

# Esempio Ese 09 – Dinamica e Controllo di due serbatoi

Strumentazione e Controllo di Impianti Chimici

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```
clear all

Aserb1=30; % m^2
Aserb2=50; % m^2
r1=1.2; % s/m^2
h_0=[3;3]; % m

Fi_0=9.4; % m^3/s
Kc=30; % m^2/s
h2_sp=6.6; % m
F0bias=Fi_0; % m^3/s
tauI=10; % s

handleopen=@(t,h)serbatoi_openloop(t,h,r1,Aserb1,Aserb2,Fi_0);
[tout,hout]=ode45(handleopen,[0 10*60],h_0,odeset('RelTol',1e-8));
figure(1)
subplot(1,3,1)
plot(tout,hout)

handleclosed=@(t,h)serbatoi_closedloop(t,h,r1,Aserb1,Aserb2,Fi_0,F0bias,Kc,h2_sp);
[tout2,hout2]=ode45(handleclosed,[0 10*60],h_0,odeset('RelTol',1e-8));
subplot(1,3,2)
plot(tout2,hout2)
hold on
plot(tout2,ones(1,length(tout2))*h2_sp,'k')
legend('h1','h2','h2 sp')
xlabel('t [s]')
title('Altezza del livello di liquido [m] - Closed loop P')

handleOutputPI=@(t,h,flag)outputPI(t,h,flag,h2_sp);
opzPI=odeset('RelTol',1e-8,'OutputFcn',handleOutputPI,'Refine',1);
handlePI=@(t,h)serbatoi_PI(t,h,r1,Aserb1,Aserb2,Fi_0,F0bias,Kc,h2_sp,tauI);
[tout3,hout3]=ode45(handlePI,[0 10*60],h_0,opzPI);
subplot(1,3,3)
plot(tout3,hout3)
hold on
plot(tout3,ones(1,length(tout3))*h2_sp,'k')
legend('h1','h2','h2 sp')
xlabel('t [s]')
title('Altezza del livello di liquido [m] - Closed loop PI')
```

```
function dhdt=serbatoi_openloop(t,h,r1,Aserb1,Aserb2,Fi_0)
```

```
if t<5*60
```

```
    Fi=Fi_0; % m^3/s
```

```
else
```

```
    Fi=2*Fi_0; % m^3/s
```

```
end
```

```
F1=(h(1)-h(2))/r1; % m^3/s
```

```
F0=1.43*h(2); % m^3/s
```

```
dhdt=zeros(2,1);
```

```
dhdt(1)=1/Aserb1*(Fi-F1); % m/s
```

```
dhdt(2)=1/Aserb2*(F1-F0); % m/s
```

```
end
```

```
function dhdt=serbatoi_closedloop(t,h,r1,Aserb1,Aserb2,Fi_0,F0bias,Kc,h2_sp)
```

```
if t<5*60
```

```
    Fi=Fi_0; % m^3/s
```

```
else
```

```
    Fi=2*Fi_0; % m^3/s
```

```
end
```

```
F1=(h(1)-h(2))/r1; % m^3/s
```

```
epsi=h(2)-h2_sp; % m
```

```
F0=F0bias+Kc*epsi; % m^3/s
```

```
F0=max(F0,0);
```

```
dhdt=zeros(2,1);
```

```
dhdt(1)=1/Aserb1*(Fi-F1); % m/s
```

```
dhdt(2)=1/Aserb2*(F1-F0); % m/s
```

```
end
```

```

function dhdt=serbatoi_PI(t,h,r1,Aserb1,Aserb2,Fi_0,F0bias,Kc,h2_sp,tauI)
global integrale told

if t<5*60
    Fi=Fi_0; % m^3/s
else
    Fi=2*Fi_0; % m^3/s
end

F1=(h(1)-h(2))/r1; % m^3/s

epsi=h(2)-h2_sp; % m

if isempty(integrale)
    integraleusaeggetta=0;
else
    integraleusaeggetta=integrale+epsi*(t-told);
end

