LAMPIRAN 1

```
unit KIELLAND1;

interface

uses
  Windows, Math, Messages, SysUtils, Classes, Graphics, Controls, Forms, Dialogs,
  StdCtrls, ExtCtrls, Grids, printers;

type
  TfMain = class(TForm)
    Label2: TLabel;
    eTITLE: TEdit;
    Label3: TLabel;
    eAA: TEdit;
    Label4: TLabel;
    Label5: TLabel;
    Label6: TLabel;
    eBA: TEdit;
    eAB: TEdit;
    Label7: TLabel;
    Label8: TLabel;
    eBB: TEdit;
    Label9: TLabel;
    Label10: TLabel;
    eZA: TEdit;
    eZB: TEdit;
    Label11: TLabel;
    eZX: TEdit;
    Label12: TLabel;
    eTN: TEdit;
    Label1: TLabel;
    eITEMS: TEdit;
    Label13: TLabel;
    Label14: TLabel;
    Label15: TLabel;
    GPoint: TStringGrid;
    Bevel1: TBevel;
    Bevel2: TBevel;
    Label16: TLabel;
    bClose: TButton;
    bOpen: TButton;
    bSave: TButton;
    bPrint: TButton;
    fKC_Alpha: TButton;
    Label17: TLabel;
    Bevel3: TBevel;
    SaveD: TSaveDialog;
    OpenD: TOpenDialog;
    PrintD: TPrintDialog;
    function fixlength(s:string; n:byte):string;
    procedure Banding(a:real;var b:real);
    procedure bCloseClick(Sender: TObject);
    procedure eITEMSKeyUp(Sender: TObject; var Key: Word;
      Shift: TShiftState);
    procedure FormCreate(Sender: TObject);
    procedure fKC_AlphaClick(Sender: TObject);
    procedure bSaveClick(Sender: TObject);
    procedure bOpenClick(Sender: TObject);
    procedure bPrintClick(Sender: TObject);
```

```
 private
  { Private declarations }
 public
  { Public declarations }
 end;
const
 max_points = 30;
 max_terms = 7;

var
 fMain: TfMain;
 ZA,ZB : double;
 AC,AS0,LOGKC  : double;
 X, Y : array[1.. max_points] of real;
 ACC: array[1.. max_points] of double;
 nPoints: 1..max_points;

implementation

uses uKCAlpha, Graph_f, GRAPH_F3,coef ,coef2;

{$R *.DFM}

procedure TfMain.bCloseClick(Sender: TObject);
begin
 Close;
end;

procedure TfMain.eITEMSKeyUp(Sender: TObject; var Key: Word;
 Shift: TShiftState);
var
 n, NItem, Errorc : Integer;

begin
 if (eITEMS.Text<>'') and (eITEMS.Text<>'0')then
 begin
  Errorc:=0;
  GPoint.Enabled:=true;
  Try
   NItem := strtoint(eITEMS.Text);
  except
   Errorc:=1;
  end;
  if Errorc=0 then
  begin
   GPoint.RowCount:=NItem;
   for n := 1 to NItem do GPoint.Cells[0,n-1]:=InttoStr(n);
  end;
 nPoints :=GPoint.RowCount ;
end
 else
 begin
  GPoint.RowCount:=1;
  GPoint.Enabled:=false;
 end;
end;

procedure TfMain.FormCreate(Sender: TObject);
Var n : byte;
begin
 GPoint.Enabled:=true;
 eITEMS.Text:='10';
```

```
 GPoint.RowCount:=10;
 for n := 1 to 10 do GPoint.Cells[0,n-1]:=InttoStr(n);
end;

function TfMain.fixlength(s:string; n:byte):string;
var i, j : byte;
begin
 //function untuk mengatur panjang string
 j:=length(s);
 if n>j then
 for i := 1 to n-j do s:='0'+s;
 fixlength:=s;
end;

procedure TfMain.Banding(a:real;var b:real);
begin
 if a < b then
      b:= a
    else
      b:= b;
end;

procedure TfMain.fKC_AlphaClick(Sender: TObject);
var
 MX, ZX,AA,AB,BA,BB,TN, MA,MB,BC,BS,KM,ION,P1,P2,Q1,Q2,LOGAM1,LOGAM2,
 K1,K2,K3,K4,K5,K6,Y1,Y2,Y3,Y4,Z1,Z2,Z3,Z4,LOGAM3,LOGAM4,
 X1,X2,LOGAMA,GAMA,ALPHA,KC,RI,alp : double;
 N, ITEMS : byte;
 sN, STRINGs :  String;
 n1, n2, n3, n4 : double;
begin
 fKCAlpha.Memo1.Clear;
 for i:=1 to 5 do
   fKCAlpha.Memo1.Lines.Add(' ');
 fKCAlpha.Memo1.Lines.Add(fmain.eTITLE.Text);
 // Input values
 AA:=strtofloat(eAA.Text); AB:=strtofloat(eAB.Text);
 BA:=strtofloat(eBA.Text); BB:=strtofloat(eBB.Text);
 ZA:=strtofloat(eZA.Text); ZB:=strtofloat(eZB.Text);
 ZX:=strtofloat(eZX.Text);
 TN:=strtofloat(eTN.Text);
 ITEMS:=strtoint(eITEMS.Text);
 Graph1.xygraph1.appearance.Graphtitle:=eTitle.Text;
 Graph1.StringGrid1.RowCount:=ITEMS+1;
 Graph1.StringGrid1.Cells[0,0]:='AC';
 Graph1.StringGrid1.Cells[1,0]:='AS';
 Graph3.xygraph3.appearance.Graphtitle:=eTitle.Text;
 Graph3.StringGrid2.RowCount:=ITEMS+1;
 Graph3.StringGrid2.Cells[0,0]:='AC(N)';
 Graph3.StringGrid2.Cells[1,0]:='Ln(KC)';
 for N := 1 to ITEMS do
 begin
  X[N]:=strtofloat(GPoint.Cells[1,N-1]);
  Y[N]:=strtofloat(GPoint.Cells[2,N-1]);
  ACC[N]:=X[N];
 end;
 for N := 1 to ITEMS do
 begin
   ACC[N]:=ACC[N]/ACC[ITEMS];
   Graph3.StringGrid2.Cells[0,N]:=floattostrf(ACC[N],ffExponent,5,2);
 end;
  // Molarity of Anion (MX)
```

```
 MX:=TN/ZX;
  // Compute the thermodynamic parameters

fKCAlpha.Memo1.Lines.Add('==========================================================
==========================================================

');
  fKCAlpha.Memo1.Lines.Add('No          AC              AS              mA              mB
ION             KM            GAMA          KC            ALPHA         LN(KC)');

fKCAlpha.Memo1.Lines.Add('==========================================================
==========================================================

');
  for N:=1 to ITEMS do
  begin
    AC:=X[N];
    BC:=1-AC;
    AS0:=Y[N];
    BS:=1-AS0;
    MA:=AS0*TN/ZA;
    MB:=BS*TN/ZB;
    n1:=POWER(AC,ZB);
    n2:=POWER(MB,ZA);
    n3:=POWER(BC,ZA);
    n4:=POWER(MA,ZB);
    KM:=n1*n2 /(n3*n4);
    // Debye-Huckel model _
    // Calculate the Ionic strength (ION)
    ION:=0.5*(MA*ZA*ZA+MB*ZB*ZB+MX*ZX*ZX);

    //Calculate the solution phase activity coefficients for the
    //incoming and outgoing cation (LOGAM1, LOGAM2)
    RI:=SQRT(ION);
    P1:=(-0.5155)*(ZA*ZX)*RI;
    P2:=(3291000000)*AA*RI;
    Q1:=(-0.5155)*(ZB*ZX)*RI;
    Q2:=(3291000000)*BA*RI;
    LOGAM1:=P1/(1.0+P2)+AB*ION;
    LOGAM2:=Q1/(1.0+Q2)+BB*ION;

    // Glueckauf model
    // ===============
    // Calculate the corrected solution phase activity coefficients for the
    // incoming and outgoing cation (LOGAM3, LOGAM4)
    K1:=ZB*(2.0*ZB-ZA+ZX);
    K2:=(ZA*(ZB+ZX)*(ZB+ZX))/(ZA+ZX);
    K3:=(0.5*ZA*ZB*ZX*(ZA-ZB)*(ZA-ZB))/(ZA+ZX);
    K4:=ZA*(2*ZA-ZB+ZX);
    K5:=(ZB*(ZA+ZX)*(ZA+ZX))/(ZB+ZX);
    K6:=(0.5*ZA*ZB*ZX*(ZB-ZA)*(ZB-ZA))/(ZB+ZX);
    Y1:=MA/(4.0*ION);
    Y2:=K4*LOGAM2;
    Y3:=K5*LOGAM1;
    Y4:=K6/(1.0+1/(SQRT(ION)));
    Z1:=MB/(4.0*ION);
    Z2:=K1*LOGAM1;
    Z3:=K2*LOGAM2;
    Z4:=K3/(1.0+1/(SQRT(ION)));
    LOGAM3:=LOGAM1-(Z1*(Z2-Z3-Z4));
    LOGAM4:=LOGAM2-(Y1*(Y2-Y3-Y4));

    // Calculate gamma
    X1:=ZA*(ZB+ZX)*LOGAM4;
```

```
  X2:=ZB*(ZA+ZX)*LOGAM3;
  LOGAMA:=(X1-X2)/ZX;
  GAMA:= POWER(10,LOGAMA);

  // calculate the Kielland coefficients (KC) and the
  // selectivity coefficients (ALPHA)
  KC:=KM*GAMA;
  LOGKC:=Ln(KC);
  ALPHA:=(AC*MB)/(BC*MA);

  sN:=inttostr(N);
  sN:=fixlength(sN,3);

  // Output thermodynamic parameters
  fKCAlpha.Memo1.Lines.Add(
    sN+'   '+
    floattostrf(AC,ffExponent,6,3)+'  '+
    floattostrf(AS0,ffExponent,6,3)+'  '+
    floattostrf(MA,ffExponent,6,3)+'  '+
    floattostrf(MB,ffExponent,6,3)+'  '+
    floattostrf(ION,ffExponent,6,3)+'  '+
    floattostrf(KM,ffExponent,6,3)+'  '+
    floattostrf(GAMA,ffExponent,6,3)+'  '+
    floattostrf(KC,ffExponent,6,3)+'  '+
    floattostrf(alpha,ffExponent,6,3)+'  '+
    floattostrf(LOGKC,ffExponent,6,3));
   Graph1.StringGrid1.Cells[0,N]:=floattostrf(AC,ffExponent,5,2);
   Graph1.StringGrid1.Cells[1,N]:=floattostrf(AS0,ffExponent,5,2);
   Graph3.StringGrid2.Cells[1,N]:=floattostrf(LOGKC,ffExponent,5,2);
 end;

fKCAlpha.Memo1.Lines.Add('==========================================================
==========================================================
');
  fKCAlpha.Showmodal;
end;

procedure TfMain.bSaveClick(Sender: TObject);
var
  berkas : textfile;
  salah  : byte;
  jwb : string;
  n, j : byte;
begin
  ForceCurrentDirectory:=true;
  SaveD.Filter:='Data program (*.txt)|*.txt';
  SaveD.FileName:='';
  if SaveD.execute then
  begin
    AssignFile(berkas,SaveD.FileName);
    salah:=0;
    {$I-}
    Rewrite(Berkas);
    {$I+}
    salah:=IOResult;
    if salah<>0 then
      MessageDlg('File don''t be wrote ! ', mtWarning, [mbOK],0)
    else
    begin
       writeln(berkas, eTITLE.Text);
       writeln(berkas, eAA.Text);
       writeln(berkas, eAB.Text);
```

```
      writeln(berkas, eBA.Text);
      writeln(berkas, eBB.Text);
      writeln(berkas, eZA.Text);
      writeln(berkas, eZB.Text);
      writeln(berkas, eZX.Text);
      writeln(berkas, eTN.Text);
      writeln(berkas, eITEMS.Text);
      n:=strtoint(eITEMS.Text);
      for j:=1 to n do
      begin
       jwb:=GPoint.Cells[1,j-1];
       write(berkas,jwb);
       jwb:=GPoint.Cells[2,j-1];
       writeln(berkas,jwb);
      end;
     CloseFile(Berkas);
    end;
  end;
end;

procedure TfMain.bOpenClick(Sender: TObject);
var
  berkas : textfile;
  salah  : byte;
  jwb : string;
  n, j : byte;
begin
  ForceCurrentDirectory:=true;
  OpenD.Filter:='data program (*.txt)|*.txt';
  OpenD.FileName:='';
  if OpenD.execute then
  begin
    AssignFile(berkas,OpenD.FileName);
    salah:=0;
    {$I-}
    Reset(Berkas);
    {$I+}
    salah:=IOResult;
    if salah<>0 then
      MessageDlg('File don''t be read ! ', mtWarning, [mbOK],0)
    else
    begin
      //while not EOF(berkas) do
      begin
        readln(berkas,jwb); eTITLE.Text:=jwb;
        readln(berkas,jwb); eAA.Text:=jwb;
        readln(berkas,jwb); eAB.Text:=jwb;
        readln(berkas,jwb); eBA.Text:=jwb;
