Appendix (1)

Table 9: Composition (%) of stainless steel and aluminium electrode material[83]

	%						
element	Cr	Mo	Mn	Si	C	Ni	other
Stainless steel AISI 304	18-20	---	2.0	1.0	0.08	8-10.5	---
element	Cr	Cu	Mg	Mn	Si	other	
aluminium UNS A91100	---	0.05-0.2	---	---	---	99.0 minimum	

Appendix 2

Table 10: Concentration of heavy metal in artificial effluents for different amounts of NaCl added for different current densities used in the electrolysis process.

	Initial concentration of heavy metal (±%5%)											
NaCl /([l]M)	Cr^{6+} /(ppm)			Ni^{2+} /(ppm)			Cu^{2+} /(ppm)			Cr^{6+}, Ni^{2+}, Cu^{2+}/(ppm)		
	[*]CA 5	CA 10	CA 15	CA 5	CA 10	CA 15	CA 5	CA 10	CA 15	CA 10	CA 15	CA 20
0.00	50		100 500		100		50 100 500	100	500			
0.01							50 100 500	50 100 500	50 100 500			
0.02								100	50 100			
0.03	100 50	100	50 100 250 500	50 100	50 100	50 100 500	50 100 500	50 100 500	50 100 250 500	100	100	100
0.05			500	100		500	50 100 500	50 100 500	50 100 500			
0.10						500		100 500	100 500			

[*] CA = current density/(mA/cm^2)
[l] M = mol/liter
1 ppm = 1 mg/L

APPENDIX (3)

Table 11a: Atomic absorption spectroscopy analysis results for different sodium chloride concentrations in standard heavy metal solutions.

	concentration/ppm		
standard	NaCl 0.10 M	NaCl 0.03 M	without NaCl
Cu 500 ppm	493	497	5 00
Cu 100 ppm	99.8	100	101
Cu 5 ppm	4.74	4.94	4.92
Cr 500 ppm	---	---	---
Cr 100 ppm	97.1	99.2	99.8
Cr 5 ppm	4.90	4.92	5.00
Ni 500 ppm	---	---	---
Ni 100 ppm	105	102	97.6
Ni 5 ppm	5.22	5.14	4.95

Table 11b: Atomic absorption spectroscopy analysis results for standard solutions for heavy metal with and without iron (III).

	concentration/ppm	
standard	Fe 500ppm	without Fe
Cu 500 ppm	497	500
Cu 100 ppm	97.8	101
Cu 5 ppm	4.83	4.92
Cr 500 ppm	---	---
Cr 100 ppm	88.0	99.8
Cr 5 ppm	4.38	5.00
Ni 500 ppm	---	---
Ni 100 ppm	101	97.6
Ni 5 ppm	5.14	4.95

Table 11c: Atomic absorption spectroscopy analysis results for mixed chromium (III) and chromium (VI) solutions.

	concentration/ppm		
standard	Cr^{6+} 100ppm	Cr^{6+} 50ppm	Cr^{6+} 5ppm
Cr^{3+} 100 ppm	208	---	---
Cr^{3+} 50 ppm	---	103	---
Cr^{3+} 5 ppm	---	---	10.8

I ppm = 1 mg/Liter

APPENDIX (4)

Table 12a: AAS Analysis results for copper samples at different wavelengths (λ).

Cu effluent sample	concentration/ppm		
	wavelength 249.2 nm	wavelength 216.5 nm	wavelength 324.7 nm
1 c0	528		[a] 524
11 cl		43.2	[b] 43.1
12 cl		101	[b] 98.9
8 al		49.6	[b] 48.6
21 al	502		[a] 493
22 al		99.9	[b] 99.1

Table 12b: AAS Analysis results for chromium samples at different wavelengths (λ).

Cr effluent sample	concentration/ppm	
	wavelength 428.9 nm	wavelength 357.9 nm
39 al	107	[b] 104
63 al	107	[b] 108
65 al	13.2	[c] 14.2

Table 12c: AAS Analysis results for nickel samples at different wavelengths (λ).

Ni effluent sample	concentration/ppm		
	wavelength 323.3 nm	wavelength 341.5 nm	wavelength 232.0 nm
71 a3a		3.70	3.67
71 b2a		0.333	0.434
63 al	109		[b] 108
64 al	112		[b] 110

[a] : sample diluted 400X
[b] : sample diluted 50X
[c] : sample diluted 10X
1 ppm = 1 mg/Liter

Appendix (5)

Instrumental Parameters for AAS Analysis

Standard Atomic Absorption Condition

A. Cr Determination By Flame Atomization

Light Source: Hollow Cathode

Lamp No: 62934/62954-02

Lamp Current: Normal and D_2 Operation: 6.0 ma
Smith-Hieftje Operation: (Bkg) 3.0 ma (Signal) match to Bkg intensity

Wavelength: 357.9 nm Bandpass: 0.5 nm

Burner Head: Long Path No: 121534-2-02

Flame Description: Air-Acetylene, Oxidizing, Fuel Lean, Blue

Photomultiplier Voltage (HV): Once the lamp current, wavelength, and bandpass have been set, adjust the HV control until the energy meter reading is in the green band (between 0.2 to 0.8).

Sensitivity

The sensitivity (at 0.0044 Absorbance = 1% Absorption) is about 0.04 µg/mL for the instrumental parameters described above.

A standard containing 1.0 µg/mL of Cr will give a reading of approximately 0.1A.

Linear Range

The working range for Cr is linear up to a concentration of approximately 5.0 µg/mL when using an aqueous solution and the instrumental parameters describedabove.

Alternative Analytical Lines:

Wavelength (nm)	Approximate sensitivity (μg/mL)	SBW (nm)	Approximate Linear Range (μg/mL)
357.9	0.06	0.5	5.0
359.4	0.10	0.5	12
360.5	0.13	0.5	16
425.4	0.20	0.5	25
427.5	0.23	0.5	28
428.9	0.50	0.5	62
520.8	12.0	0.15	1500
520.5	30.0	0.15	3750

Interferences:

Chromium absorption is suppressed by cobalt, iron and nickel in an air-acetylene flame, especially in the presence of perchloric acid. The signal suppression can also be overcome by use of a nitrous oxide-acetylene flame. No ionization suppressant is necessary.

In addition, the iron interference can be minimized by the addition of 2% (w/v) NH_4Cl to the samples and solutions.

Several investigators have found interference from copper, barium, aluminum, magnesium, and calcium in an air-acetylene flame. The extent of this interference is strongly dependent on flame stoichiometry. Use of a nitrous oxide-acetylene flame will eliminate the interference.