F0=F0bias+Kc*epsi+Kc/tauI*integraleusaeggetta; % m^3/s

F0=max(F0,0);

dhdt=zeros(2,1);
dhdt(1)=1/Aserb1*(Fi-F1); % m/s
dhdt(2)=1/Aserb2*(F1-F0); % m/s

end

function finire = outputPI(tstep,hstep,flag,h2sp)
global integrale told epsiold

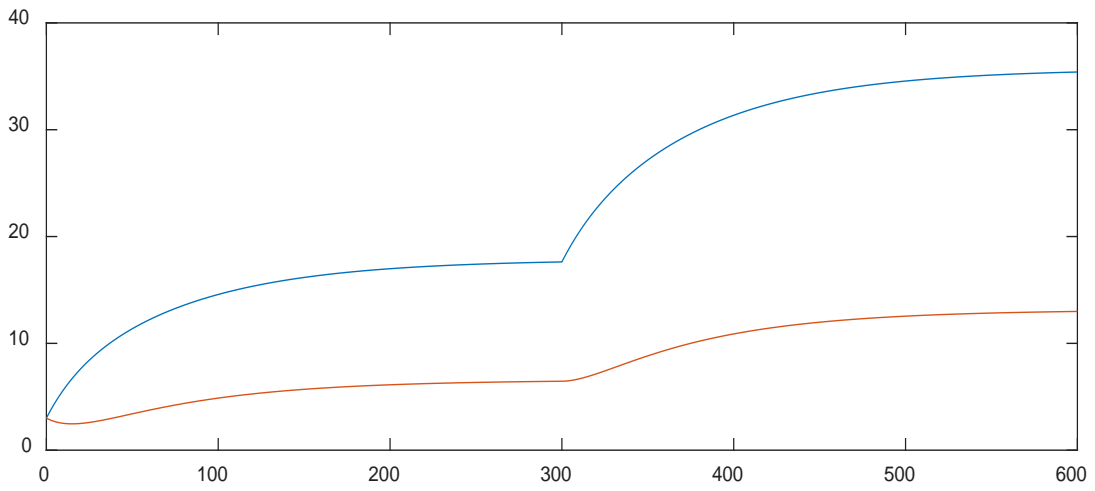
finire=0;

if strcmp(flag,'init')
    integrale=0;
    told=0;
    epsiold=0;
elseif strcmp(flag,'')
    deltat=tstep-told;
    epsistep=hstep(2)-h2sp;
    integrale=integrale+(epsistep+epsiold)/2*deltat;

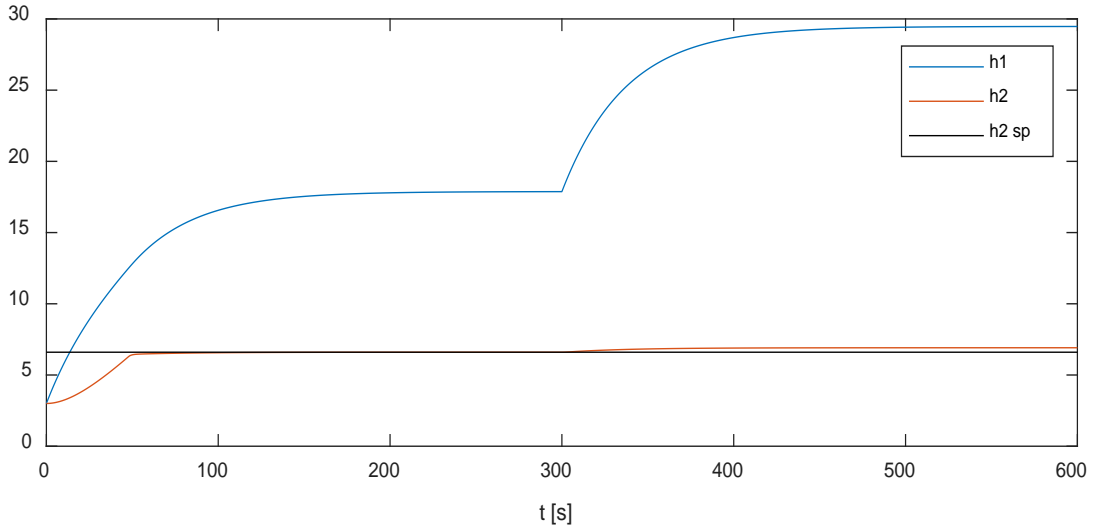
    told=tstep;
    epsiold=epsistep;
elseif strcmp(flag,'done')
    disp('')
end

end

```



Altezza del livello di liquido [m] - Closed loop P



Altezza del livello di liquido [m] - Closed loop PI

