

Program Heatpumpwithloop123;

Uses wincrt,winprocs,windos;

```
{*****  
program make to :wa,mf,time q,sec  
    input: ta, rha,mp,md,min ,ca ,cv ,hfgair ,tdi,rc,bp  
    output: wa,mf,time,q,sec  
***** }
```

Type

Qtotalrec = Record

Nr,Nc: Integer;

Doo: Real;

Lfs: Real;

St,Sl: Real;

Tf,tdo,teo,Ztnew : Real;

Wf : Real;

Li,Lf,Qt,Qex,EbyCost: real;

Comment : String[5];

End;

OptimumResult = Array [1..200] of Qtotalrec;

Type

ResultRecord = Record

Mp: Integer;

ta: Real;

rha: Real;

tmix:Real;

tco:Real;

tdi: Real;

md : Real;

Mf,Tdo,Tei,Teo,Tcoloop,atTime : Real;

Rc : Real;

Bp : Real;

Sec: real;

```

        secp:real;
        Comment: Char;
    End;
    ArrayResult = Array [1..50] of ResultRecord;
const
    days : array [0..6] of String[9] =
        ('Sunday','Monday','Tuesday',
        'Wednesday','Thursday','Friday',
        'Saturday');
Var
{.....}
    year, month, date, dow : Word;

    hh, mm, second, hund : Word;
    fileVar : text;
    filename : string[20];
    Report:Optimumresult;
    Result : ArrayResult;
    count:Real;
    loop, interval:integer;
    test,S,mp:integer;
    Mdesign,hfgair,Min,pa,ca,cv,Pva,Pvsa,RHa,Ta,Wa,XX,Pvdo,pvca,Tdocon:Real;
    dt,tdi,t,Mi,X1,X2,wdi,wdo,tdo,RHdi,Pvdi,Pvsdi:Real;
    md,Meq,Mf,Tmix,Wmix,wdn,Rc,Sec,qsum,Qh,secp:real;
    CheckMf,Checktco,CheckT,CheckR,CheckWdo,CheckTdo:Boolean;
    Comment:Char;
    {new var_bp}
    bp,x3,pvscon,rhcon,tcon,ml,bf,ter,tcr,hcr,hgc,hfc,teo,wcon,weo
    ,hge,Hd1,FreeS2,FreeD2,pcsum,pvcon,wmix1,hlc,tmix1,Qc,qe,tco,pc,pcs:real;

{*****}

```

```

Le,La,Lc,CC,Prc,Cost,Ebyc,EbyCC,Kf :real;
Mt,Mw,Q,Qex,L,Nt,Nf,Af,Aff,Afr,Veff,Tw,Ab,At,Li,Lf
,Lff,Wf,ST,SI,Doo,Di,tf,Lfs,Tso,Tsi,Tcoloop,DeltaT:Real;
Vair,A,RollAir, CpAir,MillAir, Kair, Pr :Real;
Stt,Hf,Leff, mLeff,Efin,Gmax,Re,Heo,Hb,Hco :Real;
Nc1,Nt1, Lf1, Wf1, Seo, Sco,Z1,Z9, Z2,Z8,Zt,Pv,L123
,Denl,Denv,Visl,Kl,Sigma,Cpl,Free2,H,Pp1,Tp1,Ts,SS,Tp2,Tp,DeltaTh,Qfirst,Ref
,Z3f,Free3,Z3p,Z3,Z7,ZtNew,Qnew,Qsonic,Qboil,Qtt,Kb,Tv,tb,F,X4:Real;
B,Cz,C1,M,C,C2, StDo,SIDo:real;
Nr,Nc,Choice,Select,SelectM:Integer;
countop,
Miw,Mfw,Tei,beta:Real;
Hfg:Real;
Commentop: String[5];
{.....}
{Start module}

```

```
{Procedure Input all}
```

```
Procedure InputAll;
```

```
Begin
```

```
Repeat
```

```
Clrscr;
```

```
Writeln;
```

```
Writeln('          SELECT MENU          ');
```

```
Writeln('
```

```
=====');
```

```
writeln;
```

```
Writeln('          1.Input Mase of Product(Mt 120 kg)');
```

```
Writeln('          2.Input Mase of Product(Mt 240 kg)');
```

```
Writeln('          3.Input Mase of Product(Mt 480 kg)');
```

```

writeln;
WriteLn('
=====');

WriteLn;
Write('      Select Choice (1,2 Or 3) :');

ReadLn(SelectM);
Until((SelectM>0) and ( SelectM<4));
Case SelectM of
  1: Mt:=120;
  2: Mt:=240;
  3: Mt:=480;
End;

Repeat
  Clrscr;
  writeln;writeln;
  writeln("":10,'=====Select Format=====');
  WriteLn("":10,' 1. Select Alinged Format. ');
  WriteLn("":10,' 2. Select Staggered Format. ');
  WriteLn;
  Write("":10,'Select Menu (1 or 2) : ');
  ReadLn(Choice);
until (Choice=1) or (Choice = 2);
Repeat
  Clrscr;writeln;writeln;
  WriteLn("":10,'Select Working Fluid ');
  WriteLn("":10,'1. R-123');
  WriteLn("":10,'2. R-134A');
  Write("":10,'Select Choice( 1 , 2 ):');ReadLn(Select);
Until ((Select>=1) and (Select<=2));

clrscr;
writeln; writeln;writeln;
Write('Input Initial moisture of product (Mi) ( % wb ) :');readLn(Mi);

```

```

Write('Input Final moisture of product (Mf) ( % wb ) :');readln(Mf);
Write('Input Laten Heat(L)of Water in fruit (kj/kg ) : ');readln(L);
Write('Input Length of adiabatic section (La ) :');Readln(La);
Write('Input Price of bare tube (Prc) :');Readln(Prc);
Write('Input Price of tube with fin (CC) :');Readln(CC);
Write('In put Md :');Readln(Md);
Write('Input Teo : '); Readln(Teo);
Write('Input Area of Duct (m^2) :');Readln(A);
Write('Input Fin Thickness (m) :');Readln(Tf);
Write('Input Tube Thickness (m) :');Readln(Tw);
Write('Input Temperature Out Dryer or In Evap of LTS ( Degree C ) :');readln
(tdo);

Write('Input Rc :');readln(rc);
Write('Input Bp :');readln(bp);
Write('Input Filling Ratio (0 < F <=1) :');readln(F);
Write('Input Degree ( Degree ) :');readln(beta);

{Mi:= 75;
mf:= 18;
L:=3000;
La:= 2;
prc:= 50;
CC:= 100;
md :=2000;
teo:= 33;
a:= 0.04;
Tf:= 0.00015;
Tw:= 0.00035;
tdo:= 70;
rc:= 0.8;
bp:= 0.8;
F:= 0.5;
beta:= 90;}

```

End;

```
{*****
```

```
Procedure WaterRemove : Make to Calculate Mw,Q,Qex
```

```
Input: Mt,Mi,Mf
```

```
*****}
```

```
Procedure FindQex;
```

```
Begin
```

```
{ if mt = 500 then
```

```
Qex:= 10;
```

```
if mt = 1000 then
```

```
Qex:= 27;
```

```
if mt = 2000 then
```

```
Qex:=58;}
```

```
ca:=1.008;
```

```
wdo := 0.0260;
```

```
X4:=tdo+273.15;
```

```
Pvcon:=101.325*wdo/(0.62189+wdo);
```

```
Pvscon:=exp((-7511.52/X4)+89.6312+(2.39989E-02*X4)-(1.165455e-5*X4*X4)-  
(1.2810336E-8*X4*X4*X4)
```

```
+(2.09984E-11*X4*X4*X4*X4)-(12.1507899*LN(X4)));
```

```
Rhcon:= Pvcon/Pvscon;
```

```
if Rhcon>1 then
```

```
Rhcon:= 0.99;
```

```
Tcon:=6.938+14.38*Ln(rhcon*pvscon)+1.079*(Ln(rhcon*pvscon))*(Ln  
(rhcon*pvscon));
```

```
Qex:= md*ca*(Tdo-Tcon)*rc*(1-bp)/3600;
```

```
Vair:=md/(3600*A);
```

```
End{End waterRemove};
```

```
{*****
```

```
Procedure FindTsoTsi :
```

```
Input: Tso Tsi (From Program HPD,Tdo Tei Teo Tcoloop(Degree C))
```

```
*****}
```

```
Procedure FindTsoTsi;
```

```
Begin
```

```
Tso:= tdo + 273.15 ;
```

```
Tsi:= teo +273.15;
```

```
DeltaT:= (tso-tsi);
```

```
End;
```

```
{*****}
```

```
Procedure FindHeoHco :
```

```
Input: From InputLoopthermosyphon (Air velocity pass coins)
```

```
*****}
```

```
Procedure FindAirVelocity;
```

```
Begin
```

```
Nt:= Nr*Nc;
```

```
Nf:=Li/Lfs +1;
```

```
Af:= 2*Nf*(Wf*Lf-pi*doo*doo*Nt/4)+2*Nf*Lf*tf;
```

```
Ab:=Nt*(pi*doo*li-nf*tf*pi*doo);
```

```
At:=af+ab;
```

```
Aff:=(Li*Lf)-Nc*doo*(Li-Nt*tf)-(Nf*Lf*Tf);
```

```
Afr:=Li*Lf;
```

```
Leff:=(ST-doo)/2;
```

```
Veff:=(Vair*A)/Afr;
```

```
End{End FindAirvelocity};
```

```
{=====}
```

```
=====
```

```
procedure Interpolate
```

```
=====
```

```
=====}
```

```
Procedure InterpolateMC; {In Eq..Nud = 1.13C1C2Re^m*Pr^(1/3)}
```

```
Var
```

```
Stop :char;
```

```
{ Choice :Integer;}
```