B. Ni Determination By Flame Atomization

Light Source: Hollow Cathode

Lamp No: 62819/62819-02

Lamp Current: Normal and D_2 Operation: 10.0 ma
Smith-Hieftje Operation: (Bkg) 3.0 ma (Signal) match to Bkg intensity

Wavelength: 232.0 nm Bandpass: 0.15 nm

Burner Head: Long Path No: 121534-2-02

Flame Description: Air-Acetylene, Oxidizing, Fuel Lean, Blue

Photomultiplier Voltage (HV): Once the lamp current, wavelength, and bandpass have been set, adjust the HV control until the energy meter reading is in the green band (between 0.2 to 0.8).

Sensitivity

The sensitivity (at 0.0044 Absorbance = 1% Absorption) is about 0.06 μg/mL for the instrumental parameters described above.

A standard containing 1.5 μg/mL of Ni will give a reading of approximately 0.1A.

Linear Range

The working range for Ni is linear up to a concentration of approximately 5 μg/mL when using an aqueous solution and the instrumental parameters described above.

Alternative Analytical Lines:

Wavelength (nm)	Approximate sensitivity (µg/mL)	SBW (nm)	Approximate Linear Range (µg/mL)
232.0	0.06	0.15	5.0
231.1	0.1	0.5	8.0
341.5	0.3	0.5	25
352.4	0.3	0.5	25
305.1	0.4	0.5	33
346.2	0.6	0.5	50
351.5	0.6	0.5	50
303.8	1.0	0.5	83
337.0	2.0	0.5	166
323.3	3.0	0.5	250
294.4	5.0	0.5	416
362.5	27.0	0.5	2250

Interferences:

Non-atomic species in the air-acetylene flame absorb strongly at 232.0 nm The use of background correction using the Smith-Hieftje system continuum source is strongly recommended. It has been reported that at 352.4 nm, this effect is negligible even for high matrix solutions.

Hydrochloric and/or perchloric acid solutions of Ni in the presence of chromium, cobalt and iron have been observed to cause a slight depression (approximately 5%) in the Ni absorbance. In a more oxidizing air-acetylene flame the effect is minimized, and in a nitrous oxide-acetylene flame no interferences have been observed. .

C. Cu Determination By Flame Atomization

Light Source: Hollow Cathode

Lamp No: 63041/63041-02

Lamp Current: Normal and D_2 Operation: 5.0 ma
Smith-Hieftje Operation: (Bkg) 2.5 ma (Signal) match to Bkg intensity

Wavelength: 324.7 nm Bandpass: 1.0 nm

Burner Head: Long Path No: 121534-2-02

Flame Description: Air-Acetylene, Oxidizing, Fuel Lean, Blue

Photomultiplier Voltage (HV): Once the lamp current, wavelength, and bandpass have been set, adjust the HV control until the energy meter reading is in the green band (between 0.2 to 0.8).

Sensitivity

The sensitivity (at 0.0044 Absorbance = 1% Absorption) is about 0.03 µg/mL for the instrumental parameters described above.

A standard containing 0.7 µg/mL of Cu will give a reading of approximately 0.1A.

Linear Range

The working range for Cu is linear up to a concentration of approximately 4.0 µg/mL when using an aqueous solution and the instrumental parameters described above.

Alternative Analytical Lines:

Wavelength (nm)	Approximate sensitivity (μg/mL)	SBW (nm)	Approximate Linear Range (μg/mL)
324.7	0.03	1.0	4.0
327.4	0.1	0.5	13
217.9	0.3	0.3	40
218.2	0.4	0.3	53
216.5	0.6	0.15	80
222.6	1.5	0.15	200
249.2	5.0	0.5	667
244.2	11.0	1.0	1466
224.4	15.7	0.15	2093

Interferences:

No interferences have been observed for copper in an air-acetylene flame. However, depression of the copper signal has been noted at high Zn/Cu ratios. This problem can be minimized by the use of a lean air-acetylene flame or a nitrous oxide-acetylene flame.

D. Fe Determination By Flame Atomization

Light Source: Hollow Cathode

Lamp No: 62810/62810-02

Lamp Current: Normal and D_2 Operation: 8.0 ma
Smith-Hieftje Operation: (Bkg) 3.0 ma (Signal) match to Bkg intensity

Wavelength: 248.3 nm   Bandpass: 0.3 nm

Burner Head: Long Path   No: 121534-2-02

Flame Description: Air-Acetylene, Oxidizing, Fuel Lean, Blue

Photomultiplier Voltage (HV): Once the lamp current, wavelength, and bandpass have been set, adjust the HV control until the energy meter reading is in the green band (between 0.2 to 0.8).

Sensitivity

The sensitivity (at 0.0044 Absorbance = 1% Absorption) is about 0.04 µg/mL for the instrumental parameters described above.

A standard containing 1 µg/mL of Fe will give a reading of approximately 0.1A.

Linear Range

The working range for Fe is linear up to a concentration of approximately 5 µg/mL when using an aqueous solution and the instrumental parameters described above.

Alternative Analytical Lines:

Wavelength (nm)	Approximate sensitivity (μg/mL)	SBW (nm)	Approximate Linear Range (μg/mL)
248.3	0.04	0.3	5.0
248.8	0.07	0.3	8.75
271.9	0.13	0.3	16
302.1	0.15	0.3	18
252.7	0.18	0.3	22.5
372.0	0.4	0.3	50
373.1	0.4	0.3	50
344.1	0.6	0.3	75
386.0	0.6	0.3	75
305.9	0.9	0.3	112
346.6	4.4	0.3	550
392.0	11.0	0.3	1375

Interferences:

A reduction in sensitivity has been observed when iron is determined in the presence of nitric acid and nickel. This effect can be minimized by using a very lean flame.

Citric acid at a concentration of 200 μg/mL has been reported to depress iron sensitivity up to 50%. The effect is not overcome by adjustment of flame stoichiometry. This interference can be minimized by measuring the iron absorption in the presence of phosphoric acid. It is necessary to select an optimum burner height to obtain maximum freedom from interference.

The use of a nitrous oxide-acetylene flame has been found to remove all interferences.