        readln(berkas,jwb); eBB.Text:=jwb;
        readln(berkas,jwb); eZA.Text:=jwb;
        readln(berkas,jwb); eZB.Text:=jwb;
        readln(berkas,jwb); eZX.Text:=jwb;
        readln(berkas,jwb); eTN.Text:=jwb;
        readln(berkas,jwb); eITEMS.Text:=jwb;
        n:=strtoint(jwb);
        GPoint.RowCount:=n;
        for j:=1 to n do
        begin
          GPoint.Cells[0,j-1]:=inttostr(j);
          readln(berkas,jwb); GPoint.Cells[1,j-1]:=jwb;
          readln(berkas,jwb); GPoint.Cells[2,j-1]:=jwb;
        end;
```

```
      end;
      CloseFile(Berkas);
    end;
  end;
end;

procedure TfMain.bPrintClick(Sender: TObject);
var
  Berkas: TextFile;
  jwb: string;
  n, j : integer;
begin
  if PrintD.execute then
  begin
    AssignPrn(Berkas);
    Rewrite(Berkas);
    writeln(berkas, eTITLE.Text);
    writeln(berkas, eAA.Text);
    writeln(berkas, eAB.Text);
    writeln(berkas, eBA.Text);
    writeln(berkas, eBB.Text);
    writeln(berkas, eZA.Text);
    writeln(berkas, eZB.Text);
    writeln(berkas, eZX.Text);
    writeln(berkas, eTN.Text);
    writeln(berkas, elTEMS.Text);
    n:=strtoint(elTEMS.Text);
    for j:=1 to n do
    begin
      jwb:=GPoint.Cells[1,j-1];
      write(berkas,jwb);
      jwb:=GPoint.Cells[2,j-1];
      writeln(berkas,jwb);
    end;
    CloseFile(Berkas);
  end;
end;

end.
```

```
unit uKCAlpha;

interface

uses
  Windows, Messages, SysUtils, Classes, Graphics, Controls, Forms, Dialogs,
  StdCtrls, ComCtrls, ExtCtrls, TeeProcs, TeEngine, Chart,
  Grids, xyGraph, Buttons;

type
  TfKCAlpha = class(TForm)
    bClose: TButton;
    SaveD: TSaveDialog;
    PrintD: TPrintDialog;
    Memo1: TRichEdit;
    bSave: TButton;
    bPrint: TButton;
    BitBtn1: TBitBtn;
    procedure bCloseClick(Sender: TObject);
    procedure bSaveClick(Sender: TObject);
    procedure bPrintClick(Sender: TObject);
    procedure BitBtn1Click(Sender: TObject);
  private
    { Private declarations }
  public
    { Public declarations }
  end;

var
  fKCAlpha: TfKCAlpha;

implementation

uses Graph_f, Kielland1 , GRAPH_F3,coef;

{$R *.DFM}

procedure TfKCAlpha.bCloseClick(Sender: TObject);
begin
  Close;

end;

procedure TfKCAlpha.bSaveClick(Sender: TObject);
begin
  ForceCurrentDirectory:=true;
  SaveD.Filter:='Data program (*.txt)|*.txt';
  SaveD.FileName:='';
  if SaveD.execute then
    Memo1.Lines.SaveToFile(SaveD.FileName);
end;

procedure TfKCAlpha.bPrintClick(Sender: TObject);
begin
 If PrintD.Execute then Memo1.Print('Kc & Alpha');
end;
procedure TfKCAlpha.BitBtn1Click(Sender: TObject);
begin
  Graph1.Showmodal;
end;

end.
```

```
unit GRAPH_F;
{ if running under Delphi, turn off Break on exception in Options|Environment}
interface

uses
  SysUtils, WinTypes, WinProcs, Messages, Classes, Graphics, Controls,
  Forms, Dialogs, ExtCtrls, StdCtrls, Spin, Grids, XyGraph, Printers,ComCtrls;

type
  TGraph1 = class(TForm)
    StringGrid1: TStringGrid;
    SetSeriesBtn: TButton;
    PrintBtn: TButton;
    xyGraph1: TxyGraph;
    bClose: TButton;
    EditNumTerms: TEdit;
    UpDownNumTerms: TUpDown;
    LabelNumTerms: TLabel;
    Button2: TButton;
    bSave: TButton;
    MemoResults: TRichEdit;
    Button3: TButton;
    SaveD: TSaveDialog;
    procedure FormCreate(Sender: TObject);
    procedure SetSeriesBtnClick(Sender: TObject);
    procedure PrintBtnClick(Sender: TObject);
    procedure bCloseClick(Sender: TObject);
    procedure FormActivate(Sender: TObject);
    procedure UpDownNumTermsClick(Sender: TObject; Button: TUDBtnType);
    procedure Button2Click(Sender: TObject);
    procedure Button3Click(Sender: TObject);
    procedure xyGraph1PaintEnd(sender: TObject; Canvas: TCanvas);
    procedure bSaveClick(Sender: TObject);
  private
    { Private declarations }
  public
    { Public declarations }
  end;
const
  max_points = 30;
  max_terms = 7;

var
  Graph1: TGraph1;
  nPoints: 1..max_points+1;
  X, Y : array[1.. max_points] of real;
  sig: array [1..max_terms] of real;

implementation

uses GRAPH_F3, coef, uKCAlpha, Kielland1,Fitting;

{$R *.DFM}

procedure TGraph1.FormCreate(Sender: TObject);
begin
  xyGraph1.XAxis.Title := 'AC';
  xyGraph1.YAxis.Title := 'AS';
end;

{plotting curve fitting function:}
type
```

```
 FnParmArray = array[1..7] of Double;
var
 parms : FnParmArray;

function Fn(x: Double; var p): Double; far;
var
 pA: FnParmArray absolute p;
begin
 Result := pA[1]+pA[2]*x+pA[3]*x*x+pA[4]*x*x*x+pA[5]*x*x*x*x
        +pA[6]*x*x*x*x*x+pA[7]*x*x*x*x*x*x;
end;

procedure TGraph1.PrintBtnClick(Sender: TObject):
begin
 if MessageDlg('Print Graph1?'
 , mtInformation, [mbYes, mbNo], 0) = mrYes then
  begin
   xyGraph1.print;
  end;
 if MessageDlg('Print Result?', mtInformation, [mbYes, mbNo], 0) = mrYes then
  begin
   MemoResults.print('Graph');
  end;
end;

procedure TGraph1.SetSeriesBtnClick(Sender: TObject);
var
 j:byte;
 xv, yv: Double;
begin
 with xyGraph1.Series[1] do
 begin
  AllowDuplicates := true;
  Active := true;
  Clear;
  AutoZero := false;
  DrawLine := false;
  DrawPoints :=true;
  PointSize := 3;
 end;
 j := 1;
 while j < StringGrid1.RowCount do
  try
   xv := StrToFloat(StringGrid1.Cells[0,j]);
   yv := StrToFloat(StringGrid1.Cells[1,j]);
   xyGraph1[1][xv] := yv;
   Inc(j);
  except
   on EConvertError do Break
  end;
end;

procedure TGraph1.bCloseClick(Sender: TObject);
begin
 close;
end;

procedure TGraph1.FormActivate(Sender: TObject);
begin
 UpDownNumTermsClick(Self,btPrev);
 SetSeriesBtnClick(Self);
end;
```

```
procedure TGraph1.UpDownNumTermsClick(Sender: TObject; Button: TUDBtnType);
var i,j: byte;
  xc, yc, delta: real;
  coef: array [1..max_terms,0..max_terms-1] of real;
  correl: array [1..max_terms] of real;
begin
  SetSeriesBtnClick(Self);
  nPoints:=StringGrid1.RowCount;
  // Fill in the X and Y arrays
  if UpDownNumTerms.position>nPoints-1 then
     UpDownNumTerms.Max:= nPoints-2;
  for i := 1 to nPoints-1 do
  begin
   x [i] := strtofloat(StringGrid1.Cells[0,i]);
   y [i] := strtofloat(StringGrid1.Cells[1,i]);
  end;
  // Call the PolyFit routine.  The output coeffs array and correl(ation)
  PolyFit (x, y, coef[UpDownNumTerms.position], correl[UpDownNumTerms.position]
        ,sig[UpDownNumTerms.position], nPoints-1, UpDownNumTerms.position);
 // Remove any existing display of results
 // Display the results in the lines of a MemoControl
 MemoResults.Clear;
 for i := 1 to 5 do
   MemoResults.Lines.Add('  ');
 MemoResults.Lines.Add(fmain.eTITLE.Text);
 MemoResults.Lines.Add('=============================================');
 MemoResults.Lines.Add (' No      Ac        As       Ascalc    residual');
 MemoResults.Lines.Add('=============================================');
  for i := 0 to nPoints - 2 do
  begin
    yc := 0.0;
    xc := 1.0;
      for j := 0 to UpDownNumTerms.position-1 do
      begin
        yc := yc + coef [UpDownNumTerms.position,j] * xc;
        xc := xc * x [i+1];
      end;
    delta := yc - y [i+1];
    l:=inttostr(i+1);
    l:=fmain.fixlength(l,3);
    MemoResults.Lines.Add (l+'  '+Format ('%6.4f   %6.4f      %6.4f    %8.4f
                  ,[x [i+1], y [i+1], yc, delta]));
  end;
  MemoResults.Lines.Add('=============================================');
  MemoResults.Lines.Add (' ');
  MemoResults.Lines.Add ('Coefficients');
  MemoResults.Lines.Add (Format ('%.4f  constant term', [coef [UpDownNumTerms.Position,0]]));
  for i := 1 to UpDownNumTerms.Position - 1 do
    MemoResults.Lines.Add (Format ('%.4f  X^%d', [coef [UpDownNumTerms.Position,i], i]));
  MemoResults.Lines.Add (Format ('%.4f  correlation coefficient', [correl[UpDownNumTerms.Position]]));
  MemoResults.Lines.Add (Format ('Error= %.4f ',[Sig[UpDownNumTerms.Position]]));
  for i := 1 to 7 do parms[i]:=0;
  for i := 1 to UpDownNumTerms.Position do parms[i]:=coef[UpDownNumTerms.Position,i-1];
 end;

 procedure TGraph1.Button2Click(Sender: TObject);
 begin
   graph3.showmodal;
 end;

 procedure TGraph1.Button3Click(Sender: TObject);
```

```
var i,j,s: integer;
    coef: array [1..max_terms,0..max_terms-1] of real;
    correl: array [1..max_terms] of real;
    R1:real;
begin
  s:=max_terms;
  if s>nPoints-1 then
     s:= nPoints-1;
  Coefisien.Memo1.Clear;
  for i := 1 to 5 do
    Coefisien.Memo1.Lines.Add('  ');
  Coefisien.Memo1.Lines.Add(fmain.eTITLE.Text);
  for j := 2 to s do
  begin
    for i := 0 to 6 do
    begin
      Coef[j,i]:=0;
    end;
  end;
  for i := 1 to nPoints-1 do
  begin
    x [i] := strtofloat(StringGrid1.Cells[0,i]);
    y [i] := strtofloat(StringGrid1.Cells[1,i]);
  end;

 Coefisien.Memo1.Lines.Add('==========================================================
 ==========================================');
  Coefisien.Memo1.Lines.Add(
  'Deg       Coef[0]          Coef[1]          Coef[2]          Coef[3]          Coef[4]          Coef[5]
 Coef[6]          Error ');

 Coefisien.Memo1.Lines.Add('==========================================================
 ==========================================');
  for j :=2 to s do
  begin
    // Call the PolyFit routine.  The output coeffs array and correl(ation)