{ StDo,SIDo,}MlowR,MhighR,MlowC,MhighC,ClowR,ChighR,ClowC,ChighC:Real;

Begin

Case Choice of

1:Begin {Aligned Case}

If Nr <10 then

case Nr of

1: C2:=0.64;

2: C2:=0.80;

3: C2:=0.87;

4: C2:=0.90;

5: C2:=0.92;

6: C2:=0.94;

7: C2:=0.96;

8: C2:=0.98;

9: C2:=0.99;

end

Else

C2:=1;

If (Stdo>=1.25) and(StDo <=3.0) and (sldo>=1.25)and (sldo<=3.0) Then

Begin

If (SIDo >= 1.25) and(SIDo <= 1.5) then

Begin

{CAL M..}

MlowR:=-0.1524*stdo*stdo*stdo+0.8945*stdo*stdo-1.5291*stdo+1.4034 ;

{Align 1.25}

MhighR:= -0.0678*stdo*stdo*stdo + 0.3594*stdo*stdo - 0.4668*stdo + 0.7403;

{Align 1.5}

```

MlowC:= 0.0301*sldo*sldo*sldo - 0.1536*sldo*sldo + 0.2273*sldo + 0.4891;
{Align 1.25}
MhighC:= 0.0709*sldo*sldo*sldo - 0.4486*sldo*sldo + 0.8786*sldo+ 0.0723;
{Align 1.5}
M:= MhighR- ((MhighR-MlowR )*(1.5-Sldo))/0.25;
{ M:= MhighC- ((MhighC-MlowC )*(1.5-Std0))/0.25; }
{CAL C..}
ClowR:= 0.1635*stdo*stdo*stdo - 0.8542*stdo*stdo + 1.1268*stdo - 0.0453;
ChighR:= -0.0286*stdo*stdo*stdo + 0.3627*stdo*stdo - 1.3026*stdo + 1.4844;
ClowC:= -0.1074*sldo*sldo*sldo + 0.545*sldo*sldo - 0.8116*sldo + 0.7209;
ChighC:= -0.1661*sldo*sldo*sldo + 1.053*sldo*sldo - 2.051*sldo + 1.5179;

C1:= ChighR-((ChighR-ClowR)*(1.5-Sldo))/0.25
End
Else
If (Sldo > 1.5) and(Sldo <= 2.0) then
Begin
MlowR:= -0.0678*stdo*stdo*stdo + 0.3594*stdo*stdo - 0.4668*stdo + 0.7403;
{Align 1.5}
MhighR:= 0.035*stdo*stdo*stdo - 0.2571*stdo*stdo + 0.6358*stdo + 0.1086;
{Align 2.0}
MlowC:= 0.0709*sldo*sldo*sldo - 0.4486*sldo*sldo + 0.8786*sldo+ 0.0723;
{Align 1.5}
MhighC:= 0.1345*sldo*sldo*sldo - 0.8148*sldo*sldo + 1.4678*sldo - 0.1203;
{Align 2.0}

M:= MhighR- ((MhighR-MlowR )*(2.0-Sldo))/0.50 ;

ClowR:= -0.0286*stdo*stdo*stdo + 0.3627*stdo*stdo - 1.3026*stdo + 1.4844;
ChighR:= -0.2145*stdo*stdo*stdo + 1.4668*stdo*stdo - 3.2898*stdo + 2.6573 ;
ClowC:= -0.1661*sldo*sldo*sldo + 1.053*sldo*sldo - 2.051*sldo + 1.5179;
ChighC:= -0.2343*sldo*sldo*sldo + 1.4489*sldo*sldo - 2.6479*sldo + 1.6036;

C1:= ChighR-((ChighR-ClowR)*(2.0-Sldo))/0.50;

```

```

End
Else
  If (SIDo > 2.0) and(SIDo <= 3.0) then
    Begin
      MlowR:= 0.035*stdo*stdo*stdo - 0.2571*stdo*stdo + 0.6358*stdo + 0.1086 ;
{Align 2.0}
      MhighR:= -0.0347*stdo*stdo*stdo + 0.2473*stdo*stdo - 0.551*stdo + 0.971;
{Align 3.0}
      MlowC:= 0.1345*sldo*sldo*sldo - 0.8148*sldo*sldo + 1.4678*sldo - 0.1203;
{Align 2.0}
      MhighC:= 0.1798*sldo*sldo*sldo - 1.0674*sldo*sldo + 1.8808*sldo - 0.2823;
{Align 3.0}
      M:= MhighR- ((MhighR-MlowR)*(3.0-SIDo))/1.0 {0.25};
      ClowR:= -0.2145*stdo*stdo*stdo + 1.4668*stdo*stdo - 3.2898*stdo + 2.6573;
      ChighR:= 0.1318*stdo*stdo*stdo - 0.9381*stdo*stdo + 2.0981*stdo - 1.1243;
      ClowC:= -0.2343*sldo*sldo*sldo + 1.4489*sldo*sldo - 2.6479*sldo + 1.6036;
      ChighC:= -0.2504*sldo*sldo*sldo + 1.5124*sldo*sldo - 2.7172*sldo + 1.5857;
      C1:= ChighR-((ChighR-ClowR)*(3.0-SIDo))/1.0;
    End;
  End
Else
  Writeln('Invalid Value Can''t Calculate... ');

End{End Alinged case};

```

2: Begin {Stagger Case}

```

  If Nr <10 then
    case nr of
      1: C2:=0.68;
      2: C2:=0.75;
      3: C2:=0.83;
      4: C2:=0.89;
      5: C2:=0.92;
      6: C2:=0.95;
    end case;
  end if;

```

```

7: C2:=0.97;
8: C2:=0.98;
9: C2:=0.99;
end
Else
    C2:=1;

If (Stdo>=1.25) and(StDo <=3.0) and (sldo>=1.25 )and (sldo<=3.0) Then
Begin
    If (SIDo >= 1.25) and(SIDo <= 1.5) then
        Begin
            MlowR:= -0.0084*stdo*stdo*stdo + 0.0558*stdo*stdo - 0.1138*stdo + 0.6274;
{Align 1.25}
            MhighR:= -0.032*stdo*stdo*stdo + 0.2*stdo*stdo - 0.392*stdo + 0.808; {Align
1.5}
            MlowC:= 0.035*sldo*sldo*sldo - 0.2198*sldo*sldo + 0.4531*sldo + 0.2646 ;
{Align 1.25}
            MhighC:= 0.0152*sldo*sldo*sldo - 0.099*sldo*sldo + 0.2177*sldo + 0.4069;
{Align 1.5}

            M:= MhighR- ((MhighR-MlowR)*(1.5-Sldo))/0.25 ;
            ClowR:= -0.0705*stdo*stdo*stdo + 0.4414*stdo*stdo - 0.8651*stdo + 1.0473;
            ChighR:= 0.0594*stdo*stdo*stdo - 0.3516*stdo*stdo + 0.665*stdo + 0.0531;
            ClowC:= -0.1326*sldo*sldo*sldo + 0.8617*sldo*sldo - 1.8837*sldo + 1.7851 ;
            ChighC:= -0.0594*sldo*sldo*sldo + 0.405*sldo*sldo - 0.9556*sldo + 1.1829;

            C1:= ChighR-((ChighR-ClowR)*(1.5-Sldo))/0.25;
        End
    Else
        If (SIDo > 1.5) and(SIDo <= 2.0) then
            Begin
                MlowR:= -0.032*stdo*stdo*stdo + 0.2*stdo*stdo - 0.392*stdo + 0.808; {Align
1.5}

