, 3.8143E+07, -1.4340E+08, 0.0000E+00, 0, 7

11:23:1311:23:421.000000E+05, 1.0000E-02, -5.2100E-02, 4.520000E+00, -4.8889E+05, -5.5681E+05, 0.0000E+00, 0, 5
11:23:1311:23:424.641589E+04, 1.0000E-02, -5.2100E-02, 8.050000E+00, -1.7578E+06, -1.0861E+06, 0.0000E+00, 0, 5
11:23:1311:23:422.154435E+04, 1.0000E-02, -5.2100E-02, 1.102000E+01, -4.4299E+06, -6.4004E+06, 0.0000E+00, 0, 6
11:23:1311:23:421.000000E+04, 1.0000E-02, -5.2100E-02, 1.178000E+01, 2.0060E+07, -1.1879E+07, 0.0000E+00, 0, 6
11:23:1311:23:424.641589E+03, 1.0000E-02, -5.2100E-02, 1.256000E+01, 4.7353E+07, -1.9454E+07, 0.0000E+00, 0, 6
11:23:1311:23:422.154435E+03, 1.0000E-02, -5.2100E-02, 1.554000E+01, -9.3864E+06, -7.7453E+07, 0.0000E+00, 0, 7
11:23:1311:23:421.000000E+03, 1.0000E-02, -5.2100E-02, 1.630000E+01, -6.2214E+07, -1.6671E+08, 0.0000E+00, 0, 7

11:23:4411:24:121.000000E+05, 1.0000E-02, -6.3200E-02, 4.560000E+00, -5.9765E+05, -5.6860E+05, 0.0000E+00, 0, 5
11:23:4411:24:124.641589E+04, 1.0000E-02, -6.3200E-02, 8.090000E+00, -1.8117E+06, -7.0615E+05, 0.0000E+00, 0, 5
11:23:4411:24:122.154435E+04, 1.0000E-02, -6.3200E-02, 1.106000E+01, -7.4747E+06, -8.5262E+06, 0.0000E+00, 0, 6
11:23:4411:24:121.000000E+04, 1.0000E-02, -6.3200E-02, 1.182000E+01, -5.5299E+06, -1.4841E+07, 0.0000E+00, 0, 6
11:23:4411:24:124.641589E+03, 1.0000E-02, -6.3200E-02, 1.260000E+01, -1.3214E+07, -2.9004E+07, 0.0000E+00, 0, 6
11:23:4411:24:122.154435E+03, 1.0000E-02, -6.3200E-02, 1.558000E+01, 1.5992E+07, -9.1563E+07, 0.0000E+00, 0, 7
11:23:4411:24:121.000000E+03, 1.0000E-02, -6.3200E-02, 1.634000E+01, 3.4594E+07, -2.7458E+08, 0.0000E+00, 0, 7

Z' Z''

J. Yang 7/17/02

test0611a01.txt

J.Y. 4/7/06

06-11-2001
Data File: c:\yang\test0611a01.txt
Zplot Setup File: C:\Yang\setup_Yang_Salt1.zpw
Scan Interval: 2

(ohm) (ohm)

Start T End T Z Plot Infor
Z' Z''
11:24:1511:24:431.000000E+05, 1.0000E-02, -6.0900E-02, 4.560000E+00, -4.8122E+05, -4.2531E+05, 0.0000E+00, 0, 5
11:24:1511:24:434.641589E+04, 1.0000E-02, -6.0900E-02, 8.090000E+00, -1.3866E+06, -2.2038E+06, 0.0000E+00, 0, 5
11:24:1511:24:432.154435E+04, 1.0000E-02, -6.0900E-02, 1.106000E+01, -3.4866E+06, -5.6345E+06, 0.0000E+00, 0, 6
11:24:1511:24:431.000000E+04, 1.0000E-02, -6.0900E-02, 1.183000E+01, -5.8251E+06, -1.4689E+07, 0.0000E+00, 0, 6
11:24:1511:24:434.641589E+03, 1.0000E-02, -6.0900E-02, 1.260000E+01, -3.5377E+07, 3.2043E+06, 0.0000E+00, 0, 6
11:24:1511:24:432.154435E+03, 1.0000E-02, -6.0900E-02, 1.558000E+01, 4.1575E+07, -6.5245E+07, 0.0000E+00, 0, 7
11:24:1511:24:431.000000E+03, 1.0000E-02, -6.0900E-02, 1.646000E+01, 1.9699E+08, -1.1513E+08, 0.0000E+00, 0, 7

11:24:4511:25:141.000000E+05, 1.0000E-02, -6.4900E-02, 4.570000E+00, -4.7017E+05, -5.5957E+05, 0.0000E+00, 0, 5
11:24:4511:25:144.641589E+04, 1.0000E-02, -6.4900E-02, 8.100000E+00, -1.1383E+06, -1.3035E+06, 0.0000E+00, 0, 5
11:24:4511:25:142.154435E+04, 1.0000E-02, -6.4900E-02, 1.107000E+01, -7.0252E+06, -4.9340E+06, 0.0000E+00, 0, 6
11:24:4511:25:141.000000E+04, 1.0000E-02, -6.4900E-02, 1.184000E+01, 1.7486E+07, -4.8168E+07, 0.0000E+00, 0, 6
11:24:4511:25:144.641589E+03, 1.0000E-02, -6.4900E-02, 1.261000E+01, 1.9252E+07, -1.3716E+07, 0.0000E+00, 0, 6
11:24:4511:25:142.154435E+03, 1.0000E-02, -6.4900E-02, 1.559000E+01, 3.4230E+07, -7.6293E+07, 0.0000E+00, 0, 7
11:24:4511:25:141.000000E+03, 1.0000E-02, -6.4900E-02, 1.635000E+01, 6.3508E+07, -7.8955E+07, 0.0000E+00, 0, 7