    PolyFit (x, y, coef[j], correl[j],sig[j], nPoints-1,j);
    l:=inttostr(j-1);
    l:=fmain.fixlength(l,2);
    Coefisien.Memo1.Lines.Add(
        L+'       '+
        Format('%8.4e    %8.4e    %8.4e    %8.4e    %8.4e    %8.4e    %8.4e    %8.4e',
        [Coef[j,0],Coef[j,1],Coef[j,2],Coef[j,3],Coef[j,4],Coef[j,5],Coef[j,6],{correl[j],}Sig[j]]));
  end;
  R1:=1;
  for j :=2 to s do fmain.banding(sig[j],R1);

 Coefisien.Memo1.Lines.Add('==========================================================
 ==========================================');
  Coefisien.Memo1.Lines.Add(format('Best predictive equation when fit factor is lowest is %8.4e',[R1]));
  Coefisien.showmodal;
end;


procedure TGraph1.xyGraph1PaintEnd(sender: TObject; Canvas: TCanvas);
begin

  xyGraph1.DrawFunction(Fn, parms, 0, 0, clRed, psSolid, 0);
end;

procedure TGraph1.bSaveClick(Sender: TObject);
begin
```

```
ForceCurrentDirectory:=true;
Saved.Filter:='data program (*.*)|*.*';
Saved.FileName:='';
if Saved.execute then
begin
  xygraph1.SaveToBitmap(saved.filename+'.bmp');
  MemoResults.Lines.SaveToFile(SaveD.FileName+'.txt');
end;

end;

end.
```

```
unit coef;

interface

uses
  Windows, Messages, SysUtils, Classes, Graphics, Controls, Forms, Dialogs,
  StdCtrls, ComCtrls, ExtCtrls, TeeProcs, TeEngine, Chart,
  Grids, xyGraph, Buttons;

type
  TCoefisien = class(TForm)
    bClose: TButton;
    SaveD: TSaveDialog;
    PrintD: TPrintDialog;
    Memo1: TRichEdit;
    bSave: TButton;
    bPrint: TButton;
    procedure bCloseClick(Sender: TObject);
    procedure bSaveClick(Sender: TObject);
    procedure bPrintClick(Sender: TObject);
  private
    { Private declarations }
  public
    { Public declarations }
  end;

var
  Coefisien: TCoefisien;

implementation

uses Graph_f,uKCAlpha,  GRAPH_F3, Kielland1;

{$R *.DFM}

procedure TCoefisien.bCloseClick(Sender: TObject);
begin
  Close;
end;

procedure TCoefisien.bSaveClick(Sender: TObject);
begin
  ForceCurrentDirectory:=true;
  SaveD.Filter:='Data program (*.txt)|*.txt';
  SaveD.FileName:='';
  if SaveD.execute then
    Memo1.Lines.SaveToFile(SaveD.FileName);
end;

procedure TCoefisien.bPrintClick(Sender: TObject);
begin
  If PrintD.Execute then Memo1.Print('Coefisien');
end;

end.
```

```
unit GRAPH_F3;
{ if running under Delphi, turn off Break on exception in Options|Environment}
interface

uses
  SysUtils, WinTypes, WinProcs, Messages, Classes, Graphics, Controls,
  Forms, Dialogs, ExtCtrls, StdCtrls, Spin, Grids, XyGraph, Printers,ComCtrls;

type
  TGraph3 = class(TForm)
    StringGrid2: TStringGrid;
    SetSeriesBtn: TButton;
    PrintBtn: TButton;
    bClose: TButton;
    EditNumTerms: TEdit;
    UpDownNumTerms: TUpDown;
    LabelNumTerms: TLabel;
    xyGraph3: TxyGraph;
    bSave: TButton;
    SaveD: TSaveDialog;
    MemoResults2: TRichEdit;
    Button2: TButton;
    procedure FormCreate(Sender: TObject);
    procedure SetSeriesBtnClick(Sender: TObject);
    procedure PrintBtnClick(Sender: TObject);
    procedure bCloseClick(Sender: TObject);
    procedure FormActivate(Sender: TObject);
    procedure UpDownNumTermsClick(Sender: TObject; Button: TUDBtnType);
    procedure bSaveClick(Sender: TObject);
    procedure Button2Click(Sender: TObject);
    procedure xyGraph3PaintEnd(sender: TObject; Canvas: TCanvas);
  private
    { Private declarations }
  public
    { Public declarations }
  end;
const
  max_points = 30;
  max_terms = 7;
  R=8.314 ;
  T=298 ;

var
  Graph3: TGraph3;
  coef: array [1..max_terms,0..max_terms-1] of real;
  x, y: array [1..max_points] of real;
  nPoints: 1..max_points+1;
  RKa,G,delta2:double;
  Ki,delta,xc, yc,R2:real;
  Ka:extended;
  I:string;
  sig: array [1..max_terms] of real;
  correl: array [1..max_terms] of real;

implementation
 Uses   Kielland1, coef2, GRAPH_F,Fitting;
{$R *.DFM}

procedure TGraph3.FormCreate(Sender: TObject);
begin
  xyGraph3.XAxis.Title := 'AC(N)';
  xyGraph3.YAxis.Title := 'LN(KC)';
```

```
end;

{plotting curve fitting function:}
type
 FnParmArray = array[1..7] of Double;
var
 parms : FnParmArray;

function Fn(x: Double; var p): Double; far;
var
 pA: FnParmArray absolute p;
begin
 Result := pA[1]+pA[2]*x+pA[3]*x*x+pA[4]*x*x*x+pA[5]*x*x*x*x
        +pA[6]*x*x*x*x*x+pA[7]*x*x*x*x*x*x;
end;

procedure TGraph3.PrintBtnClick(Sender: TObject);
begin
 if MessageDlg('Print Graph?', mtInformation, [mbYes, mbNo], 0) = mrYes then
 begin
  xyGraph3.Print;
 end;
 if MessageDlg('Print the result?', mtInformation, [mbYes, mbNo], 0) = mrYes then
 begin
  MemoResults2.Print('Graph3');
 end;
end;

procedure TGraph3.SetSeriesBtnClick(Sender: TObject);
var
 j: byte;
 xv, yv: real;
begin
 with xyGraph3.Series[1] do
 begin
  AllowDuplicates := true;
  Active := true;
  Clear;
  AutoZero := false;
  DrawLine := false;
  DrawPoints := true;
  PointSize := 3;
 end;
 j := 1;
 while j < StringGrid2.RowCount do
  try
   xv := StrToFloat(StringGrid2.Cells[0,j]);
   yv := StrToFloat(StringGrid2.Cells[1,j]);
   xyGraph3[1][xv] := yv;
   Inc(j);
  except
   on EConvertError do Break
  end;
end;

procedure TGraph3.bCloseClick(Sender: TObject);
begin
 close;
end;

procedure TGraph3.FormActivate(Sender: TObject);
begin
```

```
 SetSeriesBtnClick(Self);
 UpDownNumTermsClick(Self,btPrev);
end;

procedure TGraph3.UpDownNumTermsClick(Sender: TObject; Button: TUDBtnType);
var i,j: byte;
   coef2:array [0..max_terms-1] of real;
   xc, yc, delta: real;
   coef: array [1..max_terms,0..max_terms-1] of real;
   correl: array [1..max_terms] of real;

begin
 SetSeriesBtnClick(Self);
 nPoints :=StringGrid2.RowCount ;
 // Fill in the X and Y arrays
 if UpDownNumTerms.position>nPoints-1 then
    UpDownNumTerms.Max:= nPoints-2;
 for i := 1 to nPoints - 1 do
 begin
  x [i] := strtofloat(StringGrid2.Cells[0,i]);
  y [i] := strtofloat(StringGrid2.Cells[1,i]);
 end;
 // Call the PolyFit routine.  The output coeffs array and correl(ation)
 PolyFit (x, y, coef[UpDownNumTerms.position], correl[UpDownNumTerms.position]
       ,sig[UpDownNumTerms.position],nPoints-1, UpDownNumTerms.position);
 Ki:=0;
 for i := 0 to UpDownNumTerms.position-1 do
 begin
  coef2[i]:=coef[UpDownNumTerms.position,i]/(i+1);
  Ki:=Ki+coef2[i];
 end;
 RKa:=(ZB-ZA)+Ki;
 G:=-R*T*RKa/(ZB*ZA*1000);
 // Remove any existing display of results
 MemoResults2.Clear;
 for i := 1 to 5 do
 begin
  MemoResults2.Lines.Add('  ');
 end;
 MemoResults2.Lines.Add(fmain.eTITLE.Text);
// Display the results in the lines of a MemoControl
 MemoResults2.Lines.Add ('=============================================================');
 MemoResults2.Lines.Add (' No      Ac        Ln(Kc)      Ln(Kc)calc    residual');
 MemoResults2.Lines.Add ('=============================================================');
 for i := 0 to nPoints - 2 do
 begin
  yc := 0.0;
  xc := 1.0;
   for j := 0 to UpDownNumTerms.position-1 do
   begin
    yc := yc + coef [UpDownNumTerms.position,j] * xc;
    xc := xc * x [i+1];
   end;
  delta := yc - y [i+1];
  l:=inttostr(i+1);
  l:=fmain.fixlength(l,3);
  MemoResults2.Lines.Add (l+'   '+Format ('%8.4f   %8.4f      %8.4f      %8.4f'
                ,[ x [i+1], y [i+1], yc, delta]));
 end;
 MemoResults2.Lines.Add ('=============================================================');
 MemoResults2.Lines.Add (' ');
 MemoResults2.Lines.Add ('Coefficients');
```

```
 MemoResults2.Lines.Add (Format ('%.4f  constant term', [coef [UpDownNumTerms.Position,0]]));
 for i := 1 to UpDownNumTerms.Position - 1 do
  MemoResults2.Lines.Add (Format ('%.4f   X^%d  ', [coef [UpDownNumTerms.Position,i], i ]));
 MemoResults2.Lines.Add (Format ('%.4f  correlation coefficient', [correl[UpDownNumTerms.Position]]));
 MemoResults2.Lines.Add (Format ('Error= %.4f ',[Sig[UpDownNumTerms.Position]]));
 MemoResults2.Lines.Add (Format ('Ln(Ka)(at T=298 K)=%.4e ',[RKa]));
 MemoResults2.Lines.Add (Format ('G=%.4f KJ/mol ',[G]));

 // Parameter to ploting curve fitting function
 for i := 1 to 7 do parms[i]:=0;
 for i := 1 to UpDownNumTerms.Position do parms[i]:=coef[UpDownNumTerms.Position,i-1];
end;

procedure TGraph3.bSaveClick(Sender: TObject);
begin
 ForceCurrentDirectory:=true;
 Saved.Filter:='data program (*.*)|*.*';
 Saved.FileName:='';
 if Saved.execute then
 begin
  xygraph3.SaveToBitmap(saved.filename+'.bmp');
  MemoResults2.Lines.SaveToFile(SaveD.FileName+'.txt');
 end;
end;

procedure TGraph3.Button2Click(Sender: TObject);
var
 i,j,k,s: byte;
 coef2:array [0..max_terms-1] of real;
 delta3: real;
begin
 S:=max_terms;
 if s>nPoints-1 then
    s:= nPoints-1;
 Coefisien2.Memo1.Clear;
 for i := 1 to 5 do
  Coefisien2.Memo1.Lines.Add(' ');
 Coefisien2.Memo1.Lines.Add(fmain.eTITLE.Text);
 for j := 2 to s do
 begin
  for i := 0 to 6 do
  begin
   Coef[j,i]:=0;
  end;
 end;

 Coefisien2.Memo1.Lines.Add('==========================================================
 ==========================================================
 ========');
  Coefisien2.Memo1.Lines.Add(
  'Deg     Coef[0]        Coef[1]        Coef[2]        Coef[3]        Coef[4]        Coef[5]