```

```

MhighR:= 0.0206*stdo*stdo*stdo - 0.1084*stdo*stdo + 0.165*stdo + 0.4949;
{Align 2.0}
MlowC:= 0.0152*sldo*sldo*sldo - 0.099*sldo*sldo + 0.2177*sldo + 0.4069;
{Align 1.5}
MhighC:= 0.0663*sldo*sldo*sldo - 0.4109*sldo*sldo + 0.8009*sldo + 0.0674;
{Align 2.0}

M:= MhighR- ((MhighR-MlowR)*(2.0-Sldo))/0.5 ;

ClowR:= 0.0594*stdo*stdo*stdo - 0.3516*stdo*stdo + 0.665*stdo + 0.0531;
ChighR:= -0.1269*stdo*stdo*stdo + 0.7146*stdo*stdo - 1.1956*stdo + 1.0297;
ClowC:= -0.0594*sldo*sldo*sldo + 0.405*sldo*sldo - 0.9556*sldo + 1.1829 ;
ChighC:= -0.2888*sldo*sldo*sldo + 1.809*sldo*sldo - 3.6003*sldo + 2.7569;

C1:= ChighR-((ChighR-ClowR)*(2.0-Sldo))/0.25
End
Else
If (Sldo > 2.0) and(Sldo <= 3.0) then
Begin
MlowR:= 0.0206*stdo*stdo*stdo - 0.1084*stdo*stdo + 0.165*stdo + 0.4949
; {Align 2.0}
MhighR:= 0.0091*stdo*stdo*stdo - 0.0274*stdo*stdo - 0.0246*stdo +
0.6477; {Align 3.0}
MlowC:= 0.0663*sldo*sldo*sldo - 0.4109*sldo*sldo + 0.8009*sldo +
0.0674; {Align 2.0}
MhighC:= 0.0152*sldo*sldo*sldo - 0.099*sldo*sldo + 0.2097*sldo +
0.4249; {Align 3.0}

M:= MhighR- ((MhighR-MlowR)*(3.0-Sldo))/1.0 ;

ClowR:= -0.1269*stdo*stdo*stdo + 0.7146*stdo*stdo - 1.1956*stdo +
1.0297;
ChighR:= -0.0564*stdo*stdo*stdo + 0.2465*stdo*stdo - 0.1731*stdo +
0.2514;

```

```

ClowC:= -0.2888*sldo*sldo*sldo + 1.809*sldo*sldo - 3.6003*sldo +
2.7569 ;
ChighC:= -0.0225*sldo*sldo*sldo + 0.1841*sldo*sldo - 0.5144*sldo +
0.9213;

C1:= ChighR-((ChighR-ClowR)*(3.0-Sldo))/1.0
End;
End
Else
Writeln('Invalid Value Can"t Calculate... ');

End{End Staggered Case};
End{End Case};

End;
{*****}
Procedure FindHeo :
    Input: Tso
    *****}
Procedure FindHeo ;
    Begin {:= 4.481185-2.113391*0.01*Tso+4.37296*0.00001*Tso*Tso
-3.252345*0.00000001*Tso*Tso*Tso-2.356712*0.000000000001*Tso*Tso*Tso*Tso;
writeln('Dair ',Dair:8:6);

Cpair := -1.847712*100+1.573318*10*Tso-7.638958*0.01*Tso*Tso
+1.61848*0.0001*Tso*Tso*Tso-1.263942*0.0000001*Tso*Tso*Tso*Tso;
writeln('Cpair ',Cpair:8:6);

Vis := 5.737132*0.000001+4.218382*0.00000001*Tso;
writeln('Vis ',Vis:8:6);

Kair := 7.544853*0.001+6.407353*0.00001*Tso;
writeln('Kair ',Kair:8:6);

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```

Pr := (Cpair*vis)/kair;
writeln('Pr ',Pr:8:6);

Stt := 0.036*exp(-0.2*ln(Leff*vair*dair/vis))*exp(-0.667*ln(Pr));
writeln('Stt ',Stt:8:6);

Hf := Stt*Cpair*Vair*Dair;
writeln('Hf ',Hf:8:6);

mLeff := Leff*exp(0.5*ln(2*hf/(kf*Tf)));
writeln('mLeff ',mLeff:8:6);

Efin:=(exp(mLeff)-exp(-mLeff))/(mLeff*(exp(mLeff)+exp(-mLeff))); }

RollAir:= 4.481185-0.02113391*tso +4.37296e-05*tso*tso
-0.3252345e-07*tso*tso*tso-2.356712e-12*tso*tso*tso*tso;

CpAir := -184.7712+15.73318*tso-0.07638958*tso*tso+1.618482e-
04*tso*tso*tso
-1.263942e-7*tso*tso*tso*tso;
MillAir:= 5.737132e-06 + 4.218382e-08*tso;
Kair := 0.007544853+6.407353e-05*tso;
Pr := (CpAir*MillAir)/Kair;
Stt := 0.036*exp(-0.2*ln(Leff*Veff*Rollair/MillAir))*exp(-0.667*ln(Pr));
Hf := Stt*Cpair*Veff*Rollair;

mLeff := Leff*exp(0.5*ln(2*hf/(Kf*Tf))); {204=Kf for pure aluminium}
Efin:=(exp(mLeff)-exp(-mLeff))/(mLeff*(exp(mLeff)+exp(-mLeff)));
{m B Cz:variable calculate from table 7.5 constant For Air Flow OverTube}
InterpolateMC;

Gmax := Rollair*Veff*(Afr/Aff);

Re := (Doo*Gmax)/MillAir;

```

```

Hb := Kair*C2*C1*exp(m*Ln(Re))*Exp(0.3333*Ln(Pr))/Doo;
Heo := (Efin*Af*Hf+Ab*Hb)/At;
End{End FindHeo };
{*****}
Procedure FindHco :
Input: Tsi
*****}
Procedure FindHco ;
Begin
RollAir:= 4.481185-0.02113391*Tsi +4.37296e-05*Tsi*Tsi
-0.3252345e-07*Tsi*Tsi*Tsi-2.356712e-12*Tsi*Tsi*Tsi*Tsi;
CpAir := -184.7712+15.73318*Tsi-0.07638958*Tsi*Tsi+1.618482e-
04*Tsi*Tsi*Tsi
-1.263942e-7*Tsi*Tsi*Tsi*Tsi;
MillAir:= 5.737132e-06 + 4.218382e-08*Tsi;
Kair := 0.007544853+6.407353e-05*Tsi;
Pr := (CpAir*MillAir)/Kair;
Stt := 0.036*exp(-0.2*Ln(Leff*Veff*Rollair/MillAir))*exp(-0.667*Ln(Pr));
hf := Stt*Cpair*Veff*Rollair;
mLeff := Leff*exp(0.5*Ln(2*hf/(Kf*Tf)));{204=Kf for pure aluminium}
Efin :=(exp(mLeff)-exp(-mLeff))/(mLeff*(exp(mLeff)+exp(-mLeff)));

{Call Interpolate M,C1,c2}
InterpolateMC;
Gmax := Rollair*Veff*(Afr/Aff);
Re := (Doo*Gmax)/MillAir;
hb := Kair*C2*C1*exp(m*Ln(Re))*Exp(0.3333*Ln(Pr))/Doo;
Hco := (Efin*Af*Hf+Ab*Hb)/At;
End{End FindHco};

{Procedure FindOneLoop Input: }
Procedure FineOneLoop;
Begin
Nc1 := Nc/(Nc/2);

```

```

Nt1 := Nt/(Nr*Nc/2);
Lf1 := Lf/(Nc/2);
Wf1 := Wf/Nr;
Seo := At/(Nr*Nc/2);
Sco := Seo;
Le := Li*(Nt/(Nr*Nc/2));
Lc := Le;

Z1 := 1/(Heo*Seo);
Z9 := 1/(Hco*Sco);{Z9 large because Hco small}
Z2 := (ln(Doo/Di))/(2*3.1416*Kb*Le);
Z8 := (ln(Doo/Di))/(2*3.1416*Kb*Lc);
Zt := Z1+Z2+Z8+Z9;

End;
{*****}

Procedure FindTvDeltaH
  Input : Tso,Tsi,Z8 ,Z9,Zt
  *****}

Procedure FindTvDeltaT;
  Begin
    deltaT:=Tso-Tsi;
    Tv :=Tsi+(Z8+Z9)/Zt*(Tso-Tsi);
  End;
{*****}

Procedure MenuSelectWorkingFluid :
  Input: menu WorkingFluid 2 Choice
  *****}

Procedure SelectWorkingFluid;
{  Var Select: Integer; }
  Begin
    { Repeat
      Writeln('Select Working Fluid ');
      Writeln('1. R-123');
      Writeln('2. R-134A');

