```
clear
% U5.6
% A is SO2
% B is air
% C is water
MA = 64.07e-3; % kg/mol
MB = 28.84e-3;
MC = 18.02e-3;

% column properties
D = 0.9; % m
p = 101.3e3; % Pa
t = 15+273.15; % K

% gas conditions
yin = 1.5e-2; % mol-A/mol-gas
VGin = 800; % m3/h
yield = 0.98; % 98% of SO2 absorbed to water

% liquid conditions
nCratio = 1.2; % nC=1.2*nCmin
Xin = 0;       % clean water on input
```

## Equilibrium coefficient

```
% pCO2 [/Pa] = 4e5 WA
% p*yA = k*WA
% WA = mA/mC = (nA/nC)*(MA/MC) = XA*(MA/MC)
% yA = k/p*(MA/MC) * XA

% yA = YA / (1+YA), but if YA is small, let us neglect YA in the
% denominator, so
% yA = YA (approximation)

% using the definition YA=phi*XA
phi = 4e5/p*(MA/MC)
```

```
phi = 14.0395
```

## Mass transfer kinetics correlation

```
% DEFINITIONS
% Sh = 5.23 Re**0.7 * Sc**1/3 (a_t d)**-2
% Sh = ky / (cG * a_t * DG)
% Re = vG / (a_t * nuG)
% Sc = nuG / DG
DG = 1.236e-5; % m2/s (SO2 diffusivity given)
a_t = 220; % m2/m3
d = 0.025; % m
alpha = 0.6; % wetted surface fraction

etaG = 17.95e-6; % Pa.s [air at 15 deg C]
```

```
rhoG = p*MB/(8.314*t) % kg/m3
```

```
rhoG = 1.2195
```

```
cG = p/(8.314*t) % mol/m3
```

```
cG = 42.2845
```

```
vG = (VGin/3600)/(pi*D^2/4) % m/s
```

```
vG = 0.3493
```

```
RE = vG / (etaG/rhoG * a_t)
```

```
RE = 107.8702
```

```
Sc = (etaG/rhoG) / DG
```

```
Sc = 1.1909
```

```
Sh = 5.23 * RE^0.7 * Sc^(1/3) * (a_t*d)^(-2)
```

```
Sh = 4.8540
```

```
ky = Sh * cG * a_t * DG % mol/(m2.s)
```

```
ky = 0.5581
```

```
% resistance only at the gas-phase side of interface,
% therefore Ky == ky
```

## Minimum consumption of the liquid

```
Yin = yin/(1-yin) % mol-A/mol-B
```

```
Yin = 0.0152
```

```
Yout = (1-yield)*Yin % mol-A/mol-B
```

```
Yout = 3.0457e-04
```

```
nGin = p*(VGin/3600)/(8.314*t) % mol-gas/s
```

```
nGin = 9.3965
```

```
nB = (1-yin)*nGin % mol-B/s
```

```
nB = 9.2556
```

```
% note, it is not needed to plot a graph, the equilibrium is a line!
Xeq = linspace(Xin, Yin/phi, 100);
Yeq = phi*Xeq;
MXout = Yin/phi
```

```
MXout = 0.0011
```

```
plot(Xeq, Yeq, 'b-', [Xin MXout], [Yout Yin], 'r-o')

nCmin = nB*(Yin-Yout)/(MXout-Xin) % mol-C/s
```

```
nCmin = 127.3448
```

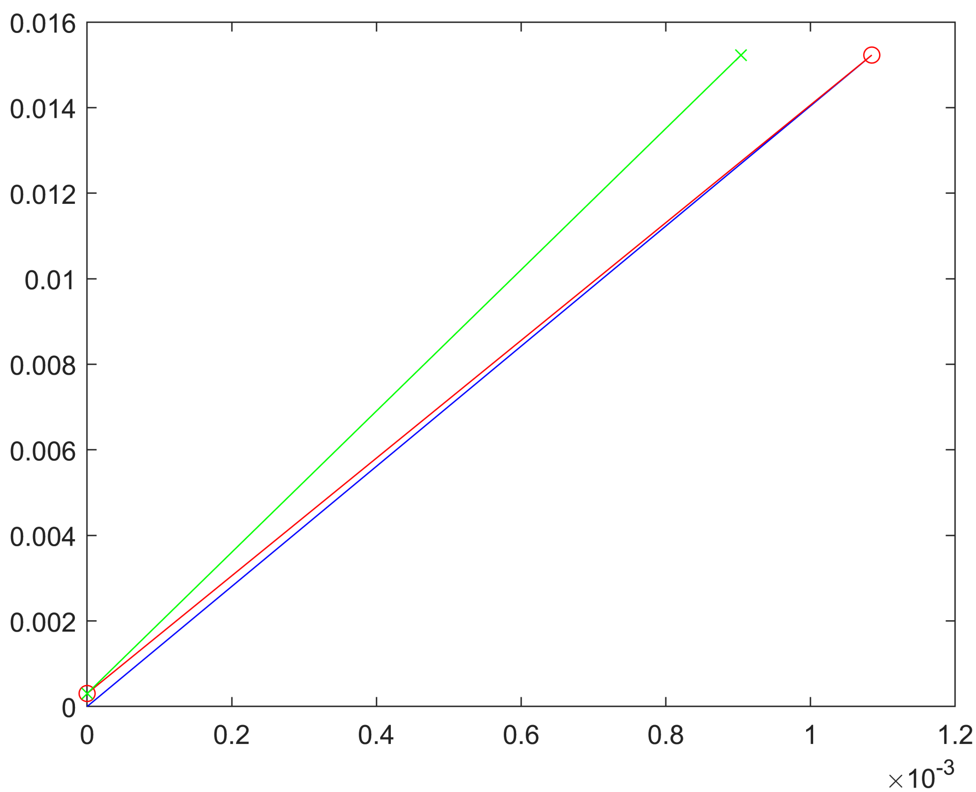
```
% the actual flux of water
nC = nCratio*nCmin % mol-C/s
```

```
nC = 152.8137
```

```
hold on % add the actual working line
Xout = Xin + nB/nC*(Yin-Yout)
```

```
Xout = 9.0391e-04
```

```
plot([Xin Xout],[Yout Yin],'g-x')
hold off
```




```
mC = MC*nC % kg-C/s [expected 2.78 kg/s]
```

```
mC = 2.7537
```

## Number of transfer units

```
xi = nC / (phi*nB) % absorption factor (not one!)
```

```
xi = 1.1760
```

```
Ny = xi/(xi-1)*log((Yin-Xout*phi)/(Yout-Xin*phi))
```

```
Ny = 14.1672
```

## Height of the transfer unit (and column height)

```
Hy = nB / (ky * a_t * alpha * pi/4*D^2) % m
```

```
Hy = 0.1975
```

```
H = Ny*Hy % m [expected 2.8 m]
```

```
H = 2.7978
```