Coef[6]       Corellation       Ln(Ka)          Delta G          Error');

 Coefisien2.Memo1.Lines.Add('==========================================================
 ==========================================================
 ========');
  for i := 1 to nPoints-1 do
  begin
   x [i] := strtofloat(StringGrid2.Cells[0,i]);
   y [i] := strtofloat(StringGrid2.Cells[1,i]);
  end;
  for j :=2 to s  do
```

```
begin
 // Call the PolyFit routine.  The output coeffs array and correl(ation)
 PolyFit (x, y, coef[j], correl[j],sig[j],nPoints-1 ,j);
 Ki:=0;
 for i := 0 to s-1 do
 begin
  coef2[i]:=coef[j,i]/(i+1);
  Ki:=Ki+coef2[i];
 end;
 RKa:=(ZB-ZA)+Ki;
 G:=-R*T*RKa/(ZB*ZA*1000);
 for i := 0 to nPoints-1  do
 begin
  yc := 0.0;
  xc := 1.0;
  for k := 0 to j-1 do
  begin
   yc := yc + coef [j,k] * xc;
   xc := xc * x [i+1];
  end;
  delta := yc - y [i+1];
 end;
 L:=inttostr(j-1);
 L:=fmain.fixlength(L,2);
 Coefisien2.Memo1.Lines.Add(
   L+'   '+
   Format('%8.4e   %8.4e   %8.4e   %8.4e   %8.4e   %8.4e   %8.4e   %8.4e   %8.4e   %8.4e
%8.4e',
   [Coef[j,0],Coef[j,1],Coef[j,2],Coef[j,3],Coef[j,4],Coef[j,5],Coef[j,6],correl[j],RKa,G,sig[j]]));
 end;
 R2:=sig[2];
 for j :=2 to s  do  fmain.Banding(sig[j],R2);

Coefisien2.Memo1.Lines.Add('=============================================================
=============================================================
=======');
 Coefisien2.Memo1.Lines.Add(format('Best predictive equation when error is lowest is %8.4e',[R2]));
 Coefisien2.ShowModal;

end;

procedure TGraph3.xyGraph3PaintEnd(sender: TObject; Canvas: TCanvas);
begin
 xyGraph3.DrawFunction(Fn, parms, 0, 0, clRed, psSolid, 0);
end;

end.
```

```
unit coef2;

interface

uses
  Windows, Messages, SysUtils, Classes, Graphics, Controls, Forms, Dialogs,
  StdCtrls, ComCtrls, ExtCtrls, TeeProcs, TeEngine, Chart,
  Grids, xyGraph, Buttons;

type
  TCoefisien2 = class(TForm)
    bClose: TButton;
    SaveD: TSaveDialog;
    PrintD: TPrintDialog;
    Memo1: TRichEdit;
    bSave: TButton;
    bPrint: TButton;
    procedure bCloseClick(Sender: TObject);
    procedure bSaveClick(Sender: TObject);
    procedure bPrintClick(Sender: TObject);
  private
    { Private declarations }
  public
    { Public declarations }
  end;

var
  Coefisien2: TCoefisien2;

implementation

uses  GRAPH_F3, Kielland1;

{$R *.DFM}

procedure TCoefisien2.bCloseClick(Sender: TObject);
begin
  Close;
end;

procedure TCoefisien2.bSaveClick(Sender: TObject);
begin
  ForceCurrentDirectory:=true;
  SaveD.Filter:='Data program (*.txt)|*.txt';
  SaveD.FileName:='';
  if SaveD.execute then
    Memo1.Lines.SaveToFile(SaveD.FileName);
end;

procedure TCoefisien2.bPrintClick(Sender: TObject);
begin
 If PrintD.Execute then Memo1.Print('Coefisien');
end;

end.
```

```
library DLL1;
{$DEFINE DLL1}

uses
 SysUtils,
 Classes,
 Fitting;

// Matrix multiplication routine
// A = transpose X times X
// G = Y times X

type
 matrix = array of array of real;

// Form square coefficient matrix

procedure square (const x: matrix;
                  const y: array of real;
                  var a: matrix;
                  var g: array of real;
                  const nrow, ncol: integer);
var
 i, k, l: integer;
begin
 for k := 0 to ncol - 1 do
 begin
  for l := 0 to k do
  begin
   a [k, l] := 0.0;
   for i := 0 to nrow - 1 do
   begin
    a [k, l] := a [k, l] + x [i, l] * x [i, k];
    if k <> l then a [l, k] := a [k, l]
   end
  end;
  g [k] := 0.0;
  for i := 0 to nrow - 1 do g [k] := g [k] + y [i] * x [i, k]
 end;
end;

procedure swap (var a, b: real);
var
 hold: real;
begin
 hold := a;
 a := b;
 b := hold
end;

procedure GaussJordan (var b: matrix;  // square matrix of coefficients
const y: array of real;   // constant vector
var coef: array of real;  // solution vector
const ncol: integer;      // order of matrix
var error: boolean);      // true if matrix singular

{ Gauss Jordan matrix inversion and solution }

{ B (n, n) coefficient matrix becomes inverse }
{ Y (n) original constant vector }
{ W (n, m) constant vector(s) become solution vector }
{ DETERM is the determinant }
{ ERROR = 1 if singular }
{ INDEX (n, 3)}
```

```
 {NV is number of constant vectors }
//Mulai Gauss Jordan
var
  nv: integer;
  index: array of array of integer;
  w: array of array of real;
//Mulai Gauss Jordan2
procedure GaussJordan2;
var
  determ: real;
  irow, icol: integer;
//Mulai Gauss Jordan3
procedure GaussJordan3;
var
  m: integer;
begin
  // Interchange rows to put pivot on diagonal
  if irow <> icol then
  begin
    determ := -determ;
    for m := 0 to ncol - 1 do swap (b [irow, m], b [icol, m]);
    if nv > 0 then
     for m := 0 to nv - 1 do swap (w [irow, m], w [icol, m])
  end;
end;
//Akhir Gauss Jordan3
var
  i, k, m, n: integer;
  big, t: real;
  pivot: real;
begin  { procedure gausj2}
  // actual start of gaussj
  error := false;
  nv := 1;                // single constant vector
  for i := 0 to ncol - 1 do
  begin
    w [i, 0] := y [i];      // copy constant vector
    index [i, 2] := -1
  end;
  determ := 1.0;
  for i := 0 to ncol - 1 do
  begin
    // Search for largest element
    big := 0.0;
      if index [i, 2] <> 0 then
      begin
        for k := 0 to ncol - 1 do
        begin
          if index [k, 2] > 0 then
          begin
            error := true;
            Raise
            EMathError.Create ('Error in GaussJordan2: matrix is singular');
          end;
          if index [k, 2] < 0 then
          if abs (b [k, i]) > big then
          begin
            irow := k;
            icol := i;
            big := abs (b [k,i])
          end
        end      { k-loop}
      end;
    index [icol, 2] := index [icol, 2] + 1;
```

```
index [i, 0] := irow;
index [i, 1] := icol;

GaussJordan3;   // further subdivision of gaussj
// divide pivot row by pivot column

pivot := b [icol, icol];
determ := determ * pivot;
b [icol, icol] := 1.0;

for m := 0 to ncol - 1 do b [icol, m] := b [icol, m] / pivot;
if nv > 0 then
for m := 0 to nv - 1 do w [icol, m] := w [icol, m] / pivot;

// Reduce nonpivot rows
for n := 0 to ncol - 1 do
begin
  if n <> icol then
  begin
    t := b [n, icol];
    b [n, icol] := 0.0;
    for m := 0 to ncol - 1 do b [n, m] := b [n, m] - b [icol, m] * t;
    if nv > 0 then
    for m := 0 to nv - 1 do w [n, m] := w [n, m] - w [icol, m] * t;
  end;
 end;
end;      { i-loop}
end;                { GaussJordan2}
//Akhir Gauus Jordan 2

var
 i, k, m: integer;
 irow, icol: integer;
begin                { gauss-jordan main routine}
 SetLength (w, ncol, ncol);
 SetLength (index, ncol, 3);
 try
 GaussJordan2;      // first half of GaussJordan

 // Interchange columns
 for i := 0 to ncol - 1 do
 begin
  m := ncol - i - 1;
  if index [m, 0] <> index [m, 1] then
  begin
    irow := index [m, 0];
    icol := index [m, 1];
    for k := 0 to ncol - 1 do swap (b [k, irow], b [k, icol])
  end
 end;

 for k := 0 to ncol - 1 do
 if index [k, 2] <> 0 then
 begin
  error := true;
  Raise EMathError.Create ('Error in GaussJordan: matrix is singular');
 end;

 for i := 0 to ncol - 1 do coef [i] := w [i, 0];
 finally
  w := nil;
  index := nil;
 end;
```

```
end;        { procedure GaussJordan }

//Akhir Gauss Jordan

// Least-squares fit to nrow sets of x and y pairs of points

procedure PolyFit (const x, y: array of real;
                   var coefs: array of real;
                   var correl_coef: real;
                   var sig: array of real;  // error on coefficients
                   const npoints, nterms: Integer);
var
  error: boolean;
  i, j,nm: integer;
  xi, yi, yc, srs, sum_y,sum_y2, see: real;
  xmatr: matrix;       // Data matrix
  a: matrix;
  g: array of real;     // Constant vector
begin
  if nterms < 1 then
    Raise EMathError.Create ('PolyFit called with less than one term');
  if npoints < 2 then
    Raise EMathError.Create ('PolyFit called with less than two points');

   SetLength (g, nterms);
   SetLength (a, nterms, nterms);
   SetLength (xmatr, npoints, nterms);
   for i := 0 to npoints - 1 do
   begin      { setup x matrix}
     xi := x [i];
     xmatr [i, 0] := 1.0;                  { first column}
     for j := 1 to nterms - 1 do

  xmatr [i, j] := xmatr [i, j - 1] * xi;
   end;
   square (xmatr, y, a, g, npoints, nterms);
   GaussJordan (a, g, coefs, nterms, error);
   sum_y := 0.0;
   sum_y2 := 0.0;
   srs := 0.0;
   for i := 0 to npoints - 1 do
   begin
     yi := y [i];
     yc := 0.0;
     for j := 0 to nterms - 1 do
       yc := yc + coefs [j] * xmatr [i, j];
     srs := srs + sqr (yc - yi);
     sum_y := sum_y + yi;
     sum_y2 := sum_y2 + yi * yi
   end;
   correl_coef := srs / (sum_y2 - sqr (sum_y)/npoints);
   if correl_coef >= 1
     then correl_coef := 0.0
     else correl_coef := sqrt (1.0 - correl_coef);

   if npoints = nterms
     then nm := 1
     else nm := npoints - nterms;

   see := sqrt (srs / nm);
   for i := 0 to nTerms - 1 do {errors on solution}
     sig [i] := see * sqrt (a [i, i]);

   g := nil;
```

```
 a := nil;
 xmatr := nil
end;

Exports PolyFit;
{$R *.RES}

begin
end.
```

