

```

clear all
clc

T04=857+273           % Turbine inlet temperature
m=48                  % inlet mass rate
T06A=927+273          % max afterburner temperature
afterburner=1 ;       % 0 if afterburner not used, 1 if used
T_inf=220              % ambient temperature
P_inf=0.25*101325      % ambient pressure
M_inf=0.85             % flight mach number
gamma=1.4 ;           % ratio of specific heats
R=287 ;               % gas constant
u=M_inf*sqrt(gamma*R*T_inf) % inlet velocity

Cp=gamma*R/(gamma-1) ; % specific heat
prc=linspace(7.2, 7.2,1) % compressor pressure ratio

% isentropic efficiencies
e_diff=0.97 ;         % inlet/diffuser
e_n_hot=0.98;         % hot stream nozzle
e_comp=0.835;         % compressor
e_turb=0.865;         % turbine
e_burner=0.95;        % burner/combustor
e_ab=0.5;             % afterburner
del_p1=0.0;           % burner pressure loss in %
del_p2=0;             % afterburner pressure loss in %
Q=45000000 ;         % fuel heat content

prc_critical= 1/(1-(gamma-1)/(e_n_hot*(gamma+1)))^(gamma/(gamma-1)) % to check if nozzle chokes or not

% diffuser stage
T02=T_inf*(1+(gamma-1)*0.5*M_inf^2)
P02=P_inf*(1+(T02/T_inf-1)*e_diff)^(gamma/(gamma-1))

for i=1:length(prc)

    f_ab(i)=0; % initializing the afterburner fuel fraction
    % compressor stage
    P03(i)=(P02*prc(i))
    T03(i)=T02*(1+(prc(i)^((gamma-1)/gamma)-1)/e_comp)

    % burner fuel air ratio
    f(i)=(T04-T03(i))/(e_burner*Q/(Cp)-T04)

    % turbine inlet pressure
    P04(i)=(P03(i))*(1-del_p1) % # given pressure loss is zero

    % compressor turbine power balance
    T05(i)=T04-(T03(i)-T02)/0.99 % -B*(T08-T02);
    P05(i)=(P04(i)*(1-(1-T05(i)/T04)/e_turb)^(gamma/(gamma-1)))
    T06(i)=(T05(i))
    P06(i)=(P05(i))

    if afterburner==0 % if the afterburner is disabled
        if P_inf/P06(i) > 1/prc_critical % loops if nozzle doesn't choke
            v7(i)=(sqrt(2*e_n_hot*Cp*T06(i)*(1-(P_inf/P06(i))^(gamma-1)/gamma)))) % exit velocity, complete expansion to P_inf
            t(i)=(1+f(i))*v7(i)-u % unchoked thrust without afterburner
            s=(f(i))/t(i) % TSFC
            sprintf('no afterburner, nozzle does not choke ')
        else % runs if nozzle chokes

            T7(i)=2*T05(i)/(gamma+1) % critical temperature
            v7(i)=(gamma*R*T7(i))^0.5 % exit choked velocity
            p7(i)=P06(i)/prc_critical % critical pressure
            rho7(i)=P06(i)/(R*T7(i)) % critical density at exit
            t(i)=(1+f(i))*v7(i)-u + (p7(i)-P_inf)/(rho7(i)*v7(i)) % choked thrust without afterburner

            s=(f(i))/t(i) %TSFC
        end
    end
end

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sprintf('no afterburner, nozzle chokes, nozzle diameter -')
d=2*sqrt(m/(rho7(i)*v7(i)*3.14))
end

else

P_06(i)=P05(i)*(1-del_p2)           % loss in afterburner
f_ab(i)=((1+f(i))*(T06A-T05(i)))/(e_ab*Q/Cp-T06A)   % fuel fraction in afterburner

if P_inf/P06(i) >1/prc_critical           % nozzle unchoked with afterburner

    v7(i)=(sqrt(2*e_n_hot*Cp*T06A*(1-(P_inf/P06(i))^((gamma-1)/gamma)))) % exit velocity, complete expansion to atmosphere
    t(i)=(1+f(i)+f_ab(i))*v7(i)-u           % unchoked thrust with afterburner
    s=(f(i)+f_ab(i))/t(i)           %TSFC
    sprintf(' afterburner on, nozzle does not choke ')

else           % nozzle choked with afterburner

T7(i)=2*T06A/(gamma+1)           % critical temperature
p7(i)=P06(i)/prc_critical           % critical pressure
v7(i)=(gamma*R*T7(i))^0.5           % critical choked velocity at exit
rho7(i)=p7(i)/(R*T7(i))           % critical denstiy

t(i)=(1+f(i)+f_ab(i))*v7(i)-u + (p7(i)-P_inf)/(rho7(i)*v7(i)) % choked thrust with afterburner
s=(f(i)+f_ab(i))/t(i)           % TSFC
    sprintf(' afterburner on, nozzle chokes ')
    d=2*sqrt(m/(rho7(i)*v7(i)*3.14))
end

end

e_prop(i)=2*t(i)*u/(t(i)*u^2+(1+f(i)+f_ab(i))*(v7(i)-u)^2) % propulsive efficiency
e_therm(i)=(t(i)*u^2+(1+f(i)+f_ab(i))*(v7(i)-u)^2)/(2*(f(i)+f_ab(i))*Q) %thermal efficiency

end

e_overall=e_prop.*e_therm
%hold on
thrust=t*m
    % plot(prc,t)
    % title('Variation of specific thrust with afteburner disabled')
    % xlabel('Compressor pressure ratio \pi_C')
    % ylabel('t N/kg.s')
% plot(prc,e_prop,'o')
% plot(prc,e_therm,'*' )
% plot(prc,e_prop.*e_therm,'+' )
% title('T_{04}=1630 K & B=0')
% xlabel(' Compressor pressure ratio \pi_C')
% ylabel('\eta')

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T04 =

1130

m =

48

T06A =

1200

T_inf =

220

P_inf =

2.5331e+04

M_inf =

0.8500

u =

252.7175

prc =

7.2000

prc_critical =

1.9202

T02 =

251.7900

P02 =

4.0091e+04

P03 =

2.8865e+05

T03 =

480.2796

f =

0.0157

P04 =

2.8865e+05

T05 =

899.2024

P05 =

1.1245e+05

T06 =

899.2024

P06 =

1.1245e+05

P_06 =

1.1245e+05

f_ab =

0.0144

T7 =

1000

p7 =

5.8561e+04

v7 =

633.8770

rho7 =

0.2040

t =

657.1544

s =

4.5795e-05

ans =

afterburner on, nozzle chokes

d =

0.6876

e_prop =

0.6894

e_therm =

0.1779

e_overall =

0.1226

thrust =

3.1543e+04