Appendix 6

```
'*********** PROGRAM = VISCAN.BAS ************
'*       for Potentiodynamic Measurements.   *
'*********************************************

'$INCLUDE: 'KDAC500.BI'

  DEFINT A-Q, S-Z: REM All real variable names must begin with letter 'r'.
  DECLARE SUB EVREST (df$, ntime, exptdate$, rmeane0, rstdev, T$, I)
  DECLARE SUB IRSELECT (RC)
  DECLARE SUB PLOTAXES (Q, RSCAN)
  DECLARE SUB IVSCAN (df$, datf$, range, RSCAN, re0, CHOICE$, NI, NNI, NS, NSCC, NSC, RVE, RVEL, RI, RLGI, R, RVSTART, RVLIMI
  DECLARE SUB PLOTi (re0, REV, RI, KKK)
  DECLARE SUB PLOTlogi (re0, REV, RLGI, KKK)
  DECLARE SUB TABLDATA (RSCAN, I, RDT, RLGI, RI, RVE, NI)
  DECLARE SUB SAVEDATA (df$, I, NI, RVSTART, RVLIMIT, RSCAN, RI, RVE, RLGI, RSIA)
  DECLARE SUB GRAPHER (datf$, I, NI, RI, RSIA, RVE, RLGI)
  DECLARE SUB IVFGREAD (REV, RIV, RSCAN, range)
  DECLARE SUB EOFGREAD (re0)
  DECLARE SUB makefile0 (df$, datf$, ntime, T$, exptdate$, RSCAN)
  DECLARE SUB plotaxes0 (Q)
  DIM RIA(2300), RLGIA(2300), RVEA(2300), RSIA(2300)

   CALL kdinit(BASIC): REM Initialize Keithley 575 Measurement & Control System
    SCREEN 0
    CLS
    LOCATE 1, 15: COLOR 14, 1: PRINT "*** CORROSION RATES via CURRENT-VOLTAGE ***"
    LOCATE 3, 15: PRINT " **            MEASUREMENTS            **"
    LOCATE 10, 1: BEEP: COLOR 15, 1: PRINT "* PRELIMINARY CHECKS *   Before initiating the measurements check that :": PRINT
    PRINT "1.  All electrical connections to the Corrosion Cell and the Potentiostat have      been correctly made.": PRINT
    PRINT "2.  The Cell Switch on the Potentiostat is OFF initially.
                              3.  Check the gas bubbling-rate and bubbler position in the Cell."
1  PRINT : INPUT "**-> ENTER Name of Datafile to store I-E data. ", df$
     PRINT : PRINT : INPUT "             Disk Drive  A, B, or C  "; DD$
    df$ = DD$ + ":" + df$
    datf$ = df$ + ".DAT"
2
   CLS : LOCATE 2, 10: COLOR 15, 1
   LOCATE 4, 10: INPUT "Enter value of room temperature (deg Celsius) : ", T$
10 LOCATE 5, 5: INPUT "ENTER period of Rest Potential measurement (not more than 1200 Second.). ", tim
   ntime = tim
   IF ntime = 0 THEN GOTO 10
   LOCATE 22, 10: COLOR 4, 15
   PRINT : INPUT "Has all required information been entered correctly (y/n) ? ", yn$
   IF yn$ = "n" THEN GOTO 1

  CALL makefile0(df$, datf$, ntime, T$, exptdate$, RSCAN)

    REM Start rest potential measurements
    CALL EVREST(df$, ntime, exptdate$, rmeane0, rstdev, T$, I)

   PRINT : INPUT "DO YOU WANT TO RERUN THE REST POTENTIAL MEASUREMENT,  y/n ? "; ny$
   IF ny$ = "y" THEN GOTO 2
    PRINT "   PRESS ANY KEY TO CONTINUE.  ==>> "
    re0 = rmeane0
    CALL IVSCAN(df$, datf$, range, RSCAN, re0, CHOICE$, NI, NS, NNI, NSCC, NSC, RVE, RVEL, RI, RLGI, R, RVSTART, RVLIMIT, I, 
Sweep Measurement Program.


400 SCREEN 0: LOCATE 5, 10: INPUT "Do you want printer output of Current-voltage data (y/n) "; yn$
    IF yn$ <> "y" THEN END
    CALL TABLDATA(RSCAN, I, RDT, RLGI, RI, RVE, NI): REM to print E-I data.


 END
```

```
DEFINT A-Q, S-Z
 SUB EOFGREAD (re0)

 DIM rvl(2)
 CALL fgread("EVIN", NONE, VARSEG(rvl(0)), VARPTR(rvl(0)), C.MILVLT, NT)
 re0 = rvl(0)

 END SUB

DEFINT A-Q, S-Z
 SUB EVREST (df$, ntime, exptdate$, rmeane0, rEstdev, T$, I)
 DIM re0(1200)

15 SCREEN 0: CLS
 CALL inton(10, MIL)
 CALL kdwarn(WARNOFF)

 exptdate$ = DATE$
 LOCATE 2, 63: COLOR 13, 5
 LOCATE 3, 65: COLOR 15: PRINT P$
 LOCATE 5, 63: COLOR 13, 5: PRINT "Room Temperature"
 LOCATE 6, 66: PRINT "    " + CHR$(248) + "C  "
 LOCATE 6, 64: COLOR 15: PRINT "    " + T$
 LOCATE 18, 63: PRINT "Datafile: " + df$
 LOCATE 8, 64: COLOR 14, 1: PRINT " DATE:"; exptdate$
 LOCATE 2, 25: COLOR 15: PRINT "** REST POTENTIAL MEASUREMENTS **"

 rsume0 = 0
 FOR I = 1 TO ntime
 STOP$ = INKEY$
 IF STOP$ <> "" THEN intoff
 IF STOP$ <> "" THEN GOTO 111
 rsum = 0
 FOR J = 1 TO 90
 CALL EOFGREAD(re0)
 rsum = rsum + re0
 NEXT J
 remean = rsum / 90: re0(I) = remean

 LOCATE 11, 10: COLOR 5: PRINT "* Potentials are"
 LOCATE 12, 10: PRINT "  w.r.t.";
 LOCATE 13, 10: COLOR 14: PRINT " SCE. "

 LOCATE 8, 10: COLOR 10: PRINT "Potential E/mV"
 LOCATE 9, 15: COLOR 15, 1: PRINT "       "
 LOCATE 9, 15: COLOR 15, 1: PRINT USING "####.#"; remean
 LOCATE 8, 35: PRINT "Time/sec."
 LOCATE 9, 35: COLOR 15, 1: PRINT "          "
 LOCATE 9, 35: PRINT USING "######"; I
 LOCATE 9, 5: PRINT "pt#"; I



 rsume0 = rsume0 + re0(I)
 lastpt = I
 IF STOP$ = " S " THEN intoff
```

```
 IF STOP$ = " S " THEN GOTO 111
 NEXT I
 ntime = lastpt
 CALL intoff

 rmeane0 = rsume0 / ntime

 LOCATE 15, 2: COLOR 12: PRINT "Mean O.C. POTENTIAL/mV =";
 PRINT USING "###.###"; rmeane0; : PRINT "mV"
 FOR I = 1 TO ntime
 rdf2sum = rdf2sum + (re0(I) - rmeane0) ^ 2
 NEXT I

 rstdev = SQR(rdf2sum / (ntime - 1))