LAMPIRAN 2

Tabel A. Nilai A_c dan A_s NH_4 zeolit- Cs

A_c	A_s
6,25000E-004	9,37500E-003
1,00000E-001	1,87500E-002
2,31250E-001	4,06250E-002
3,18750E-001	7,18750E-002
4,00000E-001	1,00000E-001
4,87500E-001	1,50000E-001
5,50000E-001	2,06250E-001
6,56250E-001	2,78125E-001
7,18750E-001	3,87500E-001
7,65625E-001	4,68750E-001
8,34375E-001	5,96875E-001
8,93750E-001	7,50000E-001
9,43750E-001	8,71875E-001

Sumber : Laboratorium Badan Tenaga Nuklir Nasional Serpong.

Tabel B. Nilai A_c dan A_s Na zeolit- Cs

A_c	A_s
4,00000E-002	9,23000E-003
8,00000E-001	2,15400E-002
1,60000E-001	4,92300E-002
2,27690E-001	8,92300E-002
2,89230E-001	1,87690E-001
3,26150E-001	2,15380E-001
3,66150E-001	2,92310E-001
4,33850E-001	3,38460E-001
4,70770E-001	4,30770E-001
5,20000E-001	5,53850E-001
5,69230E-001	6,12310E-001
6,27690E-001	7,66150E-001
6,73850E-001	8,83080E-001

Sumber : Laboratorium Badan Tenaga Nuklir Nasional Serpong.

Tabel C. Nilai A_c dan A_s Ca zeolit- Cs

A_c	A_s
1,84600E-002	9,23000E-003
7,07700E-002	1,84600E-002
1,56920E-001	4,00000E-002
2,09230E-001	8,00000E-002
2,67700E-001	1,47690E-001
2,95380E-001	2,33850E-001
3,16920E-001	3,23080E-001
3,35380E-001	4,00000E-001
3,56920E-001	5,04620E-001
3,75380E-001	5,84620E-001
3,93850E-001	7,01540E-001
4,15380E-001	8,24620E-001
4,43080E-001	9,13850E-001

Sumber : Laboratorium Badan Tenaga Nuklir Nasional Serpong.

Tabel D. Nilai A_c dan A_s Mg zeolit- Cs

A_c	A_s
6,15300E-003	1,23100E-002
4,92300E-002	2,15400E-002
1,10770E-001	3,07700E-002
1,60000E-001	8,92300E-002
1,78460E-001	1,56920E-001
2,30770E-001	2,52310E-001
2,36920E-001	3,38460E-001
2,86150E-001	4,46150E-001
3,07690E-001	5,53850E-001
3,20000E-001	6,33850E-001
3,47690E-001	7,38460E-001
4,09230E-001	8,24620E-001
4,33850E-001	8,73850E-001

Sumber : Laboratorium Badan Tenaga Nuklir Nasional Serpong.

LAMPIRAN 3

Koefisien Debye-Huckel a dan b

Garam	ax10-9	bx10-1
NH_4Cl	0.4416	0.1826
NaCl	0.4420	-0.2637
KCl	0.4368	-0.1438
RbCl	0.4046	-0.2190
CsCl	0.3899	-0.5515
$CaCl_2$	0.4855	0.5161
$MgCl_2$	0.4997	0.6577

Sumber :

Thamzil Las, Use Of Natural Zeolites For Nuclear Waste Treatment.

LAMPIRAN 4

Berikut ini hasil perhitungan dari persamaan 3.5-3.13 untuk data Lampiran 2 dengan TN bernilai 0,1, 0,01, dan 0,05. Nilai Ln(K_c) dan nilai A_c yang telah dinormalisasikan selanjutnya digunakan untuk menghitung polinomial terbaik dengan menggunakan metode kuadrat terkecil.

Tabel 1. Hasil perhitungan Ln(K_c) untuk NH_4 zeolit-Cs pada normalitas total 0.1

NH4 zeolit-Cs(0.1 N)

No	AC	AS	mA	mB	ION	KM	GAMA	KC	ALPHA	LN(KC)
001	6,25000E-004	9,37500E-003	9,37500E-004	9,90625E-002	1,00000E-001	6,60830E-002	1,01851E+000	6,73059E-002	6,60830E-002	-2,69851E+000
002	1,00000E-001	1,87500E-002	1,87500E-003	9,81250E-002	1,00000E-001	5,81481E+000	1,01851E+000	5,92243E+000	5,81481E+000	1,77875E+000
003	2,31250E-001	4,06250E-002	4,06250E-003	9,59375E-002	1,00000E-001	7,10381E+000	1,01851E+000	7,23528E+000	7,10381E+000	1,97897E+000
004	3,18750E-001	7,18750E-002	7,18750E-003	9,28125E-002	1,00000E-001	6,04188E+000	1,01851E+000	6,15370E+000	6,04188E+000	1,81705E+000
005	4,00000E-001	1,00000E-001	1,00000E-002	9,00000E-002	1,00000E-001	6,00000E+000	1,01851E+000	6,11104E+000	6,00000E+000	1,81010E+000
006	4,87500E-001	1,50000E-001	1,50000E-002	8,50000E-002	1,00000E-001	5,39024E+000	1,01851E+000	5,49000E+000	5,39024E+000	1,70293E+000
007	5,50000E-001	2,06250E-001	2,06250E-002	7,93750E-002	1,00000E-001	4,70370E+000	1,01851E+000	4,79075E+000	4,70370E+000	1,56669E+000
008	6,56250E-001	2,78125E-001	2,78125E-002	7,21875E-002	1,00000E-001	4,95506E+000	1,01851E+000	5,04676E+000	4,95506E+000	1,61875E+000
009	7,18750E-001	3,87500E-001	3,87500E-002	6,12500E-002	1,00000E-001	4,03943E+000	1,01851E+000	4,11418E+000	4,03943E+000	1,41444E+000
010	7,65625E-001	4,68750E-001	4,68750E-002	5,31250E-002	1,00000E-001	3,70222E+000	1,01851E+000	3,77074E+000	3,70222E+000	1,32727E+000
011	8,34375E-001	5,96875E-001	5,96875E-002	4,03125E-002	1,00000E-001	3,40245E+000	1,01851E+000	3,46542E+000	3,40245E+000	1,24283E+000
012	8,93750E-001	7,50000E-001	7,50000E-002	2,50000E-002	1,00000E-001	2,80392E+000	1,01851E+000	2,85581E+000	2,80392E+000	1,04936E+000
013	9,43750E-001	8,71875E-001	8,71875E-002	1,28125E-002	1,00000E-001	2,46555E+000	1,01851E+000	2,51118E+000	2,46555E+000	9,20753E-001

Tabel 2. Hasil perhitungan Ln(K_c) untuk NH_4 zeolit-Cs pada normalitas total 0,01.

