

Appendix B - Matlab code for moisture diffusion through BCB

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% Model of Diffusion through Organic Seals%

clear all;

figure(1);

% Definitions of Constants%

depth=40e-6; %Depth of cavity

width=5e-3; %Width of cavity

length=5e-3; %Length of cavity

thickness=2.5e-6; %Thickness of seal

W=1000e-6; %Width of Seal

D=4.5e-12; %Diffusion Coefficient

S=2*width*thickness+2*length*thickness; % seal and cavity contact surface area

V=depth*width*length; % Cavity volume

C0=0; %initial concentration in seal

C1=7.934e-3; %external concentration

C2=0; %initial concentration in cavity

%Calculation Parameters

Ni=200; %number of iterations

Nx=100; %number of x

% Limits of t

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lim_t=3600*24*38; %simulation duration
it_t=2000; %number of iterations

%C(x,t) Calculation

X=linspace(0,W,Nx);
X2=linspace(-W/(Nx-1)*20,W+W/(Nx-1)*20,Nx+40);

p=linspace(1,Ni,Ni);

T=linspace(0,lim_t,it_t);

% 1st iteration

j=1;
for i=1:Nx
    x=X(i);
    A0=2./(p*pi).*((C0-C1).*(1-cos(p*pi))-(C2-C1)./(p*pi).*(sin(p*pi)-
p*pi.*cos(p*pi)));
    sum_0=A0.*sin(p*pi*x/W);%.*exp(-p.^2*pi^2*D*(lim_t/it_t)/W^2);
    C(i)=C1+(C2-C1)*x/W+sum(sum_0);
end
txt=sprintf('t=%4.2f s',lim_t/it_t);

%For t=0
Ccurve=zeros(1,140);

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for i=1:20
    Ccurve(i)=C1;
end

for i=21:(Nx+20)
    Ccurve(i)=C(i-20);
end

for i=(Nx+21):(Nx+40)
    Ccurve(i)=C2;
end

figure(1)
plot(X2,Ccurve);
axis([-W/(Nx-1)*20 W+W/(Nx-1)*20 0 10e-3]);
xlabel(txt);
M(j)=getframe;

%Following Iterations

t=lim_t/it_t;

Mt(1)=C2*V;

for j=2:(it_t)
    t=t+(lim_t/it_t);

%New C2 calculation
B=A0./p.*cos(p*pi).*(1-exp(-p.^2*pi^2*D*(lim_t/it_t)/W^2));
Mt0=-D*S/W*((C2-C1)*(lim_t/it_t)+W^2/(pi*D)*sum(B));

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Mt(j)=Mt(j-1)+Mt0;

new_C2=C2+Mt0/V;

%C(x) Calculation

for i=1:Nx

    x=X(i);

    A=A0.*exp(-p.^2*pi^2*D*(lim_t/it_t)/W^2)+(C2-
new_C2)*(2./(p.^2*pi^2)).*(sin(p*pi)-p*pi.*cos(p*pi));

Somme=A.*sin(p*pi*x/W);%.*exp(-p.^2*pi^2*D*(lim_t/it_t)/W^2);

C(i)=C1+(new_C2-C1)*x/W+sum(Somme);

end

%For curve C(x)

txt=sprintf('t= %4.2f s',t);

for i=1:20

    Ccurve(i)=C1;

end

for i=21:(Nx+20)

    Ccurve(i)=C(i-20);

end

for i=(Nx+21):(Nx+40)

    Ccurve(i)=new_C2;

end

plot(X2,Ccurve);

axis([-W/(Nx-1)*20 W+W/(Nx-1)*20 0 10e-3]);

xlabel(txt);

M(j)=getframe;

C2=new_C2;

A0=A;

end

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figure(2);
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plot(T,Mt); %Quantity of gas that has penetrated the into the cavity
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figure(3);
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plot(T,Mt/V); %Change in internal concentration
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xlabel('t(s)');
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ylabel('Cin');
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figure(4);
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plot(T,Mt/V*1.42); %Change in internal pressure
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