Ethylene Glycol Flowsheet

Murphy (2005), Problem P3.50, page 260. Consult the problem statement for further details.

Contents

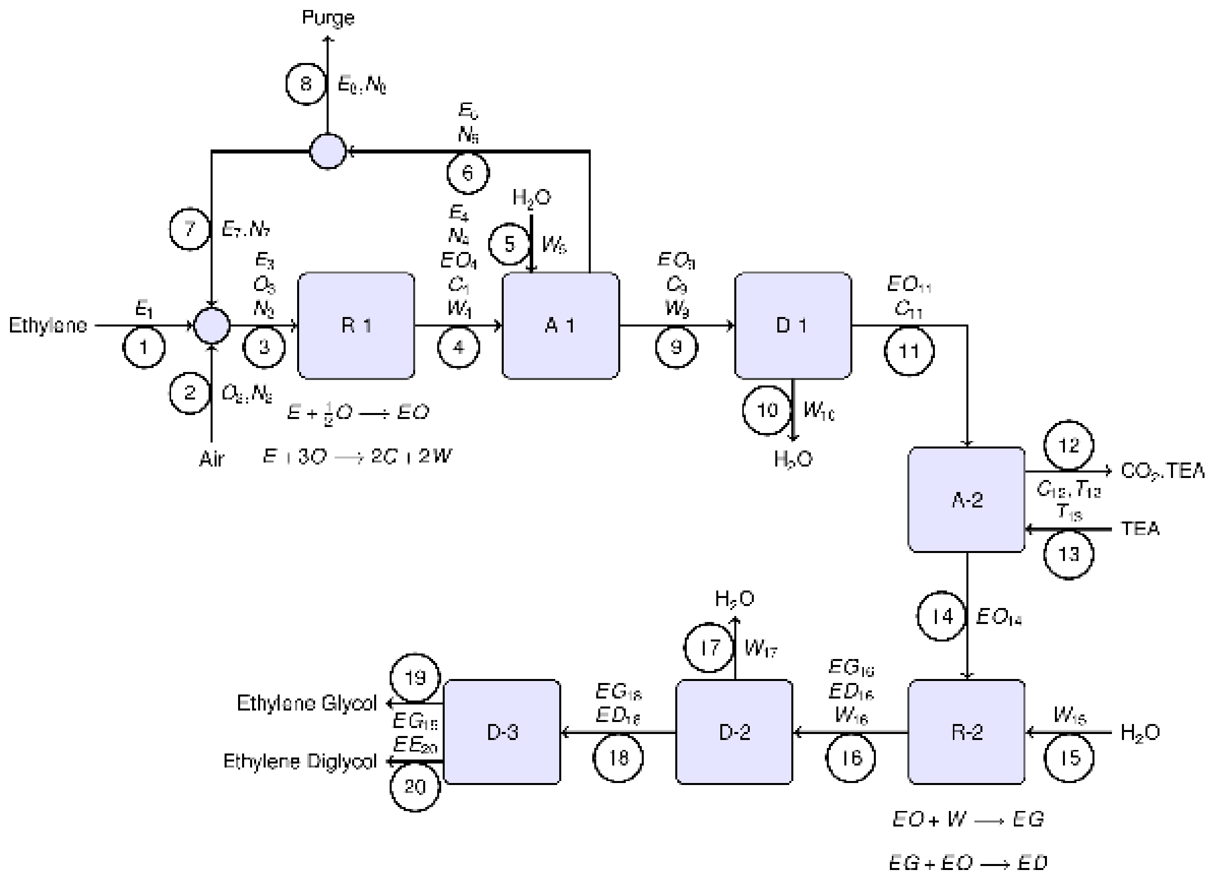
Required Matlab

- CVX
- displaytable.m

Show Flowsheet

The flowsheet has been transcribed from the problem statement. The streams are numbered and labeled with component flows.

```
[I,m] = imread('ethylene_glycol_flowsheet.png','png');
I = imresize(I,0.25,'Method','nearest','Antialiasing',false);
imshow(I,m);
axis off;
```