NH4zeolit-Cs(0.01 N)

No	AC	AS	mA	mB	ION	KM	GAMA	KC	ALPHA	LN(KC)
001	6,25000E-004	9,37500E-003	9,37500E-005	9,90625E-003	1,00000E-002	6,60830E-002	1,00242E+000	6,62426E-002	6,60830E-002	-2,71443E+000
002	1,00000E-001	1,87500E-002	1,87500E-004	9,81250E-003	1,00000E-002	5,81481E+000	1,00242E+000	5,82886E+000	5,81481E+000	1,76282E+000
003	2,31250E-001	4,06250E-002	4,06250E-004	9,59375E-003	1,00000E-002	7,10381E+000	1,00242E+000	7,12097E+000	7,10381E+000	1,96304E+000
004	3,18750E-001	7,18750E-002	7,18750E-004	9,28125E-003	1,00000E-002	6,04188E+000	1,00242E+000	6,05647E+000	6,04188E+000	1,80113E+000
005	4,00000E-001	1,00000E-001	1,00000E-003	9,00000E-003	1,00000E-002	6,00000E+000	1,00242E+000	6,01449E+000	6,00000E+000	1,79417E+000
006	4,87500E-001	1,50000E-001	1,50000E-003	8,50000E-003	1,00000E-002	5,39024E+000	1,00242E+000	5,40326E+000	5,39024E+000	1,68700E+000
007	5,50000E-001	2,06250E-001	2,06250E-003	7,93750E-003	1,00000E-002	4,70370E+000	1,00242E+000	4,71506E+000	4,70370E+000	1,55076E+000
008	6,56250E-001	2,78125E-001	2,78125E-003	7,21875E-003	1,00000E-002	4,95506E+000	1,00242E+000	4,96702E+000	4,95506E+000	1,60282E+000
009	7,18750E-001	3,87500E-001	3,87500E-003	6,12500E-003	1,00000E-002	4,03943E+000	1,00242E+000	4,04918E+000	4,03943E+000	1,39851E+000
010	7,65625E-001	4,68750E-001	4,68750E-003	5,31250E-003	1,00000E-002	3,70222E+000	1,00242E+000	3,71116E+000	3,70222E+000	1,31135E+000
011	8,34375E-001	5,96875E-001	5,96875E-003	4,03125E-003	1,00000E-002	3,40245E+000	1,00242E+000	3,41067E+000	3,40245E+000	1,22691E+000
012	8,93750E-001	7,50000E-001	7,50000E-003	2,50000E-003	1,00000E-002	2,80392E+000	1,00242E+000	2,81069E+000	2,80392E+000	1,03343E+000
013	9,43750E-001	8,71875E-001	8,71875E-003	1,28125E-003	1,00000E-002	2,46555E+000	1,00242E+000	2,47151E+000	2,46555E+000	9,04828E-001

Tabel 3. Hasil perhitungan Ln(K_c) untuk NH_4 zeolit-Cs pada normalitas total 0,05.

NH4 zeolit-Cs (0.05 N)

No	AC	AS	mA	mB	ION	KM	GAMA	KC	ALPHA	LN(KC)
001	6,25000E-004	9,37500E-003	4,68750E-004	4,95312E-002	5,00000E-002	6,60830E-002	1,01022E+000	6,67584E-002	6,60830E-002	-2,70668E+000
002	1,00000E-001	1,87500E-002	9,37500E-004	4,90625E-002	5,00000E-002	5,81481E+000	1,01022E+000	5,87425E+000	5,81481E+000	1,77058E+000
003	2,31250E-001	4,06250E-002	2,03125E-003	4,79688E-002	5,00000E-002	7,10381E+000	1,01022E+000	7,17642E+000	7,10381E+000	1,97080E+000
004	3,18750E-001	7,18750E-002	3,59375E-003	4,64063E-002	5,00000E-002	6,04188E+000	1,01022E+000	6,10364E+000	6,04188E+000	1,80888E+000
005	4,00000E-001	1,00000E-001	5,00000E-003	4,50000E-002	5,00000E-002	6,00000E+000	1,01022E+000	6,06133E+000	6,00000E+000	1,80193E+000
006	4,87500E-001	1,50000E-001	7,50000E-003	4,25000E-002	5,00000E-002	5,39024E+000	1,01022E+000	5,44534E+000	5,39024E+000	1,69476E+000
007	5,50000E-001	2,06250E-001	1,03125E-002	3,96875E-002	5,00000E-002	4,70370E+000	1,01022E+000	4,75178E+000	4,70370E+000	1,55852E+000
008	6,56250E-001	2,78125E-001	1,39063E-002	3,60938E-002	5,00000E-002	4,95506E+000	1,01022E+000	5,00570E+000	4,95506E+000	1,61058E+000
009	7,18750E-001	3,87500E-001	1,93750E-002	3,06250E-002	5,00000E-002	4,03943E+000	1,01022E+000	4,08071E+000	4,03943E+000	1,40627E+000
010	7,65625E-001	4,68750E-001	2,34375E-002	2,65625E-002	5,00000E-002	3,70222E+000	1,01022E+000	3,74006E+000	3,70222E+000	1,31910E+000
011	8,34375E-001	5,96875E-001	2,98438E-002	2,01563E-002	5,00000E-002	3,40245E+000	1,01022E+000	3,43723E+000	3,40245E+000	1,23466E+000
012	8,93750E-001	7,50000E-001	3,75000E-002	1,25000E-002	5,00000E-002	2,80392E+000	1,01022E+000	2,83258E+000	2,80392E+000	1,04119E+000
013	9,43750E-001	8,71875E-001	4,35938E-002	6,40625E-003	5,00000E-002	2,46555E+000	1,01022E+000	2,49075E+000	2,46555E+000	9,12585E-001

Tabel 4. Hasil perhitungan Ln(K_c) untuk Na zeolit-Cs pada normalitas total 0,1.

Na zeolit-Cs (0.1 N)

No	AC	AS	mA	mB	ION	KM	GAMA	KC	ALPHA	LN(KC)
001	4,00000E-002	9,23000E-003	9,23000E-004	9,90770E-002	1,00000E-001	4,47260E+000	1,01668E+000	4,54720E+000	4,47260E+000	1,51451E+000
002	8,00000E-002	2,15400E-002	2,15400E-003	9,78460E-002	1,00000E-001	3,95002E+000	1,01668E+000	4,01591E+000	3,95002E+000	1,39026E+000
003	1,60000E-001	4,92300E-002	4,92300E-003	9,50770E-002	1,00000E-001	3,67863E+000	1,01668E+000	3,73999E+000	3,67863E+000	1,31908E+000
004	2,27690E-001	8,92300E-002	8,92300E-003	9,10770E-002	1,00000E-001	3,00919E+000	1,01668E+000	3,05939E+000	3,00919E+000	1,11822E+000
005	2,89230E-001	1,87690E-001	1,87690E-002	8,12310E-002	1,00000E-001	1,76114E+000	1,01668E+000	1,79052E+000	1,76114E+000	5,82507E-001
006	3,26150E-001	2,15380E-001	2,15380E-002	7,84620E-002	1,00000E-001	1,76323E+000	1,01668E+000	1,79264E+000	1,76323E+000	5,83689E-001
007	3,66150E-001	2,92310E-001	2,92310E-002	7,07690E-002	1,00000E-001	1,39853E+000	1,01668E+000	1,42186E+000	1,39853E+000	3,51965E-001
008	4,33850E-001	3,38460E-001	3,38460E-002	6,61540E-002	1,00000E-001	1,49781E+000	1,01668E+000	1,52279E+000	1,49781E+000	4,20547E-001
009	4,70770E-001	4,30770E-001	4,30770E-002	5,69230E-002	1,00000E-001	1,17546E+000	1,01668E+000	1,19506E+000	1,17546E+000	1,78200E-001
010	5,20000E-001	5,53850E-001	5,53850E-002	4,46150E-002	1,00000E-001	8,72672E-001	1,01668E+000	8,87228E-001	8,72672E-001	-1,19653E-001
011	5,69230E-001	6,12310E-001	6,12310E-002	3,87690E-002	1,00000E-001	8,36673E-001	1,01668E+000	8,50629E-001	8,36673E-001	-1,61779E-001
012	6,27690E-001	7,66150E-001	7,66150E-002	2,33850E-002	1,00000E-001	5,14593E-001	1,01668E+000	5,23177E-001	5,14593E-001	-6,47835E-001
013	6,37850E-001	8,83080E-001	8,83080E-002	1,16920E-002	1,00000E-001	2,73549E-001	1,01668E+000	2,78112E-001	2,73549E-001	-127973E+000

Tabel 5. Hasil perhitungan Ln(K_c) untuk Na zeolit-Cs pada normalitas total 0,01.

Na zeolit-Cs (0.01 N)

No	AC	AS	mA	mB	ION	KM	GAMA	KC	ALPHA	LN(KC)
001	4,00000E-002	9,23000E-003	9,23000E-005	9,90770E-003	1,00000E-002	4,47260E+000	1,00224E+000	4,48262E+000	4,47260E+000	1,50021E+000
002	8,00000E-002	2,15400E-002	2,15400E-004	9,78460E-003	1,00000E-002	3,95002E+000	1,00224E+000	3,95887E+000	3,95002E+000	1,37596E+000
003	1,60000E-001	4,92300E-002	4,92300E-004	9,50770E-003	1,00000E-002	3,67863E+000	1,00224E+000	3,68687E+000	3,67863E+000	1,30478E+000
004	2,27690E-001	8,92300E-002	8,92300E-004	9,10770E-003	1,00000E-002	3,00919E+000	1,00224E+000	3,01593E+000	3,00919E+000	1,10391E+000
005	2,89230E-001	1,87690E-001	1,87690E-003	8,12310E-003	1,00000E-002	1,76114E+000	1,00224E+000	1,76509E+000	1,76114E+000	5,68201E-001
006	3,26150E-001	2,15380E-001	2,15380E-003	7,84620E-003	1,00000E-002	1,76323E+000	1,00224E+000	1,76718E+000	1,76323E+000	5,69383E-001
007	3,66150E-001	2,92310E-001	2,92310E-003	7,07690E-003	1,00000E-002	1,39853E+000	1,00224E+000	1,40166E+000	1,39853E+000	3,37659E-001
008	4,33850E-001	3,38460E-001	3,38460E-003	6,61540E-003	1,00000E-002	1,49781E+000	1,00224E+000	1,50117E+000	1,49781E+000	4,06242E-001
009	4,70770E-001	4,30770E-001	4,30770E-003	5,69230E-003	1,00000E-002	1,17546E+000	1,00224E+000	1,17809E+000	1,17546E+000	1,63894E-001
010	5,20000E-001	5,53850E-001	5,53850E-003	4,46150E-003	1,00000E-002	8,72672E-001	1,00224E+000	8,74626E-001	8,72672E-001	-1,33959E-001
011	5,69230E-001	6,12310E-001	6,12310E-003	3,87690E-003	1,00000E-002	8,36673E-001	1,00224E+000	8,38547E-001	8,36673E-001	-1,76085E-001
012	6,27690E-001	7,66150E-001	7,66150E-003	2,33850E-003	1,00000E-002	5,14593E-001	1,00224E+000	5,15746E-001	5,14593E-001	-6,62141E-001
013	6,73850E-001	8,83080E-001	8,83080E-003	1,16920E-003	1,00000E-002	2,73549E-001	1,00224E+000	2,74161E-001	2,73549E-001	-1,29404E+000

Tabel 6. Hasil perhitungan Ln(K_c) untuk Na zeolit-Cs pada normalitas total 0,05.

