Scilab Textbook Companion for Applied Chemistry by J. A. Parikh[1]

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Book Description

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Scilab numbering policy used in this document and the relation to the above book.

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

AP Appendix to Example(Scilab Code that is an Appednix to a particular Example of the above book)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means a scilab code whose theory is explained in Section 2.3 of the book.

Contents

List of Scilab Codes

Chapter 2

Water and its Treatment

Scilab code Exa 2.18.1 hardness calculation

```
1 //water and its treatment//
2 //example 2.18.1//
3 clc
4 W1=12.5;//CaCO3 in water in mg/lit//
5 W2=8.4;//MgCO3 in water in mg/lit//
6 W3=22.2;//CaCl2 in water in mg/lit//
7 W4=9.5;//MgCl2 in water in mg/lit//
8 W5=33;//CO2 in water in mg/lit//
9 W6=6.68;//NaHCO3 in water in mg/lit//
10 M1=100/100;//multiplication factor of CaCO3//
11 M2=100/84;//multiplication factor of MgCO3//
12 M3=100/111;//multiplication factor of CaCl2//
13 M4=100/95;//multiplication factor of MgCl2//
14 M6=100/84;//multiplication factor of NaHCO3//
15 P1=W1*M1;//CaCO3 in terms of CaCO3//
16 P2=W2*M2;//MgCO3 in terms of CaCO3//
17 P3=W3*M3;//CaCl2  in terms of CaCO3//
18 P4=W4*M4;//MgCl2 in terms of CaCO3//
19 P6=W6*M6;//NaHCO3 in terms of CaCO3//
20 printf ("We do not take CO2 since it does not
     contribute to hardness ");
```

```
21 C=P1+P2+P6;
22 printf("\nCarbonate hardness is %.1f mg/l or ppm",C)
     ;
23 NC=P3+P4;
24 printf("\nNon Carbonate hardness is %.0f mg/l or ppm
     ",NC);
```

Scilab code Exa 2.18.2 hardness calculation

```
1  //water and its treatment//
2  //example 2.18.2//
3  clc
4  W1=40.5;//Ca(HCO3)2 in water in mg/lit//
5  W2=33.3;//CaCl2 in water in mg/lit//
6  W3=41;//Ca(NO3)2 in water in mg/lit//
7  W4=101;//KNO3 in water in mg/lit//
8  W5=33.6;//MgCO3 in water in mg/lit//
9  M1=100/162;//multiplication factor of Ca(HCO3)2//
10 M2=100/111;//multiplication factor of CaCl2//
11 M3=100/164;//multiplication factor of Ca(NO3)2//
12 M5=100/84;//multiplication factor of MgCO3//
13 P1=W1*M1;//Ca(HCO3)2 in terms of CaCO3//
14 P2=W2*M2;//CaCl2 in terms of CaCO3//
15 P3=W3*M3;//Ca(NO3)2  in terms of CaCO3//
16 P5=W5*M5;//MgCO3 in terms of CaCO3//
17 printf ("We do not take KNO3 since it does not
     contribute to hardness ");
18 C=P1+P5;
19 printf("\nCarbonate hardness is %.0f mg/l or ppm",C)
     ;
20 NC=P2+P3;
21 printf("\nNon Carbonate hardness is %.0f mg/l or ppm
     ",NC);
```

Scilab code Exa 2.18.3 hardness calculation

```
1 //water and its treatment//
2 //example 2.18.3//
3 clc
4 W1=29.1;//Mg(HCO3)2 in water in mg/lit//
5 W2=40.5;//Ca(HCO3)2 in water in mg/lit//
6 W3=11.1;//CaCl2 in water in mg/lit//
7 W4=15.82;//MgCl2 in water in mg/lit//
8 W5=28.5;//NaCl in water in mg/lit//
9 W6=22.0;//CO2 in water in mg/lit//
10 M1=100/146.007;//multiplication factor of Mg(HCO3)
   2//
11 M2=100/162;//multiplication factor of Ca(HCO3)2//
12 M3=100/111;//multiplication factor of CaCl2//
13 M4=100/95.005;//multiplication factor of MgCl2//
14 P1=W1*M1;//Mg(HCO3)2 in terms of CaCO3//
15 P2=W2*M2;//Ca(HCO3)2 in terms of CaCO3//
16 P3=W3*M3;//CaCl2  in terms of CaCO3//
17 P4=W4*M4;//MgCl2 in terms of CaCO3//
18 printf ("We do not take NaCl and CO2 since they do
   not contribute to hardness ");
19 C=P1+P2;
20 printf("\nCarbonate hardness is %.3f mg/l or ppm",C)
   ;
21 NC=P3+P4;
22 printf("\nNon Carbonate hardness is %.3f mg/l or ppm
   ",NC);
```

Scilab code Exa 2.18.4 hardness calculation

```
1 //water and its treatment//
```

```
2 //example 2.18.4//
3 clc
4 W1=16.2;//Ca(HCO3)2 in water in mg/lit//
5 W2=14.6;//Mg(HCO3)2 in water in mg/lit//
6 W3=9.5;//MgCl2 in water in mg/lit//
7 W4=48;//MgSO4 in water in mg/lit//
8 W5=12;//KCl in water in mg/lit//
9 M1=100/162;//multiplication factor of Ca(HCO3)2//
10 M2=100/146;//multiplication factor of Mg(HCO3)2 //
11 M3=100/95;//multiplication factor of MgCl2//
12 M4=100/120;//multiplication factor of MgSO4//
13 P1=W1*M1;//Ca(HCO3)2 in terms of CaCO3//
14 P2=W2*M2;//Mg(HCO3)2 in terms of CaCO3//
15 P3=W3*M3;//MgCl2 in terms of CaCO3//
16 P4=W4*M4;//MgSO4 in terms of CaCO3//
17 printf ("We do not take KCl since it does not
   contribute to hardness ");
18 C=P1+P2;
19 printf("\nCarbonate hardness is %.0f mg/l or ppm",C)
   ;
20 NC=P3+P4;
21 printf("\nNon Carbonate hardness is %.0f mg/l or ppm
   ",NC);
```

Scilab code Exa 2.18.5 hardness calculation

```
1 //water and its treatment//
2 //example 2.18.5//
3 clc
4 W1=81;//Ca(HCO3)2 in water in mg/lit//
5 W2=84;//MgCO3 in water in mg/lit//
6 W3=22.2;//CaCl2 in water in mg/lit//
7 W4=60;//MgSO4 in water in mg/lit//
8 W5=30;//KCl in water in mg/lit//
9 M1=100/162;//multiplication factor of Ca(HCO3)2//
```

```
10 M2=100/84;//multiplication factor of MgCO3//
11 M3=100/111;//multiplication factor of CaCl2//
12 M4=100/120;//multiplication factor of MgSO4//
13 P1=W1*M1;//Ca(HCO3)2 in terms of CaCO3//
14 P2=W2*M2;//MgCO3 in terms of CaCO3//
15 P3=W3*M3;//CaCl2  in terms of CaCO3//
16 P4=W4*M4;//MgSO4 in terms of CaCO3//
17 printf ("We do not take KCl since it does not
     contribute to hardness ");
18 T=P1+P2;
19 printf("\nTemporary hardness is %.0f mg/l or ppm",T)
     ;
20 P=P3+P4;
21 printf("\nPermanant hardness is %.0f mg/l or ppm",P)
     ;
22 To=T+P;
23 printf("\nTotal hardness is %.0f mg/l or ppm",To);
```

Scilab code Exa 2.18.6 hardness calculation

```
1 //water and its treatment//
2 //example 2.18.6//
3 clc
4 W1=29.2;//MgCO3 in water in mg/lit//
5 W2=36;//MgSO4 in water in mg/lit//
6 W3=22.2;//CaCl2 in water in mg/lit//
7 W4=142.5;//MgCl2 in water in mg/lit//
8 M1=100/84;//multiplication factor of MgCO3//
9 M2=100/120;//multiplication factor of MgSO4//
10 M3=100/111;//multiplication factor of CaCl2//
11 M4=100/95;//multiplication factor of MgCl2//
12 P1=W1*M1;//MgCO3 in terms of CaCO3//
13 P2=W2*M2;//MgSO4 in terms of CaCO3//
14 P3=W3*M3;//CaCl2  in terms of CaCO3//
15 P4=W4*M4;//MgCl2 in terms of CaCO3//
```

```
16 T=P1;
17 printf("\nCarbonate hardness is %.2f mg/l or ppm",T)
     ;
18 P=P2+P3+P4;
19 printf("\nNon Carbonate hardness is %.0f mg/l or ppm
     ",P);
```

Scilab code Exa 2.18.7 hardness in different systems

```
1 //water and its treatment//
2 //example 2.18.7//
3 clc
4 Hardness_ppm=304//ppm in terms of CaCO3//
5 Cl=0.07*Hardness_ppm//0.07 Clarke =1 ppm//
6 Fr=0.1*Hardness_ppm//0.1 French =1 ppm//
7 mgperlit=Hardness_ppm
8 printf("Hardness in terms of Clarke %.2f Cl",Cl)
     ;
9 printf("\nHardness in terms of French %.1f Fr",
     Fr);
10 printf("\nHardness in terms of mg/lit %.0f mg/l",
     mgperlit);
```

Scilab code Exa 2.18.7.A hardness calculation

```
1 //water and its treatment//
2 //example 2.18.7.A//
3 clc
4 W1=32.4;//Ca(HCO3)2 in water in mg/lit//
5 W2=29.2;//Mg(HCO3)2 in water in mg/lit//
6 W3=13.5;//CaSO4 in water in mg/lit//
7 M1=100/162;//multiplication factor of Ca(HCO3)2//
8 M2=100/146;//multiplication factor of Mg(HCO3)2 //
```

```
M3=100/136;//multiplication factor of CaSO4//
P1=W1*M1;//Ca(HCO3)2 in terms of CaCO3//
P2=W2*M2;//Mg(HCO3)2  in terms of CaCO3//
P3=W3*M3;//CaSO4 in terms of CaCO3//
T=P1+P2;
printf("\nTemporary hardness is %.0f mg/l or ppm",T)
   ;
P=P3;
printf("\nPermanant hardness is %.0f mg/l or ppm",P)
   ;
To=T+P;
printf("\nTotal hardness is %.0f mg/l or ppm",To);
```

Scilab code Exa 2.18.8 hardness in different systems

```
//water and its treatment//
//example 2.18.8//
clc
Hardness_Cl=2.42//in terms of  Clarke//
Hardness_Fr=3.6//in terms of  French//
Cl=Hardness_Cl/0.07//0.07 Clarke =1 ppm//
Fr=Hardness_Fr/0.1//0.1 French =1 ppm//
printf("2.42 Clarke %.2f mg/l or ppm",Cl);
printf("\n 3.6  French %.0f mg/l or ppm",Fr);
```

Scilab code Exa 2.18.9 hardness in different systems

```
//water and its treatment//
//example 2.18.9//
clc
Hardness_ppm1=350//ppm in terms of CaCO3//
Hardness_ppm2=500//ppm in terms of CaCO3//
Cl=0.07*Hardness_ppm1//0.07 Clarke =1 ppm//
```

```
7 Fr=0.1*Hardness_ppm2//0.1 French =1 ppm//
8 printf("1)Hardness in terms of degree Clarke %.1f
      Cl",Cl);
9 printf("\n 2)Hardness in terms of degree French %.0f
      Fr",Fr);
```

Scilab code Exa 2.18.10 hardness calculation

```
1 //water and its treatment//
2 //example 2.18.10//
3 clc
4 W1=40.5;//Ca(HCO3)2 in water in mg/lit//
5 W2=23.75;//MgCl2 in water in mg/lit//
6 W3=21;//MgCO3 in water in mg/lit//
7 W4=6;//SiO2 in water in mg/lit//
8 W5=3;//CO2 in water in mg/lit//
9 W6=55.5;//CaCl2 in water in mg/lit//
10 M1=100/162;//multiplication factor of Ca(HCO3)2//
11 M2=100/95;//multiplication factor of MgCl2//
12 M3=100/84;//multiplication factor of MgCO3//
13 M6=100/111;//multiplication factor of CaCl2//
14 P1=W1*M1;//Ca(HCO3)2 in terms of CaCO3 or //
15 P2=W2*M2;//MgCl2 in terms of CaCO3 or //
16 P3=W3*M3;//MgCO3 in terms of CaCO3 or //
17 P6=W6*M6;//CaCl2 in terms of CaCO3 or //
18 printf ("We do not take SiO2 and CO2 since they do
     not contribute to hardness ");
19 C=P1+P3;
20 printf("\nCarbonate hardness is %.0f mg/l or ppm",C)
     ;
21 NC=P2+P6;
22 printf("\nNon Carbonate hardness is %.0f mg/l or ppm
     ",NC);
```