11:25:1611:25:441.000000E+05, 1.0000E-02, -7.6300E-02, 4.580000E+00, -5.3107E+05, -5.8753E+05, 0.0000E+00, 0, 5
11:25:1611:25:444.641589E+04, 1.0000E-02, -7.6300E-02, 8.110000E+00, -1.9930E+06, -1.0403E+06, 0.0000E+00, 0, 5
11:25:1611:25:442.154435E+04, 1.0000E-02, -7.6300E-02, 1.108000E+01, -3.3754E+06, -8.1497E+06, 0.0000E+00, 0, 6
11:25:1611:25:441.000000E+04, 1.0000E-02, -7.6300E-02, 1.185000E+01, 1.3605E+06, -1.3879E+07, 0.0000E+00, 0, 6
11:25:1611:25:444.641589E+03, 1.0000E-02, -7.6300E-02, 1.262000E+01, -7.8890E+06, -2.4201E+07, 0.0000E+00, 0, 6
11:25:1611:25:442.154435E+03, 1.0000E-02, -7.6300E-02, 1.560000E+01, -9.7444E+06, -8.5564E+07, 0.0000E+00, 0, 7
11:25:1611:25:441.000000E+03, 1.0000E-02, -7.6300E-02, 1.637000E+01, 2.5931E+08, -1.4160E+08, 0.0000E+00, 0, 7

11:25:4711:26:151.000000E+05, 1.0000E-02, -6.6400E-02, 4.580000E+00, -4.8310E+05, -5.2126E+05, 0.0000E+00, 0, 5
11:25:4711:26:154.641589E+04, 1.0000E-02, -6.6400E-02, 8.110000E+00, -2.7253E+06, -9.1866E+05, 0.0000E+00, 0, 5
11:25:4711:26:152.154435E+04, 1.0000E-02, -6.6400E-02, 1.108000E+01, -2.6191E+06, -6.2904E+06, 0.0000E+00, 0, 6
11:25:4711:26:151.000000E+04, 1.0000E-02, -6.6400E-02, 1.185000E+01, -4.4078E+06, -1.2086E+07, 0.0000E+00, 0, 6
11:25:4711:26:154.641589E+03, 1.0000E-02, -6.6400E-02, 1.262000E+01, -7.4146E+06, -1.0657E+07, 0.0000E+00, 0, 6
11:25:4711:26:152.154435E+03, 1.0000E-02, -6.6400E-02, 1.560000E+01, 2.6131E+07, -1.4086E+08, 0.0000E+00, 0, 7
11:25:4711:26:151.000000E+03, 1.0000E-02, -6.6400E-02, 1.636000E+01, 2.3469E+08, -1.3710E+08, 0.0000E+00, 0, 7

both measurement J.Y. 06/13/01

11:26:1711:26:461.000000E+05, 1.0000E-02, -9.7800E-02, 4.570000E+00, -4.5571E+05, -6.2846E+05, 0.0000E+00, 0, 5
11:26:1711:26:464.641589E+04, 1.0000E-02, -9.7800E-02, 8.100000E+00, -1.7598E+06, -7.7029E+05, 0.0000E+00, 0, 5
11:26:1711:26:462.154435E+04, 1.0000E-02, -9.7800E-02, 1.107000E+01, -6.3606E+06, -1.0374E+07, 0.0000E+00, 0, 6
11:26:1711:26:461.000000E+04, 1.0000E-02, -9.7800E-02, 1.184000E+01, 2.6631E+06, -2.1526E+07, 0.0000E+00, 0, 6
11:26:1711:26:464.641589E+03, 1.0000E-02, -9.7800E-02, 1.261000E+01, 7.4683E+06, 2.0741E+07, 0.0000E+00, 0, 6
11:26:1711:26:462.154435E+03, 1.0000E-02, -9.7800E-02, 1.559000E+01, 3.8171E+07, -1.0844E+08, 0.0000E+00, 0, 7
11:26:1711:26:461.000000E+03, 1.0000E-02, -9.7800E-02, 1.635000E+01, 7.3821E+07, -1.4548E+08, 0.0000E+00, 0, 7

Should add a comma.

J. Yang 06/13/01

test0611a00PData.txt

06-11-2001
Data File: c:\yang\test0611a00PData.txt
Zplot Setup File: C:\Yang\setup_Yang_Salt1.zpw
Scan Interval: 2
Date ,Time Started , 100000 , 46415.89 , 21544.35 , 10000 , 4641.589 , 2154.435 , 1000 ,
06-11-2001,11:21:42, 743634.409168914 , 2028521.24672136 , 9161535.46082751 , 43035123.0537337 , 30648792.7624172 , 87632296.341018 , 113449917.712619 ,
06-11-2001,11:22:11, 826841.747010877 , 2153007.88665532 , 8007350.85843002 , 54762286.3109275 , 15554153.1752777 , 143170457.134145 , 334011607.38663 ,
06-11-2001,11:22:42, 761674.269094079 , 1989378.27725146 , 8633241.30382095 , 17237184.821194 , 25020501.2939389 , 396445572.683061 , 148386146.418727 ,
06-11-2001,11:23:13, 740979.627385261 , 2066270.56553589 , 7783902.24566059 , 23313391.8810627 , 51193405.0928437 , 78019687.9893787 , 177940456.040778 ,
06-11-2001,11:23:44, 824919.076334158 , 1944454.86255146 , 11338748.8961525 , 15837773.6759306 , 31872273.4049518 , 92949056.1167783 , 276750648.122096 ,

Z. (ohm)

verification.

the last data $|z| = 276,750,648$ at 1000 Hz

ohm.

From the last row of page 21

F = 1000 Hz, $Z_{real} = Z'(a) = 3.4394 E7$

$Z_{im} = Z''(b) = -2.7458 E8$

$\sqrt{Z_{real}^2 + Z_{im}^2} = 2.76751 E8$

correct!

J.Y.

06/13/01

J.yang 2/14/06

4/7/06

test0611a01PData.txt

06-11-2001
Data File: c:\yang\test0611a01PData.txt
Zplot Setup File: C:\Yang\setup_Yang_Salt1.zpw
Scan Interval: 2
Date ,Time Started , 100000 , 46415.89 , 21544.35 , 10000 , 4641.589 , 2154.435 , 1000 ,
06-11-2001,11:24:15, 642231.488250148 , 2603726.94420901 , 6626007.0789277 , 15801851.5057572 , 35521819.5971152 , 77365306.5010409 , 228166555.393204 ,
06-11-2001,11:24:45, 730875.101368216 , 1730560.35433613 , 8584741.75732736 , 51243696.3928247 , 23638277.4330111 , 83620061.881106 , 101326985.985965 ,
06-11-2001,11:25:16, 791976.54371831 , 2248171.05443514 , 8821050.68855179 , 13945522.6237671 , 25454365.4802079 , 86117079.7656307 , 295452595.351606 ,
06-11-2001,11:25:47, 710702.186291839 , 2875968.75601944 , 6813869.45648359 , 12864684.0940615 , 12982601.5174155 , 143263284.762705 , 271801041.388733 ,
06-11-2001,11:26:17, 776294.773716789 , 1921000.4487506 , 12168693.7819965 , 21690107.8284549 , 22044604.46209 , 114961988.678867 , 163137887.815798 ,

Z values (ohm)

verification. The first Data:

$|z| = 642231$ at 100 000 Hz.