```

```
Write('Select Choice( 1 , 2 :');Readln(Select);
```

```
Until ((Select>=1) and (Select<=2)); }
```

```
beta:=(beta*22/7/180);
```

```
H:=St*sin(beta)+Di;
```

```
Case Select Of
```

```
1:Begin
```

```
Pv := (3.63756*0.0000001*Tv*Tv*Tv-  
2.75888152*0.0001*Tv*Tv+7.08937378*0.01*Tv-6.1618722)*1000000;  
Denl := -1.20316*0.00001*Tv*Tv*Tv+7.0041221*0.001*Tv*Tv-  
3.47655751*Tv+2195.9391;  
Denv := -1.2471*0.000001*Tv*Tv*Tv+1.2340328*0.001*Tv*Tv-  
0.4092082*Tv+45.532137;  
hfg := -  
1.037158*0.000001*Tv*Tv*Tv*Tv+1.581940*0.001*Tv*Tv*Tv*Tv-  
9.580286*0.1*Tv*Tv*Tv+2.861354  
*100*Tv*Tv-4.224487*10000*Tv+2.665453*1000000;  
Cpl := (1.174*0.0000001*Tv*Tv*Tv-  
1.412015*0.0001*Tv*Tv+5.67987446*0.01*Tv-6.504516)*1000;  
Visl := (-2.57171*0.0001*Tv*Tv*Tv+0.26822144*Tv*Tv-  
96.07987*Tv+12040.2477856)*0.000001;  
Kl := (4.9036*0.00001*Tv*Tv*Tv-4.520896*0.01*Tv*Tv+13.59310666*Tv-  
1256.987201)*0.001;  
Sigma:= 7.144718*0.000000000000001*Tv*Tv*Tv*Tv*Tv-  
1.074596*0.0000000001*Tv*Tv*Tv*Tv+6.454130  
*0.00000001*Tv*Tv*Tv-1.926599*0.00001*Tv*Tv+2.72647*0.001*Tv-  
1.146340*0.1;  
Free2:= -  
1.408303*0.000000001*Tv*Tv*Tv*Tv*Tv+2.188393*0.000001*Tv*Tv*Tv*Tv-  
1.310368*0.001*Tv*Tv*Tv  
+3.645493*0.1*Tv*Tv-4.543735*10*Tv+2.687154*1000;  
  
Pp1 :=Pv+Denl*9.81*F*H;
```

```

Tp1 := 7E-16*Pp1*Pp1*Pp1 - 8E-10*PP1*PP1 + 0.0004*PP1 + 268.92 ;
End;
2:begin {Find Equation R-134A}
{Pv := (1.0544E-6*Tv*Tv*Tv - 7.178932E-4*Tv*Tv + 0.1667463094*Tv -
13.1789800204)*1000000;
hfg:=(-2.64471e-5*Tv*Tv*Tv+0.0193350036*Tv*Tv-
5.3931559072*Tv+768.17393)*1000;
Denl := -9.76588E-5*Tv*Tv*Tv + 0.0731803998*Tv*Tv - 21.3677974467*Tv +
3660.3769723422;
Denv := 3.249005e-4*Tv*Tv*Tv - 0.2874328052*Tv*Tv + 85.8078559652*Tv -
8611.2784470490;
Visl:= (-1.680634e-4*Tv*Tv*Tv + 0.1663635602*Tv*Tv - 56.8711386361*Tv +
6834.5094878799)*0.000001;
Kl :=( 7.696e-7*Tv*Tv*Tv - 6.651412E-4*Tv*Tv - 0.2698945207*Tv +
201.0899195361)*0.001;
Sigma := (7.098E-7*Tv*Tv*Tv - 4.380946E-4*Tv*Tv - 6.25684404E-2*Tv +
47.0268530495)*0.001;
Cpl := ( 5.077E-7*Tv*Tv*Tv - 4.051491E-4*Tv*Tv + 0.1105763137*Tv -
8.9864972822)*1000;
Free2:=76539.52-1355.393*Tv+10.23239*Tv*Tv-
0.03782874*Tv*Tv*Tv+6.8569e-5*Tv*Tv*Tv*Tv
-4.931108e-8*Tv*Tv*Tv*Tv*Tv;
Pp1:=Pv+Denl*9.81*F*H;
Tp1:=232.6368+1.774618e-4*Pp1-1.701669e-10*Pp1*Pp1+9.681997e-
17*Pp1*Pp1*Pp1-2.702995e-23*Pp1*Pp1*Pp1*Pp1
+2.879151e-30*Pp1*Pp1*Pp1*Pp1*Pp1;}

{writeln('Pv=',Pv:6:4,' Denl=',Denl:6:4,' Denv=',Denv:6:4,' Hfg=',Hfg:6:4,'
Cpl=',Cpl:6:4);
writeln('Kl=',Kl:6:4,' Sigma=',Sigma:6:4,' Free2=',Free2:6:4,'
Visl=',Visl:6:4);
readln; }

```

```

        End;
    End;
End;
{*****}
Procedure CalQFirst
    Input:
    *****}

Procedure CalQFirst;{Find new Tp1}
    var beta:real;
    Begin

        {give}
        Ts:=(Tp1+Tv)/2;
        SS:=Ts*9.81/hfg*(Denl/Denv-1);
        Tp2:=Tv+SS*F*H;
        Tp:=(Tp1+Tp2)/2;
        DeltaTh:=(Tp-Tv)/2*F;
        DeltaT:=(Tso-Tsi)-DeltaTh;
        Qfirst:=DeltaT/Zt;
        End{End FindQfirst};
    {*****}

Procedure CalRef From Eq 4.3
    *****}

Procedure CalRef ;
    Begin
        Ref:= 4*QFirst/(hfg*Pi*Di);
    End;
    {*****}

Procedure FindQNew
    Input:
    *****}

Procedure FindQNew;
    var Check:Boolean;

```

```

Begin
Repeat
  Z3f:=(0.335*exp(0.3333*ln(Qfirst)))/((Di*exp(0.3333*ln(9.81)))^exp(4/3*ln
(Le))^exp(4/3*ln(Free2)));
  Free3:=(0.32*exp(0.65*ln(Denl))*exp(0.3*ln(Kl))*exp(0.7*ln(Cpl))*exp(0.23*ln
(Pv/101.325)))/(exp(0.25*ln(Denv))
  *exp(0.4*ln(hfg))*exp(0.1*ln(Visl)));
  Z3p:=1/(Free3*exp(0.2*ln(9.81))*exp(0.4*ln(Qfirst))*exp(0.6*ln(3.1416*Di*Le)));
  If Z3p>Z3f Then
    Z3:=Z3f*Z3p/(Z3f+Z3p)
  Else
    Z3:=Z3p;

  Z7:=(0.335*exp(0.3333*ln(Qfirst)))/(Di*exp(0.3333*ln(9.81))*exp(4/3*ln(Lc))^exp
(4/3*ln(Free2)));

  ZtNew:= Zt+Z3+Z7;
  Qnew:= DeltaT/ZtNew;
  if Abs(Qnew-Qfirst)>0.001 then
    Begin
      Qfirst:=Qnew ;
      Check :=False;
    End
  Else
    Check:= True;
  Until(Check);
End;
{*****}

Procedure FindQMax
  Input:
  *****}

Procedure FindQMax;
  Begin
    {check q sonic}

```

```

Qsonic:=3.1416*Di*Di/4*hfg*0.5*exp(0.5*ln(Pv*Denv));
Qboil:=3.1416*Di*Le*0.12*hfg*exp(0.5*ln(Denv))*exp(0.25*ln(9.81*sigma*(Denl-
Denv)));
End{End };
{*****}
Procedure FindQTotal
  InPut:
  {*****}
Procedure FindQTotal;
  Begin
    Qtt:=(Qnew*Nc/2*Nr)/1000;
    EbyC:=(Qtt/Cost)*1000;
  End;
{=====}
Procedure Cost
  :Calculate Energy per Cost
  Prc= Price/m ofTube
  CC= Price/m*m of fin
}
Procedure EperCost;
  Begin
    Le:=Li;
    Lc:=Le;
    Cost:= (Le+La+Lc)*Nr*Nc*Prc + ( Sl*(Nr+1) * St*(Nc+1))*CC*3+ (Sl*(Nr+1)+
(Le+Lc))*2*CC;
  End;
{-----End Module-----}

{Procedure CallAllProcedure}
Procedure CallAllProcedure;
  var time:integer;
  Teoh:real;

```

```

Begin
  Repeat
    FindQex;

    { Repeat}

    FindTsoTsi;
    FindAirVelocity;
    FindHeo;
    FindHco;
    FineOneLoop;
    FindTvDeltaT;
    SelectWorkingFluid;
    CalQFirst;
    CalRef ;
    FindQNew;
    FindQMax;

    writeln('Qnew =',Qnew:5:4,' Qsonic=',Qsonic*0.5:5:4,' Qboil=',Qboil*0.5:5:4);
    {Until(( Qnew < (Qsonic*0.5)) and(Qnew < (Qboil*0.5)) )};
    EperCost;
    FindQTotal;
    writeln('Qex=',Qex:5:4);
    writeln('Qtt',Qtt:5:4);

    Tcoloop:= Qtt/(md*ca*rc*(1-bp))+Teo;
    tei := Tdo- Qtt/(md*ca*rc*(1-bp));
    writeln('Tdo',Tdo:5:4,'Tei',Tei:5:4,' tcoloop=',tcoloop:5:4);
    X4:=tei+273.15;
    Pvcon:=101.325*wdo/(0.62189+wdo);
    Pvscon:=exp((-7511.52/X4)+89.6312+(2.39989E-02*X4)-(1.165455e-5*X4*X4)-
(1.2810336E-8*X4*X4*X4)
    +(2.09984E-11*X4*X4*X4*X4)-(12.1507899*LN(X4)));