Scilab code Exa 2.18.11 `hardness calculation`

```
1 //water and its treatment//
2 //example 2.18.11//
3 clc
4 W1=17.5;//Ca(HCO3)2 in water in mg/lit//
5 W2=14.6;//Mg(HCO3)2 in water in mg/lit//
6 W3=9.5;//MgCl2 in water in mg/lit//
7 W4=12.0;//MgSO4 in water in mg/lit//
8 W5=8.4;//MgCO3 in water in mg/lit//
9 W6=5.5;//CaCl2 in water in mg/lit//
10 W7=35;//NaCl in water in mg/lit//
11 M1=100/162;//multiplication factor of Ca(HCO3)2//
12 M2=100/146;//multiplication factor of Mg(HCO3)2//
13 M3=100/95;//multiplication factor of MgCl2//
14 M4=100/120;//multiplication factor of MgSO4//
15 M5=100/84;//multiplication factor of MgCO3//
16 M6=100/111;//multiplication factor of CaCl2//
17 P1=W1*M1;//Ca(HCO3)2 in terms of CaCO3 or //
18 P2=W2*M2;//Mg(HCO3)2 in terms of CaCO3 or //
19 P3=W3*M3;//MgCl2  in terms of CaCO3 or //
20 P4=W4*M4;//MgSO4 in terms of CaCO3 or //
21 P5=W5*M5;//MgCO3 in terms of CaCO3 or //
22 P6=W6*M6;//CaCl2 in terms of CaCO3 or //
23 printf ("We do not take NaCl since it does not
     contribute to hardness ");
24 T=P1+P2+P5;
25 printf("\nTemporary hardness is %.1f mg/l or ppm",T)
     ;
26 P=P3+P4+P6;
27 printf("\nPermanant hardness is %.0f mg/l or ppm",P)
     ;
28 To=T+P;
29 printf("\nTotal hardness is %.1f mg/l or ppm",To);
```

Scilab code Exa 2.18.12 hardness calculation by EDTA method

```
1 //water and its treatment//
2 //example 2.18.12//
3 clc
4 strength_CaCl2=250/200//in terms of mgs/ml CaCO3//
5 volume_CaCl2=25//volume of CaCl2 titrated(ml)//
6 EDTA_CaCl2=35//volume in terms of ml//
7 volume_hardwater=25//volume of hardwater titrated(ml
    )//
8 EDTA_hardwater=30//volume used to titrate unknown
    hardwater//
9 CaCO3_equivalent_CaCl2=strength_CaCl2*volume_CaCl2//
    in terms of mg//
10 one_ml_EDTA=CaCO3_equivalent_CaCl2/EDTA_CaCl2//in
    terms of CaCO3 equivalent//
11 titrate_equivalent=one_ml_EDTA*EDTA_hardwater/
    volume_hardwater//CaCO3 equivalent of titrated
    volume//
12 Hardness=titrate_equivalent*1000//in terms of mg/lit
     or ppm//
13 printf("\nHardness of water is %.0f mg/l or ppm",
    Hardness);
```

Scilab code Exa 2.18.13 hardness calculation by EDTA method

```
1 //water and its treatment//
2 //example 2.18.13//
3 clc
4 strength_SH=1//strength of Std hardwater
5 volume_SH=50//in terms of ml//
6 volume_H=50//in terms of ml//
```

```
7 EDTA_SH=35//volume for Std hardwater(ml)//
8 EDTA_H=20//volume for sample hardwater(ml)//
9 AB_EDTA=12//volume required after boiling(ml)//
10 CaCO3_equivalent_SH=strength_SH*volume_SH//in terms
    of CaCO3 equivalent//
11 one_ml_EDTA=CaCO3_equivalent_SH/EDTA_SH//in terms of
    CaCO3 equivalent//
12 To_sample=one_ml_EDTA*EDTA_H/volume_H//total
    hardness for given volume//
13 To=To_sample*1000//total hardness per litre(ppm)//
14 P_sample=AB_EDTA*one_ml_EDTA/volume_H//permanent
    hardness for given volume//
15 P=P_sample*1000//permanent hardness per litre(ppm)//
16 T=To-P
17 printf("\nTotal Hardness is %.2f mg/l or ppm",To);
18 printf("\nPermanent Hardness is %.2f mg/l or ppm",P)
    ;
19 printf("\nTemporary Hardness is %.2f mg/l or ppm",T)
    ;
```

Scilab code Exa 2.18.14 hardness calculation by EDTA method

```
1 //water and its treatment//
2 //example 2.18.14//
3 clc
4 conc_SH=.5/500//in terms of g/lit//
5 strength_SH=conc_SH*1000//in terms of mgs/lit//
6 volume_SH=25//in terms of ml//
7 volume_H=50//in terms of ml//
8 EDTA_SH=24//volume for Std hardwater(ml)//
9 EDTA_H=22.5//volume for sample hardwater(ml)//
10 AB_EDTA=20//volume required after boiling(ml)//
11 CaCO3_equivalent_SH=strength_SH*volume_SH//in terms
    of CaCO3 equivalent//
12 one_ml_EDTA=CaCO3_equivalent_SH/EDTA_SH//in terms of
```

```
    CaCO3 equivalent//
To_sample=one_ml_EDTA*EDTA_H/volume_H//total
    hardness for given volume//
To=To_sample*1000//total hardness per litre(ppm)//
P_sample=AB_EDTA*one_ml_EDTA/volume_H//permanent
    hardness for given volume//
P=P_sample*1000//permanent hardness per litre(ppm)//
T=To-P
printf("\nTotal Hardness is %.f mg/l or ppm",To);
printf("\nPermanent Hardness is %.f mg/l or ppm",P);
printf("\nTemporary Hardness is %.f mg/l or ppm",T);
```

Scilab code Exa 2.18.15 hardness calculation by EDTA method

```
//water and its treatment//
//example 2.18.15//
clc
conc_SH=.2/200//in terms of g/lit//
strength_SH=conc_SH*1000//in terms of mgs/lit//
volume_SH=50//in terms of ml//
volume_H=50//in terms of ml//
EDTA_SH=48//volume for Std hardwater(ml)//
EDTA_H=15//volume for sample hardwater(ml)//
AB_EDTA=10//volume required after boiling(ml)//
CaCO3_equivalent_SH=strength_SH*volume_SH//in terms
    of CaCO3 equivalent//
one_ml_EDTA=CaCO3_equivalent_SH/EDTA_SH//in terms of
    CaCO3 equivalent//
To_sample=one_ml_EDTA*EDTA_H/volume_H//total
    hardness for given volume//
To=To_sample*1000//total hardness per litre(ppm)//
P_sample=AB_EDTA*one_ml_EDTA/volume_H//permanent
    hardness for given volume//
P=P_sample*1000//permanent hardness per litre(ppm)//
T=To-P
```

```
18 printf("\nTotal Hardness is %.f mg/l or ppm",To);
19 printf("\nPermanent Hardness is %.f mg/l or ppm",P);
20 printf("\nTemporary Hardness is %.f mg/l or ppm",T);
```

Scilab code Exa 2.18.16 hardness calculation by EDTA method

```
1 //water and its treatment//
2 //example 2.18.16//
3 clc
4 strength_SH=1//in terms of mgs/lit//
5 volume_SH=50//in terms of ml//
6 volume_H=50//in terms of ml//
7 EDTA_SH=20//volume for Std hardwater(ml)//
8 EDTA_H=25//volume for sample hardwater(ml)//
9 AB_EDTA=18//volume required after boiling(ml)//
10 CaCO3_equivalent_SH=strength_SH*volume_SH//in terms
   of CaCO3 equivalent//
11 one_ml_EDTA=CaCO3_equivalent_SH/EDTA_SH//in terms of
    CaCO3 equivalent//
12 To_sample=one_ml_EDTA*EDTA_H/volume_H//total
   hardness for given volume//
13 To=To_sample*1000//total hardness per litre(ppm)//
14 P_sample=AB_EDTA*one_ml_EDTA/volume_H//permanent
   hardness for given volume//
15 P=P_sample*1000//permanent hardness per litre(ppm)//
16 T=To-P
17 printf("\nTotal Hardness is %.f mg/l or ppm",To);
18 printf("\nPermanent Hardness is %.f mg/l or ppm",P);
19 printf("\nTemporary Hardness is %.f mg/l or ppm",T);
```

Scilab code Exa 2.18.17 hardness calculation by EDTA method

```
1 //water and its treatment//
```

```
2 //example 2.18.17//
3 clc
4 strength_SH=1//in terms of mgs/lit//
5 volume_SH=50//in terms of ml//
6 volume_H=50//in terms of ml//
7 EDTA_SH=20//volume for Std hardwater(ml)//
8 EDTA_H=30//volume for sample hardwater(ml)//
9 CaCO3_equivalent_SH=strength_SH*volume_SH//in terms
    of CaCO3 equivalent//
10 one_ml_EDTA=CaCO3_equivalent_SH/EDTA_SH//in terms of
    CaCO3 equivalent//
11 To_sample=one_ml_EDTA*EDTA_H/volume_H//total
    hardness for given volume//
12 To=To_sample*1000//total hardness per litre(ppm)//
13 printf("\nTotal Hardness is %.f mg/l or ppm",To);
```

Scilab code Exa 2.18.18 hardness calculation by EDTA method

```
1 //water and its treatment//
2 //example 2.18.18//
3 clc
4 strength_SH=1//in terms of mgs/lit//
5 volume_SH=50//in terms of ml//
6 volume_H=50//in terms of ml//
7 EDTA_SH=20//volume for Std hardwater(ml)//
8 EDTA_H=25//volume for sample hardwater(ml)//
9 CaCO3_equivalent_SH=strength_SH*volume_SH//in terms
    of CaCO3 equivalent//
10 one_ml_EDTA=CaCO3_equivalent_SH/EDTA_SH//in terms of
    CaCO3 equivalent//
11 To_sample=one_ml_EDTA*EDTA_H/volume_H//total
    hardness for given volume//
12 To=To_sample*1000//total hardness per litre(ppm)//
13 printf("\nTotal Hardness is %.f mg/l or ppm",To);
```

Scilab code Exa 2.18.19 hardness calculation by EDTA method

```
1 //water and its treatment//
2 //example 2.18.19//
3 clc
4 conc_SH=0.28//in terms of g/lit//
5 strength_SH=conc_SH//in terms of mgs/lit//
6 volume_SH=100//in terms of ml//
7 volume_H=100//in terms of ml//
8 EDTA_SH=28//volume for Std hardwater(ml)//
9 EDTA_H=33//volume for sample hardwater(ml)//
10 AB_EDTA=10//volume required after boiling(ml)//
11 CaCO3_equivalent_SH=strength_SH*volume_SH//in terms
   of CaCO3 equivalent//
12 one_ml_EDTA=CaCO3_equivalent_SH/EDTA_SH//in terms of
    CaCO3 equivalent//
13 To_sample=one_ml_EDTA*EDTA_H/volume_H//total
   hardness for given volume//
14 To=To_sample*1000//total hardness per litre(ppm)//
15 P_sample=AB_EDTA*one_ml_EDTA/volume_H//permanent
   hardness for given volume//
16 P=P_sample*1000//permanent hardness per litre(ppm)//
17 T=To-P
18 printf("\nTotal Hardness is %.f mg/l or ppm",To);
19 printf("\nPermanent Hardness is %.f mg/l or ppm",P);
20 printf("\nTemporary Hardness is %.f mg/l or ppm",T);
```