From the first data row on page 23.

F = 100 Hz; $Z' = -4.8122 E5$

$Z'' = -4.2531 E5$.

$\sqrt{Z'^2 + Z''^2} = 6.42231 E5$.

correct!

J.Y.

06/13/01

J.yang 2/14/06

test0611aTemp

"ZPlotW Data File: Version 2.2"
"Raw Data"
"Sweep Frequency: Control Voltage"
Date: 06-11-2001 Time: 11:26:28
"Open Circuit Potential (V): -0.0978 "
""
"c:\yang\test0611aTemp"
"Frequency"
0,3,0,1,100000,1000
7
" Freq(Hz) Ampl Bias Time(Sec) Z'(a) Z"(b) GD Err Range"
1.000000E+05, 1.0000E-02, -9.7800E-02, 4.570000E+00, -4.5571E+05, -6.2846E+05, 0.0000E+00, 0, 5
4.641589E+04, 1.0000E-02, -9.7800E-02, 8.100000E+00, -1.7598E+06, -7.7029E+05, 0.0000E+00, 0, 5
2.154435E+04, 1.0000E-02, -9.7800E-02, 1.107000E+01, -6.3606E+06, -1.0374E+07, 0.0000E+00, 0, 6
1.000000E+04, 1.0000E-02, -9.7800E-02, 1.184000E+01, 2.6631E+06, -2.1526E+07, 0.0000E+00, 0, 6
4.641589E+03, 1.0000E-02, -9.7800E-02, 1.261000E+01, 7.4683E+06, 2.0741E+07, 0.0000E+00, 0, 6
2.154435E+03, 1.0000E-02, -9.7800E-02, 1.559000E+01, 3.8171E+07, -1.0844E+08, 0.0000E+00, 0, 7
1.000000E+03, 1.0000E-02, -9.7800E-02, 1.635000E+01, 7.3821E+07, -1.4548E+08, 0.0000E+00, 0, 7

ohm

agrees with last paragraph of test0611a01.txt. page 23.

J.Yang 06/13/01

conclusion: J.Y. 06/13/01

The data files from AutoZplot contains the data that are the same as the original data from the Zplot alone.

J.Y. 06/13/01

J.Y. 2/14/06

Alfa Aesar
A Johnson Matthey Company
30 BOND STREET WARD HILL, MA 01835

EMERGENCY PHONE NUMBER
1-800-424-9300

PHONE NUMBER (800)343-0660
D-U-N-S 04-507-9068
FEDERAL ID NO. 04-2641868

CUST# 56047005 DAS

SHIP TO
Advanced Research Institute
Attn: J. Yang Bldg 189
8220 Culebra Rd
San Antonio TX 78228
TEL # 210-522-5275

DATE SHIPPED	SHIPPING CHARGES
5-17	

SHIPPER	NO. OF PKGS.	GROSS WEIGHT
DN	1	

F.O.B. PLANT	PRINT DATE & TIME
WARD HILL	5/17/01 15:43:4

SHIP VIA
FEDEX PTI

CUSTOMER ORDER NUMBER	DATE ENTERED	ALFA AESAR ORDER NUMBER
101507	5/17/01	041601

TERMS
NET 30 DAYS

STOCK NUMBER	UNIT OF MEASURE	SHIP QTY	B/O QTY	ORDER QTY
10045-BY BA-PB-06 A0086	100 GM MSDS Y	1		1

SHIPPING DATA AND DESCRIPTION
Platinum wire, 0.25mm, 0.021 diam, 99.95% (metals basis)

C07491

*** ORDER IS COMPLETE ***
THANK YOU FOR YOUR ORDER.

0086

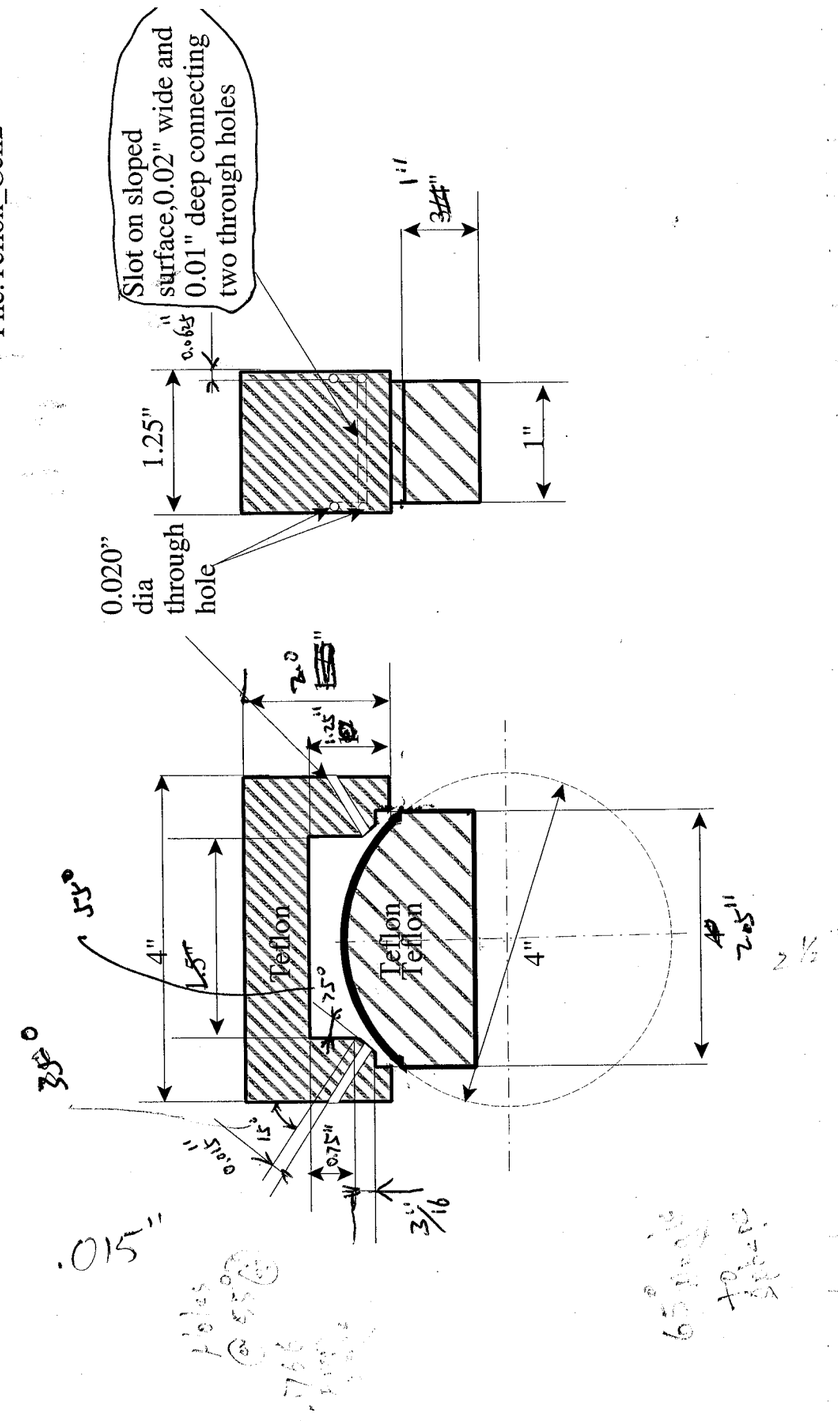
Platinum Wire to be used as electrode in the conductivity measurement. (Similar to Counter electrode)

