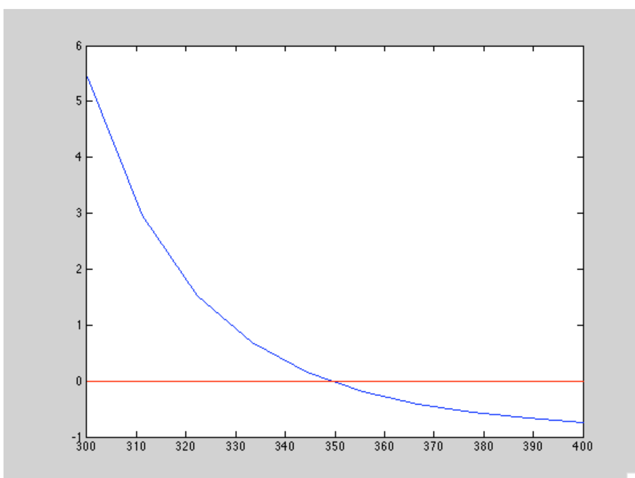
10.213 Chemical & Biological Engineering Thermodynamics

"Single & Multistage Flash"

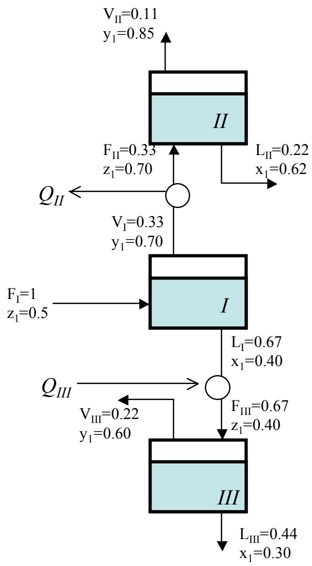
April 24, 2008

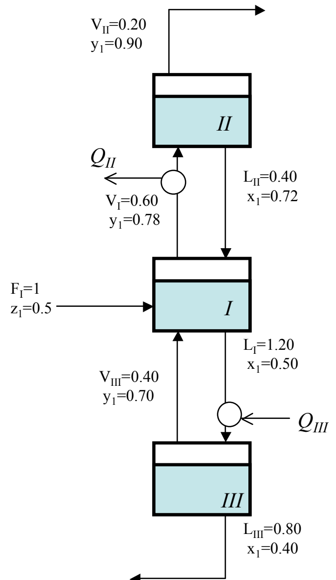
```
function dewpoint(P,z1,z2,z3)
% Example 8.3 of Koretsky. dew point calculation for a mixture of
% n-pentane, cyclohexane, n-hexane and n-heptane with composition
% z1,z2,z3,z4 and at pressure P (in bar).
% G.C. Rutledge, 4/24/08
N = 4;  % number of components
z(1)=z1;z(2)=z2;z(3)=z3;     % load vector
z(4) = 1-z(1)-z(2)-z(3);     % sum of feed compositions = 1
% Antoine coefficients (from Koretsky, Table A.1) T in K, P in bar:
A(1)=9.2131;B(1)=2477.07; C(1)=-39.94;    % n-pentane
A(2)=9.1325;B(2)=2766.63; C(2)=-50.50;    % cyclohexane
A(3)=9.2164;B(3)=2697.55; C(3)=-48.78;    % n-hexane
A(4)=9.2535;B(4)=2911.32; C(4)=-56.51;    % n-heptane
%
% GRAPHICAL METHOD (guess a range of T's to locate solution):
% first, allocate vectors for T, RRFF_res, Psat and K
m = 10; % number of temperatures to test (graphical method)
Tmin=300;  % K
Tmax=400;  % K
T=linspace(Tmin,Tmax,m);
RRFF_res=zeros(m);
Psat=zeros(N,m);
K = zeros(N,m);
% loop over all temperature and components to compute saturation pressures
% and K-values:
for k=1:m
    for i=1:N
        Psat(i,k) = exp(A(i)-B(i)./(T(k)+C(i))); % bar
        K(i,k) = Psat(i,k)./P;
    end
    % compute residual of Rachford-Rice Flash Function for each temperature
    RRFF_res(k)=z(1)./K(1,k)+z(2)./K(2,k)+z(3)./K(3,k)+z(4)./K(4,k)-1;
end
plot(T,RRFF_res);
```

```
%
% NUMERICAL METHOD:
Tdew = fzero(@(T) RRFF(T,P,z,A,B,C,N),300)
%
%compute liquid composition:
for i=1:N
    Psati = exp(A(i)-B(i)./(Tdew+C(i)));
    Ki = Psati/P;
    x(i) = z(i)/Ki;
end
x
end


function res=RRFF(T,P,z,A,B,C,N)
Psat=zeros(N);
K = zeros(N);
% loop over all components to compute saturation pressures and
K-values:
for i=1:N
    Psat(i) = exp(A(i)-B(i)./(T+C(i))); % bar
    K(i) = Psat(i)./P;
end
% compute residual of Rachford-Rice Flash Function for each
temperature
res=z(1)./K(1)+z(2)./K(2)+z(3)./K(3)+z(4)./K(4)-1;
end
```




```
>> dewpoint(1,.3,.3,.2)

Tdew =    348.8639
x =        0.0908    0.3451    0.1594    0.4047

>>
```