Scilab code Exa 2.18.20 hardness calculation by EDTA method

```
1 //water and its treatment//
2 //example 2.18.20//
3 clc
```

```
4  strength_SH=1//in terms of mgs/lit//
5  volume_SH=50//in terms of ml//
6  volume_H=50//in terms of ml//
7  EDTA_SH=20//volume for Std hardwater(ml)//
8  EDTA_H=25//volume for sample hardwater(ml)//
9  AB_EDTA=18//volume required after boiling(ml)//
10 CaCO3_equivalent_SH=strength_SH*volume_SH//in terms
      of CaCO3 equivalent//
11 one_ml_EDTA=CaCO3_equivalent_SH/EDTA_SH//in terms of
       CaCO3 equivalent//
12 To_sample=one_ml_EDTA*EDTA_H/volume_H//total
      hardness for given volume//
13 To=To_sample*1000//total hardness per litre(ppm)//
14 P_sample=AB_EDTA*one_ml_EDTA/volume_H//permanent
      hardness for given volume//
15 P=P_sample*1000//permanent hardness per litre(ppm)//
16 T=To-P
17 printf("\nTotal Hardness is %.f mg/l or ppm",To);
18 printf("\nPermanent Hardness is %.f mg/l or ppm",P);
19 printf("\nTemporary Hardness is %.f mg/l or ppm",T);
```

Scilab code Exa 2.18.20.A hardness calculation by EDTA method

```
1  //water and its treatment//
2  //example 2.18.20.A//
3  clc
4  conc_SH=1.29//in terms of g/lit//
5  strength_SH=conc_SH//in terms of mgs/lit//
6  volume_SH=50//in terms of ml//
7  volume_H=100//in terms of ml//
8  EDTA_SH=32//volume for Std hardwater(ml)//
9  EDTA_H=14//volume for sample hardwater(ml)//
10 AB_EDTA=8.5//volume required after boiling(ml)//
11 CaCO3_equivalent_SH=strength_SH*volume_SH//in terms
      of CaCO3 equivalent//
```

```
12 one_ml_EDTA=CaCO3_equivalent_SH/EDTA_SH//in terms of
       CaCO3 equivalent//
13 To_sample=one_ml_EDTA*EDTA_H/volume_H//total
       hardness for given volume//
14 To=To_sample*1000//total hardness per litre(ppm)//
15 P_sample=AB_EDTA*one_ml_EDTA/volume_H//permanent
       hardness for given volume//
16 P=P_sample*1000//permanent hardness per litre(ppm)//
17 T=To-P
18 printf("\nTotal Hardness is %.f mg/l or ppm",To);
19 printf("\nPermanent Hardness is %.1f mg/l or ppm",P)
       ;
20 printf("\nTemporary Hardness is %.1f mg/l or ppm",T)
       ;
```

Scilab code Exa 2.18.20.B hardness calculation by EDTA method

```
1 //water and its treatment//
2 //example 2.18.20.B//
3 clc
4 conc_SH=15//in terms of g/lit//
5 strength_SH=conc_SH//in terms of mgs/lit//
6 volume_SH=20//in terms of ml//
7 volume_H=100//in terms of ml//
8 EDTA_SH=25//volume for Std hardwater(ml)//
9 EDTA_H=18//volume for sample hardwater(ml)//
10 AB_EDTA=12//volume required after boiling(ml)//
11 CaCO3_equivalent_SH=strength_SH*volume_SH//in terms
       of CaCO3 equivalent//
12 one_ml_EDTA=CaCO3_equivalent_SH/EDTA_SH//in terms of
       CaCO3 equivalent//
13 To_sample=one_ml_EDTA*EDTA_H/volume_H//total
       hardness for given volume//
14 To=To_sample*1000//total hardness per litre(ppm)//
15 P_sample=AB_EDTA*one_ml_EDTA/volume_H//permanent
```

```
    hardness for given volume//
P=P_sample*1000//permanent hardness per litre(ppm)//
T=To-P
printf("\nTotal Hardness is %.f mg/l or ppm",To);
printf("\nTemporary Hardness is %.f mg/l or ppm",T);
printf("\nPermanent Hardness is %.f mg/l or ppm",P);
```

Scilab code Exa 2.18.21 calculation of required lime and soda

```
//water and its treatment//
//example 2.18.21//
clc
Purity_Lime=.85
Purity_soda=.95
W1=55.5;//amount of CaCl2 in ppm//
W2=20;//amount of SiO2 in ppm//
W3=12.6;//amount of  NaHCO3 in ppm//
W4=250;//amount of KCl in ppm//
W5=48;//amount of MgSO4 in ppm//
W6=2.2;//amount of CO2 in ppm//
W7=43.8;//amount of Mg(HCO3)2 in ppm//
W8=2;//amount of Fe++ in ppm//
W9=10;//amount of AlCl3 in ppm//
M1=100/111;//multiplication factor of CaCl2//
M3=100/(84*2);//multiplication factor of NaHCO3//
M5=100/120;//multiplication factor of MgSO4//
M6=100/44;//multiplication factor of CO2//
M7=100/146;//multiplication factor of Mg(HCO3)2//
M8=100/55.8;//multiplication factor of Fe++//
M9=100/133.42;//multiplication factor of AlCl3//
P1=W1*M1;//in terms of CaCO3//L
P3=W3*M3;//in terms of CaCO3//+L and -S
P5=W5*M5;//in terms of CaCO3//L+S
P6=W6*M6;//in terms of CaCO3//L
P7=W7*M7;//in terms of CaCO3//L
```

```
27 P8=W8*M8;//in terms of CaCO3//L+S
28 P9=W9*M9;//in terms of CaCO3//L+S
29 printf ("We do not take SiO2 and KCl since they do
      not react with lime/soda");
30 V=50000;//volume of water in litres//
31 L=0.74*(P3+P5+P6+P7*2+P8+P9)*V/Purity_Lime;//lime
      required in mg//
32 L=L/10^6;
33 printf("\nLime required is %.3fkg",L);
34 S=1.06*(P1-P3+P5+P8+P9)*V/Purity_soda;//soda
      required in mg//
35 S=S/10^6;
36 printf("\nSoda required is %.4fkg",S)
```

Scilab code Exa 2.18.22 cost of lime and soda required

```
1 //water and its treatment//
2 //example 2.18.22//
3 clc
4 Purity_Lime=.85
5 Purity_soda=.80
6 Rate_lime=9//Rs.per kg//
7 Rate_soda=35//Rs.per kg//
8 W1=20.4;//amount of CaSO4 in ppm//
9 W2=9.5;//amount of MgCl2 in ppm//
10 W3=7.3;//amount of HCl in ppm//
11 M1=100/136;//multiplication factor of CaSO4//
12 M2=100/95;//multiplication factor of MgCl2//
13 M3=100/(36.5*2);//multiplication factor of HCl//
14 P1=W1*M1;//in terms of CaCO3//S
15 P2=W2*M2;//in terms of CaCO3//L+S
16 P3=W3*M3;//in terms of CaCO3//L+S
17 V=80000;//volume of water in litres//
18 L=0.74*(P2+P3)*V/Purity_Lime;//lime required in mg//
19 L=L/10^6;
```

```
20 printf("\nLime required is %.3f kg",L);
21 S=1.06*(P1+P2+P3)*V/Purity_soda;//soda required in
      mg//
22 S=S/10^6;
23 printf("\nSoda required is %.2f kg",S)
24 Cost_lime=L*Rate_lime
25 Cost_soda=S*Rate_soda
26 printf("\nCost of lime is Rs. %.2f",Cost_lime);
27 printf("\nCost of soda is Rs. %.2f",Cost_soda)
```

Scilab code Exa 2.18.23 calculation of required lime and soda

```
1  //water and its treatment//
2  //example 2.18.23//
3  clc
4  Purity_Lime=.85
5  Purity_soda=.90
6  W1=27.2;//amount of CaSO4 in ppm//
7  W2=24;//amount of MgSO4 in ppm//
8  W3=11.1;//amount of CaCl2 in ppm//
9  W4=47.5;//amount of MgCl2 in ppm//
10 W5=2.195;//amount of CO2 in ppm//
11 W6=1.825;//amount of HCl in ppm//
12 W7=13.35;//amount of AlCl3 in ppm//
13 M1=100/136;//multiplication factor of CaSO4//
14 M2=100/120;//multiplication factor of MgSO4//
15 M3=100/111;//multiplication factor of CaCl2//
16 M4=100/95;//multiplication factor of MgCl2//
17 M5=100/44;//multiplication factor of CO2//
18 M6=100/(36.5*2);//multiplication factor of HCl//
19 M7=100/133.5;//multiplication factor of AlCl3//
20 P1=W1*M1;//in terms of CaCO3//S
21 P2=W2*M2;//in terms of CaCO3//L+S
22 P3=W3*M3;//in terms of CaCO3//S
23 P4=W4*M4;//in terms of CaCO3//L+S
```

```
24 P5=W5*M5;//in terms of CaCO3//L
25 P6=W6*M6;//in terms of CaCO3//L+S
26 P7=W7*M7;//in terms of CaCO3//L+S
27 V=100000;//volume of water in litres//
28 L=0.74*(P2+P4+P5+P6+P7)*V/Purity_Lime;//lime
      required in mg//
29 L=L/10^6;
30 printf("Lime required is %.3fkg",L);
31 S=1.06*(P1+P2+P3+P4+P6+P7)*V/Purity_soda;//soda
      required in mg//
32 S=S/10^6;
33 printf("\n Soda required is %.2fkg",S)
```

Scilab code Exa 2.18.24 calculation of required lime and soda

```
1  //water and its treatment//
2  //example 2.18.24//
3  clc
4  W1=50;//amount of CaCO3 in ppm//
5  W2=14.4;//amount of MgCO3 in ppm//
6  W3=22.2;//amount of CaCl2 in ppm//
7  W4=9.5;//amount of MgCl2 in ppm//
8  W5=20;//amount of Fe2O3 in ppm//
9  W6=20;//amount of Na2SO4 in ppm//
10 W7=5;//amount of SiO2 in ppm//
11 W8=2.2;//amount of CO2 in ppm//
12 M1=100/100;//multiplication factor of CaCO3//
13 M2=100/84;//multiplication factor of MgCO3//
14 M3=100/111;//multiplication factor of CaCl2//
15 M4=100/95;//multiplication factor of MgCl2//
16 M8=100/44.05;//multiplication factor of CO2//
17 P1=W1*M1;//in terms of CaCO3//L
18 P2=W2*M2;//in terms of CaCO3//L
19 P3=W3*M3;//in terms of CaCO3//S
20 P4=W4*M4;//in terms of CaCO3//L+S
```

```
21 P8=W8*M8;//in terms of CaCO3//L
22 printf ("We do not take Fe2O3, Na2SO4 and SiO2 since
       they do not react with lime/soda");
23 V=75000;//volume of water in litres//
24 L=0.74*(P1+P2*2+P4+P8)*V;//lime required in mg//
25 L=L/10^6;
26 printf("\nLime required is %.5fkg",L);
27 S=1.06*(P3+P4)*V;//soda required in mg//
28 S=S/10^6;
29 printf("\nSoda required is %.3fkg",S)
```

Scilab code Exa 2.18.25 cost of lime and soda required

```
1 //water and its treatment//
2 //example 2.18.25//
3 clc
4 Purity_Lime=.90
5 Purity_soda=.90
6 Rate_lime=7//Rs.per kg//
7 Rate_soda=35//Rs.per kg//
8 W1=30;//amount of Ca++ in ppm//
9 W2=21.6;//amount of Mg++ in ppm//
10 W3=12.2;//amount of HCO3- in ppm//
11 W4=4.4;//amount of CO2 in ppm//
12 W5=4.9;//amount of H2SO4 in ppm//
13 M1=100/40;//multiplication factor of Ca++//
14 M2=100/24;//multiplication factor of Mg++//
15 M3=100/(61*2);//multiplication factor of HCO3-//
16 M4=100/44;//multiplication factor of CO2//
17 M5=100/98;//multiplication factor of H2SO4//
18 P1=W1*M1;//in terms of CaCO3//S
19 P2=W2*M2;//in terms of CaCO3//L+S
20 P3=W3*M3;//in terms of CaCO3//+L and -S
21 P4=W4*M4;//in terms of CaCO3//L
22 P5=W5*M5;//in terms of CaCO3//L+S
```

```
23 V=25000;//volume of water in litres//
24 L=0.74*(P2+P3+P4+P5)*V/Purity_Lime;//lime required
      in mg//
25 L=L/10^6;
26 printf("Quantity of Lime required is %.4f kg",L);
27 S=1.06*(P1+P2-P3+P5)*V/Purity_soda;//soda required
      in mg//
28 S=S/10^6;
29 printf("\nQuantity of Soda required is %.4f kg",S)
30 Cost_lime=L*Rate_lime
31 Cost_soda=S*Rate_soda
32 printf("\nCost of lime is Rs. %.2f",Cost_lime);
33 printf("\nCost of soda is Rs. %.2f",Cost_soda)
```