 LOCATE 16, 37: PRINT "Std. Dev./mV = "; : PRINT USING "#.#"; rstdev



111 LOCATE 22, 25: COLOR 4, 15: INPUT "SAVE DATA on Hardisk  (y/n) ?", ny$
     IF ny$ = "n" THEN GOTO 30
     LOCATE 22, 25: COLOR 14, 15
     INPUT "SAVE 1 DATA PT. EVERY (M) MIN OR (S) SEC. "; MS$
     IF MS$ = "M" THEN MS = 60 ELSE MS = 1

LOCATE 22, 25: COLOR 4, 15: PRINT "<<< NOW SAVING DATA on Hardisk. >>>"

 OPEN df$ FOR APPEND AS #1
   WRITE #1, rmeane0, rstdev

    FOR I = 1 TO ntime STEP MS
    WRITE #1, I, re0(I)
    NEXT I
  CLOSE #1
30
   END SUB


DEFINT A-Q, S-Z
 SUB GRAPHER (datf$, I, NI, RI, RSIA, RVE, RLGI) : 'to store I-E data in GRAPHER datafile.


 OPEN datf$ FOR APPEND AS #2
 FOR I = 1 TO NI
 WRITE #2, RI, RSIA, RVE, RLGI
 NEXT I
 CLOSE #2

END SUB

DEFINT A-Q, S-Z
SUB IRSELECT (RC)

 REM Subroutine to select Current Range
 COLOR 1, 15
 PRINT : PRINT "   * SELECT CURRENT RANGE by pushing appropriate Potentiostat RANGE BUTTON.  *
                                                    Enter selected current range value."
 PRINT : INPUT "        << 0.001,  0.01,  0.1,  1,  10,  100,  1000  mA  >> ", RC

 END SUB

DEFINT A-Q, S-Z
     SUB IVFGREAD (REV, RIV, RSCAN, range) STATIC'PROCEDURE TO READ CHANNELS(EVIN, IVIN)


     DIM rv1(1)
```

```
IF (RSCAN = .1 AND range = 1) OR (RSCAN = .1 AND range = 2) OR RSCAN = .2 THEN K = 60
IF RSCAN = .1 AND range = 4 THEN K = 110
IF (RSCAN = .5 AND range = 2) OR (RSCAN = .5 AND range = 4) THEN K = 50
IF RSCAN = .5 AND range = 1 THEN K = 150
IF RSCAN = 1 AND range = 4 THEN K = 250
IF (RSCAN = 1 AND range = 1) OR (RSCAN = 1 AND range = 2) THEN K = 100
IF RSCAN = 2 OR (RSCAN = 5 AND range = 2) OR (RSCAN = 5 AND range = 4) THEN K = 100
IF RSCAN = 5 AND range = 1 THEN K = 50
IF RSCAN = 10 AND range = 4 THEN K = 100
IF (RSCAN = 10 AND range = 2) OR (RSCAN = 20 AND range = 4) THEN K = 50
IF (RSCAN = 10 AND range = 1) OR (RSCAN = 20 AND range = 2) THEN K = 10
IF RSCAN = 20 AND range = 1 THEN K = 5
IF RSCAN = 50 THEN K = 2
IF RSCAN = 100 THEN K = 2
IF RSCAN = 200 THEN K = 2
IF RSCAN = 500 THEN K = 1


RSUME = 0: RSUMIV = 0
FOR J = 1 TO K
CALL fgread("EVIN,IVIN", NONE, VARSEG(rvl(0)), VARPTR(rvl(0)), C.MILVLT, NT)
RSUME = RSUME + rvl(0): RSUMIV = RSUMIV + rvl(1)
NEXT J
REV = RSUME / K: RIV = RSUMIV / K

END SUB

DEFINT A-Q, S-Z
SUB IVSCAN (df$, datf$, range, RSCAN, re0, CHOICE$, NI, NNI, NS, NSCC, NSC, RVE, RVEL, RI, RLGI, R, RVSTART, RVLIMIT, I, KKK)
DIM RIA(2300), RLGIA(2300), RVEA(2300), RSIA(2300)

   A$ = " Press ENTER key to begin preparation for polarization measurements "
   LOCATE 24, 1: PRINT CHR$(177); AS$ + CHR$(177)
   LOCATE 24, 1: FOR I = 1 TO 78: PRINT CHR$(177); : NEXT I
   I = I - 1
100 LOCATE 22, I: PRINT CHR$(177)
   IF I = 1 THEN GOTO 120
   I = I - 1
110 GOTO 100
120 PRINT CHR$(177) + AS$ + CHR$(177)
   SOUND 500, 3: SOUND 700, 5
   LOCATE 25, 1: INPUT " ", Y$
200 CLS : PRINT "<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>"
   PRINT "<<<<<<<<<<*   POLARIZATION MEASUREMENTS for CORROSION STUDIES   *>>>>>>>>>>>"
   PRINT "<<<<<<<<<<<<<<<<<<<<<LINEAR SWEEP & CYCLIC VOLTAMMETRY>>>>>>>>>>>>>>>>>>>>>>>>"

   PRINT : PRINT : PRINT "***> SELECT Measurement Mode  and ENTER  corresponding letter : "
   PRINT : PRINT "Mode    Initial direction   Initial E/V    Final E/V"
   PRINT : PRINT "(a)          ANODIC          Rest Potential  Most Anodic"
   PRINT : PRINT "(b)          ANODIC          Most Cathodic   Rest Potential"
   PRINT : PRINT "(c)          ANODIC          Most Cathodic   Most Anodic"
   PRINT : PRINT "(d)          CATHODIC        RestPotential   Msot Cathodic"
   PRINT : PRINT "(e)          CATHODIC        Most Anodic     Rest Potential"
   PRINT : PRINT "(f)          CATHODIC        Most Anodic     Most cathodic"


   PRINT : INPUT "YOUR CHOICE  ? ", CHOICE$

   IF ASC(CHOICE$) < 97 OR ASC(CHOICE$) > 102 THEN 200
   PRINT : INPUT " How many Sweeps ", NS

   PRINT "****  Select Potential Sweep Rate [ 0.1, 0.2, 0.5, 1, 2, 5, 10, 20,"
   PRINT : PRINT : INPUT "50, 100, 200, 500 mV/s ] :", RSCAN
   PRINT : PRINT : COLOR 14, 15: PRINT "      REST POTENTIAL/ mV(SCE) = "; re0
```

```
PRINT : INPUT " Begin SCAN from what potential (in milivolts) ? ", RVSTART
PRINT : PRINT "ENTER (value in mV, and include - or + sign) the SCAN"
PRINT : INPUT "limit of the most cathodic or the most anodic potential : ", RVLIMIT
PRINT : INPUT "ENTER THE SCAN RANGE,ABOUT 1 ; 2 OR 4 VOLT ???", range
PRINT : COLOR 13, 5: PRINT " PLEASE SET THE INITIAL AND FINAL POTENTIAL ACCORDING TO THE VALUE YOU KEYIN"
PRINT : INPUT "AND PRESS ENTER KEY TO CONTINUE. ", EN$

CALL IRSELECT(RC): REM - To select Current Range .
R = RC
PRINT : COLOR 14, 5: PRINT " PLEASE MAKE SURE ALL THE CONTROLS HAVE BEEN CORRECTLY MADE": PRINT
BEEP: SLEEP
COLOR 12, 15
PRINT "  Push in CELL ON/OFF BUTTON to complete cell connection to the Potentiostat ."