CVX Model

```
cvx_begin

    % Stream Variables (37)
    variables E1
    variables O2 N2
    variables E3 O3 N3
    variables E4 N4 EO4 C4 W4
    variables W5
    variables E6 N6
    variables E7 N7
    variables E8 N8
    variables EO9 C9 W9
    variables W10
    variables EO11 C11
    variables C12 T12
    variables T13
    variables EO14
    variables W15
    variables W16 EG16 ED16
    variables W17
    variables EG18 ED18
    variables EG19
    variables ED20

    % Extents of Reaction (4)
    variables X1 X2 X3 X4
```

```
% MATERIAL BALANCES (31)

% Mixer (3)
0 == E1 + E7 - E3;
0 == O2 - O3;
0 == N2 + N7 - N3;

% Reactor R-1 (6)
0 == E3 - E4 - X1 - X2;
0 == O3 - 0.5*X1 - 3*X2;
0 == N3 - N4;
0 == -EO4 + X1;
0 == -C4 + 2*X2;
0 == -W4 + 2*X2;

% Absorber A-1 (5)
0 == E4 - E6;
0 == N4 - N6;
0 == EO4 - EO9;
0 == C4 - C9;
0 == W4 + W5 - W9

% Purge (2)
0 == E6 - E7 - E8;
0 == N6 - N7 - N8;

% Distillation D-1 (3)
0 == EO9 - EO11;
0 == C9 - C11;
0 == W9 - W10;

% Absorber A-2 (3)
0 == EO11 - EO14;
0 == C11 - C12;
0 == T13-T12;

% Reactor R-2 (4)
0 == EO14 - X3 - X4;
0 == -EG16 + X3 - X4;
0 == -ED16 + X4;
0 == W15 - W16 - X3;

% Distillation D-2 (3)
0 == EG16 - EG18;
0 == ED16 - ED18;
0 == W16 - W17;

% Distillation D-3 (2)
0 == EG18 - EG19;
0 == ED18 - ED20;

% SPECIFICATIONS (7)

% Air composition
0.21*N2 == 0.79*O2;

% Feed rate of Ethylene
E1 == 1000;

% CO2 Production
C12 == 50;
```

```
    % 25% Fractional Conversion in R-1
    E4 == 0.75*E3;

    % Feed rate of Water at R-2
    W15 == 5*EO14;

    % Diglycol Production
    ED16 == 0.1*EG16;

    % Water in A-1
    W5 == 2*EO4;

    % Purge Fraction
    N8 == 0.05*N6;
    E8 == 0.05*E6;

cvx_end
```

```
Homogeneous problem detected; solution determined analytically.
Status: Solved
Optimal value (cvx_optval): +0
```

Streamtable

The stream variables are organized into a stream table. To keep the width small enough to fit on a sheet of paper, the stream table is presented with columns representing components, and rows denoting streams.

```
flows = [ ...
    E1    0    0    0    0    0    0    0    0;
     0   O2   N2    0    0    0    0    0    0;
    E3   O3   N3    0    0    0    0    0    0;
    E4    0   N4  EO4   C4   W4    0    0    0;
     0    0    0    0    0   W5    0    0    0;
    E6    0   N6    0    0    0    0    0    0;
    E7    0   N7    0    0    0    0    0    0;
    E8    0   N8    0    0    0    0    0    0;
     0    0    0  EO9   C9   W9    0    0    0;
     0    0    0    0    0  W10    0    0    0;
     0    0    0 EO11  C11    0    0    0    0;
     0    0    0    0  C12    0  T12    0    0;
     0    0    0    0    0    0  T13    0    0;
     0    0    0 EO14    0    0    0    0    0;
     0    0    0    0    0   W15   0    0    0;
     0    0    0    0    0   W16   0 EG16 ED16;
     0    0    0    0    0   W17   0    0    0;
     0    0    0    0    0    0    0 EG18 ED18;
     0    0    0    0    0    0    0 EG19    0;
     0    0    0    0    0    0    0    0 ED20];

comps = {'E','O','N','EO','CO2','W','TEA','EG','ED'};
displaytable(flows,'S',comps);
```

```
              E        O        N       EO      CO2        W      TEA       EG       ED
S(1)       1000        0        0        0        0        0        0        0        0
S(2)          0   497.28   1870.7        0        0        0        0        0        0
S(3)     3478.3   497.28    37415        0        0        0        0        0        0
```

```
    S(4)   2608.7        0   37415  844.57       50       50        0        0        0
    S(5)        0        0       0       0        0   1689.1        0        0        0
    S(6)   2608.7        0   37415       0        0        0        0        0        0
    S(7)   2478.3        0   35544       0        0        0        0        0        0
    S(8)   130.43        0  1870.7       0        0        0        0        0        0
    S(9)        0        0       0  844.57       50   1739.1        0        0        0
    S(10)       0        0       0       0        0   1739.1        0        0        0
    S(11)       0        0       0  844.57       50        0        0        0        0
    S(12)       0        0       0       0       50        0        0        0        0
    S(13)       0        0       0       0        0        0        0        0        0
    S(14)       0        0       0  844.57        0        0        0        0        0
    S(15)       0        0       0       0        0   4222.8        0        0        0
    S(16)       0        0       0       0        0   3448.6        0    703.8    70.38
    S(17)       0        0       0       0        0   3448.6        0        0        0
    S(18)       0        0       0       0        0        0        0    703.8    70.38
    S(19)       0        0       0       0        0        0        0    703.8        0
    S(20)       0        0       0       0        0        0        0        0    70.38
```

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