Scilab code Exa 2.18.26 quantity of lime and soda

```
1 //water and its treatment//
2 //example 2.18.26//
3 clc
4 Purity_Lime=.89
5 Purity_soda=.92
6 W1=30;//amount of CaCO3 in ppm//
7 W2=90;//amount of MgCO3 in ppm//
8 W3=160;//amount of MgCl2 in ppm//
9 W4=35;//amount of MgSO4 in ppm//
10 W5=25;//amount of CaSO4 in ppm//
11 W6=120;//amount of NaCl in ppm//
12 M1=100/100;//multiplication factor of CaCO3//
13 M2=100/84.01;//multiplication factor of MgCO3//
14 M3=100/95;//multiplication factor of MgCl2//
15 M4=100/120;//multiplication factor of MgSO4//
16 M5=100/135.9;//multiplication factor of CaSO4//
17 P1=W1*M1;//in terms of CaCO3//L
18 P2=W2*M2;//in terms of CaCO3//L
19 P3=W3*M3;//in terms of CaCO3//L+S
```

```
20 P4=W4*M4;//in terms of CaCO3//L+S
21 P5=W5*M5;//in terms of CaCO3//S
22 printf ("We do not take NaCl since it does not react
       with lime/soda");
23 V=40000;//volume of water in litres//
24 L=0.74*(P1+P2*2+P3+P4)*V/Purity_Lime;//lime required
       in mg//
25 L=L/10^6;
26 printf("\nQuantity of Lime required is %.3fkg",L);
27 S=1.06*(P3+P4+P5)*V/Purity_soda;//soda required in
     mg//
28 S=S/10^6;
29 printf("\nQuantity of Soda required is %.3fkg",S)
```

Scilab code Exa 2.18.27 quantity of lime and soda

```
1 //water and its treatment//
2 //example 2.18.27//
3 clc
4 Purity_Lime=0.90
5 Purity_soda=0.90
6 W1=2.1;//amount of CaCO3 in  Clarke//
7 W2=0.63;//amount of MgCO3 in  Clarke//
8 W3=0.35;//amount of CaSO4 in  Clarke//
9 W4=0.21;//amount of MgSO4 in  Clarke//
10 W5=0.063;//amount of MgCl2 in  Clarke//
11 W6=0.035;//amount of KCl in  Clarke//
12 M1=100/(100*0.07);//multiplication factor of CaCO3//
13 M2=100/(84.04*0.07);//multiplication factor of MgCO3
     //
14 M3=100/(136*0.07);//multiplication factor of CaSO4//
15 M4=100/(120*0.07);//multiplication factor of MgSO4//
16 M5=100/(95*0.07);//multiplication factor of MgCl2//
17 P1=W1*M1;//in terms of CaCO3//L
18 P2=W2*M2;//in terms of CaCO3//L
```

```
19 P3=W3*M3;//in terms of CaCO3//S
20 P4=W4*M4;//in terms of CaCO3//L+S
21 P5=W5*M5;//in terms of CaCO3//L+S
22 printf ("We do not take KCl since it do not react
      with lime/soda");
23 V=85000;//volume of water in litres//
24 L=0.74*(P1+P2*2+P4+P5)*V/Purity_Lime;//lime required
       in mg//
25 L=L/10^6;
26 printf("\nQuantity of Lime required is %.4fkg",L);
27 S=1.06*(P3+P4+P5)*V/Purity_soda;//soda required in
      mg//
28 S=S/10^6;
29 printf("\nQuantity of Soda required is %.3fkg",S)
```

Scilab code Exa 2.18.28 quantity of lime and soda

```
1 //water and its treatment//
2 //example 2.18.28//
3 clc
4 Purity_Lime=.89
5 Purity_soda=.95
6 W1=14.6;//amount of HCl in ppm//
7 W2=34.2;//amount of Al2(SO4)3 in ppm//
8 W3=9.5;//amount of MgCl2 in ppm//
9 W4=30;//amount of KCl in ppm//
10 M1=100/(2*36.5);//multiplication factor of HCl//
11 M2=(3*100)/342.3;//multiplication factor of Al2(SO4)
      3//
12 M3=100/95;//multiplication factor of MgCl2//
13 P1=W1*M1;//in terms of CaCO3//L+S
14 P2=W2*M2;//in terms of CaCO3//L+S
15 P3=W3*M3;//in terms of CaCO3//L+S
16 printf ("We do not take KCl since it does not react
      with lime/soda");
```

```
17 V=20000;//volume of water in litres//
18 L=0.74*(P1+P2+P3)*V/Purity_Lime;//lime required in
     mg//
19 L=L/10^6;
20 printf("\nQuantity of Lime required is %.3fkg",L);
21 S=1.06*(P1+P2+P3)*V/Purity_soda;//soda required in
     mg//
22 S=S/10^6;
23 printf("\nQuantity of Soda required is %.3fkg",S)
```

Scilab code Exa 2.18.29 quantity of lime and soda

```
1 //water and its treatment//
2 //example 2.18.29//
3 clc
4 Purity_Lime=0.85
5 Purity_soda=0.95
6 W1=3.5;//amount of CaCO3 in ppm//
7 W2=6.8;//amount of CaSO4 in ppm//
8 W3=8.4;//amount of MgCO3 in ppm//
9 W4=5.7;//amount of MgCl2 in ppm//
10 W5=6.0;//amount of MgSO4 in ppm//
11 W6=3.0;//amount of SiO2 in ppm//
12 W7=11.7;//amount of NaCl in ppm//
13 M1=100/100;//multiplication factor of CaCO3//
14 M2=100/135.86;//multiplication factor of CaSO4//
15 M3=100/84;//multiplication factor of MgCO3//
16 M4=100/95.1;//multiplication factor of MgCl2//
17 M5=100/120;//multiplication factor of MgSO4//
18 P1=W1*M1;//in terms of CaCO3//L
19 P2=W2*M2;//in terms of CaCO3//S
20 P3=W3*M3;//in terms of CaCO3//L
21 P4=W4*M4;//in terms of CaCO3//L+S
22 P5=W5*M5;//in terms of CaCO3//L+S
23 printf ("We do not take SiO2 and NaCl since they do
```

```
    not react with lime/soda");
24 V=35000;//volume of water in litres//
25 L=0.74*(P1+P3*2+P4+P5)*V/Purity_Lime;//lime required
    in mg//
26 L=L/10^6;
27 printf("\nQuantity of Lime required in month of Feb
    2000 is %.2fkg",L*29);
28 S=1.06*(P2+P4+P5)*V/Purity_soda;//soda required in
    mg//
29 S=S/10^6;
30 printf("\nQuantity of Soda required in month of Feb
    2000 is %.4fkg",S*29)
```

Scilab code Exa 2.18.30 quantity of lime and soda

```
1  //water and its treatment//
2  //example 2.18.30//
3  clc
4  Purity_Lime=0.95
5  Purity_soda=0.90
6  W1=9.5;//amount of MgCl2 in ppm//
7  W2=272;//amount of CaSO4 in ppm//
8  W3=120;//amount of MgSO4 in ppm//
9  W4=49;//amount of H2SO4 in ppm//
10 W5=8;//amount of SiO2 in ppm//
11 M1=100/95;//multiplication factor of MgCl2//
12 M2=100/136;//multiplication factor of CaSO4//
13 M3=100/120;//multiplication factor of MgSO4//
14 M4=100/98;//multiplication factor of H2SO4//
15 P1=W1*M1;//in terms of CaCO3//L+S
16 P2=W2*M2;//in terms of CaCO3//S
17 P3=W3*M3;//in terms of CaCO3//L+S
18 P4=W4*M4;//in terms of CaCO3//L+S
19 printf ("We do not take SiO2 since it does not react
    with lime/soda");
```

```
20 V=1000000;//volume of water in litres//
21 L=0.74*(P1+P3+P4)*V/Purity_Lime;//lime required in
      mg//
22 L=L/10^6;
23 printf("\nQuantity of Lime required is %.2fkg",L);
24 S=1.06*(P1+P2+P3+P4)*V/Purity_soda;//soda required
      in mg//
25 S=S/10^6;
26 printf("\nQuantity of Soda required is %.0fkg",S)
```

Scilab code Exa 2.18.31 calculation of required lime and soda

```
1 //water and its treatment//
2 //example 2.18.31//
3 clc
4 Purity_Lime=.80
5 Purity_soda=.88
6 W1=84;//amount of MgCO3 in ppm//
7 W2=25;//amount of SiO2 in ppm//
8 W3=68;//amount of CaSO4 in ppm//
9 W4=30;//amount of MgSO4 in ppm//
10 W5=19;//amount of MgCl2 in ppm//
11 W6=120;//amount of CaCO3 in ppm//
12 M1=100/84.004;//multiplication factor of MgCO3//
13 M3=100/136;//multiplication factor of CaSO4//
14 M4=100/120;//multiplication factor of MgSO4//
15 M5=100/95;//multiplication factor of MgCl2//
16 M6=100/100;//multiplication factor of CaCO3//
17 P1=W1*M1;//in terms of CaCO3//L
18 P3=W3*M3;//in terms of CaCO3//S
19 P4=W4*M4;//in terms of CaCO3//L+S
20 P5=W5*M5;//in terms of CaCO3//L+S
21 P6=W6*M6;//in terms of CaCO3//L
22 printf ("We do not take SiO2 since it does not react
      with lime/soda");
```

```
23 V=1000000;//volume of water in litres//
24 L=0.74*(P1*2+P4+P5+P6)*V/Purity_Lime;//lime required
       in mg//
25 L=L/10^6;
26 printf("\nLime required is %.2fkg",L);
27 S=1.06*(P3+P4+P5)*V/Purity_soda;//soda required in
      mg//
28 S=S/10^6;
29 printf("\nSoda required is %.2fkg",S)
```

Scilab code Exa 2.18.32 calculation of required lime and soda

```
1 //water and its treatment//
2 //example 2.18.32//
3 clc
4 Purity_Lime=.97
5 Purity_soda=.91
6 W1=24;//amount of Mg2+ in ppm//
7 W2=20;//amount of Ca2+ in ppm//
8 W3=30;//amount of CO2 in ppm//
9 W4=150;//amount of HCO3- in ppm//
10 W5=40;//amount of K+ in ppm//
11 M1=100/24;//multiplication factor of Mg2+//
12 M2=100/40;//multiplication factor of Ca2+//
13 M3=100/44;//multiplication factor of CO2//
14 M4=100/(61*2);//multiplication factor of HCO3-//
15 P1=W1*M1;//in terms of CaCO3//L+S
16 P2=W2*M2;//in terms of CaCO3//S
17 P3=W3*M3;//in terms of CaCO3//L
18 P4=W4*M4;//in terms of CaCO3//+L and -S
19 printf ("We do not take K+ since it does not react
      with lime/soda");
20 V=1000000;//volume of water in litres//
21 L=0.74*(P1+P3+P4)*V/Purity_Lime;//lime required in
      mg//
```

```
22 L=L/10^6;
23 printf("\nLime required is %.0fkg",L);
24 S=1.06*(P1+P2-P4)*V/Purity_soda;//soda required in
     mg//
25 S=S/10^6;
26 printf("\nSoda required is %.1fkg",S)
```