```

```

Rhcon:= Pvcon/Pvscon;

if Rhcon>1 then
  Rhcon:= 0.99;

Tcon:=6.938+14.38*Ln(rhcon*pvscon)+1.079*(Ln(rhcon*pvscon))*(Ln(rhcon*pvscon));
TeoH := 0.2*tei+0.8*tcon;

if (abs(Teo-Teoh)>2) then
  teo:= (Teo+Teoh)/2
else
  teo:= teoh;
writeln('TeoH =',TeoH:5:4,' Teo=',Teo:5:4);
until(abs(Teo-Teoh)< 2) or not(( Qnew < (Qsonic*0.5)) and(Qnew < (Qboil*0.5)) );
If (Qex-Qtt) >= 0 Then

  Commentop := 'True'
Else
  Commentop := 'Fail' ;

writeln('Qex =',Qex:5:4,' Qtt=',Qtt:5:4);

End;
{End CallAllProcedure }

Procedure MaxSix(Var loop:integer);
  Begin
    if( (Qtt > 0) and ((Qex-Qtt) >= 0) and (Nr<Nc) ) then
      Begin
        {Compare Value Sec}
        If( Loop>=1 ) then
          Begin
            if(( Ebyc > Report[1].Ebycost) or ( Report[1].Qtt = 0 ) ) then

```

```

begin
  Report[6]:=Report[5];
  Report[5]:=Report[4];
  Report[4]:=Report[3];
  Report[3]:=Report[2];
  Report[2]:=Report[1];
  Report[1].Doo:=Doo;
  Report[1].Lfs:=Lfs;
  Report[1].St:=ST;
  Report[1].Sl:=Sl;
  Report[1].Tf:=Tf;
  Report[1].Wf:=Wf;
  Report[1].Li:=Li;
  Report[1].Lf:=Lf;
  Report[1].Nc:=nc;
  Report[1].Nr:=nr;
  Report[1].tdo:= tdo;
  Report[1].teo:= teo;
  Report[1].ztnew:=Ztnew;
  Report[1].Qtt:=Qtt;
  Report[1].Qex:=Qex;
  Report[1].Ebycost:=EbyC;

  Report[1].Comment:=Commentop;
  { Report[1].QNew:=Qnew;
  Report[1].Qsonic:=Qsonic;
  Report[1].Qboil:=Qboil; }
end
else
  if(( Ebyc > Report[2].Ebycost) or ( Report[2].Qtt = 0 )) then
    begin
      Report[6]:=Report[5];
      Report[5]:=Report[4];
      Report[4]:=Report[3];

```

```

Report[3]:=Report[2];
Report[2].Doo:=Doo;
Report[2].Lfs:=Lfs;
Report[2].St:=ST;
Report[2].Sl:=Sl;
Report[2].Tf:=Tf;
Report[2].Wf:=Wf;
Report[2].Li:=Li;
Report[2].Lf:=Lf;
Report[2].Nc:=nc;
Report[2].Nr:=nr;
Report[2].tdo:= tdo;
Report[2].teo:= teo;
Report[2].ztnew:=Ztnew;
Report[2].Qtt:=Qtt;
Report[2].Qex:=Qex;
Report[2].Ebycost:=EbyC;

Report[2].Comment:=Commentop;
{ Report[2].QNew:=Qnew;
Report[2].Qsonic:=Qsonic;
Report[2].Qboil:=Qboil; }
end
else
if(( Ebyc > Report[3].Ebycost) or ( Report[3].Qtt = 0 )) then
begin
Report[6]:=Report[5];
Report[5]:=Report[4];
Report[4]:=Report[3];
Report[3].Doo:=Doo;
Report[3].Lfs:=Lfs;
Report[3].St:=ST;
Report[3].Sl:=Sl;
Report[3].Tf:=Tf;

```

```

Report[3].Wf:=Wf;
Report[3].Li:=Li;
Report[3].Lf:=Lf;
Report[3].Nc:=nc;
Report[3].Nr:=nr;
Report[3].tdo:= tdo;
Report[3].teo:= teo;
Report[3].ztnew:=Ztnew;

Report[3].Qtt:=Qtt;
Report[3].Qex:=Qex;
Report[3].Ebycost:=EbyC;

Report[3].Comment:=Commentop;
{ Report[3].QNew:=Qnew;
Report[3].Qsonic:=Qsonic;
Report[3].Qboil:=Qboil; }
end
else
if(( Ebyc > Report[4].Ebycost) or ( Report[4].Qtt = 0 )) then
begin
Report[6]:=Report[5];
Report[5]:=Report[4];
Report[4].Doo:=Doo;
Report[4].Lfs:=Lfs;
Report[4].St:=ST;
Report[4].Sl:=Sl;
Report[4].Tf:=Tf;
Report[4].Wf:=Wf;
Report[4].Li:=Li;
Report[4].Lf:=Lf;
Report[4].Nc:=nc;
Report[4].Nr:=nr;
Report[4].tdo:= tdo;

```

```

Report[4].teo:= teo;
Report[4].ztnew:=Ztnew;
Report[4].Qtt:=Qtt;
Report[4].Qex:=Qex;

Report[4].Ebycost:=EbyC;
Report[4].Comment:=Commentop;
{ Report[4].QNew:=Qnew;
Report[4].Qsonic:=Qsonic;
Report[4].Qboil:=Qboil; }
end
else
  if(( Ebyc > Report[5].Ebycost) or ( Report[5].Qtt = 0 )) then
begin
Report[6]:=Report[5];
Report[5].Doo:=Doo;
Report[5].Lfs:=Lfs;
Report[5].St:=ST;
Report[5].Sl:=Sl;
Report[5].Tf:=Tf;
Report[5].Wf:=Wf;
Report[5].Li:=Li;
Report[5].Lf:=Lf;
Report[5].Nc:=nc;
Report[5].Nr:=nr;
Report[5].tdo:= tdo;
Report[5].teo:= teo;
Report[5].ztnew:=Ztnew;
Report[5].Qtt:=Qtt;
Report[5].Qex:=Qex;
Report[5].Ebycost:=EbyC;

Report[5].Comment:=Commentop;
{ Report[5].QNew:=Qnew;

```

```

Report[5].Qsonic:=Qsonic;
Report[5].Qboil:=Qboil; }
end
else
  if(( Ebyc > Report[6].Ebycost) or ( Report[6].Qtt = 0 )) then
  begin
    Report[6].Doo:=Doo;
    Report[6].Lfs:=Lfs;
    Report[6].St:=ST;
    Report[6].Sl:=Sl;
    Report[6].Tf:=Tf;
    Report[6].Wf:=Wf;
    Report[6].Li:=Li;
    Report[6].Lf:=Lf;
    Report[6].Nc:=nc;
    Report[6].Nr:=nr;
    Report[6].tdo:= tdo;
    Report[6].teo:= teo;
    Report[6].ztnew:=Ztnew;

    Report[6].Qtt:=Qtt;
    Report[6].Qex:=Qex;
    Report[6].Ebycost:=EbyC;

    Report[6].Comment:=Commentop;
    { Report[6].QNew:=Qnew;
    Report[6].Qsonic:=Qsonic;
    Report[6].Qboil:=Qboil; }
  end
End{End if <1 loop}

```

```

End{sec>10} ;
End{End MinSix};

```

{.....Start Main.....}

Procedure Optimum;

Begin

Kb:= 238;{for pure copper ,watt/m.K}

Kf:= 204;{ fin aluminium , W/m.K }

Inputall;

{ EperCost; }

{Input Data}

{ A:=0.04;

tf := 0.00015;

tb:= 0.00035; {Tube Thikness}

Doo:=0.010;

Di:=Doo-2*tw;

{Start Doo}

Repeat

 Nr:=2;

 {Start Nr}

 Repeat

 Nc:=2;

 {Start Nc}

 Repeat

 Lfs:=0.0014;

 {Start Lfs}

 Repeat

 St:=1.25*Doo;

 {Start St}

 Repeat

 Sl:=1.25*Doo;