J.Yang 2/14/06

No need to make entries to Lab log book. J.Y. 06/14/01

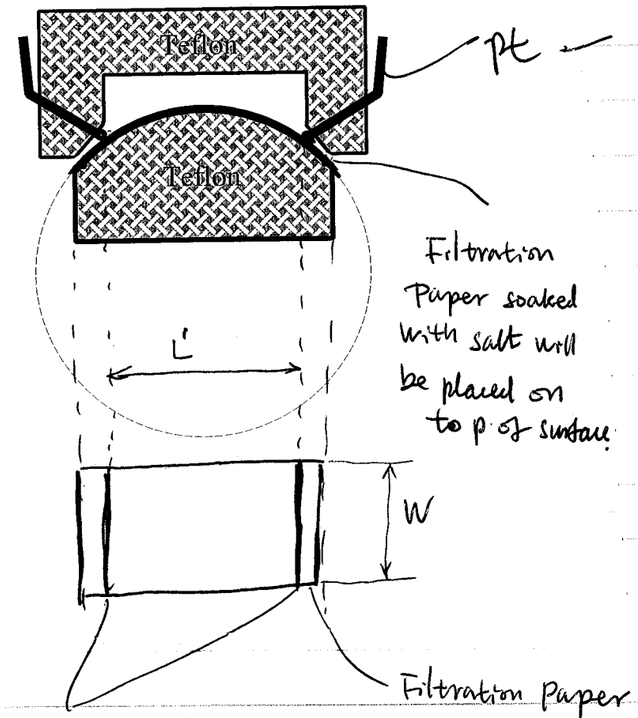
Conductivity Cell

File: Teflon_Cell2



Note: Pencil Writings were by machine shop Technician.

J. Yang 7/17/02



Cell Constant: Width : W
Thickness : δ
Length : L (related to L')

J. Yang 7/17/02

Two cells made.

Cell one (I) : W = 2.6 cm , L = 4.7 cm (L' = 4.5 cm)

Cell Two (II) : W = 2.6 cm , L = 4.5 (L' = 4.4 cm)

Paper thickness:

① measured 100 sheets (dry), 2.3 cm thick

therefore $2.3/100 = 0.023$ cm thick/sheet.

② Soak (diomzed) water then measure water weight

using 15 cm diameter circle sheet.

Pase average weight : 1.62 g

weight gain when soaked on flat horizontal surface after lifted, remove extra drops at bottom.

6.25 g
5.94 g
6.03 g

average : 6.07 g.

weight gain when soaked vertically, and after removing extra drops at bottom.

5.72 g
5.68 g
5.61 g

average 5.67 g.

Ivy. 08/07/01

~~Net weight gain : 6.6 5.62 = 1.62 = 5.~~

Average weight gain vertical + Horizontal 5.847 g.

Net weight gain $5.847 - 1.62 = 4.227$

thickness of water if assume no paper

$\delta = \frac{V}{A} = 4.227\ cm^3 / [(15^2/4) * 3.14] = 0.0239$ mm

Ivy
07/15/02

Therefore use $\delta = 0.023$ cm (the dry paper thickness) as the cell thickness for pure water.

cell constant for I

$\frac{l}{S} = \frac{4.7}{2.6 * 0.023} = 78.6\ \frac{1}{cm}$

cell constant for II

$\frac{l}{S} = \frac{4.5}{2.6 * 0.023} = 75.3\ \frac{1}{cm}$

Ivy
08/07/01

conductivity cells 06/01/01

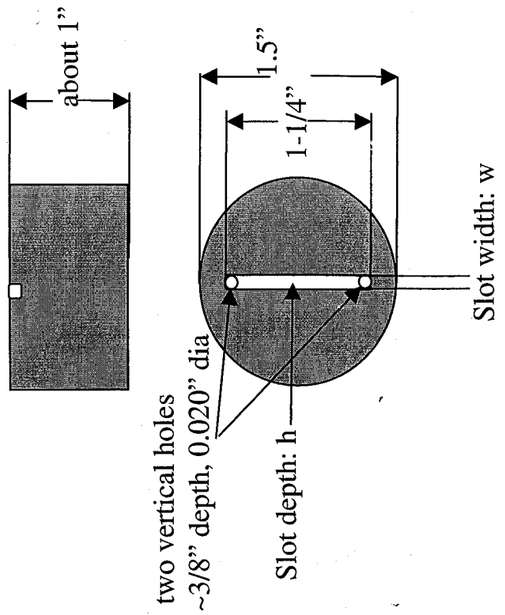
L.Yang

File:Cond_cell

Quantities: one h=1 mm, w=2 mm
one h=0.5 mm, w=2 mm
one h=0.5 mm, w=1 mm
one h=0.25 mm, w=1 mm