Scilab code Exa 2.18.33 calculation of required lime and soda

```
1 //water and its treatment//
2 //example 2.18.33//
3 clc
4 Purity_Lime=.80
5 Purity_soda=.85
6 W1=162;//amount of Ca(HCO3)2 in ppm//
7 W2=9.5;//amount of MgCl2 in ppm//
8 W3=58.5;//amount of  NaCl in ppm//
9 W4=7.3;//amount of Mg(HCO3)2 in ppm//
10 W5=36.5;//amount of HCl in ppm//
11 W6=44;//amount of CO2 in ppm//
12 W7=111;//amount of CaCl2 in ppm//
13 W8=60;//amount of MgSO4 in ppm//
14 M1=100/162;//multiplication factor of Ca(HCO3)2//
15 M2=100/95;//multiplication factor of MgCl2//
16 M4=100/146;//multiplication factor of Mg(HCO3)2//
17 M5=100/(2*36.5);//multiplication factor of HCl//
18 M6=100/44;//multiplication factor of CO2//
19 M7=100/111;//multiplication factor of CaCl2//
20 M8=100/120;//multiplication factor of MgSO4//
21 P1=W1*M1;//in terms of CaCO3//L
22 P2=W2*M2;//in terms of CaCO3//L+S
23 P4=W4*M4;//in terms of CaCO3//L
24 P5=W5*M5;//in terms of CaCO3//L+S
25 P6=W6*M6;//in terms of CaCO3//L
26 P7=W7*M7;//in terms of CaCO3//S
```

```
27 P8=W8*M8;//in terms of CaCO3//L+S
28 printf ("We do not take NaCl since they do not react
       with lime/soda");
29 V=1000000;//volume of water in litres//
30 L=0.74*(P1+P2+P4*2+P5+P6+P8)*V/Purity_Lime;//lime
      required in mg//
31 L=L/10^6;
32 printf("\nLime required is %.0fkg",L);
33 S=1.06*(P2+P5+P7+P8)*V/Purity_soda;//soda required
      in mg//
34 S=S/10^6;
35 printf("\nSoda required is %.3fkg",S)
```

Scilab code Exa 2.18.34 quantity of lime and soda

```
1 //water and its treatment//
2 //example 2.18.34//
3 clc
4 Purity_Lime=.90
5 Purity_soda=.90
6 W1=30;//amount of Ca2+ in ppm//
7 W2=21.6;//amount of Mg2+ in ppm//
8 W3=4.9;//amount of H2SO4 in ppm//
9 W4=4.4;//amount of CO2 in ppm//
10 W5=12.2;//amount of HCO3- in ppm//
11 W6=15.4;//amount of Fe2O3 in ppm//
12 M1=100/40;//multiplication factor of Ca2+//
13 M2=100/24;//multiplication factor of Mg2+//
14 M3=100/98;//multiplication factor of H2SO4//
15 M4=100/44.01;//multiplication factor of CO2//
16 M5=100/122;//multiplication factor of HCO3-//
17 P1=W1*M1;//in terms of CaCO3//S
18 P2=W2*M2;//in terms of CaCO3//L+S
19 P3=W3*M3;//in terms of CaCO3//L+S
20 P4=W4*M4;//in terms of CaCO3//L
```

```
21 P5=W5*M5;//in terms of CaCO3//+L and -S
22 printf ("We do not take Fe2O3 since it does not
      react with lime/soda");
23 V=25000;//volume of water in litres//
24 L=0.74*(P2+P3+P4+P5)*V/Purity_Lime;//lime required
      in mg//
25 L=L/10^6;
26 printf("\nQuantity of Lime required is %.4fkg",L);
27 S=1.06*(P1+P2+P3-P5)*V/Purity_soda;//soda required
      in mg//
28 S=S/10^6;
29 printf("\nQuantity of Soda required is %.4fkg",S)
```

Scilab code Exa 2.18.35 quantity of lime and soda

```
1 //water and its treatment//
2 //example 2.18.35//
3 clc
4 Purity_Lime=.95
5 Purity_soda=.80
6 W1=14.6;//amount of Mg(HCO3)2 in ppm//
7 W2=6.8;//amount of CaSO4 in ppm//
8 W3=8.1;//amount of Ca(HCO3)2 in ppm//
9 W4=12;//amount of MgSO4 in ppm//
10 W5=15;//amount of Na2SO4 in ppm//
11 W6=2;//amount of SiO2 in ppm//
12 M1=100/146;//multiplication factor of Ca2+//
13 M2=100/157;//multiplication factor of Mg2+//
14 M3=100/162.08;//multiplication factor of H2SO4//
15 M4=100/120;//multiplication factor of CO2//
16 P1=W1*M1;//in terms of CaCO3//L
17 P2=W2*M2;//in terms of CaCO3//S
18 P3=W3*M3;//in terms of CaCO3//L
19 P4=W4*M4;//in terms of CaCO3//L+S
20 printf ("We do not take Na2SO4 and SiO2 since they
```

```
    do not react with lime/soda");
21 V=50000;//volume of water in litres//
22 L=0.74*(P1*2+P3+P4)*V/Purity_Lime;//lime required in
    mg//
23 L=L/10^6;
24 printf("\nQuantity of Lime required is %.4fkg",L);
25 S=1.06*(P2+P4)*V/Purity_soda;//soda required in mg//
26 S=S/10^6;
27 printf("\nQuantity of Soda required is %.1fkg",S)
```

Scilab code Exa 2.18.36 quantity of lime and soda

```
1  //water and its treatment//
2  //example 2.18.36//
3  clc
4  Purity_Lime=.86
5  Purity_soda=.90
6  W1=35.2;//amount of CaCO3 in ppm//
7  W2=7.8;//amount of MgCl2 in ppm//
8  W3=12.5;//amount of HCl in ppm//
9  W4=33.3;//amount of Al2(SO4)3 in ppm//
10 W5=8.8;//amount of Na2SO4 in ppm//
11 W6=18.6;//amount of Fe2O3 in ppm//
12 M1=100/99.976;//multiplication factor of CaCO3//
13 M2=100/94.08;//multiplication factor of MgCl2//
14 M3=100/73;//multiplication factor of HCl//
15 M4=100/114//multiplication factor of Al2(SO4)3//
16 P1=W1*M1;//in terms of CaCO3//L
17 P2=W2*M2;//in terms of CaCO3//L+S
18 P3=W3*M3;//in terms of CaCO3//L+S
19 P4=W4*M4;//in terms of CaCO3//L+S
20 printf ("We do not take Na2SO4 and Fe2O3 since they
    do not react with lime/soda");
21 V=25000;//volume of water in litres//
22 L=0.74*(P1+P2+P3+P4)*V/Purity_Lime;//lime required
```

```
    in mg//
23 L=L/10^6;
24 printf("\nQuantity of Lime required is %.6fkg",L);
25 S=1.06*(P2+P3+P4)*V/Purity_soda;//soda required in
    mg//
26 S=S/10^6;
27 printf("\nQuantity of Soda required is %.4fkg",S)
```

Scilab code Exa 2.18.37 quantity of lime and soda

```
1  //water and its treatment//
2  //example 2.18.37//
3  clc
4  Purity_Lime=.80
5  Purity_soda=.90
6  W1=7.1;//amount of Mg(HCO3)2 in ppm//
7  W2=8.1;//amount of Ca(HCO3)2 in ppm//
8  W3=4.2;//amount of MgCO3 in ppm//
9  W4=10;//amount of CaCO3 in ppm//
10 M1=100/142;//multiplication factor of Mg(HCO3)2//
11 M2=100/162;//multiplication factor of Ca(HCO3)2//
12 M3=100/84;//multiplication factor of MgCO3//
13 M4=100/100//multiplication factor of CaCO3//
14 P1=W1*M1;//in terms of CaCO3//L
15 P2=W2*M2;//in terms of CaCO3//L
16 P3=W3*M3;//in terms of CaCO3//L
17 P4=W4*M4;//in terms of CaCO3//L
18 V=100000;//volume of water in litres//
19 L=0.74*(P1*2+P2+P3*2+P4)*V/Purity_Lime;//lime
    required in mg//
20 L=L/10^6;
21 printf("\nQuantity of Lime required is %.4fkg",L);
22 S=1.06*(0)*V/Purity_soda;//soda required in mg//
23 S=S/10^6;
24 printf("\nQuantity of Soda required is %.0fkg",S)
```

Scilab code Exa 2.18.38 calculation of required lime and soda

```
1 //water and its treatment//
2 //example 2.18.38//
3 clc
4 Purity_Lime=.85
5 Purity_soda=.90
6 W1=95;//amount of MgCl2 in ppm//
7 W2=272;//amount of CaSO4 in ppm//
8 W3=120;//amount of MgSO4 in ppm//
9 W4=49;//amount of CaSO4 in ppm//
10 W5=4;//amount of SiO2 in ppm//
11 M1=100/95;//multiplication factor of CaCO3//
12 M2=100/136;//multiplication factor of MgCl2//
13 M3=100/120;//multiplication factor of HCl//
14 M4=100/98//multiplication factor of Al2(SO4)3//
15 P1=W1*M1;//in terms of CaCO3//L
16 P2=W2*M2;//in terms of CaCO3//S
17 P3=W3*M3;//in terms of CaCO3//L+S
18 P4=W4*M4;//in terms of CaCO3//L+S
19 printf ("We do not take SiO2 since it does not react
       with lime/soda");
20 V=10000;//volume of water in litres//
21 L=0.74*(P1+P3+P4)*V/Purity_Lime;//lime required in
     mg//
22 L=L/10^6;
23 printf("\nLime required is %.4fkg",L);
24 S=1.06*(P1+P2+P3)*V/Purity_soda;//soda required in
     mg//
25 S=S/10^6;
26 printf("\nSoda required is %.3fkg",S)
```

Scilab code Exa 2.18.39 calculation of required lime and soda

```
1 //water and its treatment//
2 //example 2.18.39//
3 clc
4 Purity_Lime=.90
5 Purity_soda=1
6 W1=136;//amount of CaSO4 in ppm//
7 W2=49;//amount of H2SO4 in ppm//
8 W3=95;//amount of MgCl2 in ppm//
9 W4=60;//amount of MgSO4 in ppm//
10 W5=50;//amount of SiO2 in ppm//
11 M1=100/136;//multiplication factor of CaSO4//
12 M2=100/98;//multiplication factor of H2SO4//
13 M3=100/95;//multiplication factor of MgCl2//
14 M4=100/120//multiplication factor of MgSO4//
15 P1=W1*M1;//in terms of CaCO3//S
16 P2=W2*M2;//in terms of CaCO3//L+S
17 P3=W3*M3;//in terms of CaCO3//S
18 P4=W4*M4;//in terms of CaCO3//S
19 printf ("We do not take SiO2 since it does not react
    with lime/soda");
20 V=1000000;//volume of water in litres//
21 L=0.74*(P2)*V/Purity_Lime;//lime required in mg//
22 L=L/10^6;
23 printf("\nQuantity of Lime required is %.2fkg",L);
24 S=1.06*(P1+P3+P4)*V/Purity_soda;//soda required in
   mg//
25 S=S/10^6;
26 printf("\nQuantity of Soda required is %.0fkg",S)
```

Scilab code Exa 2.18.40 calculation of required lime and soda

```
1 //water and its treatment//
2 //example 2.18.40//
```

```
clc
Purity_Lime=.74
Purity_soda=.90
W1=73;//amount of Mg(HCO3)2 in ppm//
W2=120;//amount of MgSO4 in ppm//
W3=22.2;//amount of CaCl2 in ppm//
W4=164;//amount of Ca(NO3)3 in ppm//
W5=15;//amount of SiO2 in ppm//
M1=100/146;//multiplication factor of Mg(HCO3)2//
M2=100/120;//multiplication factor of MgSO4//
M3=100/111;//multiplication factor of CaCl2//
M4=100/164//multiplication factor of Ca(NO3)2//
P1=W1*M1;//in terms of CaCO3//L
P2=W2*M2;//in terms of CaCO3//L+S
P3=W3*M3;//in terms of CaCO3//S
P4=W4*M4;//in terms of CaCO3//S
printf ("We do not take SiO2 since it does not react
    with lime/soda");
V=5000;//volume of water in litres//
L=0.74*(P1*2+P2)*V/Purity_Lime;//lime required in mg
   //
L=L/10^6;
printf("\nLime required is %.0fkg",L);
S=1.06*(P2+P3+P4)*V/Purity_soda;//soda required in
   mg//
S=S/10^6;
printf("\nSoda required is %.1fkg",S)
```