(assuming ψ=1/3 at each stage)

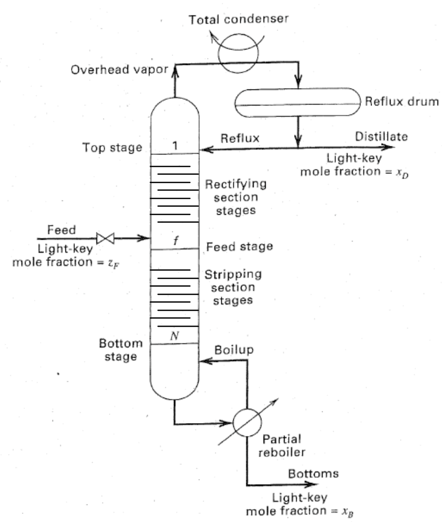
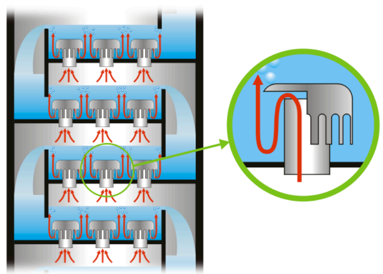


Figure 7.2 Distillation operation using a total condenser and partial reboiler.

after Seader & Henley, Separation Process Principles

Bubble trays, Sieve trays (“plates”)



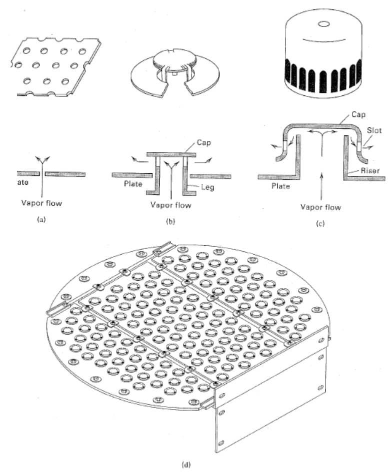


Figure 6.5 Three types of tray openings for passage of vapor up into liquid: (a) perforation; (b) valve cap; (c) bubble cap; (d) tray with valve caps.

Seader & Henley, Separation Process Principles

Packed Columns

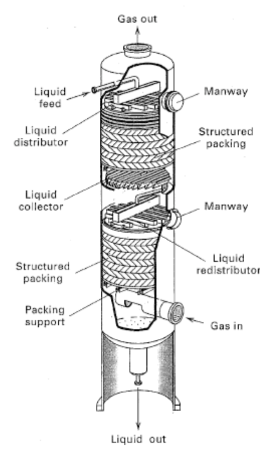


Figure 6.6 Details of internals used in a packed column.

Figure 6.7 Typical materials used in a packed column: (a) random packing materials; (*continued*)

Seader & Henley, Separation Process Principles