Material: Teflon

Charge Number: 20.1402.561



JUN 11 2001
Cal 30.1C-3
JC# 74923
1/pc

06/01/01 L.Yang

File: Conductitity_Dimension of cells
Conductivity measurement:

Cond= 1/cm-ohm	0.2				
l=cm (length)	5	3	2	1	0.5
h= cm (height)	0.1	0.1	0.1	0.1	0.1
w= cm (width)	0.2	0.2	0.2	0.2	0.2
S= cm^2	0.02	0.02	0.02	0.02	0.02
Cond= 1/cm-ohm	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**
R= (ohm)	1250	750	500	250	125
I= A (with 10 mV)	0.008	0.013333	0.02	0.04	0.08
l=cm	5	3	2	1	0.5
h= cm	0.05	0.05	0.05	0.05	0.05
w= cm	0.2	0.2	0.2	0.2	0.2
S= cm^2	0.01	0.01	0.01	0.01	0.01
Cond= 1/cm-ohm	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**
R= (ohm)	2500	1500	1000	500	250
I= A (with 10 mV)	0.004	0.006667	0.01	0.02	0.04
l=cm (length)	5	3	2	1	0.5
h= cm	0.05	0.05	0.05	0.05	0.05
w= cm	0.1	0.1	0.1	0.1	0.1
S= cm^2	0.005	0.005	0.005	0.005	0.005
Cond= 1/cm-ohm	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**
R= (ohm)	5000	3000	2000	1000	500
I= A (with 10 mV)	0.002	0.003333	0.005	0.01	0.02
l=cm (length)	5	3	2	1	0.5
height h= cm	0.3	0.3	0.3	0.3	0.3
base width w= cm	0.2	0.2	0.2	0.2	0.2
S= cm^2	0.06	0.06	0.06	0.06	0.06
Cond= 1/cm-ohm	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**
R= (ohm)	416.6667	250	166.6667	83.33333	41.66667
I= A (with 10 mV)	0.024	0.04	0.06	0.12	0.24

Weight calculation.

a (width) (cm)	0.2		
b (height, cm)	0.3		
S (area, cm²)	0.06		
L (length, cm)	4		
V (volume, cm³)	0.24		
	water	Sat KCl	
Weight	0.24	0.29	
density	1	1.2	
volume cm^3	0.24	0.241667	

L.Yang
7/12/02

06/12/01

conductivity measurement.

Cell: h = 1mm
w = 2mm
L = 3.0 cm.
} see page 32

platinum Eletrode: diameter 0.5 mm
see page 27.

filtration paper cut to fit the conductivity cell slot. (2 mm x 1 mm (deep) * 30 mm legth).

10:09 Paper soaked with saturated KCl solution ~~lot#~~ lot #005573 by. 06/12/01

lot #: 005573 dry paper thickness 0.23 mm. by. 7/16/01

Paper placed in cell, Pt electrode inserted through the paper to have good contact.

cell placed in GS Blue In Electric Humidity Chamber

Filtration Paper: Whatman Cat No 1004150 J. Yang 7/17/02
Cut from 150 mm dia, Quantitative Filtration Paper.

GS Blue In Eletric
Humidity Chamber:

The attached indicator: SN: 91E3453

Caliberated: May 01, 01
by kwh.
SwRI Cal-Lab.

J. Yang
7/17/02

06/12/01

10:04 VB program (Auto Zplot) started, File: 0612b_SatKCl

10:12 Chamber set to (22°/30°) (Wet T/Dry T)

	Data #,	T_{wet}/T_{dry}	Impedence(Ω)	setting
10:12	5	22/30	log|Z| = 7	22°/30°C
10:17	7	29/30	log|Z| = 5	
11:06	#57	29/30	log|Z| = 3.1	to 19°/30°C
12:28	#130	22/30		to 28.5/30°C
13:48	#201	27/30	log|Z| = 5.5	
15:03	276	27/30	log|Z| = 4.3	29.75/30
16:18	350	27/30	log|Z| = 3.5.	to 30.25/30
16:46		28/29.		

program stopped. accidently.

16:53 program restarted, File: 0612c-Sat_kcl

06/13

8:01	761	28/30		30.25/30
8:08		program halted.		to 29.5/30
8:14		program restarted	0613a-Sat-kcl	
9:08	#47	27/30		29.5/30
9:57	#89	27/30		to 29.25/30
11:57	#139	27/30		to 28.75/30
15:22	362	27/30		to 28/30
15:27	368	26/30		

J.Yang 7/15/02

06/14/01

	Data in File #	T_{wet}/T_{dry}	Imp.(Ω)	settings (T_{wet}/T_{dry})
11:22				
11:22		27/30	log|Z| = 5.2	28/30
11:22		New File:	0614a	to 27/30
11:33		26/30		27/30
13:50		26/30	log|Z| = 5.8	to 26/30
16:04	#138	25/30	log|Z| = 6.0 (at 1k — default)	
16:18	145	24.5/30		to 24.75/30
18:02	196	24/30	log|Z| = 6.5	
18:06				to 23.5/30°C
~~07:44~~	06/15/01 #348	24/30		to 22/30°C
07:44	J.y. 06/15/01			
7:50		23/30	New File: ~~0615b.sat-kcl~~ ~~0615b~~	0615a J.y. 06/15/01
10:17	#73	23/30		22/30

Caliberation the Dial-control

10:18	Set	set to 26/30
10:21	25/30	set to 30/30
10:24	29/30	set to 29/30
10:37	27/30	to 32/30
10:38	29/30	to 31/30
10:43	29.5/30	to 30/30
10:45	28/30	to 29/30
10:49	28/30	to 31/30
10:52	29/30	~~30/15~~ 33/30 J.Y. 06/15/01

J.Yang 7/15/02

J.y 06/15/01

10:53 ~~29.5~~ 29.5/30

10:57	29.5/30	to	32.5/30
11:01	29.5/30	to	31.5/30
11:23	29/30	to	30.5/30

from above. the maximum Twet is 29.5°C/30 at low2, so all measured results should offset by -0.5°C

11:33	28/30	to	29.5/30
11:47	28/30	to	28.5/30
11:50	27/30	to	29/30
14:31	22/30		

15:04 Test terminated. Cell rinsed, reloaded with $NaNO_3$ soaked filter paper.

