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%Torque Calculation
%Design and Manufacture by W.J. Wang Nov 2007
clear all; close all;
p_at=1.013*10^5; %atmosphere pressure (absolute pressure)
p0=0.97*10^5;   %Intake pressure
pmax=6.89*10^5; %delivery pressure (absolute pressure)
r=0.09945; %crank circle radius (metre)
L=3.5*r;   %connecting rod length (adopt 3.5 or other)
d=0.132;   %bore (piston)diameter
A=pi*d^2/4;%piston area
n=1.3;
v0=A*2*r*1.05;
theta=0:0.001:pi*2;
N=length(theta);
cos_beta=sqrt(1-(r/L .*sin(theta)).^2);

%piston displacement
x=L*(cos_beta-1)+r*(1-cos(theta));
x1=r*(1-cos(theta));    %if L is very very long
subplot(3,1,1)
plot(theta,x);
hold;
plot(theta,x1,'--');
hold off;
title('Piston Displacement (m)');
ylabel('piston displacement');

%cylincer pressure without valves
px=p0*(v0./(v0-A*x)).^n;

%cylincer pressure with valves
for k=1:N/2
    px1(k)=px(k);
    if px(k)>pmax
        px1(k)=pmax;
    end;
end;
for k=1:N/2
   px1(k+N/2)=p0;
end;

%torque without valves
T=(px-p_at)*A*r.*sin(theta);

%torque
%compression 1/2 cycle
for k=1:N/2
 T1(k)=(px1(k)-p_at)*A*r*sin(theta(k));
end;
%induction  1/2 cycle
for k=N/2+1:N
 T1(k)=(p0-p_at)*A*r*sin(theta(k));
end;

subplot(3,1,2);
plot(theta,px,'--');
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hold on;
plot(theta,px1,'-');
hold off;
title('Pressure');
ylabel('pressure (pascal)');

subplot(3,1,3);
plot(theta,T,'--');
hold on;
plot(theta,T1,'-');
hold off;
title('Torque (Nm)');
xlabel('theta (rad)');
ylabel('torque (Nm)');
T_max=max(T1)   %maximum torque
T_mean=mean(T1) %mean torque over one cycle

%if rpm=500, required power (Watts)
power=T_mean*500/60*2*pi
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