 {Start Sl}

 Repeat

 Li:=0.2;

```

{Start Li}
Repeat
    Wf:=2*Doo+(Nr-1)*Sl ;      {Follow to Nr ,Doo}
    Lf:=2*Doo+(Nc-1)*St ;     {Follow to Nc,Doo,St}

    Stdo:=St/Doo;
    Sldo:=Sl/Doo;
    loop:=10;
    CallAllProcedure;
    Report[loop].Ebycost:=Ebyc;
    MaxSix(loop);
    Li:=Li+0.4;
    Until(Li > 1.0 );{End Loop li max 1.0}
    Sl:=Sl+Doo;
    Until(Sl >(3*Doo));{End loop Sl}

    St:=St+Doo ;
    Until( St >(3*Doo));{End Loop St}

    Lfs:=Lfs+0.002;
    Until(Lfs >0.0034); {End Loop Lfs}

    Nc:=Nc + 4;
    Until(Nc > 10 ); {Loop Nc}

    Nr:=Nr+2;
    Until(Nr >10 ); {Loop Nr}

    Doo:=Doo+ 0.01;
    Di:=Doo-2*tw;
    Until((Doo >0.03 ) {and (Di >= Doo-0.00035*2) });{End loop Doo,Di,0.00035= Tube
thinkness}
    append(fileVar);
    Writeln(fileVar,'-----',
'-----');

```

```

Writeln(fileVar,'| NO | Doo | Lfs | TF | ST | SI | WF | Li |',
' Lf | NC | Nr | Qtotal | Qex | EbyCost | Comment |');
Writeln(fileVar,'-----',
'-----');
for test := 1 to 6 do
  With Report[test] do

writeln(fileVar,test:9,Doo:8:3,lfs:10:4,tf:10:4,st:10:4,SI:9:2,Wf:10:4,Li:10:4,Lf:10:4,Nc:8,Nr:8
,Qtt:18:4
,Qex:18:2,EbyCost:8:2,Comment:10);
close(filevar);
writeln;
writeln('.....Good Bye Optimum.....');

End;

```

```

Procedure SetVariable_start;

```

```

  Begin
    S:=1;
    ca:=1.008;
    cv:= 1.88;
    hfgair :=2500;
    pa := 101.325;
    Min := 3;
    dt := 0.01;
    Mdesign :=0.25;
    mi:= min;
    wdo:=0.0290;
    t:=0;
    sec:=0;
    CheckWdo:= False;
    Checktco:=False;
    CheckTdo:=False;
    CheckT:=False;

```

```

CheckR:=False;
CheckMf:=False;
Qe:=0;
Qc:=0;
Qsum:=0;
Pcsum:=0;
tmix:=0;
tmix1:=0;
wmix:=0;
wmix1:=0;
End;

```

```

{*****
Function FindQe
input :
Output : wdi
*****}

```

```

Procedure FindQe_Qc_Pc ;

```

```

Var TeoH,Qtr:Real ;

```

```

Begin

```

```

{ tei:=Tdo - (Qtt *3600)/(Rc*0.8*md*Ca);

```

```

X3:=tei+273.15;

```

```

Pvcon:=101.325*wdo/(0.62189+wdo);

```

```

Pvscon:=exp((-7511.52/X3)+89.6312+(2.39989E-02*X3)-(1.165455e-5*X3*X3)-
(1.2810336E-8*X3*X3*X3)

```

```

+(2.09984E-11*X3*X3*X3*X3)-(12.1507899*LN(X3)));

```

```

Rhcon:= Pvcon/Pvscon;

```

```

if Rhcon>1 then

```

```

Rhcon:= 0.99;

```

```

Tcon:=6.938+14.38*Ln(rhcon*pvscon)+1.079*(Ln(rhcon*pvscon))*(Ln
(rhcon*pvscon)); }

```

```

{Cr=4,r-12} {writeln('Tcon ',Tcon:5:2);}

{ Ter:=Tcon;
  Tcr:=-4e-05*ter*ter*ter+9e-4*ter*ter+1.4188*ter+49.836;
  FreeS2:=-2e-09*Ter*Ter*Ter*Ter+2e-07*Ter*Ter*Ter+5e-07*Ter*Ter-6e-
04*Ter+1.5602;
  FreeD2:=-2e-09*Tcr*Tcr*Tcr*Tcr+2e-07*Tcr*Tcr*Tcr+5e-07*Tcr*Tcr-6e-
04*Tcr+1.5602;
  Ter:=ter+273.15;
  Tcr:=tcr+273.15;
  Hd1:= Hgc+(FreeS2-FreeD2)*Tcr;          {Tcr = Kelvin}
  {Hge:=355.19+0.378*(ter-273.15);
  Hfc:=199.79+1.020*(tcr-273.15);
  Hgc:=355.19+0.378*(tcr-273.15);
  Qe:=0.07*(Hge-Hfc);                    { KW ,ml=0.07}
  { Qc:=0.07*(Hd1-Hfc);
  Teo:=
(0.2*tdo*(ca+cv*wdo)+0.8*tcon*(ca+cv*wcon))/(ca+0.8*cv*wcon+0.2*cv*wdo); }
          {BF=0.2}
  { Pv:=5.4867-101.325*6.66e-4*(tcon-34.57); }
  { Wcon:=0.62197*pvcon/(101.325-pvcon);
  Weo:=0.8*Wcon+0.2*Wdo;
  Wmix1:=(1-BP)*weo+BP*wdo;
  Tcoloop:=Teo+(Qtt*3600)/(Rc*0.8*md*ca);
  Tmix1:=((1-
BP)*(ca*teo+weo*(hfgair+cv*teo))+BP*(ca*tdo+wdo*(hfgair+cv*tdo))-wmix1*hfgair)/
(ca+wmix1*cv);
  Pc:=Qc-Qe;                             {Pc= Kw}
  { Pcsum:=Pcsum+Pc*dt*3600; }          {Pcsum = Kj , dt= hour}

  {Find Tei True}

  {X4:=tdo+273.15;
  Pvcon:=101.325*wdo/(0.62189+wdo);

```

```

Pvscon:=exp((-7511.52/X4)+89.6312+(2.39989E-02*X4)-(1.165455e-5*X4*X4)-
(1.2810336E-8*X4*X4*X4)
+(2.09984E-11*X4*X4*X4*X4)-(12.1507899*LN(X4)));
Rhcon:= Pvcon/Pvscon;
if Rhcon>1 then
  Rhcon:= 0.99;

Tcon:=6.938+14.38*Ln(rhcon*pvscon)+1.079*(Ln(rhcon*pvscon))*(Ln
(rhcon*pvscon));
{writeln(' Tcon =',Tcon:5:5);}
{ tei1:= tcon;
repeat
tei1:= tei1+1;
Qtr1:= Md*ca*(Tdo-tei1)*Rc*(1-Bp)/3.6;
Qtt:=Qtr1;
tei:=Tdo - Qtt/(Rc*(1-Bp)*md*Ca)*3.6;
until (abs(tei-tei1)<1 ) ; }

Repeat
Qtr := (Tdo-Teo)/(Ztnew*Nr*Nc);
Tcoloop:= Qtr/(md*ca*rc*(1-bp))+Teo;
tei := Tdo- Qtr/(md*ca*rc*(1-bp));
writeln('Tdo',Tdo:5:4,'Tei',Tei:5:4,' tcoloop=',tcoloop:5:4);
X4 := tei+273.15;
Pvcon := 101.325*wdo/(0.62189+wdo);
Pvscon := exp((-7511.52/X4)+89.6312+(2.39989E-02*X4)-(1.165455e-5*X4*X4)-
(1.2810336E-8*X4*X4*X4)
+(2.09984E-11*X4*X4*X4*X4)-(12.1507899*LN(X4)));
Rhcon := Pvcon/Pvscon;

if Rhcon>1 then
  Rhcon:= 0.99;