Scilab code Exa 2.18.41 calculation of required lime and soda

```
//water and its treatment//
//example 2.18.41//
clc
Purity_Lime=.85
Purity_soda=.90
```

```
W1=95;//amount of MgCl2 in ppm//
W2=272;//amount of CaSO4 in ppm//
W3=120;//amount of MgSO4 in ppm//
W4=49;//amount of H2SO4 in ppm//
W5=4;//amount of SiO2 in ppm//
M1=100/95;//multiplication factor of MgCl2//
M2=100/136;//multiplication factor of CaSO4//
M3=100/120;//multiplication factor of MgSO4//
M4=100/98//multiplication factor of H2SO4//
P1=W1*M1;//in terms of CaCO3//L+S
P2=W2*M2;//in terms of CaCO3//S
P3=W3*M3;//in terms of CaCO3//L+S
P4=W4*M4;//in terms of CaCO3//L+S
printf ("We do not take SiO2 since it does not react
    with lime/soda");
V=10000;//volume of water in litres//
L=0.74*(P1+P3+P4)*V/Purity_Lime;//lime required in
   mg//
L=L/10^6;
printf("\nLime required is %.2fkg",L);
S=1.06*(P1+P2+P3+P4)*V/Purity_soda;//soda required
   in mg//
S=S/10^6;
printf("\nSoda required is %.1fkg",S)
```

Scilab code Exa 2.18.42 calculation of required lime and soda

```
//water and its treatment//
//example 2.18.42//
clc
W1=10;//amount of CaCO3 in ppm//
W2=14.6;//amount of Mg(HCO3)2 in ppm//
W3=4.4;//amount of CO2 in ppm//
W4=22.2;//amount of CaCl2 in ppm//
W5=9.5;//amount of MgCl2 in ppm//
```

```
W6=2.8;//amount of SiO2 in ppm//
M1=100/100;//multiplication factor of CaCO3//
M2=100/146;//multiplication factor of Mg(HCO3)2//
M3=100/44;//multiplication factor of CO2//
M4=100/111//multiplication factor of CaCl2//
M5=100/95;//multiplication factor of MgCl2/
P1=W1*M1;//in terms of CaCO3//L
P2=W2*M2;//in terms of CaCO3//L
P3=W3*M3;//in terms of CaCO3//L
P4=W4*M4;//in terms of CaCO3//S
P5=W5*M5;//in terms of CaCO3//L+S
printf ("We do not take SiO2 since it does not react
    with lime/soda");
V=50000;//volume of water in litres//
L=0.74*(P1+P2+P3+P5)*V;//lime required in mg//
L=L/10^6;
printf("\nLime required is %.2fkg",L);
S=1.06*(P4+P5)*V;//soda required in mg//
S=S/10^6;
printf("\nSoda required is %.2fkg",S)
```

Scilab code Exa 2.18.43 calculation of required lime and soda

```
//water and its treatment//
//example 2.18.43//
clc
Purity_Lime=.92
Purity_soda=.95
W1=68.2;//amount of CaCO3 in ppm//
W2=29.6;//amount of Mg(NO3)2 in ppm//
W3=58.4;//amount of Mg(HCO3)2 in ppm//
W4=36;//amount of MgSO4 in ppm//
W5=95;//amount of MgCl2 in ppm//
W6=27.2;//amount of CaSO4 in ppm//
W7=19.3;//amount of Fe2O3 in ppm//
```

```
13 M1=100/100;//multiplication factor of CaCO3//
14 M2=100/148;//multiplication factor of Mg(NO3)2//
15 M3=100/146;//multiplication factor of Mg(HCO3)2//
16 M4=100/120//multiplication factor of MgSO4//
17 M5=100/95;//multiplication factor of MgCl2//
18 M6=100/136;//multiplication factor of CaSO4//
19 P1=W1*M1;//in terms of CaCO3//L
20 P2=W2*M2;//in terms of CaCO3//S
21 P3=W3*M3;//in terms of CaCO3//L
22 P4=W4*M4;//in terms of CaCO3//L+S
23 P5=W5*M5;//in terms of CaCO3//L+S
24 P6=W6*M6;//in terms of CaCO3//S
25 printf ("We do not take Fe2O3 since it does not
      react with lime/soda");
26 V=15000;//volume of water in litres//
27 L=0.74*(P1+P3+P4+P5)*V/Purity_Lime;//lime required
      in mg//
28 L=L/10^6;
29 printf("\nLime required is %.3fkg",L);
30 S=1.06*(P2+P4+P5+P6)*V/Purity_soda;//soda required
      in mg//
31 S=S/10^6;
32 printf("\nSoda required is %.3fkg",S)
```

Scilab code Exa 2.18.44 calculation of required lime and soda

```
1 //water and its treatment//
2 //example 2.18.44//
3 clc
4 Purity_Lime=.85
5 Purity_soda=.95
6 W1=49.95;//amount of CaCl2 in ppm//
7 W2=42;//amount of MgSO4 in ppm//
8 W3=12.6;//amount of NaHCO3 in ppm//
9 W4=10;//amount of SiO2 in ppm//
```

```
10 W5=500;//amount of NaCl in ppm//
11 W6=51.1;//amount of Mg(HCO3)2 in ppm//
12 W7=3;//amount of CO2 in ppm//
13 W8=3;//amount of Fe2+ in ppm//
14 W9=15;//amount of AlCl3 in ppm//
15 M1=100/111;//multiplication factor of CaCl2//
16 M2=100/120;//multiplication factor of MgSO4//
17 M6=100/146;//multiplication factor of Mg(HCO3)2//
18 M7=100/44.3//multiplication factor of CO2//
19 M8=100/55;//multiplication factor of Fe2+//
20 M9=100/133.5//multiplication factor of AlCl3//
21 P1=W1*M1;//in terms of CaCO3//S
22 P2=W2*M2;//in terms of CaCO3//L+S
23 P6=W6*M6;//in terms of CaCO3//L
24 P7=W7*M7;//in terms of CaCO3//L
25 P8=W8*M8;//in terms of CaCO3//L+S
26 P9=W9*M9;//in terms of CaCO3//L+S
27 printf ("We do not take NaHCO3, NaCl and Mg(HCO3)2
      since they do not react with lime/soda");
28 V=1000000;//volume of water in litres//
29 L=0.74*(P2+P6*2+P7+P8+P9)*V/Purity_Lime;//lime
      required in mg//
30 L=L/10^6;
31 printf("\nLime required is %.1fkg",L);
32 S=1.06*(P1+P2+P8+P9)*V/Purity_soda;//soda required
      in mg//
33 S=S/10^6;
34 printf("\nSoda required is %.1fkg",S)
```

Scilab code Exa 2.18.44.A calculation of required lime and soda

```
1 //water and its treatment//
2 //example 2.18.44.A//
3 clc
4 Purity_Lime=.90
```

```
5  Purity_soda=.90
6  W1=146;//amount of Mg(HCO3)2 in ppm//
7  W2=81;//amount of Ca(HCO3)2 in ppm//
8  W3=15;//amount of Na2SO4 in ppm//
9  W4=95;//amount of MgCl2 in ppm//
10 W5=111;//amount of CaCl2 in ppm//
11 W6=10;//amount of SiO2 in ppm//
12 M1=100/146;//multiplication factor of Mg(HCO3)2//
13 M2=100/162.7;//multiplication factor of Ca(HCO3)2//
14 M4=100/95.07;//multiplication factor of MgCl2//
15 M5=100/111//multiplication factor of CaCl2//
16 P1=W1*M1;//in terms of CaCO3//L
17 P2=W2*M2;//in terms of CaCO3//L
18 P4=W4*M4;//in terms of CaCO3//L+S
19 P5=W5*M5;//in terms of CaCO3//L+S
20 printf ("We do not take Na2SO4 and SiO2 since they
      do not react with lime/soda");
21 V=100000;//volume of water in litres//
22 L=0.74*(P1+P2*2+P4+P5)*V/Purity_Lime;//lime required
       in mg//
23 L=L/10^6;
24 printf("\nLime required is %.1fkg",L);
25 S=1.06*(P4+P5)*V/Purity_soda;//soda required in mg//
26 S=S/10^6;
27 printf("\nSoda required is %.2fkg",S)
```

Scilab code Exa 2.18.44.B calculation of required lime and soda

```
1  //water and its treatment//
2  //example 2.18.44.B//
3  clc
4  Purity_Lime=.85
5  Purity_soda=.90
6  W1=16.2;//amount of Ca(HCO3)2 in ppm//
7  W2=6.8;//amount of CaSO4 in ppm//
```

```
W3=11.1;//amount of CaCl2 in ppm//
W4=6;//amount of MgSO4 in ppm//
W5=8.4;//amount of Mg(HCO3)2 in ppm//
W6=8;//amount of SiO2 in ppm//
M1=100/162;//multiplication factor of Ca(HCO3)2//
M2=100/136;//multiplication factor of CaSO4//
M3=100/111;//multiplication factor of CaCl2//
M4=100/120//multiplication factor of MgSO4//
M5=100/146//multiplication factor of Mg(HCO3)2//
P1=W1*M1;//in terms of CaCO3//L
P2=W2*M2;//in terms of CaCO3//L+S
P3=W3*M3;//in terms of CaCO3//L+S
P4=W4*M4;//in terms of CaCO3//L+S
P5=W5*M5;//in terms of CaCO3//L
printf ("We do not take SiO2 since it does not react
    with lime/soda");
V=1000000;//volume of water in litres//
L=0.74*(P1+P4+P5*2)*V/Purity_Lime;//lime required in
    mg//
L=L/10^6;
printf("\nLime required is %.3fkg",L);
S=1.06*(P2+P3+P4)*V/Purity_soda;//soda required in
   mg//
S=S/10^6;
printf("\nSoda required is %.2fkg",S)
```

Scilab code Exa 2.18.44.C calculation of required lime and soda

```
//water and its treatment//
//example 2.18.44.C//
clc
Purity_Lime=.90
Purity_soda=.95
W1=81;//amount of Ca(HCO3)2 in ppm//
W2=42;//amount of MgCO3 in ppm//
```

```
W3=4.1;//amount of NaAlO2 in ppm//
W4=3.65;//amount of HCl in ppm//
W5=82;//amount of Ca(NO3)2 in ppm//
W6=4.5;//amount of NaCl in ppm//
M1=100/162;//multiplication factor of Ca(HCO3)2//
M2=100/84;//multiplication factor of MgCO3//
M3=100/82;//multiplication factor of NaAlO2//
M4=100/36.5//multiplication factor of HCl//
P1=W1*M1;//in terms of CaCO3//L
P2=W2*M2;//in terms of CaCO3//L
P3=W3*M3;//in terms of CaCO3//-L-S
P4=W4*M4;//in terms of CaCO3//L+S
printf ("We do not take Ca(NO3)2 and NaCl since they
    do not react with lime/soda");
V=20000;//volume of water in litres//
L=0.74*(P1+P2*2-P3+P4)*V/Purity_Lime;//lime required
    in mg//
L=L/10^6;
printf("\nLime required is %.3fkg",L);
S=1.06*(P4-P3)*V/Purity_soda;//soda required in mg//
S=S/10^6;
printf("\nSoda required is %.1fkg",S)
```

Scilab code Exa 2.18.44.D Calculation of hardness using Zeolite process

```
//water and its treatment//
//example 2.18.44.D//
clc
volume_hardwater=7000//in litres//
volume_NaCl=60//Volume of NaCl in litres//
conc_NaCl=10//% NaCl consumed by zeolite bed//
Wt_per_Litre=conc_NaCl*10//gms NaCl consumed by
   zeolite bed per litre//
total_wt=Wt_per_Litre*volume_NaCl//total gms NaCl
   consumed by zeolite bed//
```

```
9 CaCO3_equivalent=total_wt*50/58.5//in terms of (gms/
    lit)//
10 H=CaCO3_equivalent/volume_hardwater//Hardness of
    water(gms/lit)//
11 Hardness=H*1000//Hardness of water(mg/lit) or ppm//
12 printf("\nCaCO3 equivalent is %.1f gms",
    CaCO3_equivalent);
13 printf("\nHardness of water is %.1fppm",Hardness);
```