J. Yang 7/15/02

15:24 load $NaNO_3$ — saturated-solution soaked filter paper. Fisher C.A.C.S. $NaNO_3$ — lot # 961772A.

before load the $NaNO_3$ soaked paper, put a wet unsoaked paper, same size as used in the real test and put in the chamber. measure when the paper was wet.

15:35 #5 log|Z| at 1k = 7.5

program started 15:24; 06:56

Proof: paper even with water (Deionized water) does not conduct.

16:23 #24 log|Z| = 7.3 (at 1k Hz)

Go to page 47.

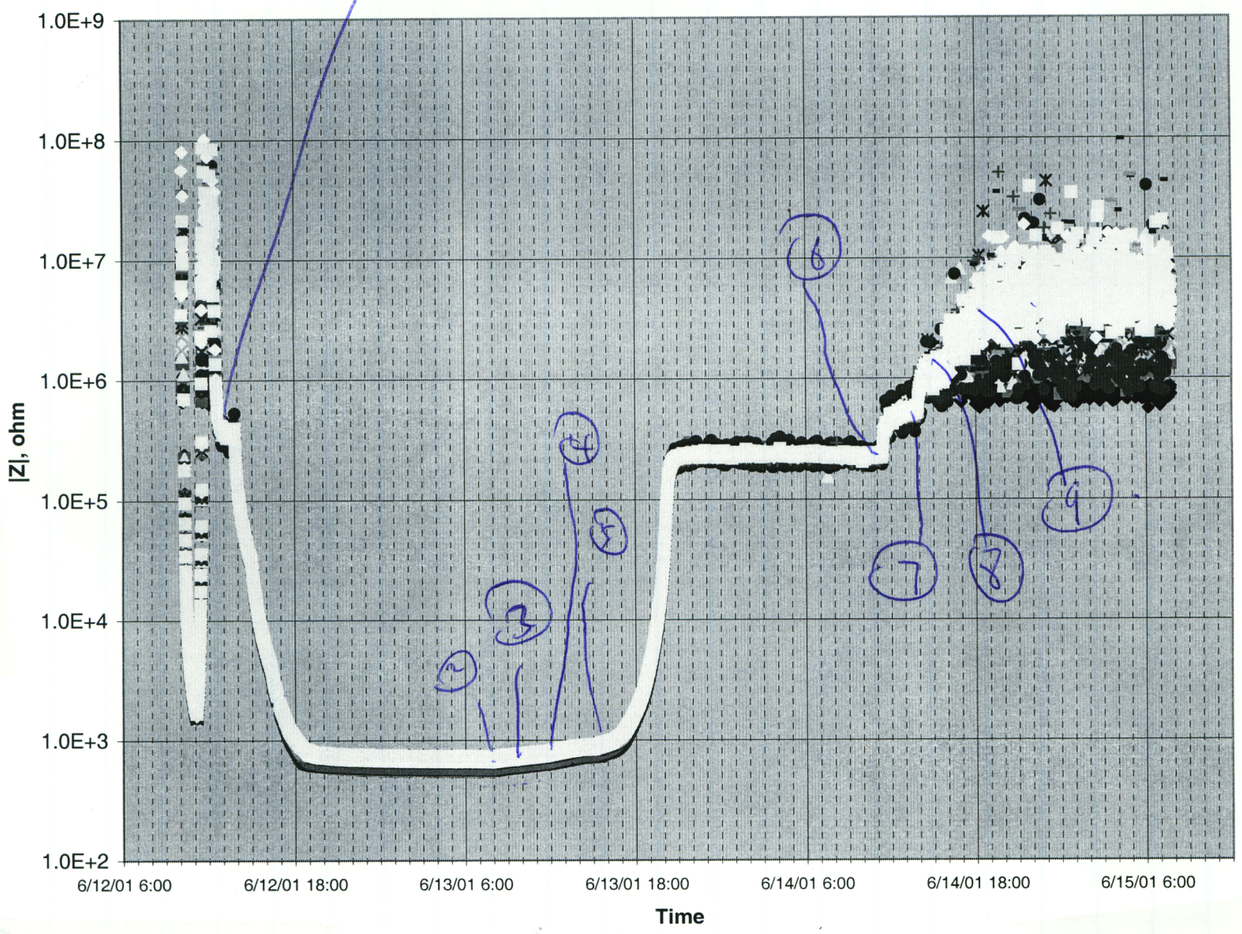
J.Y. 6/19/01

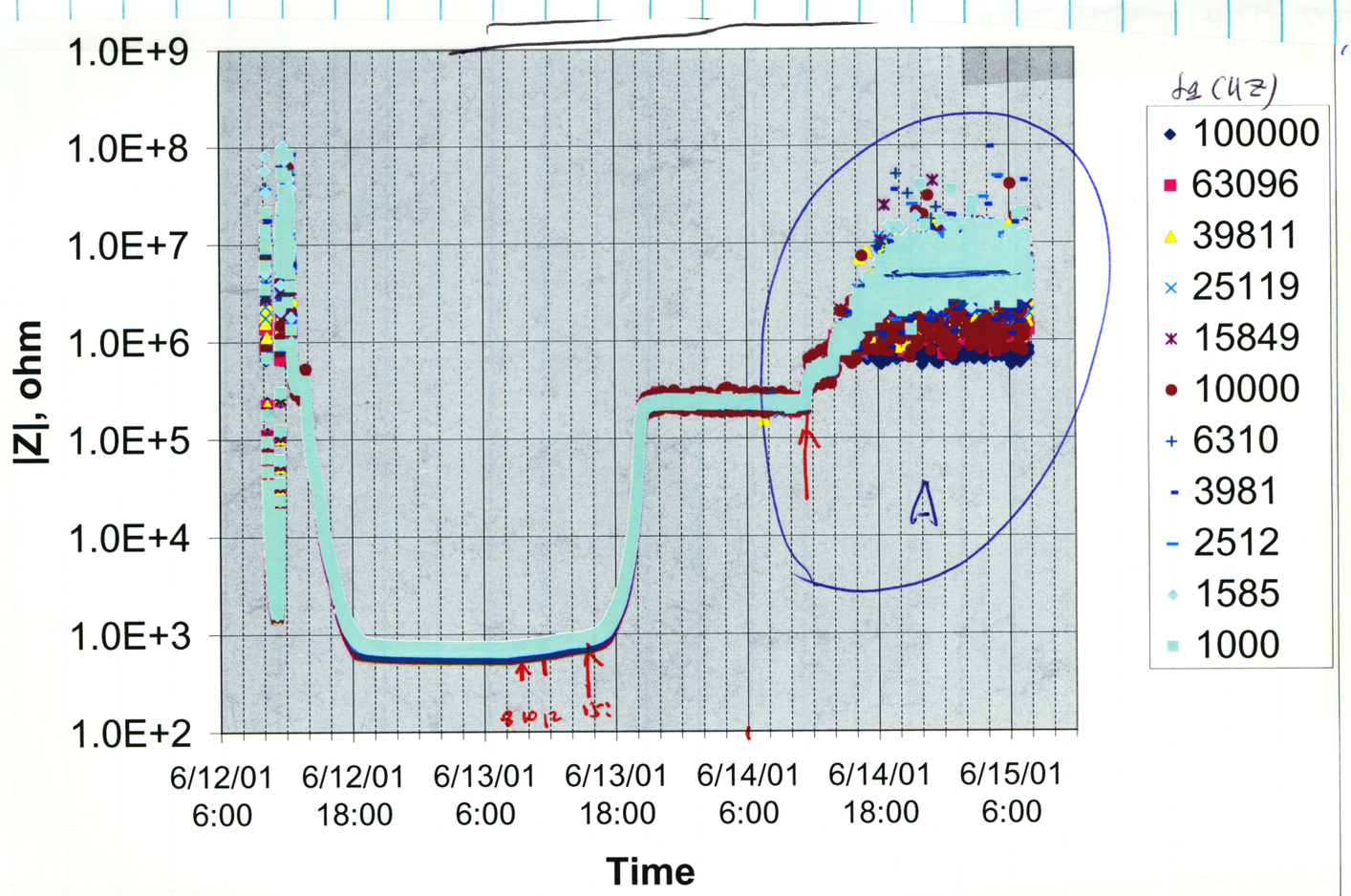
J. Yang 2/14/06

0612b_00_14a_01.xls

Data for kcl test

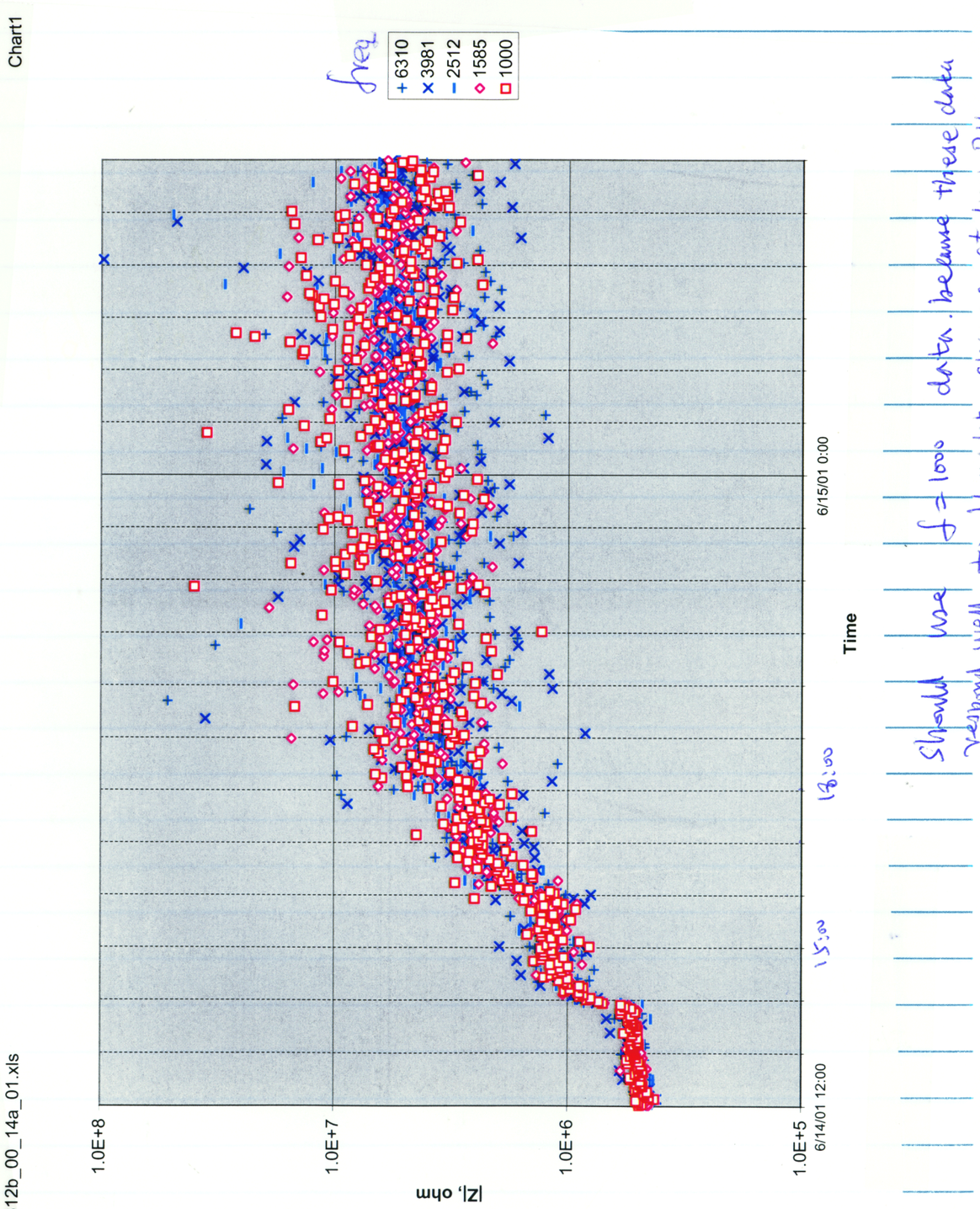
Chart1





This Diagram shows that only f = 1000 and f = 1585 respond to humidity changes at lower levels (Section A). ~~dy~~ dy. 06/15/01

see also Page 42.



freq

If ≠ 1000 data. because these data should not be used to Humidity change at low RH.