Na zeolit-Cs (0.05 N)

No	AC	AS	mA	mB	ION	KM	GAMA	KC	ALPHA	LN(KC)
001	4,00000E-002	9,23000E-003	4,61500E-004	4,95385E-002	5,00000E-002	4,47260E+000	1,00932E+000	4,51430E+000	4,47260E+000	1,50725E+000
002	8,00000E-002	2,15400E-002	1,07700E-003	4,89230E-002	5,00000E-002	3,95002E+000	1,00932E+000	3,98685E+000	3,95002E+000	1,38300E+000
003	1,60000E-001	4,92300E-002	2,46150E-003	4,75385E-002	5,00000E-002	3,67863E+000	1,00932E+000	3,71293E+000	3,67863E+000	1,31182E+000
004	2,27690E-001	8,92300E-002	4,46150E-003	4,55385E-002	5,00000E-002	3,00919E+000	1,00932E+000	3,03725E+000	3,00919E+000	1,11095E+000
005	2,89230E-001	1,87690E-001	9,38450E-003	4,06155E-002	5,00000E-002	1,76114E+000	1,00932E+000	1,77756E+000	1,76114E+000	5,75244E-001
006	3,26150E-001	2,15380E-001	1,07690E-002	3,92310E-002	5,00000E-002	1,76323E+000	1,00932E+000	1,77967E+000	1,76323E+000	5,76425E-001
007	3,66150E-001	2,92310E-001	1,46155E-002	3,53845E-002	5,00000E-002	1,39853E+000	1,00932E+000	1,41157E+000	1,39853E+000	3,44702E-001
008	4,33850E-001	3,38460E-001	1,69230E-002	3,30770E-002	5,00000E-002	1,49781E+000	1,00932E+000	1,51177E+000	1,49781E+000	4,13284E-001
009	4,70770E-001	4,30770E-001	2,15385E-002	2,84615E-002	5,00000E-002	1,17546E+000	1,00932E+000	1,18642E+000	1,17546E+000	1,70937E-001
010	5,20000E-001	5,53850E-001	2,76925E-002	2,23075E-002	5,00000E-002	8,72672E-001	1,00932E+000	8,80808E-001	8,72672E-001	-1,26916E-001
011	5,69230E-001	6,12310E-001	3,06155E-002	1,93845E-002	5,00000E-002	8,36673E-001	1,00932E+000	8,44473E-001	8,36673E-001	-1,69042E-001
012	6,27690E-001	7,66150E-001	3,83075E-002	1,16925E-002	5,00000E-002	5,14593E-001	1,00932E+000	5,19391E-001	5,14593E-001	-6,55099E-001
013	6,73850E-001	8,83080E-001	4,41540E-002	5,84600E-003	5,00000E-002	2,73549E-001	1,00932E+000	2,76099E-001	2,73549E-001	-1,28700E+000

Tabel 7. Hasil perhitungan Ln(K_c) untuk Ca zeolit-Cs pada normalitas total 0,1.

Ca zeolit-Cs(0.1 N)

No	AC	AS	mA	mB	ION	KM	GAMA	KC	ALPHA	LN(KC)
001	1,84600E-002	9,23000E-003	9,23000E-004	4,95385E-002	1,49539E-001	2,01881E+001	6,08542E-001	1,22853E+001	1,00940E+000	2,50840E+000
002	7,07700E-002	1,84600E-002	1,84600E-003	4,90770E-002	1,49077E-001	7,76229E+001	6,09027E-001	4,72744E+001	2,02475E+000	3,85597E+000
003	1,56920E-001	4,00000E-002	4,00000E-003	4,80000E-002	1,48000E-001	8,76212E+001	6,10166E-001	5,34635E+001	2,23352E+000	3,97900E+000
004	2,09230E-001	8,00000E-002	8,00000E-003	4,60000E-002	1,46000E-001	3,97902E+001	6,12304E-001	2,43637E+001	1,52139E+000	3,19309E+000
005	2,67700E-001	1,47690E-001	1,47690E-002	4,26155E-002	1,42616E-001	1,91193E+001	6,15991E-001	1,17773E+001	1,05481E+000	2,46618E+000
006	2,95380E-001	2,33850E-001	2,33850E-002	3,83075E-002	1,38308E-001	8,67394E+000	6,20816E-001	5,38492E+000	6,86709E-001	1,68360E+000
007	3,16920E-001	3,23080E-001	3,23080E-002	3,38460E-002	1,33846E-001	4,76777E+000	6,25979E-001	2,98452E+000	4,86044E-001	1,09344E+000
008	3,35380E-001	4,00000E-001	4,00000E-002	3,00000E-002	1,30000E-001	3,17323E+000	6,30572E-001	2,00095E+000	3,78464E-001	6,93623E-001
009	3,56920E-001	5,04620E-001	5,04620E-002	2,47690E-002	1,24769E-001	1,92689E+000	6,37044E-001	1,22751E+000	2,72427E-001	2,04989E-001
010	3,75380E-001	5,84620E-001	5,84620E-002	2,07690E-002	1,20769E-001	1,37086E+000	6,42180E-001	8,80341E-001	2,13500E-001	-1,27445E-001
011	3,93850E-001	7,01540E-001	7,01540E-002	1,49230E-002	1,14923E-001	7,75948E-001	6,49999E-001	5,04365E-001	1,38215E-001	-6,84454E-001
012	4,15380E-001	8,24620E-001	8,24620E-002	8,76900E-003	1,08769E-001	3,80592E-001	6,58666E-001	2,50683E-001	7,55559E-002	-1,38357E+000
013	4,43080E-001	9,13850E-001	9,13850E-002	4,30750E-003	1,04307E-001	1,81822E-001	6,65255E-001	1,20958E-001	3,75007E-002	-2,11231E+000

Tabel 8. Hasil perhitungan Ln(K_c) untuk Ca zeolit-Cs pada normalitas total 0,01.

Ca zeolit-Cs(0.01 N)

No	AC	AS	mA	mB	ION	KM	GAMA	KC	ALPHA	LN(KC)
001	1,84600E-002	9,23000E-003	9,23000E-005	4,95385E-003	1,49538E-002	2,01881E+002	7,91712E-001	1,59831E+002	1,00940E+000	5,07412E+000
002	7,07700E-002	1,84600E-002	1,84600E-004	4,90770E-003	1,49077E-002	7,76229E+002	7,91983E-001	6,14760E+002	2,02475E+000	6,42123E+000
003	1,56920E-001	4,00000E-002	4,00000E-004	4,80000E-003	1,48000E-002	8,76212E+002	7,92618E-001	6,94501E+002	2,23352E+000	6,54319E+000
004	2,09230E-001	8,00000E-002	8,00000E-004	4,60000E-003	1,46000E-002	3,97902E+002	7,93805E-001	3,15856E+002	1,52139E+000	5,75529E+000
005	2,67700E-001	1,47690E-001	1,47690E-003	4,26155E-003	1,42616E-002	1,91193E+002	7,95839E-001	1,52159E+002	1,05481E+000	5,02493E+000
006	2,95380E-001	2,33850E-001	2,33850E-003	3,83075E-003	1,38307E-002	8,67394E+001	7,98477E-001	6,92594E+001	6,86709E-001	4,23786E+000
007	3,16920E-001	3,23080E-001	3,23080E-003	3,38460E-003	1,33846E-002	4,76777E+001	8,01269E-001	3,82026E+001	4,86044E-001	3,64290E+000
008	3,35380E-001	4,00000E-001	4,00000E-003	3,00000E-003	1,30000E-002	3,17323E+001	8,03727E-001	2,55042E+001	3,78464E-001	3,23884E+000
009	3,56920E-001	5,04620E-001	5,04620E-003	2,47690E-003	1,24769E-002	1,92689E+001	8,07151E-001	1,55529E+001	2,72427E-001	2,74425E+000
010	3,75380E-001	5,84620E-001	5,84620E-003	2,07690E-003	1,20769E-002	1,37086E+001	8,09834E-001	1,11017E+001	2,13500E-001	2,40710E+000
011	3,93850E-001	7,01540E-001	7,01540E-003	1,49230E-003	1,14923E-002	7,75948E+000	8,13864E-001	6,31517E+000	1,38215E-001	1,84295E+000
012	4,15380E-001	8,24620E-001	8,24620E-003	8,76900E-004	1,08769E-002	3,80592E+000	8,18256E-001	3,11422E+000	7,55559E-002	1,13598E+000
013	4,43080E-001	9,13850E-001	9,13850E-003	4,30750E-004	1,04308E-002	1,81822E+000	8,21542E-001	1,49375E+000	3,75007E-002	4,01287E-001

Tabel 9. Hasil perhitungan Ln(K_c) untuk Ca zeolit-Cs pada normalitas total 0,05

Ca zeolit-Cs (0.05 N)

No	AC	AS	mA	mB	ION	KM	GAMA	KC	ALPHA	LN(KC)
001	1,84600E-002	9,23000E-003	4,61500E-004	2,47693E-002	7,47693E-002	4,03761E+001	6,61361E-001	2,67032E+001	1,00940E+000	3,28478E+000
002	7,07700E-002	1,84600E-002	9,23000E-004	2,45385E-002	7,45385E-002	1,55246E+002	6,61778E-001	1,02738E+002	2,02475E+000	4,63219E+000
003	1,56920E-001	4,00000E-002	2,00000E-003	2,40000E-002	7,40000E-002	1,75242E+002	6,62758E-001	1,16143E+002	2,23352E+000	4,75482E+000
004	2,09230E-001	8,00000E-002	4,00000E-003	2,30000E-002	7,30000E-002	7,95803E+001	6,64593E-001	5,28885E+001	1,52139E+000	3,96819E+000
005	2,67700E-001	1,47690E-001	7,38450E-003	2,13078E-002	7,13078E-002	3,82387E+001	6,67752E-001	2,55340E+001	1,05481E+000	3,24001E+000
006	2,95380E-001	2,33850E-001	1,16925E-002	1,91538E-002	6,91537E-002	1,73479E+001	6,71871E-001	1,16555E+001	6,86709E-001	2,45578E+000
007	3,16920E-001	3,23080E-001	1,61540E-002	1,69230E-002	6,69230E-002	9,53553E+000	6,76259E-001	6,44849E+000	4,86044E-001	1,86385E+000
008	3,35380E-001	4,00000E-001	2,00000E-002	1,50000E-002	6,50000E-002	6,34647E+000	6,80147E-001	4,31653E+000	3,78464E-001	1,46245E+000
009	3,56920E-001	5,04620E-001	2,52310E-002	1,23845E-002	6,23845E-002	3,85377E+000	6,85600E-001	2,64215E+000	2,72427E-001	9,71592E-001
010	3,75380E-001	5,84620E-001	2,92310E-002	1,03845E-002	6,03845E-002	2,74173E+000	6,89906E-001	1,89154E+000	2,13500E-001	6,37389E-001
011	3,93850E-001	7,01540E-001	3,50770E-002	7,46150E-003	5,74615E-002	1,55190E+000	6,96427E-001	1,08078E+000	1,38215E-001	7,76861E-002
012	4,15380E-001	8,24620E-001	4,12310E-002	4,38450E-003	5,43845E-002	7,61184E-001	7,03607E-001	5,35574E-001	7,55559E-002	-6,24415E-001
013	4,43080E-001	9,13850E-001	4,56925E-002	2,15375E-003	5,21537E-002	3,63644E-001	7,09030E-001	2,57835E-001	3,75007E-002	-1,35544E+000

Tabel 10. Hasil perhitungan Ln(K_c) untuk Mg zeolit-Cs pada normalitas total 0,1.