PRINT : INPUT "PRESS ENTER KEY", EN$
PRINT : INPUT " <<<<<<<        Press ENTER key and to begin Sweep.      >>>>>>>                    <<<<<<<  Enter any Le
reset conditions. >>>>>>>"; EN$
IF LEN(EN$) <> 0 THEN 200
COLOR 15, 1

IF (RSCAN = .1 AND range = 4) OR (RSCAN = .1 AND range = 2) OR (RSCAN = .2 AND range = 4) THEN RDT = 200
IF (RSCAN = .5 AND range = 4) OR (RSCAN = .2 AND range = 2) OR (RSCAN = .1 AND range = 1) THEN RDT = 100
IF RSCAN = .5 AND range = 1 THEN RDT = 10
IF (RSCAN = .5 AND range = 2) OR (RSCAN = .2 AND range = 1) THEN RDT = 10
IF RSCAN = 20 OR RSCAN = 10 OR RSCAN = 5 OR RSCAN = 2 OR RSCAN = 1 THEN RDT = 5
IF RSCAN = 50 AND range = 4 THEN RDT = 10
IF (RSCAN = 50 AND range = 1) OR (RSCAN = 50 AND range = 2) THEN RDT = 5
IF RSCAN = 100 OR RSCAN = 200 OR RSCAN = 500 THEN RDT = 5

SCREEN 9: CLS : CALL PLOTAXES(Q, RSCAN)
CALL inton(RDT, MIL)
CALL kdwarn(WARNOFF)

  I = 0: NI = 0: NSC = 1: NSCC = 1: NNI = 1: NNA = 1: NNB = 1: NNC = 1: NND = 1
  IOI = 1

  IF I = 0 AND CHOICE$ = "a" THEN RVEL = RVSTART - 100
  IF I = 0 AND CHOICE$ = "b" THEN RVEL = RVSTART - 100
  IF I = 0 AND CHOICE$ = "c" THEN RVEL = RVSTART - 100
  IF I = 0 AND CHOICE$ = "d" THEN RVEL = RVSTART + 100
  IF I = 0 AND CHOICE$ = "e" THEN RVEL = RVSTART + 100
  IF I = 0 AND CHOICE$ = "f" THEN RVEL = RVSTART + 100

300     I = I + 1: NI = NI + 1
  IF I = 5 + NNI THEN RVEL = RVED
  IF I = 4 + NND THEN RVED = RVEC
  IF I = 3 + NNC THEN RVEC = RVEB
  IF I = 2 + NNB THEN RVEB = RVEA
  IF I = 1 + NNA THEN RVEA = RVE
  IF I = 1 + NNA THEN NNA = NNA + 1
  IF I = 2 + NNB THEN NNB = NNB + 1
  IF I = 3 + NNC THEN NNC = NNC + 1
  IF I = 4 + NND THEN NND = NND + 1
  IF I = 5 + NNI THEN NNI = NNI + 1

  CALL IVFGREAD(REV, RIV, RSCAN, range)
LOCATE 1, 40: PRINT "E initial/mV:"; RVSTART
LOCATE 2, 40: PRINT "E limit/mV:"; RVLIMIT
LOCATE 1, 60: PRINT "pt."; I
LOCATE 3, 40: PRINT "RVEL="; RVEL
RVE = REV: RI = RIV * R / 1000: RSIV = RI: REM Current in mA
IF RI < 0 THEN RI = -RI
IF RI > 0 THEN RLGI = LOG(RI / 1000) / LOG(10)
LOCATE 2, 20: PRINT "E/mV:"; : PRINT USING "####.#"; REV
LOCATE 3, 20: PRINT "I/mA"; : PRINT USING "##.#####"; RI
LOCATE 2, 60: PRINT "SCAN RATE:"; : PRINT USING "###.#"; RSCAN; : PRINT "mV/s"
```

```
LOCATE 1, 20: PRINT "RVI/mV:"; : PRINT USING "####.#"; RIV

IF NSC = 1 THEN KKK = 14
IF NSC = 2 THEN KKK = 12
IF NSC = 3 THEN KKK = 10
IF NSC = 4 THEN KKK = 15
IF NSC = 5 THEN KKK = 13
IF NSC = 6 THEN KKK = 11
IF NSC > 6 THEN KKK = 4



IF Q = 1 THEN CALL PLOTi(re0, REV, RI, KKK)
IF Q = 2 THEN CALL PLOTlogi(re0, REV, RLGI, KKK)

RIA(I) = RI: RLGIA(I) = RLGI: RVEA(I) = RVE: RSIA(I) = RSIV

STOP$ = INKEY$
IF STOP$ = "s" THEN intoff
IF STOP$ = "s" THEN GOTO 450
G = 2 * NSCC - 1
H = 2 * NSCC


IF CHOICE$ = "a" AND NSC = G AND RVEL < REV THEN IOI = 1
IF CHOICE$ = "a" AND NSC = G AND RVEL < REV THEN GOTO 300
IF CHOICE$ = "b" AND NSC = G AND RVEL < REV THEN IOI = 1
IF CHOICE$ = "b" AND NSC = G AND RVEL < REV THEN GOTO 300
IF CHOICE$ = "c" AND NSC = G AND RVEL < REV THEN IOI = 1
IF CHOICE$ = "c" AND NSC = G AND RVEL < REV THEN GOTO 300
IF CHOICE$ = "a" AND NSC = H AND RVEL > REV THEN IOI = 1
IF CHOICE$ = "a" AND NSC = H AND RVEL > REV THEN GOTO 300
IF CHOICE$ = "b" AND NSC = H AND RVEL > REV THEN IOI = 1
IF CHOICE$ = "b" AND NSC = H AND RVEL > REV THEN GOTO 300
IF CHOICE$ = "c" AND NSC = H AND RVEL > REV THEN IOI = 1
IF CHOICE$ = "c" AND NSC = H AND RVEL > REV THEN GOTO 300
IF CHOICE$ = "d" AND NSC = G AND RVEL > REV THEN IOI = 1
IF CHOICE$ = "d" AND NSC = G AND RVEL > REV THEN GOTO 300
IF CHOICE$ = "e" AND NSC = G AND RVEL > REV THEN IOI = 1
IF CHOICE$ = "e" AND NSC = G AND RVEL > REV THEN GOTO 300
IF CHOICE$ = "f" AND NSC = G AND RVEL > REV THEN IOI = 1
IF CHOICE$ = "f" AND NSC = G AND RVEL > REV THEN GOTO 300
IF CHOICE$ = "d" AND NSC = H AND RVEL < REV THEN IOI = 1
IF CHOICE$ = "d" AND NSC = H AND RVEL < REV THEN GOTO 300
IF CHOICE$ = "e" AND NSC = H AND RVEL < REV THEN IOI = 1
IF CHOICE$ = "e" AND NSC = H AND RVEL < REV THEN GOTO 300
IF CHOICE$ = "f" AND NSC = H AND RVEL < REV THEN IOI = 1
IF CHOICE$ = "f" AND NSC = H AND RVEL < REV THEN GOTO 300
IOI = IOI + 1
IF IOI < 4 THEN GOTO 300
IF NSCC = (NSC / 2) THEN NSCC = NSCC + 1
NSC = NSC + 1
IOI = 1

IF NSC <= NS THEN GOTO 300
intoff
450 LOCATE 24, 40: INPUT "Press ENTER-key to continue.", EN$
SCREEN 0: LOCATE 22, 25: COLOR 4, 15: INPUT "SAVE DATA (Y/N) ? ", ny$
IF ny$ = "n" THEN END

LOCATE 22, 25: COLOR 4, 15: PRINT "<< NOW SAVING DATA >>"

OPEN df$ FOR APPEND AS #1
IF I = 1 THEN WRITE #1, NI, RVSTART, RVLIMIT, RSCAN
FOR I = 1 TO NI
```

```
    WRITE #1, I, RIA(I), RLGIA(I), RVEA(I), RSIA(I)
    NEXT I
    CLOSE #1

    OPEN datf$ FOR APPEND AS #2
    FOR I = 1 TO NI
    WRITE #2, RIA(I), RVEA(I), RLGIA(I), RSIA(I)
    NEXT I