Should respond well

J. Yang 7/15/02

0612b_DP.xls Sheet1

J.Y. 06/17/01

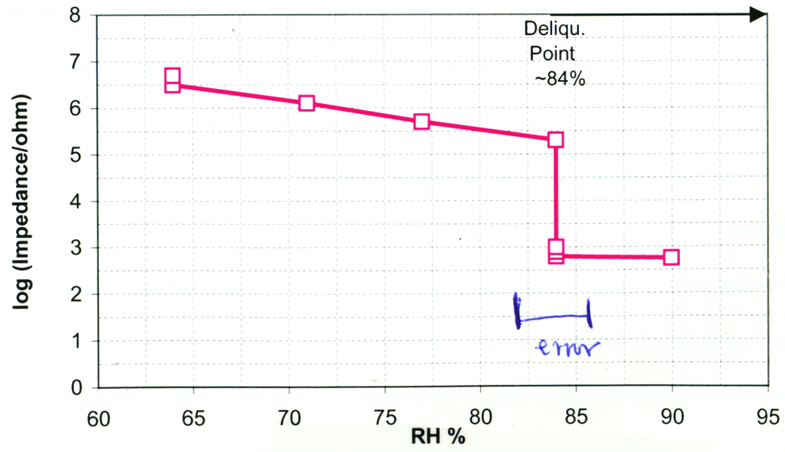
Test Results from June 12 to June 15

Time	Indicated Reading Dry Bulb	Indicated Reading Wet Bulb	Wet Bulb Corrected* by +0.5oC	RH** %	Dial Reading Dry Bulb	Dial Reading Wet Bulb	log(Z, ohm)
6/12/01 16:18	30	28	28.5	90	30	30.25	2.75
6/13/01 8:01	30	27	27.5	84	30	29.5	2.8
6/13/01 9:57	30	27	27.5	84	30	29.25	2.9
6/13/01 11:55	30	27	27.5	84	30	28.75	3
6/13/01 15:27	30	27	27.5	84	30	28	5.3
6/14/01 11:22	30	26	26.5	77	30	27	5.7
6/14/01 13:50	30	25	25.5	71	30	26	6.1
6/14/01 16:18	30	24	24.5	64	30	24.75	6.5
6/14/01 18:06	30	24	24.5	64	30	23.75	6.7

* see Note Book Page 38

** According to Perry's Chem Eng. Handbook, 6th Ed, page 20-6

Numbers see page 40.



J. Yang 7/17/02

The plot on page 43 is too coarse. RH error by ± 0.5°C on wet T plus ± 0.5°C on dry T. we have

About ± 5% — too big.

From Data shown in page 36, when the setting Dial temp changes, °C changes. The dial has a better resolution 0.25°C. Therefore the dial value should be used.

As shown in page 43. There is good correlation between Dial setting temp. and humidity.

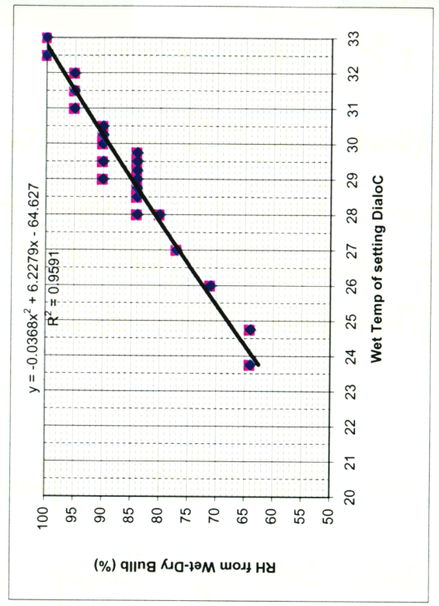
Regression:

$$RH(\%) = -0.0368\, T_{wet,set}^{2} + 6.2279\, T_{wet,set} - 64.63$$

Results see page 46.

J.y.
06/15/01

J. Yang 2/14/06



J.y.
06/15/01

Calibration Data, Scientific Note Book P 36 to 38

	Wet Bulb Corrected*	RH** %	Set Dry T °C	Dry T °C	Set Wet T °C
NBook P36	22.5	55	30	30	19
NBook P36	27	84	30	30	28.5
NBook P36	27	84	30	30	29.25
6/12/01 15:03	27	84	30	30	29.75
6/12/01 16:18	28	90	30	30	30.25
6/13/01 8:01	27	84	30	30	29.5
6/13/01 9:57	27	84	30	30	29.25
6/13/01 11:55	27	84	30	30	28.75
6/13/01 15:27	27	84	30	30	28
6/14/01 11:22	26	77	30	30	27
6/14/01 13:50	25	71	30	30	26
6/14/01 16:18	24	64	30	30	24.75
6/14/01 18:06	24.5	64	30	30	23.75
6/15/01 10:18	27	80	30	30	28
Notebook P37-38	25.5	71	30	30	26
Notebook P37-38	28.5	90	30	30	30
Notebook P37-38	27.5	84	30	30	29
Notebook P37-38	29.5	95	30	30	32
Notebook P37-38	29.5	95	30	30	31
Notebook P37-38	28.5	90	30	30	30
Notebook P37-38	28.5	90	30	30	29
Notebook P37-38	29.5	95	30	30	31
Notebook P37-38	30	100	30	30	33
Notebook P37-38	29.5	95	30	30	32.5
Notebook P37-38	29	100	30	30	31.5
Notebook P37-38	28	95	30	30	30.5
Notebook P37-38	28.5	90	30	30	29.5
Notebook P37-38	28.5	90	30	30	28.5
Notebook P37-38	27.5	84	30	30	28.5
6/15/01 11:47	24.5	64	30	30	23.75

* see Note Book Page 38
** According to Perry's Chem Eng. Handbook, 6th Ed, page 20-6

0612b_DP.xls

J. Yang 2/14/06