Mg zeolit-Cs(0.1 N)

No	AC	AS	mA	mB	ION	KM	GAMA	KC	ALPHA	LN(KC)
001	6,15300E-003	1,23100E-002	1,23100E-003	4,93845E-002	1,49385E-001	1,24145E+000	6,18998E-001	7,68455E-001	2,48370E-001	-2,63374E-001
002	4,92300E-002	2,15400E-002	2,15400E-003	4,89230E-002	1,48923E-001	2,68786E+001	6,19499E-001	1,66512E+001	1,17604E+000	2,81248E+000
003	1,10770E-001	3,07700E-002	3,07700E-003	4,84615E-002	1,48462E-001	7,06272E+001	6,20002E-001	4.37890E+001	1,96190E+000	3,77938E+000
004	1,60000E-001	8,92300E-002	8,92300E-003	4,55385E-002	1,45539E-001	1,74308E+001	6,23224E-001	1,08633E+001	9,72095E-001	2,38539E+000
005	1,78460E-001	1,56920E-001	1,56920E-002	4,21540E-002	1,42154E-001	6,63644E+000	6,27040E-001	4,16132E+000	5,83543E-001	1,42583E+000
006	2,30770E-001	2,52310E-001	2,52310E-002	3,73845E-002	1,37384E-001	4,06560E+000	6,32581E-001	2,57182E+000	4,44509E-001	9,44615E-001
007	2,36920E-001	3,38460E-001	3,38460E-002	3,30770E-002	1,33077E-001	2,12395E+000	6,37758E-001	1,35457E+000	3,03424E-001	3,03482E-001
008	2,86150E-001	4,46150E-001	4,46150E-002	2,76925E-002	1,27692E-001	1,59581E+000	6,44475E-001	1,02846E+000	2,48810E-001	2,80621E-002
009	3,07690E-001	5,53850E-001	5,53850E-002	2,23075E-002	1,22308E-001	9,94472E-001	6,51488E-001	6,47887E-001	1,79008E-001	-4,34039E-001
010	3,20000E-001	6,33850E-001	6,33850E-002	1,83075E-002	1,18308E-001	6,86194E-001	6,56902E-001	4,50762E-001	1,35920E-001	-7,96816E-001
011	3,47690E-001	7,38460E-001	7,38460E-002	1,30770E-002	1,13077E-001	4,44411E-001	6,64264E-001	2,95206E-001	9,43885E-002	-1,22008E+000
012	4,09230E-001	8,24620E-001	8,24620E-002	8,76900E-003	1,08769E-001	3,65560E-001	6,70586E-001	2,45139E-001	7,36623E-002	-1,40593E+000
013	4,33850E-001	8,73850E-001	8,73850E-002	6,30750E-003	1,06307E-001	2,74619E-001	6,74310E-001	1,85179E-001	5,53132E-002	-1,68643E+000

Tabel 11. Hasil perhitungan Ln(K_c) untuk Mg zeolit-Cs pada normalitas total 0,01.

Mg zeolit-Cs(0.01 N)

No	AC	AS	mA	mB	ION	KM	GAMA	KC	ALPHA	LN(KC)
001	6,15300E-003	1,23100E-002	1,23100E-004	4,93845E-003	1,49384E-002	1,24145E+001	7,93762E-001	9,85415E+000	2,48370E-001	2,28789E+000
002	4,92300E-002	2,15400E-002	2,15400E-004	4,89230E-003	1,48923E-002	2,68786E+002	7,94035E-001	2,13425E+002	1,17604E+000	5,36329E+000
003	1,10770E-001	3,07700E-002	3,07700E-004	4,84615E-003	1,48462E-002	7,06272E+002	7,94308E-001	5,60998E+002	1,96190E+000	6,32972E+000
004	1,60000E-001	8,92300E-002	8,92300E-004	4,55385E-003	1,45539E-002	1,74308E+002	7,96052E-001	1,38758E+002	9,72095E-001	4,93273E+000
005	1,78460E-001	1,56920E-001	1,56920E-003	4,21540E-003	1,42154E-002	6,63644E+001	7,98101E-001	5,29655E+001	5,83543E-001	3,96964E+000
006	2,30770E-001	2,52310E-001	2,52310E-003	3,73845E-003	1,37384E-002	4,06560E+001	8,01047E-001	3,25674E+001	4,44509E-001	3,48331E+000
007	2,36920E-001	3,38460E-001	3,38460E-003	3,30770E-003	1,33077E-002	2,12395E+001	8,03768E-001	1,70717E+001	3,03424E-001	2,83742E+000
008	2,86150E-001	4,46150E-001	4,46150E-003	2,76925E-003	1,27692E-002	1,59581E+001	8,07255E-001	1,28822E+001	2,48810E-001	2,55585E+000
009	3,07690E-001	5,53850E-001	5,53850E-003	2,23075E-003	1,22308E-002	9,94472E+000	8,10843E-001	8,06361E+000	1,79008E-001	2,08736E+000
010	3,20000E-001	6,33850E-001	6,33850E-003	1,83075E-003	1,18308E-002	6,86194E+000	8,13577E-001	5,58272E+000	1,35920E-001	1,71968E+000
011	3,47690E-001	7,38460E-001	7,38460E-003	1,30770E-003	1,13077E-002	4,44411E+000	8,17246E-001	3,63193E+000	9,43885E-002	1,28976E+000
012	4,09230E-001	8,24620E-001	8,24620E-003	8,76900E-004	1,08769E-002	3,65560E+000	8,20353E-001	2,99888E+000	7,36623E-002	1,09824E+000
013	4,33850E-001	8,73850E-001	8,73850E-003	6,30750E-004	1,06307E-002	2,74619E+000	8,22165E-001	2,25782E+000	5,53132E-002	8,14401E-001

Tabel 12. Hasil perhitungan Ln(K_c) untuk Mg zeolit-Cs pada normalitas total 0,05.

Mg zeolit-Cs(0.05 N)

No	AC	AS	mA	mB	ION	KM	GAMA	KC	ALPHA	LN(KC)
001	6,15300E-003	1,23100E-002	6,15500E-004	2,46922E-002	7,46923E-002	2,48290E+000	6,67922E-001	1,65838E+000	2,48370E-001	5,05843E-001
002	4,92300E-002	2,15400E-002	1,07700E-003	2,44615E-002	7,44615E-002	5,37571E+001	6,68348E-001	3,59285E+001	1,17604E+000	3,58153E+000
003	1,10770E-001	3,07700E-002	1,53850E-003	2,42308E-002	7,42308E-002	1,41254E+002	6,68775E-001	9,44674E+001	1,96190E+000	4,54826E+000
004	1,60000E-001	8,92300E-002	4,46150E-003	2,27693E-002	7,27693E-002	3,48616E+001	6,71509E-001	2,34099E+001	9,72095E-001	3,15316E+000
005	1,78460E-001	1,56920E-001	7,84600E-003	2,10770E-002	7,10770E-002	1,32729E+001	6,74736E-001	8,95570E+000	5,83543E-001	2,19229E+000
006	2,30770E-001	2,52310E-001	1,26155E-002	1,86923E-002	6,86922E-002	8,13121E+000	6,79404E-001	5,52438E+000	4,44509E-001	1,70917E+000
007	2,36920E-001	3,38460E-001	1,69230E-002	1,65385E-002	6,65385E-002	4,24790E+000	6,83746E-001	2,90449E+000	3,03424E-001	1,06626E+000
008	2,86150E-001	4,46150E-001	2,23075E-002	1,38462E-002	6,38462E-002	3,19162E+000	6,89353E-001	2,20015E+000	2,48810E-001	7,88526E-001
009	3,07690E-001	5,53850E-001	2,76925E-002	1,11538E-002	6,11538E-002	1,98894E+000	6,95172E-001	1,38266E+000	1,79008E-001	3,24008E-001
010	3,20000E-001	6,33850E-001	3,16925E-002	9,15375E-003	5,91538E-002	1,37239E+000	6,99641E-001	9,60179E-001	1,35920E-001	-4,06357E-002
011	3,47690E-001	7,38460E-001	3,69230E-002	6,53850E-003	5,65385E-002	8,88821E-001	7,05686E-001	6,27229E-001	9,43885E-002	-4,66443E-001
012	4,09230E-001	8,24620E-001	4,12310E-002	4,38450E-003	5,43845E-002	7,31120E-001	7,10849E-001	5,19716E-001	7,36623E-002	-6,54473E-001
013	4,33850E-001	8,73850E-001	4,36925E-002	3,15375E-003	5,31537E-002	5,49239E-001	7,13877E-001	3,92089E-001	5,53132E-002	-9,36266E-001

BADAN TENAGA NUKLIR NASIONAL
PUSAT PENGEMBANGAN PENGELOLAAN LIMBAH RADIOAKTIF
KAWASAN PUSPIPTEK SERPONG, TANGERANG 15310
TELP. (021) 7563142, FAX. (021) 7560927

SURAT PERNYATAAN

Kami yang bertanda tangan dibawah ini :

Nama : DR. Thamzil Las
Pekerjaan : Peneliti P2PLR –BATAN

Dengan ini menyatakan bahwa data-data yang diinputkan dalam program AMPTYC yang diciptakan oleh Sdr Ayudhya SMM, Mahasiswa FMIPA UNDIP, adalah data-data hasil penelitian laboratorium Bidang Teknologi Pengolahan Limbah Radioaktif P2PLR yang dapat digunakan untuk menprediksi/mempelajari mekanisme reaksi pertukaran ion dengan zeolit.

Demikian, pernyataan ini kami buat, kiranya dapat dipergunakan seperlunya.

Serpong, 19 Juni 2002

Mengetahui,
Ka. Bidang Teknologi Pengolahan
Limbah Radioaktif

Ir. Aisyah, MT

Pembimbing III,

DR. Thamzil Las