```

```
Tcon:=6.938+14.38*Ln(rhcon*pvscn)+1.079*(Ln(rhcon*pvscn))*(Ln
(rhcon*pvscn));
```

```
TeoH := 0.2*tei+0.8*tcon;
```

```
if (abs(Teo-Teoh)>1) then
```

```
    teo:= (Teo+Teoh)/2
```

```
else
```

```
    teo:= teoh;
```

```
    writeln('TeoH =',TeoH:5:4,' Teo=',Teo:5:4);
```

```
until(abs(Teo-Teoh)< 1) ;
```

```
Ter:=Tcon;
```

```
Tcr:=-4e-05*ter*ter*ter+9e-4*ter*ter+1.4188*ter+49.836;
```

```
{writeln('Tcr ',Tcr:5:2);}
```

```
FreeS2:=-2e-09*Ter*Ter*Ter*Ter+2e-07*Ter*Ter*Ter+5e-07*Ter*Ter-6e-
04*Ter+1.5602;
```

```
FreeD2:=-2e-09*Tcr*Tcr*Tcr*Tcr+2e-07*Tcr*Tcr*Tcr+5e-07*Tcr*Tcr-6e-
04*Tcr+1.5602;
```

```
Ter:=ter+273.15;
```

```
Tcr:=tcr+273.15;
```

```
Hd1:= Hgc+(FreeS2-FreeD2)*Tcr;
```

```
Hge:=355.19+0.378*(ter-273.15);
```

```
Hfc:=199.79+1.020*(tcr-273.15);
```

```
Hgc:=355.19+0.378*(tcr-273.15);
```

```
Qe:=0.07*(hge-hfc); { KW ,ml=0.07}
```

```
{writeln('Qe ',Qe:5:2);}
```

```
Qc:=0.07*(Hd1-hfc);
```

```
{writeln('Qc ',Qc:5:2);}
```

```

Pvca:=5.4867-101.325*6.66e-4*(tcon-34.57);

Wcon:=0.62197*pvca/(101.325-pvca);

Weo:=0.8*wcon+0.2*Rc*(1-BP)*wdo;

Wmix1:=(1-bp)*weo+bp*wdo;

Tmix1:=((1-bp)*(ca*tcoloop+weo*(hfg+cv*tcoloop))+bp*(ca*tdo+wdo*
(hfg+cv*tdo))-wmix1*hfg)/(ca+wmix1*cv);
Pc:=Qc-Qe;
Pcsum:=Pcsum+Pc*dt*3600;
End{End FindQe_Qc_Pc};
{*****

Procedure FindWa
Input: ta ,rha
Output:Wa
***** }

Procedure FindWa;
Begin
XX:=Ta+273.15;
Pvsa:=exp(-7511.52/XX+89.6312+2.39989E-02*XX-1.165455e-5*XX*XX-
1.2810336E-8*XX*XX*XX
+2.09984E-11*XX*XX*XX*XX-12.1507899*LN(XX));
Pva:= RHa/100*Pvsa;
Wa:= (0.62189*Pva)/(Pa-Pva);
End{End FineWa};
{*****

Function Findwmix
input : wa,wdo,rc
Output : wdi
*****}

Procedure FindWmix;

```

```

Begin
  { writeln(' Wmix1=',Wmix1:5:4,' Weo ',Weo:5:4,' Wdo',Wdo:5:4,' Wdn ',Wdn:5:4);}
  Wmix := (1-RC)*wa+RC*wmix1;

End{End FindWdi};
{*****}
Function FidTdo
  input: tdi ,ca,wdi,cv,hfgair,wdo
  Output :tdo
  *****}
Procedure FindTdo;

Begin

  Tdo:=(tdi*ca+tdi*wdi*cv+hfgair*wdi-hfgair*wdo)/(ca+wdo*cv);
  Pvdo := 101.325*wdo/(0.62189+wdo);
  Tdocon:= 6.983+14.38*ln(Pvdo)+1.079*ln(Pvdo)*ln(Pvdo);

End{End findTdo};
{*****}
Function FindRhdi
  input: wdi,tdi,tdo,wdo
  Output :Rhdi
  *****}
Procedure FindRhdi;
  Var
    Pvdi,TestRhdi,Pvsdi:real ;
  Begin
    { writeln('in rhdi');
      readln; }
    Pvdi:=101.325*((wdi+wdo)/2)/(0.62189+(wdi+wdo)/2);
    {absolute}
    {writeln('Tdi=',tdi:5:3,' tdo=',tdo:5:3);}
    {readln;}

```

```

        X1:=((Tdi+tdo)/2+273);
        { writeln(' In (X1):',LN(x1):6:5);
          readln; }
{!!!!!!ERROR!!! rc>1.0}
        Pvsdi:=exp((-7511.52/X1)+89.6312+(2.39989E-02*X1)-(1.165455e-5*X1*X1)-
(1.2810336E-8*X1*X1*X1)
        +(2.09984E-11*X1*X1*X1*X1)-(12.1507899*LN(X1)));
        { writeln('pvsdi ',pvsdi:5:5,' pvdi=',pvdi:5:5 );}
        Rhdi:= Pvdi/Pvsdi;

```

```

End{End FindRhdi};

```

```

{*****}
Function FindMeq
  input: X1,X2,Rhdi
  Output :Meq
*****}

```

```

Procedure FindMeq;
  Var
    A,B:Real;
  Begin
    A:=2.3015 - 0.00615*X1;
    B:=-1.3453+0.00507*X1;
    X2:=RHdi/(1-RHdi);
    Meq:=exp(ln(A)+B*ln(X2))

```

```

End{End FindMeq};

```

```

{*****}
Function FindMf
  input: Tdi,Min,Meq,dt,t
  Output : Mf
*****}

```

```

Procedure FindMf;

```

```

  Var

```

```

        K:real;
Begin
    k:=-5e-5*Tdi*Tdi+0.0082*Tdi-0.2692;
    Mf:=Mi-(Min-Meq)*dt*k*exp(-k*t);
End{End FindMf};
{*****}
Function FindWdn
    input: mp,mi,mf,dt,md,wdi
    Output : Wdn
*****}
Procedure FindWdn;
    Begin
        Wdn:= mp*(Mi-Mf)/(dt*md)+Wdi;
    End{End FindWdn};
{*****}
Function Compare Wdn_With_Wdo
    Input: wdn,wdo
    Output: True,False
*****}
Function Compare_Wdn_Wdo(Var Wdo,Wdn : Real):Boolean;
    Begin
        if (Abs(wdn-wdo)<0.0001) then
            Begin
                Compare_Wdn_Wdo:= True;
                wdo := Wdn;
            End
        else
            Begin
                Compare_Wdn_Wdo:=False;
                wdo := (wdn+wdo)/2;
            End;
        End{End Compare_wdo_wdn};
{*****}
Function FindTmix

```

input: rc,ca,ta,wa,hfgair,cv,tdo,wdn

Output : Tmix

*****}

Procedure FindTmix;

Begin

Tmix:=((1-

RC)*(ca*ta+wa*(hfgair+cv*ta))+rc*(ca*tmix1+wmix1*(hfgair+cv*tmix1))-wmix*hfgair/

(ca+cv*wmix);

End{End FindTmix};

{*****

procedure FindTco

input: tmix,Qc,wmix

output: tco

*****}

Procedure FindTco;

begin

Tco:=tmix+(Qc*3600)/(md*(ca+wmix*cv));

end;

{*****

Function FindSec

input: qsum,mp,tdi,tmix,md,ca,wdi,cv,dt

Output : Sec

*****}

Procedure FindSec;

Begin

if tco<tdi then

Qh:= (Tdi-Tco)*md*(ca+Wdi*cv)*dt {Qh =Kj}

else

Qh:=0;

Qsum:= Qsum+Qh;

Sec:= Qsum/(3*mp); {Sec = Kj/Kg Water remove}

secp:= psum/(3*mp);

End{End FindSec};


```

if Rhdi < 0.95 Then
begin
FindMeq;           {call findMeq function}
FindMf;           {call FindMf fuction}
FindWdn;          {call FindWdn function}
FindTdo;
FindTmix;         {call FindTmix Function}
end
else
Begin
CheckR:=True;
Comment:='R';
End;
Checkwdo:= Compare_Wdn_Wdo( Wdo,Wdn);
Until (Checkwdo or checkR );      {check Wdn with Wdo}

```

```

if Rhdi < 0.95 then
begin
FindQe_Qc_Pc;
FindWmix;         {call FindWdi function}
wdi:=wmix;
FindMeq;          {call findMeq function}
FindMf;           {call FindMf fuction}
FindWdn;
wdo:=wdn;         {call FindWdn function}
FindTdo;
FindTmix;
Findtco;
FindSec;          {call FindSec funtion}
if tco > tdi then
begin

checktco:= True;
comment:='t';

```

```

End ;

checkMf:= Compare_Mf_Mdesign(Mf,Mdesign);
end
End
Else
Begin
FindQe_Qc_Pc;
FindWmix;                {call FindWdi function}
wdi:=wmix;
FindRhdi;                {call FindRhdi function}
If Rhdi<0.95 then
Begin
FindMeq;                {call findMeq function}
FindMf;                {call FindMf fucntion}
FindWdn;                {call FindWdn function}
wdo:=wdn;
FindTdo;
if ((Tdo>tdi)or (Tdo < Tdocon))Then
begin
CheckTdo := True;
Comment:= 'D' ;
end
else
begin
FindTmix;                {call FindTmix Function}
Findtco;
FindSec ;
if tco > tdi then
begin
checktco:= True;
comment:='t';
end
else

```

```

        checkMf:= Compare_Mf_Mdesign(Mf,Mdesign);
    end
End
Else
Begin
checkR:=True;
Comment:='R';
End
End ;
if t>200 then
begin

Comment:='T';
CheckT:=True;
end;
Until ( CheckMf or checktco or checkT or checkR or CheckTdo); {copare Mf
Mdesign}

if Compare_Mf_Mdesign(Mf,Mdesign) Then
Comment:='M';
count:=count+1;
write(' Comment  ",comment,' ');
write(' ',count:4:0);
End{End CallAll};
{*****
Procedure MinSix fuction all
*****}
Procedure MinSix(Var loop:integer);
Begin
if ((Sec > 0 ) and (Comment ='M')) then
Begin
{Compare Value Sec}
If( Loop>=1 ) and (Result[loop].tco <= Result[loop].tdi) then
Begin