Scilab code Exa 2.18.45 Hardwater quantity softened using Zeolite process

```
1 //water and its treatment//
2 //example 2.18.45//
3 clc
4 Hardness=250//Hardness of water(mg/lit) or ppm//
5 H=Hardness/1000//Hardness of water(gms/lit)//
6 volume_NaCl=50//Volume of NaCl//
7 conc_NaCl=15//% NaCl consumed by zeolite bed//
8 Wt_per_Litre=conc_NaCl*10//gms NaCl consumed by
    zeolite bed per litre//
9 total_wt=Wt_per_Litre*volume_NaCl//total gms NaCl
    consumed by zeolite bed//
10 CaCO3_equivalent=total_wt*50/58.5//in terms of (gms/
    lit)//
11 volume_hardwater=CaCO3_equivalent/H
12 printf("\nCaCO3 equivalent is %.f mgs",
    CaCO3_equivalent*1000);
13 printf("\nQuantity of water softened using zeolite
    bed is %.f litres",volume_hardwater);
```

Scilab code Exa 2.18.46 NaCl required for zeolite bed regeneration

```
1 //water and its treatment//
```

```
2 //example 2.18.46//
3 clc
4 volume_hardwater=5000//in litres//
5 H=250//Hardness of water(mg/lit) or ppm//
6 Hardness=H/1000//Hardness of water(gms/lit)//
7 CaCO3_equivalent=volume_hardwater*Hardness//in terms
      of (gms/lit)//
8 conc_NaCl=10//% NaCl consumed by zeolite bed//
9 Wt_per_Litre=conc_NaCl*10//gms NaCl consumed by
     zeolite bed per litre//
10 total_wt=CaCO3_equivalent*58.5/50//total gms NaCl
     consumed by zeolite bed//
11 volume_NaCl=total_wt/Wt_per_Litre//in litres//
12 printf("\nVolume of NaCl solution required is %.3f
     litres",volume_NaCl);
```

Scilab code Exa 2.18.47 NaCl required for zeolite bed regeneration

```
1 //water and its treatment//
2 //example 2.18.47//
3 clc
4 volume_hardwater=20//in litres//
5 H=375//Hardness of water(mg/lit) or ppm//
6 CaCO3_equivalent=volume_hardwater*H//in terms of (
     gms/lit)//
7 conc_NaCl=20//% NaCl consumed by zeolite bed//
8 Wt_per_Litre=conc_NaCl*10//gms NaCl consumed by
     zeolite bed per litre//
9 total_wt=CaCO3_equivalent*58.5/50//total gms NaCl
     consumed by zeolite bed//
10 volume_NaCl=total_wt/Wt_per_Litre//in litres//
11 printf("\nVolume of NaCl solution required is %.f
     litres",volume_NaCl);
```

Scilab code Exa 2.18.48 Calculation of hardness using Zeolite process

```
1 //water and its treatment//
2 //example 2.18.48//
3 clc
4 volume_hardwater=25000//in litres//
5 volume_NaCl=200//Volume of NaCl//
6 Wt_per_Litre=20//gms NaCl consumed by zeolite bed
    per litre//
7 total_wt=Wt_per_Litre*volume_NaCl//total gms NaCl
    consumed by zeolite bed//
8 CaCO3_equivalent=total_wt*50/58.5//in terms of (gms/
    lit)//
9 H=CaCO3_equivalent/volume_hardwater//Hardness of
    water(gms/lit)//
10 Hardness=H*1000//Hardness of water(mg/lit) or ppm//
11 printf("\nHardness of water sample is %.1fppm",
    Hardness);
```

Scilab code Exa 2.18.49 Calculation of hardness using Zeolite process

```
1 //water and its treatment//
2 //example 2.18.49//
3 clc
4 volume_hardwater=10^4//in litres//
5 volume_NaCl=80//Volume of NaCl//
6 conc_NaCl=1000//mg NaCl consumed by zeolite bed per
    litre//
7 Wt_per_Litre=conc_NaCl/1000//gms NaCl consumed by
    zeolite bed per litre//
8 total_wt=Wt_per_Litre*volume_NaCl//total gms NaCl
    consumed by zeolite bed//
```

```
9 CaCO3_equivalent=total_wt*50/58.5//in terms of (gms/
    lit)//
10 H=CaCO3_equivalent/volume_hardwater//Hardness of
    water(gms/lit)//
11 Hardness=H*1000//Hardness of water(mg/lit) or ppm//
12 printf("\nCaCO3 equivalent is %.f mg",
    CaCO3_equivalent*1000);
13 printf("\nHardness of water is %.2f mg/lit",Hardness
    );
```

Scilab code Exa 2.18.50 Calculation of hardness using Zeolite process

```
1 //water and its treatment//
2 //example 2.18.50//
3 clc
4 volume_hardwater=75000//in litres//
5 volume_NaCl=117//Volume of NaCl in litres//
6 conc_NaCl=1500//mg NaCl consumed by zeolite bed per
    litre//
7 Wt_per_Litre=conc_NaCl/1000//gms NaCl consumed by
    zeolite bed per litre//
8 total_wt=Wt_per_Litre*volume_NaCl//total gms NaCl
    consumed by zeolite bed//
9 CaCO3_equivalent=total_wt*50/58.5//in terms of (gms/
    lit)//
10 H=CaCO3_equivalent/volume_hardwater//Hardness of
    water(gms/lit)//
11 Hardness=H*1000//Hardness of water(mg/lit) or ppm//
12 printf("\nCaCO3 equivalent is %.f mg",
    CaCO3_equivalent*1000);
13 printf("\nHardness of water is %.f ppm",Hardness);
```

Scilab code Exa 2.18.51 Hardwater quantity softened using Zeolite process

```
1 //water and its treatment//
2 //example 2.18.51//
3 clc
4 Hardness=600//Hardness of water(mg/lit) or ppm//
5 H=Hardness/1000//Hardness of water(gms/lit)//
6 volume_NaCl=300//Volume of NaCl//
7 Wt_per_Litre=75//gms NaCl consumed by zeolite bed
    per litre//
8 total_wt=Wt_per_Litre*volume_NaCl//total gms NaCl
    consumed by zeolite bed//
9 CaCO3_equivalent=total_wt*50/58.5//in terms of (gms/
    lit)//
10 volume_hardwater=CaCO3_equivalent/H
11 printf("\nCaCO3 equivalent is %.2f mgs",
    CaCO3_equivalent*1000);
12 printf("\nQuantity of water softened using zeolite
    bed is %.2f litres",volume_hardwater);
```

Scilab code Exa 2.18.52 Hardwater quantity softened using Zeolite process

```
1 //water and its treatment//
2 //example 2.18.52//
3 clc
4 Hardness=50//Hardness of water(mg/lit) or ppm//
5 H=Hardness/1000//Hardness of water(gms/lit)//
6 volume_NaCl=100//Volume of NaCl//
7 conc_NaCl=1200//mgs NaCl consumed by zeolite bed per
    litre//
8 Wt_per_Litre=conc_NaCl/1000//gms NaCl consumed by
    zeolite bed per litre//
9 total_wt=Wt_per_Litre*volume_NaCl//total gms NaCl
    consumed by zeolite bed//
10 CaCO3_equivalent=total_wt*50/58.5//in terms of (gms/
    lit)//
11 volume_hardwater=CaCO3_equivalent/H
```

```
12 printf("\nCaCO3 equivalent is %.2f mgs",
      CaCO3_equivalent*1000);
13 printf("\nQuantity of water softened using zeolite
      bed is %.f litres",volume_hardwater);
```

Scilab code Exa 2.18.53 Calculation of hardness using Zeolite process

```
1 //water and its treatment//
2 //example 2.18.53//
3 clc
4 volume_hardwater=75000//in litres//
5 volume_NaCl=1500//Volume of NaCl in litres//
6 conc_NaCl=117//mgs NaCl consumed by zeolite bed per
      litre//
7 Wt_per_Litre=conc_NaCl/1000//gms NaCl consumed by
      zeolite bed per litre//
8 total_wt=Wt_per_Litre*volume_NaCl//total gms NaCl
      consumed by zeolite bed//
9 CaCO3_equivalent=total_wt*50/58.5//in terms of (gms/
      lit)//
10 H=CaCO3_equivalent/volume_hardwater//Hardness of
      water(gms/lit)//
11 Hardness=H*1000//Hardness of water(mg/lit) or ppm//
12 printf("\nHardness of water is %.fppm or mg/lit",
      Hardness);
```

Scilab code Exa 2.18.54 Hardwater quantity softened using Zeolite process

```
1 //water and its treatment//
2 //example 2.18.54//
3 clc
4 Hardness=500//Hardness of water(mg/lit) or ppm//
5 H=Hardness/1000//Hardness of water(gms/lit)//
```

```
6 volume_NaCl=1000//Volume of NaCl//
7 Wt_per_Litre=100//gms NaCl consumed by zeolite bed
    per litre//
8 total_wt=Wt_per_Litre*volume_NaCl//total gms NaCl
    consumed by zeolite bed//
9 CaCO3_equivalent=total_wt*50/58.5//in terms of (gms/
    lit)//
10 volume_hardwater=CaCO3_equivalent/H
11 printf("\nQuantity of water softened using zeolite
    bed is %.f litres",volume_hardwater);
```

Scilab code Exa 2.18.55 Hardwater quantity softened using Zeolite process

```
1 //water and its treatment//
2 //example 2.18.55//
3 clc
4 Hardness=450//Hardness of water(mg/lit) or ppm//
5 H=Hardness/1000//Hardness of water(gms/lit)//
6 volume_NaCl=150//Volume of NaCl//
7 Wt_per_Litre=50//gms NaCl consumed by zeolite bed
    per litre//
8 total_wt=Wt_per_Litre*volume_NaCl//total gms NaCl
    consumed by zeolite bed//
9 CaCO3_equivalent=total_wt*50/58.505//in terms of (
    gms/lit)//
10 volume_hardwater=CaCO3_equivalent/H
11 printf("\nQuantity of water softened using zeolite
    bed is %.f litres",volume_hardwater);
```

Scilab code Exa 2.18.56 Hardwater quantity softened using Zeolite process

```
1 //water and its treatment//
2 //example 2.18.56//
```

```
clc
Hardness=300//Hardness of water(mg/lit) or ppm//
H=Hardness/1000//Hardness of water(gms/lit)//
volume_NaCl=75//Volume of NaCl//
Wt_per_Litre=75//gms NaCl consumed by zeolite bed
    per litre//
total_wt=Wt_per_Litre*volume_NaCl//total gms NaCl
    consumed by zeolite bed//
CaCO3_equivalent=total_wt*50/58.595//in terms of (
    gms/lit)//
volume_hardwater=CaCO3_equivalent/H
printf("\nQuantity of water softened using zeolite
    bed is %.f litres",volume_hardwater);
```

Scilab code Exa 2.18.57 Calculation of hardness using Zeolite process

```
//water and its treatment//
//example 2.18.57//
clc
volume_hardwater=800//in litres//
volume_NaCl=40//Volume of NaCl in litres//
Wt_per_Litre=110//gms NaCl consumed by zeolite bed
    per litre//
total_wt=Wt_per_Litre*volume_NaCl//total gms NaCl
    consumed by zeolite bed//
CaCO3_equivalent=total_wt*50/58.5//in terms of (gms/
    lit)//
H=CaCO3_equivalent/volume_hardwater//Hardness of
    water(gms/lit)//
Hardness=H*1000//Hardness of water(mg/lit) or ppm//
printf("\nCaCO3 equivalent is %.1f gms",
    CaCO3_equivalent);
printf("\nHardness of water is %.2fppm",Hardness);
```

Chapter 3

Lubricants

Scilab code Exa 3.7.1 Saponification value of oil

```
1 //lubricants//
2 //example 3.7.1//
3 clc
4 wt_oil=5//weight f oil saponified(gms)//
5 blank=45//volume blank titration reading(ml)//
6 back=15//volume back titration reading(ml)//
7 volume=blank-back//volume of alcoholic KOH consumed(
    ml)//
8 normality_KOH=0.5//normality of KOH//
9 S=volume*normality_KOH*56/wt_oil//formula for
    saponification value//
10 printf("\nSaponification value of oil is %.0f mgs
    KOH",S);
```

