Solving Material Balances using CVX

Implementation of material balances for Ex. 2.15, Adipic Acid Production, R. Murphy, "Introduction to Chemical Engineering Analysis"

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Contents

Requirements

- CVX (available from http://cvxr.com)
- `displaytable.m`

CVX Model

```
cvx_begin quiet

    % Declare unknown molar flowrates (kg-moles/hour)
    %         Oxy    Nit    Glu    Wat    Hyd    CO2    AdA    MuA
    variables  O1     N1                                          % Stream  1
    variables               G2     W2                           % Stream  2
    variables                             H3                    % Stream  3
    variables         N4                          C4            % Stream  4
    variables                      W5                           % Stream  5
    variables                                            A6       % Stream  6
    variables  O7     N7     G7     W7                           % Stream  7
    variables         N8            W8           C8           M8   % Stream  8
    variables                                                  M9   % Stream  9
    variables                              H10                 M10  % Stream 10

    % Declare unknown extents of reaction
    variables Extent1 Extent2

    % Mixer 1
    0 == O1 - O7;
    0 == N1 - N7;
    0 == G2 - G7;
    0 == W2 - W7;

    % Reactor 1
    % Extent of Reaction (7/3)G + (17/2)X -> M + 8C + 11W
    0 == O7       - (17/2)*Extent1;
    0 == N7 - N8;
    0 == G7       -  (7/3)*Extent1;
    0 ==    - C8  +      8*Extent1;
    0 ==    - M8  +        Extent1;
    0 == W7 - W8  +     11*Extent1;

    % Separator
```

```
    0 == N8 - N4;
    0 == C8 - C4;
    0 == M8 - M9;
    0 == W8 - W5;

    % Mixer 2
    0 == M9 - M10;
    0 == H3 - H10;

    % Reactor 2
    % Extent of Reaction M + 2H -> A
    0 == H10      - 2*Extent2;
    0 == M10      -   Extent2;
    0 ==     - A6 +   Extent2;

    % Problem Specifications
    A6 == 82.2;
    N1 == (.79/.21)*O1;
    G2 == 0.001006*W2;

cvx_end
```

Display Stream Table

```
disp('Stream Table (flows in kg-moles/hour)');
Comps = {'O2','N2','Glu','H2O','H2','CO2','M Acid','A Acid'};
flows = [ ...
     O1,  0,  0,  0,  0,  0, O7,  0,  0,   0;
     N1,  0,  0, N4,  0,  0, N7, N8,  0,   0;
      0, G2,  0,  0,  0,  0, G7,  0,  0,   0;
      0, W2,  0,  0, W5,  0, W7, W8,  0,   0;
      0,  0, H3,  0,  0,  0,  0,  0,  0, H10;
      0,  0,  0, C4,  0,  0,  0, C8,  0,   0;
      0,  0,  0,  0,  0,  0,  0, M8, M9, M10;
      0,  0,  0,  0,  0, A6,  0,  0,  0,   0];

displaytable(flows,Comps,'S','%6.0f');
displaytable(Extent1,'Extent 1 = ');
displaytable(Extent2,'Extent 2 = ');
```

```
Stream Table (flows in kg-moles/hour)
         S( 1)   S( 2)   S( 3)   S( 4)   S( 5)   S( 6)   S( 7)   S( 8)   S( 9)   S(10)
O2         699       0       0       0       0       0     699       0       0       0
N2        2628       0       0    2628       0       0    2628    2628       0       0
Glu          0     192       0       0       0       0     192       0       0       0
H2O          0  190656       0       0  191560       0  190656  191560       0       0
H2           0       0     164       0       0       0       0       0       0     164
CO2          0       0       0     658       0       0       0     658       0       0
M Acid       0       0       0       0       0       0       0      82      82      82
A Acid       0       0       0       0       0      82       0       0       0       0

Extent 1 =   82.2

Extent 2 =   82.2
```

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