```

```
if(( sec< Result[1].sec) or ( Result[1].sec = 0 )) then
begin
    Result[6]:=Result[5];
    Result[5]:=Result[4];
    Result[4]:=Result[3];
    Result[3]:=Result[2];
    Result[2]:=Result[1];
    Result[1].mp := mp;
    Result[1].ta:= ta;
    Result[1].rha:= rha;
    Result[1].tdi:= tdi;
    Result[1].tco:=tco;
    Result[1].tmix:= tmix;
    Result[1].secp:= secp;
    Result[1].md:= md;
    Result[1].rc:= rc;
    Result[1].bp:= bp;
    Result[1].Sec:= Sec;
    Result[1].Comment:= Comment;
end
else
if(( sec< Result[2].sec) or( Result[2].sec = 0 ))then
begin
    Result[6]:=Result[5];
    Result[5]:=Result[4];
    Result[4]:=Result[3];
    Result[3]:=Result[2];
    Result[2].mp := mp;
    Result[2].ta:= ta;
    Result[2].rha:= rha;
    Result[2].tdi:= tdi;
    Result[2].tco:=tco;
    Result[2].tmix:= tmix;
    Result[2].secp:= secp;
```

```

Result[2].md:= md;
Result[2].rc:= rc;
Result[2].bp:= bp;
Result[2].Sec:= Sec;
Result[2].Comment:= Comment;
end
else
if ((sec< Result[3].sec)or( Result[3].sec = 0 )) then
begin
Result[6]:=Result[5];
Result[5]:=Result[4];
Result[4]:=Result[3];
Result[3].mp := mp;
Result[3].ta:= ta;
Result[3].rha:= rha;
Result[3].tdi:= tdi;
Result[3].tco:=tco;
Result[3].tmix:= tmix;
Result[3].secp:= secp;
Result[3].md:= md;
Result[3].rc:= rc;
Result[3].bp:= bp;
Result[3].Sec:= Sec;
Result[3].Comment:= Comment;
end
else
if ((sec< Result[4].sec) or( Result[4].sec = 0 )) then
begin
Result[6]:=Result[5];
Result[5]:=Result[4];
Result[4].mp := mp;
Result[4].ta:= ta;
Result[4].rha:= rha;
Result[4].tdi:= tdi;

```

```

Result[4].tco:=tco;
Result[4].tmix:= tmix;
Result[4].secp:= secp;
Result[4].md:= md;
Result[4].rc:= rc;
Result[4].bp:= bp;
Result[4].Sec:= Sec;
Result[4].Comment:= Comment;
end
else
if ((sec< Result[5].sec)or( Result[5].sec = 0 )) then
begin
Result[6]:=Result[5];
Result[5].mp := mp;
Result[5].ta:= ta;
Result[5].rha:= rha;
Result[5].tdi:= tdi;
Result[5].tco:=tco;
Result[5].tmix:= tmix;
Result[5].secp:= secp;
Result[5].md:= md;
Result[5].rc:= rc;
Result[5].bp:= bp;
Result[5].Sec:= Sec;
Result[5].Comment:= Comment;
end
else
if(( sec< Result[6].sec )or( Result[6].sec = 0 )) then
begin
Result[6].mp := mp;
Result[6].ta:= ta;
Result[6].rha:= rha;
Result[6].tdi:= tdi;
Result[6].tco:=tco;

```

```

        Result[6].tmix:= tmix;
        Result[6].secp:= secp;
        Result[6].md:= md;
        Result[6].rc:= rc;
        Result[6].bp:= bp;
        Result[6].Sec:= Sec;
        Result[6].Comment:= Comment;
    end
End{End if <1 loop}
else
    if (Result[loop].tco <= Result[loop].tdi) then
    begin
        Result[1].mp := mp;
        Result[1].ta:= ta;
        Result[1].rha:= rha;
        Result[1].tdi:= tdi;
        Result[1].tco:=tco;
        Result[1].tmix:= tmix;
        Result[1].secp:= secp;
        Result[1].md:= md;
        Result[1].rc:= rc;
        Result[1].bp:= bp;
        Result[1].Sec:= Sec;
        Result[1].Comment:= Comment;
    end
    End{sec>10} ;
    End{End MinSix};
{*****}
    Procedure ChangeMp
        :procedure make to change Mp Value (125 ,250 , 500,...)
        *****}
Procedure ChangeMp;
    Begin
        ta:=30;

```

```
Repeat
  rha:=60;
  Repeat
    tdi:=80;
    Repeat
      md:=720;
      Repeat
        rc:=0.10;
        Repeat
          bp:=0.100;
          Repeat
            loop :=10;
            CallAll;
            Result[loop].tco:=tco;
            Result[loop].tdi:=tdi;
            Result[loop].sec:=sec;
            MinSix(loop);
            bp:=bp+0.1;
            SetVariable_start;
          Until(bp>1.0);
        rc:=rc+0.1;
      Until(rc>1.0);
      md:=md+50;
    Until(Md>600);
    tdi:=tdi+10;
  Until(tdi>80);
  rha:= rha+20;
Until(Rha>60);
ta:=ta+10;
```

```
        Until(ta>30);
    End{End ChangeMp};
```

```
function LeadingZero(w : Word) : String;
```

```
var
```

```
    s : String;
```

```
begin
```

```
    Str(w:0,s);
```

```
    if Length(s) = 1 then
```

```
        s := '0' + s;
```

```
    LeadingZero := s;
```

```
end;
```

```
    {.....Start Main .....}
```

```
BEGIN
```

```
    filename:='HLN2.dat';
```

```
    assign(fileVar,filename) ;
```

```
    rewrite(fileVar);
```

```
    GetDate(year,month,date,dow);
```

```
    GetTime(hh,mm,second,hund);
```

```
    Writeln(filevar,'Today is.... ', days[dow],', ', date:0, '/', month:0, '/', year:0);
```

```
    writeln(filevar,'Start program at time :',LeadingZero(hh),':',LeadingZero  
(mm),':',LeadingZero(second),'
```

```
    ',LeadingZero(hund));
```

```
    close(filevar);
```

```
{Call Optimum }
```

```
    Writeln;
```

```
    Writeln('.....Start Optimum Process.....');
```

```
    Optimum;
```

```
{Write Qtotal to File }
```

```
    append(filevar);
```

```
    Writeln(filevar,' '); Writeln(filevar,' '); Writeln(filevar,' ');
```

```

writeln(filevar,'  Mase of Product(Mt) =',Mt:5:2,'  Qtotal =',Qtt:5:4);
close(filevar);
{Start Process HeatPump }
SetVariable_start;
Ztnew := Report[1].Ztnew;
tdo:= Report[1].tdo;
teo:= Report[1].teo;
Nr:= Report[1].Nr;
Nc:= Report[1].Nc;
writeln(' Zt=',Ztnew,' Teo=',Teo:5:4,' Tdo=',Tdo:5:4);readln;
Writeln(' - - - The Program HeatPump - - -');
Writeln('  - - Please Wait - - ');
write(' ');
mp:=round(Mt/4);
while mp<=120 do
begin
case mp of
30: ChangeMp;
60: ChangeMp;
120: ChangeMp;
End;
mp:=mp+30;
End;
writeln;
Writeln('-----');
Writeln('| No| Mp | md | Ta | Rha | Tmix| Tco | Tdi | Rc | Bp | Sec'
,' | Secp | Comment|');
Writeln('-----');
for test := 1 to 6 do
begin
With Result[test] do
begin
writeln(test:3,mp:9,md:9:0,ta:9:0,rha:9:0,Tmix:9:0,tco:9:0,tdi:9:0,rc:9:2,bp:9:2,sec:10:2,

```

```

        Secp:9:2,",Comment:5)
    end;
end;

{Write Result Minimum value of Sec to File Output }
append(fileVar);
Writeln(fileVar,'-----');
Writeln(fileVar,'| No| Mp | md | Ta | Rha |Tmix|Tco |Tdi | Rc | Bp | Sec'
,' | Secp | Comment!');
Writeln(fileVar,'-----');
for test := 1 to 6 do
begin
    With Result[test] do
        begin

writeln(fileVar,test:3,mp:9,md:9:0,ta:9:0,rha:9:0,Tmix:9:0,tco:9:0,tdi:9:0,rc:9:2,bp:9:2,sec:
10:2,
        Secp:9:2,",Comment:5)
            end;
        end;
end;
GetTime(hh,mm,second,hund);
{Write Time when Progarm terminate}
writeln(filevar);
writeln(filevar,'End of program at time
: ',LeadingZero(hh),': ',LeadingZero(mm),': ',LeadingZero(second),': ',LeadingZero(hund));
close(filevar);
{Close Output file}
writeln('    Good bye __ HeatPump');
END.

```