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# SCO-2 energy conversion example

```
clear
clc
close 'all'
```

# Add current directory to the Python Path

```
EasyProp_path = ' '; %<- Path if EasyProp.py is in your current directory
if count(py.sys.path,EasyProp_path) == 0  % <-- see if desired directory is on
 path
    insert(py.sys.path,int32(0),EasyProp_path); %<-- if not; add it.
end
```

# Initialize Fluid Property object

```
fluid = 'CO2';
units = 'SI';
gas = py.EasyProp.EasyProp(fluid,units);

To_C = 25; % C
To = To_C + 273; % K
Po = 101.3; % kPa
ho = gas.h_pT(Po,To_C);
so = gas.s_pT(Po,To_C);


% function for specific flow exergy neglecting kinetic and potential energy
ef_fun = @(h_val,s_val) h_val - ho - To*(s_val - so);
```

# Initialize State Point Data Arrays

```
numSP = 6;
h = nan(numSP,1);
h_s = nan(numSP,1);
s = nan(numSP,1);
s_s = nan(numSP,1);
T = nan(numSP,1);
P = nan(numSP,1);
ef = nan(numSP,1);
```

```matlab
eta_t = 1.0;
eta_c = 1.0;

Pmax = 20000; % kPa
Pmin = 7700; % kPa

xi_regen = 0.9; % let's be optimistic
```

# Statepoint Properties

```matlab
P(1) = Pmin;
T(1) = 32; % C
h(1) = gas.h_pT(P(1),T(1));
s(1) = gas.s_pT(P(1),T(1));
ef(1) = ef_fun(h(1),s(1));


P(2) = Pmax;
s_s(2) = s(1);
h_s(2) = gas.h_ps(P(2),s_s(2));
h(2) = h(1) - (h(1) - h_s(2))/eta_c;
s(2) = gas.s_ph(P(2),h(2));
T(2) = gas.T_ph(P(2),h(2));
ef(2) = ef_fun(h(2),s(2));


w_comp = h(1) - h(2);

% come back to state point 3
P(3) = P(2);

% state point 4
P(4) = P(3);
T(4) = 550; % C
h(4) = gas.h_pT(P(4),T(4));
s(4) = gas.s_pT(P(4),T(4));
ef(4) = ef_fun(h(4),s(4));

% state point 5
P(5) = Pmin;
s_s(5) = s(4);
h_s(5) = gas.h_ps(P(5),s_s(5));
h(5) = h(4) - eta_t*(h(4) - h_s(5));
s(5) = gas.s_ph(P(5),h(5));
T(5) = gas.T_ph(P(5),h(5));
ef(5) = ef_fun(h(5),s(5));
w_turb = h(4) - h(5);

% state point 6
P(6) = P(5);
h(6) = h(5) - xi_regen*(h(5) - gas.h_pT(P(6),T(2)));
T(6) = gas.T_ph(P(6),h(6));
s(6) = gas.s_ph(P(6),h(6));
ef(6) = ef_fun(h(6),s(6));
```

```matlab
h(3) = h(2) + (h(5) - h(6));
T(3) = gas.T_ph(P(3),h(3));
s(3) = gas.s_ph(P(3),h(3));
ef(3) = ef_fun(h(3),s(3));

q_s = h(4) - h(3);


%h(6) = h(5) - (h(3) - h(2)); % conservation of energy in the regenerator

ef_in = ef(4) - ef(3);




q_r = h(1) - h(6);
ef_out = ef(6) - ef(1);


Ex_d_regen = ef(5) + ef(2) - ef(6) - ef(3);


w_net = w_comp + w_turb;
q_net = q_s + q_r;

Flow_ex_balance = (ef_in - ef_out) - (w_net + Ex_d_regen);
fprintf('Specific flow exergy balance: %g kJ/kg \n',Flow_ex_balance);




eta_th = w_net/q_s;
fprintf('Net specific heat = %g kJ/kg \n',q_net);


bwr = abs(w_comp)/w_turb;


fprintf('\n\n\n\n\n')

fprintf('Thermal efficiency = %g percent \n',eta_th*100);
fprintf('Back work ratio = %g percent \n',bwr*100);

fprintf('Flow exergy in: %g kJ/kg \n',ef_in);
fprintf('Flow exergy out: %g kJ/kg \n',ef_out);
fprintf('Net specific work = %g kJ/kg \n',w_net);
fprintf('Exergy destroyed in the regen: %g kJ/kg \n',...
    Ex_d_regen);
```

*Specific flow exergy balance: 2.84217e-12 kJ/kg*
*Net specific heat = 120.534 kJ/kg*

*Thermal efficiency = 37.6636 percent*
*Back work ratio = 13.1581 percent*
*Flow exergy in: 180.793 kJ/kg*
*Flow exergy out: 12.9293 kJ/kg*
*Net specific work = 120.534 kJ/kg*
*Exergy destroyed in the regen: 47.3296 kJ/kg*

```
fprintf('\n\nState point data: \n\n');

% display state point data neatly
SP = {'1','2','3','4','5','6'};
SP_table = table(P,T,h,s,ef,'RowName',SP);
disp(SP_table);
```

*State point data:*

|   | *P* | *T* | *h* | *s* | *ef* |
|---|---|---|---|---|---|
| *1* | *7700* | *32* | *306.23* | *1.3463* | *214.78* |
| *2* | *20000* | *59.999* | *324.5* | *1.3463* | *233.04* |
| *3* | *20000* | *290.11* | *715.11* | *2.2738* | *347.25* |
| *4* | *20000* | *550* | *1035.1* | *2.7411* | *528.04* |
| *5* | *7700* | *424.55* | *896.34* | *2.7411* | *389.24* |
| *6* | *7700* | *87.807* | *505.73* | *1.9724* | *227.7* |

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