    CLOSE #2




500
END SUB

DEFINT A-Q, S-Z
SUB makefile0 (df$, datf$, ntime, T$, exptdate$, RSCAN) STATIC

 OPEN df$ FOR OUTPUT AS #1
 WRITE #1, ntime, T$, exptdate$
 CLOSE #1

 OPEN datf$ FOR OUTPUT AS #2
 WRITE #2, RSCAN, "mV/s"
 CLOSE #2

END SUB

DEFINT A-Q, S-Z
SUB PLOTAXES (Q, RSCAN)

 REM Subroutine to plot axes.

 CLS : LOCATE 12
     INPUT "Plot Potential versus  <1> I   or   <2> log I  "; Q
     CLS
     PRINT : PRINT "***** PRESS IN THE INITIAL/SCAN PUSHBUTTON if you need to do a"
     PRINT "potentiodynamic scan *****"
     BEEP: SLEEP
     SCREEN 9, 1: COLOR 15, 1
     CLS : LINE (79, 290)-(639, 290), 11: 'x-axis

     LOCATE 1, 50: COLOR 14
     G = REMEANE0 * 14 / 800 + 150
     COLOR 15
     LOCATE 22: IF Q = 2 THEN PRINT "                    -4          -3          -2          -1          0" ELSE PRI
   2    4    6    8    10    12    14    16    18    20"
     LINE (79, 10)-(80, 308), 11, BF: 'y-axis.
     FOR I1 = 10 TO 308 STEP 7
     LINE (76, I1)-(79, I1), 11
     NEXT I1
     FOR L = 10 TO 308 STEP 14
     LINE (72, L)-(79, L), 11
     NEXT L
     IF Q = 1 THEN ldiv = 25 ELSE ldiv = 50
     IF Q = 1 THEN kstart = 104 ELSE kstart = 129
     FOR K = kstart TO 639 STEP ldiv
     LINE (K, 290)-(K, 296), 11
     NEXT K
     IF Q = 1 THEN div = 5 ELSE div = 10
     FOR H = 79 TO 639 STEP div
     LINE (H, 290)-(H, 292), 11
     NEXT H
     LOCATE 3, 4: PRINT "+0.40"
```

```
     LOCATE 5, 4: PRINT "+0.30"
     LOCATE 7, 4: PRINT "+0.20"
     LOCATE 9, 4: PRINT "+0.10"
     LOCATE 1, 2: COLOR 14: PRINT "E/V (w.r.t. SCE)"
     LOCATE 11, 4: COLOR 15: PRINT " 0.00"
     LOCATE 13, 4: PRINT "-0.10"
     LOCATE 15, 4: PRINT "-0.20"
     LOCATE 17, 4: PRINT "-0.30"
     LOCATE 19, 4: PRINT "-0.40"
     LOCATE 21, 4: PRINT "-0.50"
     LOCATE 23, 67: COLOR 14: IF Q = 1 THEN PRINT " I / mA" ELSE PRINT " log (I/A)"

END SUB


DEFINT A-Q, S-Z
SUB plotaxes0 (Q)

 LOCATE 2, 25: COLOR 15: PRINT "** REST POTENTIAL MEASUREMENTS **"
 scale = 200
  y2n = -7 * scale: y3n = -8 * scale: y4n = -9 * scale
  y1n = -6 * scale: y0 = -5 * scale: y1 = -4 * scale: y2 = -3 * scale
  y3 = -2 * scale: y4 = -1 * scale
  y1n$ = STR$(y1n): y0$ = STR$(y0): y1$ = STR$(y1): y2$ = STR$(y2)
  y3$ = STR$(y3): y4$ = STR$(y4)
  y2n$ = STR$(y2n): y3n$ = STR$(y3n): y4n$ = STR$(y4n)

 x0$ = "0": x1$ = "10": x2$ = "20": x3$ = "30": x4$ = "40": x5$ = "50": x6$ = "60": x7$ = "70": x8$ = "80"

  dy = 30
  h1 = 15
  h0 = 23
 v1 = 2
 LINE (50, 270 + dy)-(450, 270 + dy), 15: 'x-axis
 LINE (50, 300 + dy)-(50, 20 + dy), 15: 'y-axis.
 FOR L = 300 + dy TO 24 + dy STEP -6
 LINE (48, L)-(51, L), 15
 NEXT L
 FOR L = 300 + dy TO 24 + dy STEP -30
 LINE (47, L)-(53, L), 14
 NEXT L
 FOR K = 50 TO 450 STEP 10
 LINE (K, 269 + dy)-(K, 271 + dy), 15
 NEXT K
 FOR H = 50 TO 450 STEP 50
 LINE (H, 267 + dy)-(H, 273 + dy), 14
 NEXT H
 COLOR 15, 5
 LOCATE h1 + 1, v1: PRINT y1n$
 LOCATE h1 + 3, v1: PRINT y2n$
 LOCATE h1 + 5, v1: PRINT y3n$
 LOCATE h1 + 7, v1: PRINT y4n$

 LOCATE h1 - 2, v1: PRINT y0$
 LOCATE h1 - 4, v1: PRINT y1$ + " "
 LOCATE h1 - 6, v1: PRINT y2$ + " "
 LOCATE h1 - 8, v1: PRINT y3$ + " "
 LOCATE h1 - 10, v1: PRINT y4$ + " "
 LOCATE h0, 13: PRINT x1$
 LOCATE h0, 19: PRINT x2$
 LOCATE h0, 26: PRINT x3$
 LOCATE h0, 32: PRINT x4$
 LOCATE h0, 38: PRINT x5$
 LOCATE h0, 44: PRINT x6$
 LOCATE h0, 51: PRINT x7$
```

```
LOCATE h0, 57: PRINT x8$
LOCATE (h0 - 2), 45: COLOR 14, 1: PRINT "Time / min."
LOCATE 3, 2
PRINT "REST POTENTIAL / mV"

END SUB

DEFINT A-Q, S-Z
SUB PLOTi (re0, REV, RI, KKK)
    REM Subroutine to plot E vs. current(mA)  data.
    RX0 = 0: RY0 = 0
    XPIX = (RI - RX0) * 25 + 79
    YPIX = (RY0 - REV) * (24 / 100) + 150
    PSET (XPIX, YPIX), KKK

END SUB

DEFINT A-Q, S-Z
SUB PLOTlogi (re0, REV, RLGI, KKK)
    REM Subroutine to plot E vs. log i data.
    RX0 = -5: RY0 = 0
    XPIX = (RLGI - RX0) * 100 + 79
    YPIX = (RY0 - REV) * (24 / 100) + 150
    PSET (XPIX, YPIX), KKK

    END SUB

DEFINT A-Q, S-Z
  SUB SAVEDATA (df$, I, NI, RVSTART, RVLIMIT, RSCAN, RI, RVE, RSIA, RLGI) : ' to save I-E data on disk.


  OPEN df$ FOR APPEND AS #1
  IF I = 1 THEN WRITE #1, NI, RVSTART, RVLIMIT, RSCAN
  FOR I = 1 TO NI
  WRITE #1, I, RI, RLGI, RVE, RSIA
  NEXT I
  CLOSE #1

  END SUB

DEFINT A-Q, S-Z
SUB TABLDATA (RSCAN, I, RDT, RLGI, RI, RVE, NI)

    REM Subroutine to print data ( I, log I, E ).

    LPRINT "SCAN Rate/ mV/s = "; : LPRINT USING "##.##"; RSCAN: LPRINT
    LPRINT " Pt.#         E/V              I/A              log(I/A)"
    FOR I = 0 TO NI
    LPRINT I; "              ";
    LPRINT USING "##.####"; RVE; : LPRINT "      ";
    LPRINT USING "#.###^^^^"; RI; : LPRINT "         ";
    LPRINT USING "##.######"; RLGI
    NEXT I
    LOCATE 24, 50: INPUT "Press ENTER to continue. ", SPB$

END SUB
```