Scilab code Exa 3.7.2 Alcoholic KOH consumed in Saponification

```
1 //lubricants//
2 //example 3.7.2//
```

```
clc
S=180//Saponification value of oil//
wt_oil=1//weight f oil saponified(gms)//
blank=50//volume blank titration reading(ml)//
normality_KOH=0.4//normality of KOH //
volume=S*wt_oil/(normality_KOH*56)//formula for
    saponification value//
back=blank-volume//volume of alcoholic KOH consumed(
    ml)//
printf("\nQuantity of alcoholic KOH required per gm
    is %.0f ml",back);
```

Scilab code Exa 3.7.3 Saponification value of oil

```
//lubricants//
//example 3.7.3//
clc
wt_oil=5//weight f oil saponified(gms)//
blank=50//volume blank titration reading(ml)//
back=15//volume back titration reading(ml)//
volume=blank-back//volume of alcoholic KOH consumed(
    ml)//
normality_KOH=0.5//normality of KOH //
S=volume*normality_KOH*56/wt_oil//formula for
    saponification value//
printf("\nSaponification value of oil is %.0f mgs
    KOH",S);
```

Scilab code Exa 3.7.4 Saponification value of oil

```
//lubricants//
//example 3.7.4//
clc
```

```
4 wt_oil=2.5//weight f oil saponified(gms)//
5 blank=40//volume blank titration reading(ml)//
6 back=20//volume back titration reading(ml)//
7 normality_KOH=0.25//normality of KOH //
8 normality_HCl=.5//normality of HCl//
9 e=normality_HCl/normality_KOH//for equivalence in
    titration //
10 volume=(blank-back)*e//volume of alcoholic KOH
    consumed(ml)//
11 S=volume*normality_KOH*56/wt_oil//formula for
    saponification value//
12 printf("\nSaponification value of oil is %.0f mgs
    KOH",S);
```

Scilab code Exa 3.7.5 Saponification value of oil

```
1 //lubricants//
2 //example 3.7.5//
3 clc
4 wt_oil=5//weight f oil saponified(gms)//
5 blank=40//volume blank titration reading(ml)//
6 back=10//volume back titration reading(ml)//
7 strength_KOH=1.4/50//strength of KOH (gm/ml)//
8 normality_KOH=strength_KOH*1000//normality of KOH//
9 normality_HCl=.5//normality of HCl//
10 e=normality_HCl/normality_KOH//for equivalence in
    titration//
11 volume=(blank-back)*e//volume of alcoholic KOH
    consumed(ml)//
12 S=volume*normality_KOH*56/wt_oil//formula for
    saponification value//
13 printf("\nSaponification value of oil is %.0f mgs
    KOH",S);
```

Scilab code Exa 3.7.6 Saponification value of oil

```
1 //lubricants//
2 //example 3.7.6//
3 clc
4 wt_oil=5//weight f oil saponified(gms)//
5 blank=50//volume blank titration reading(ml)//
6 back=25//volume back titration reading(ml)//
7 volume=blank-back//volume of alcoholic KOH consumed(
    ml)//
8 normality_KOH=0.5//normality of KOH //
9 S=volume*normality_KOH*56/wt_oil//formula for
    saponification value//
10 printf("\nSaponification value of oil is %.0f mgs
    KOH",S);
```

Scilab code Exa 3.7.7 Saponification value of oil

```
1 //lubricants//
2 //example 3.7.7//
3 clc
4 wt_oil=1.55//weight f oil saponified(gms)//
5 blank=26//volume blank titration reading(ml)//
6 back=15//volume back titration reading(ml)//
7 volume=blank-back//volume of alcoholic KOH consumed(
    ml)//
8 normality_KOH=1/2//normality of KOH //
9 S=volume*normality_KOH*56/wt_oil//formula for
    saponification value//
10 printf("\nSaponification value of oil is %.1f mgs
    KOH",S);
```

Scilab code Exa 3.7.8 Saponification value of oil

```
1 //lubricants//
2 //example 3.7.8//
3 clc
4 wt_oil=5//weight f oil saponified(gms)//
5 blank=52//volume blank titration reading(ml)//
6 back=20//volume back titration reading(ml)//
7 volume=blank-back//volume of alcoholic KOH consumed(
    ml)//
8 normality_KOH=0.5//normality of KOH //
9 S=volume*normality_KOH*56/wt_oil//formula for
    saponification value//
10 printf("\nSaponification value of oil is %.1f mgs
    KOH",S);
```

Scilab code Exa 3.7.9 Saponification of blended oils

```
1 //lubricants//
2 //example 3.7.9//
3 clc
4 S_C=192//Saponification value of castor oil//
5 wt_oil=16//weight f oil saponified(gms)//
6 blank=45//volume blank titration reading(ml)//
7 back=31.5//volume back titration reading(ml)//
8 volume=blank-back//volume of alcoholic KOH consumed(
    ml)//
9 N_H=0.5//normality of HCl in titration//
10 V_H=blank//volume of HCl in titration(ml)//
11 V_K=50//volume of KOH in titration(ml)//
12 N_K=N_H*V_H/V_K//normality of KOH for equivalence//
```

```
13 S_blended=volume*N_K*56/wt_oil//formula for
      saponification value//
14 printf("\nSaponification value of blended oil is %.2
      f mgs KOH",S_blended);
15 pc_C=(S_blended/S_C)*100
16 printf("\npercentage of castor oil in blend is %.3f
      percent",pc_C);
```

Scilab code Exa 3.7.9.A Saponification value of oil

```
1 //lubricants//
2 //example 3.7.9.A//
3 clc
4 wt_oil=1.55//weight f oil saponified(gms)//
5 blank=20//volume blank titration reading(ml)//
6 back=15//volume back titration reading(ml)//
7 volume=blank-back//volume of alcoholic KOH consumed(
      ml)//
8 normality_KOH=0.5//normality of KOH //
9 S=volume*normality_KOH*56/wt_oil//formula for
      saponification value//
10 printf("\nSaponification value of oil is %.2f mgs
      KOH",S);
```

Scilab code Exa 3.7.9.B Saponification value of oil

```
1 //lubricants//
2 //example 3.7.9.B//
3 clc
4 wt_oil=3//weight f oil saponified(gms)//
5 blank=36//volume blank titration reading(ml)//
6 back=12//volume back titration reading(ml)//
```

```
7 volume=blank-back//volume of alcoholic KOH consumed(
    ml)//
8 normality_KOH=0.5//normality of KOH //
9 S=volume*normality_KOH*56/wt_oil//formula for
    saponification value//
10 printf("\nSaponification value of oil is %.f mgs KOH
    ",S);
```

Scilab code Exa 3.7.10 Acid value of oil

```
1 //lubricants//
2 //example 3.7.10//
3 clc
4 wt_oil=2.5//weight f oil saponified(gms)//
5 volume=2.5//volume of alcoholic KOH consumed to
    neutralize fatty acids(ml)//
6 normality_KOH=(1/100)//normality of KOH //
7 A=volume*normality_KOH*56/wt_oil//formula for acid
    value//
8 printf("\nAcid value of oil is %.2f mgs KOH",A);
```

Scilab code Exa 3.7.11 Acid value of oil

```
1 //lubricants//
2 //example 3.7.11//
3 clc
4 wt_oil=10//weight f oil saponified(gms)//
5 volume=.2//volume of alcoholic KOH consumed to
    neutralize fatty acids(ml)//
6 normality_KOH=0.02//normality of KOH //
7 A=volume*normality_KOH*56/wt_oil//formula for acid
    value//
8 printf("\nAcid value of oil is %.4f mgs KOH",A);
```

Scilab code Exa 3.7.12 Acid value of oil

```
1 //lubricants//
2 //example 3.7.12//
3 clc
4 wt_oil=4.45//weight f oil saponified(gms)//
5 volume=2.5//volume of alcoholic KOH consumed to
    neutralize fatty acids(ml)//
6 normality_KOH=0.01//normality of KOH //
7 A=volume*normality_KOH*56/wt_oil//formula for acid
    value//
8 printf("\nAcid value of oil is %.3f mgs KOH",A);
9 if A<=0.1 then printf("\nOil can be used for
    lubrication");
10 else printf("\nOil cannot be used for lubrication");
11     end
```

Scilab code Exa 3.7.13 Acid value of oil

```
1 //lubricants//
2 //example 3.7.13//
3 clc
4 volume_oil=5//volume of oil titrated(ml)//
5 density_oil=0.92//density of oil titrated//
6 wt_oil=volume_oil*density_oil//weight f oil
    saponified(gms)//
7 volume=2//volume of alcoholic KOH consumed to
    neutralize fatty acids(ml)//
8 normality_KOH=0.01//normality of KOH //
9 A=volume*normality_KOH*56/wt_oil//formula for acid
    value//
10 printf("\nAcid value of oil is %.3f mgs KOH",A);
```

Scilab code Exa 3.7.14 Acid value of oil

```
1 //lubricants//
2 //example 3.7.14//
3 clc
4 volume_oil=9//volume of oil titrated(ml)//
5 density_oil=0.81//density of oil titrated//
6 wt_oil=volume_oil*density_oil//weight f oil
    saponified(gms)//
7 volume=3.75//volume of alcoholic KOH consumed to
    neutralize fatty acids(ml)//
8 normality_KOH=0.1//normality of KOH //
9 A=volume*normality_KOH*56/wt_oil//formula for acid
    value//
10 printf("\nAcid value of oil is %.2f mgs KOH",A);
```

Scilab code Exa 3.7.15 Acid value of oil

```
1 //lubricants//
2 //example 3.7.15//
3 clc
4 volume_oil=20//volume of oil titrated(ml)//
5 density_oil=0.86//density of oil titrated//
6 wt_oil=volume_oil*density_oil//weight f oil
    saponified(gms)//
7 volume=2.5//volume of alcoholic KOH consumed to
    neutralize fatty acids(ml)//
8 normality_KOH=0.1//normality of KOH //
9 A=volume*normality_KOH*56/wt_oil//formula for acid
    value//
10 printf("\nAcid value of oil is %.3f mgs KOH",A);
```

Scilab code Exa 3.7.16 Acid value of oil

```
1 //lubricants//
2 //example 3.7.16//
3 clc
4 wt_oil=3//weight f oil saponified(gms)//
5 volume=.2//volume of alcoholic KOH consumed to
    neutralize fatty acids(ml)//
6 normality_KOH=0.025//normality of KOH //
7 A=volume*normality_KOH*56/wt_oil//formula for acid
    value//
8 printf("\nAcid value of oil is %.4f mgs KOH",A);
```

Scilab code Exa 3.7.17 Acid value of oil

```
1 //lubricants//
2 //example 3.7.17//
3 clc
4 volume_oil=7//volume of oil titrated(ml)//
5 density_oil=0.885//density of oil titrated//
6 wt_oil=volume_oil*density_oil//weight f oil
    saponified(gms)//
7 volume=3.8//volume of alcoholic KOH consumed to
    neutralize fatty acids(ml)//
8 normality_KOH=1/20//normality of KOH //
9 A=volume*normality_KOH*56/wt_oil//formula for acid
    value//
10 printf("\nAcid value of oil is %.2f mgs KOH",A);
```

Chapter 5

Phase rule and steels

Scilab code Exa 5.1 Eutectic in alloy

```
1 //phase rule and steels//
2 //problem 1//
3 clc
4 pc_tin=(73/100)//% composition of tin in alloy//
5 eutectic_tin=64//% composition of tin in eutectic
    alloy//
6 wt_alloy=1//weight of alloy in terms of kg//
7 w=wt_alloy*1000//weight of alloy in terms of gms//
8 wt_tin=pc_tin*w//wight of tin in alloy(gms)//
9 wt_lead=w-wt_tin//wight of lead in alloy(gms)//
10 wt_eutectic_tin=wt_lead*eutectic_tin/(100-
    eutectic_tin)//weight of eutectic tin(gms)//
11 To=wt_lead+wt_eutectic_tin//total mass of eutectic
    alloy(gms)//
12 printf("\nTotal mass of eutectic in alloy is %.f g",
    To);
```