Appendix 7

Environmental Quality Act 1974

Environment Qualitiy (Sewage and Industrial Effluents) Regulations 1978 [regulation 8(1), 8(2), 8(3)]

Table 13. Parameter Limits of Effluent of Standard B

Parameter	Parameter limit
1. Temperature	40°C
2. pH value	5.5-9.0
3. BOD at 20°C	50 ppm
4. COD	100 ppm
5. Suspended Solids	100 ppm
6. Mercury	0.05 ppm
7. Cadmium, Hexavalent	0.02 ppm
8. Chromium	0.05 ppm
9. Arsenic	0.10 ppm
10. Cyanide	0.10 ppm
11. Lead	0.5 ppm
12. Chromium, Trivalent	1.0 ppm
13. Copper	1.0 ppm
14. Manganese	1.0 ppm
15. Nickel	1.0 ppm
16. Tin	1.0 ppm
17. Zinc	1.0 ppm
18. Boron	4.0 ppm
19. Iron	5.0 ppm
20. phenol	1.0 ppm
21. Free chloride	2.0 ppm
22. Sulphide	0.05 ppm
23. Oil and grease	10.0 ppm
	* 1ppm = 1 mg/L

Appendix (8)

Table 14a: Voltage across the electrolysis cell during the electrolysis process for solution in the absence of NaCl.

Electrode: Stainless steel Without NaCl							
	Current density 5 mA/cm²			Current density 10mA/cm²		Current density 15mA/cm²	
	Voltage /V			Voltage /V		Voltage /V	
Time/min	Cu 500 ppm	Cu 100 ppm	Cr 50 ppm	Cu 100 ppm	Ni 100 ppm	Cu 500 ppm	Cr 100 ppm
0	2.5	11.5	17.8	31.3	24.1	5.8	21.8
15	3.58	10.4	17.5	16.8	16.7	7.2	25.3
30	3.6	12.2	18.2	20.6	15.1	7.5	29.8
45	3.1	15.8	20.0	22.2	15.0	5.9	28.9
60	3.2	16.8	19.3	21.6	15.2	5.1	28.6
90	3.0	------	20.0		14.8	-----	30.3

Table 14b: Voltage across the electrolysis cell during the electrolysis process for solution with the addition of 0.01 mol/L NaCl.

Electrode: Stainless steel NaCl: 0.01 mol/L							
	Current density 5 mA/cm²		Current density 10mA/cm²			Current density 15mA/cm²	
	Voltage /V		Voltage /V			Voltage /V	
Time/min	Cu 500 ppm	Cu 50 ppm	Cu 50 ppm	Cu 100 ppm	Cu 500 ppm	Cu 500 ppm	Cu 100 ppm
0	3.6	5.9	8.7	8.9	6.4	7.1	11.9
15	3.2	5.9	9.1	8.5	5.6	7.3	11.3
30	3.6	5.8	9.1	8.6	5.6	7.6	11.3
45	3.6	5.8	9.1	8.4	5.7	7.7	11.5
60	3.6	5.9	9.1	8.7	5.7	7.8	11.3
90	-----	5.9	9 1	----	-----	----	11.2

Table 14c: Voltage across the electrolysis cell during the electrolysis process for solution with addition of 0.03 mol/L NaCl.

Electrode: Stainless steel NaCl: 0.03 mol/L									
	Current density 5 mA/cm^2			Current density 10mA/cm^2			Current density 15mA/cm^2		
	Voltage /V			Voltage /V			Voltage /V		
Time/min	Cu 500 ppm	Cu 100 ppm	Cr 50 ppm	Ni 50 ppm	Ni 100 ppm	Cr 100 ppm	Ni 100 ppm	Cu 100 ppm	Cr 100 ppm
0	2.9	4.4	3.7	5.4	5.5	4.7	6.5	6.4	6.4
15	2.8	4.1	3.6	4.9	4.8	4.8	5.9	5.4	6.1
30	2.8	4.1	3.5	5.1	4.9	4.7	5.9	5.4	6.0
45	2.9	4.1	3.4	5.2	4.9	4.7	5.9	5.3	6.1
60	2.9	4.1	3.4	5.2	4.9	4.7	5.8	5.2	6.0
90	---	---	3.4	5.2	5.0	4.6	5.8	---	6.0

Table 14d: Voltage across the electrolysis cell during the electrolysis process for solution with addition of 0.05 mol/L NaCl.

Electrode: Stainless steel NaCl: 0.05 mol/L								
	Current density 5 mA/cm^2			Current density 10mA/cm^2			Current density 15mA/cm^2	
	Voltage /V			Voltage /V			Voltage /V	
Time/min	Cu 500 ppm	Cu 100 ppm	Ni 100 ppm	Cu 100 ppm	Cu 500 ppm	Ni 500 ppm	Cr 500 ppm	Cu 500 ppm
0	2.6	3.0	2.9	8.9	3.8	4.0	5.2	4.0
15	2.3	2.6	2.7	8.5	3.5	3.4	--	4.0
30	2.2	2.6	2.7	8.6	3.5	4.0	3.7	4.2
45	2.3	2.6	2.7	8.4	3.5	4.0	--	4.6
60	2.2	2.6	2.6	8.7	3.5	4.0	3.7	4.6
90	---	2.6	2.7	--	--	4.1	3.6	--

Appendix (9)

Table 15: Voltage across the electrolysis cell during the electrolysis process.

Electrode: Aluminium Current density: 20 mA/cm^2
Solution : mixed of 100 ppm each Cu, Cr, Ni ions and 0.03 mol/L NaCl

Time/min.	Potential/ V
0	5.11
15	4.93
30	4.94
45	5.06
60	5.13
90	4.97

Electrode: Stainless steel Current density: 20 mA/cm^2
Solution : mixed of 100 ppm each Cu, Cr, Ni ions and 0.03 mol/L NaCl

Time/min.	Potential/ V
0	6.35
15	6.09
30	6.08
45	5.88
60	5.94
90	6.01

APPENDIX (10)

Table 16: Atomic absorption spectroscopy analysis results for concentration of iron remaining in solution after treatment and filtration.

sample no.	initial heavy metal concentration (ppm)	heavy metal in solution (ppm)	treatment time (minute)	current density (mA/cm^2)	sodium chloride concentration (mol/L)	Fe ions (ppm)
2C4	Cu 500	219.4	45	15	0	276
2C7	Cu 500	2.338	420	15	0	431
30A6	Cu 50	0.074	90	10	0.03	0.019
22A4	Cu 100	0.218	90	15	0.03	0.032
41A5	Cr 500	4.644	120	15	0.05	0.020
39A6	Cr 100	0.058	90	15	0.03	0.054
47A5	Cr 100	114.7	90	15	0	134
55A5	Ni 100	38.60	90	10	0	72.4
59A5	Ni 100	7.192	90	10	0.03	0.022

1 ppm = 1mg/Liter

Appendix 11

(a). Results of image processing and analysis of non-magnetic iron hydrous oxide

Number	Area (μm²)	X FCP	Y FCP	Feret0 (μm)	Length (μm)	Breadth (μm)	Perimeter (μm)	EquivDiam (μm)
1	1.272	315	145	1.294	1.294	1.164	4.269	1.272
2	1.272	358	166	1.294	1.294	1.164	4.269	1.272
3	0.87	170	173	1.035	1.035	0.905	3.493	1.052
4	0.87	338	196	1.035	1.035	0.905	3.493	1.052
5	1.272	395	221	1.294	1.294	1.164	4.269	1.272
6	0.87	171	227	1.035	1.035	0.905	3.493	1.052
7	0.87	375	252	1.035	1.035	0.905	3.493	1.052
8	0.87	57	276	1.035	1.035	0.905	3.493	1.052
9	0.87	151	280	1.035	1.035	0.905	3.493	1.052
10	1.272	206	280	1.294	1.294	1.164	4.269	1.272
11	0.87	188	290	1.035	1.035	0.905	3.493	1.052
12	1.272	54	295	1.294	1.294	1.164	4.269	1.272
13	0.87	258	309	1.035	1.035	0.905	3.493	1.052
14	0.87	199	347	1.035	1.035	0.905	3.493	1.052
15	0.87	190	435	1.035	1.035	0.905	3.493	1.052
Total	15.059	3425	3892	16.816	16.816	14.876	56.269	16.886
Mean	1.004	228.33	259.47	1.121	1.121	0.992	3.751	1.126
Std Dev	0.189	104.37	73.108	0.122	0.122	0.122	0.366	0.104
Std Error	0.049	26.948	18.876	0.031	0.031	0.031	0.094	0.027
Max	1.272	395	435	1.294	1.294	1.164	4.269	1.272
Min	0.87	54	145	1.035	1.035	0.905	3.493	1.052
2-s Range	0.757	417.48	292.43	0.488	0.488	0.488	1.463	0.415
Features	15							

(b). Results of image processing and analysis of magnetic iron hydrous oxide

Number	Area (μm²)	X FCP	Y FCP	Feret0 (μm)	Length (μm)	Breadth (μm)	Perimeter (μm)	EquivDiam (μm)
1	1.874	282	96	1.552	1.552	1.423	5.303	1.545
2	1.874	183	102	1.552	1.552	1.423	5.303	1.545
3	2.476	182	215	1.811	1.811	1.682	5.95	1.776
4	1.272	188	270	1.294	1.294	1.164	4.269	1.272
5	1.874	305	321	1.552	1.552	1.423	5.303	1.545
6	1.874	154	371	1.552	1.552	1.423	5.303	1.545
7	0.87	284	416	1.035	1.035	0.905	3.493	1.052
8	1.272	308	431	1.294	1.294	1.164	4.269	1.272
9	1.874	255	436	1.552	1.552	1.423	5.303	1.545
Total	15.26	2141	2658	13.194	13.194	12.03	44.497	13.096
Mean	1.696	237.89	295.33	1.466	1.466	1.337	4.944	1.455
Std Dev	0.448	57.2	126.2	0.211	0.211	0.211	0.721	0.203
Std Error	0.149	19.067	42.068	0.07	0.07	0.07	0.24	0.068
Max	2.476	308	436	1.811	1.811	1.682	5.95	1.776
Min	0.87	154	96	1.035	1.035	0.905	3.493	1.052
2-s Range	1.794	228.8	504.81	0.845	0.845	0.845	2.884	0.813
Features	9							

APPENDIX (12)

Table 17: Maximum (based on assuming 100% efficiencies and the quantity of electricity passed through the cell) amounts of iron and aluminium dissolved from anodes during electrolysis treatment for a given period.

	amount of iron dissolved in solution (mg)			amount of aluminium dissolved in solution (mg)		
electrolysis time (minute)	current density 5 mA/cm^2 (840 mA)	current density 10 mA/cm^2 (1680 mA)	current density 15 mA/cm^2 (2520 mA)	current density 5 mA/cm^2 (840 mA)	current density 10mA/cm^2 (1680 mA)	current density 15 mA/cm^2 (2520 mA)
15	219	439	658	71	141	212
30	439	877	1316	141	282	423
45	658	1155	1974	211	423	635
60	877	1755	2632	282	564	846
90	1316	2632	3948	423	846	1269
120	1755	3510	5264	564	1128	1692

$$\text{amount of metal dissolved (g)} = \frac{\text{current passed (A) x time (second) x molar mass (g/mol)}}{\text{charge tranferred x Faraday number (96485 C/mol)}}$$