# Appendix B: MATLAB source codes

clear all;

clc;

D = input('Please input the pool diameter');

H = input('Please input the pool thickness');

h\_1 = input('Please input the heat transfer coefficient between liquid and concrete'); h\_2 = input('Please input the heat dissipation coefficient of concrete');

K\_2 = 10; % Heat transfer coefficient between the flame and the concrete

C\_d = 1750; % Specific heat capacity of diesel

lamda\_d = 0.15; % Thermal conductivity of diesel

rho\_d = 830; % Density of diesel

alpha\_d = lamda\_d/(rho\_d\*C\_d); % Thermal diffusivity

L\_v = 250000; % Latent heat of vaporization

upsilon\_d = 6\*10^(-6); % Diesel kinematic viscosity

pr = upsilon\_d/alpha\_d;

T\_L = zeros(1,1800);

T\_F = zeros(1,1800);

for i = 1 : 1800

if i < 300

T\_L(i) = 273+242/300^2\*i^2;

else

T\_L(i) = 515;

end

end

for i = 1 : 1800

if i < 300

T\_F(i) = 273+873/300^2\*i^2;

else

T\_F(i) = 1146;

end

end

T\_0 = 293; % Initial temperature of liquid

sigma = 5.67\*10^(-8); % Blackbody emissivity

Q\_rad = zeros(1,1800); % Radiation heat absorption

K = zeros(1,1800); % Effective emission coefficient

epsilon\_F = zeros(1,1800); % Flame emissivity

V\_L = zeros(1,1800); % Burning line speed

R = zeros(1,1800); % Thickness of pool fire burning

if D < 0.1

K\_1 = 10;

else

K\_1 = 0; % Coefficient

end

X\_F = 1; % Angular coefficient

C\_0 = 4;

C\_2 = 1.4388/100;

f\_v = 2\*10^(-6);

H\_F = 0.23\*(430.46\*pi\*D^2/4-0.4978)^(2/5)-1.02\*D;

V\_F = pi\*D^2\*H\_F/12;

A\_F = pi\*D/2\*(((H\_F)^2+ (D/2)^2 )^0.5+0.5);h\_r = 0.07 - H;

F = 1 + (2\*h\_r/D)^2/2 - (2\*h\_r/D)/2\*((2\*h\_r/D)^2+4)^0.5;

L = 3.6\*V\_F/A\_F; % Average optical length of the flame body

epsilon\_L = 0.42; % Liquid emissivity

epsilon\_1 = 0.08; % Flame reflectivity to liquid

h = 400; % Natural convection heat transfer coefficient of diesel

T\_B = zeros(1,1800);

alpha\_v = 0.000725;

G\_r = zeros(1,1800);

N\_u = zeros(1,1800);

lamda = zeros(1,1800);

C\_11 = zeros(1,1800);

C\_21 = zeros(1,1800);

for i = 1 : 1800

K(i) = 3.72\*C\_0\*f\_v\*T\_F(i)/C\_2;% Effective emission coefficient

epsilon\_F(i) = 1-exp(-K(i)\*L);% Flame emissivity

Q\_rad(i) = epsilon\_F(i)\*sigma\*T\_F(i)^4\*F\*X\_F\*(1-epsilon\_1)-epsilon\_L\*sigma\*T\_L(i)^4;

end

for i = 1 : 1800

if Q\_rad(i) > 0

Q\_rad(i) = epsilon\_F(i)\*sigma\*T\_F(i)^4\*F\*X\_F\*(1-epsilon\_1)-epsilon\_L\*sigma\*T\_L(i)^4;

else

Q\_rad(i) = 0;

end

end

for i = 1 : 1800

V\_L(i) = 1/(rho\_d\*L\_v+C\_d\*rho\_d\*(T\_L(i)-T\_0))\*(4\*K\_1/D\*(T\_F(i)-T\_L(i))+K\_2\*(T\_F(i)-T\_L(i))+Q\_rad(i));% Burning speed

end

R(1)=0;

for i = 1 : 1799

R(i+1) = V\_L(i)+R(i);

end

t\_s = find(R<H, 1, 'last' );

if t\_s >= 300

for i = 1 : 1800

if i < 300

T\_L(i) = 293+222/300^2\*i^2;

elseif i >= t\_s

T\_L(i) = 222\*exp(-0.0067\*(i-t\_s))+293;

else

T\_L(i) = 515;

end

end

for i = 1 : 1800

if i < 300

T\_F(i)=293+853/300^2\*i^2;

elseif i >= t\_s

T\_F(i) = 853\*exp(-0.0067\*(i-t\_s))+293;

else

T\_F(i) = 1146;

end

end

for i = 1 : 1800

K(i) = 3.72\*C\_0\*f\_v\*T\_F(i)/C\_2; % Effective emission coefficient

epsilon\_F(i) = 1-exp(-K(i)\*L); % Flame emissivity

Q\_rad(i) = epsilon\_F(i)\*sigma\*T\_F(i)^4\*X\_F\*(1-epsilon\_1)-epsilon\_L\*sigma\*T\_L(i)^4;

end

for i = 1 : 1800

if Q\_rad(i) > 0

Q\_rad(i) = epsilon\_F(i)\*sigma\*T\_F(i)^4\*X\_F\*(1-epsilon\_1)-epsilon\_L\*sigma\*T\_L(i)^4;

else

Q\_rad(i) = 0;

end

end

for i = 1 : 1800

if i <= t\_s

V\_L(i) = 1/(rho\_d\*L\_v+C\_d\*rho\_d\*(T\_L(i)-T\_0))\*(4\*K\_1/D\*(T\_F(i)-T\_L(i))+K\_2\*(T\_F(i)-T\_L(i))+Q\_rad(i));% Burning speed

else

V\_L(i) = 0;

end

end

for i = 1:1800

C\_11(i) = T\_L(i)-T\_0;

C\_21(i) = T\_L(i)-C\_11(i);

end

for i = 1:1800

G\_r(i) = 9.8\*alpha\_v\*(T\_L(i)-T\_B(i))\*(H-R(i))^3/upsilon\_d^2;

if G\_r(i) > 4.6\*10^5

N\_u(i) = 0.061\*(G\_r(i)\*pr)^(1/3);

else

N\_u(i) = 0.212\*(G\_r(i)\*pr)^(1/4);

end

end

for i = 1:1800

lamda(i) = h\*(H-R(i))/ N\_u(i);

end

for i = 1 : 1800

if i < t\_s % If the remaining fuel thickness is greater than or equal to 0

T\_B(i) = C\_11(i)\*exp(-rho\_d\*C\_d\*max(V\_L)/(lamda\_d+lamda(i))\*(H-R(i)))+C\_21(i);

else

T\_B(i) = 222\*exp(-0.002\*(i-t\_s))+293;

end

end

else

for i = 1 : 1800

if i<= t\_s

T\_L(i) = 293+222/300^2\*i^2;

elseif i < 1000 && i > t\_s

T\_L(i) = 293+222/300^2\*t\_s^2\*exp(-0.0067\*(i-t\_s));

else

T\_L(i) = 293;

end

end

for i = 1 : 1800

if i <= t\_s

T\_F(i)=293+853/300^2\*i^2;

elseif i < 1000 && i > t\_s

T\_F(i) = 293+853/300^2\*t\_s^2\*exp(-0.0067\*(i-t\_s));

else

T\_F(i) = 293;

end

end

for i = 1 : 1800

K(i)=3.72\*C\_0\*f\_v\*T\_F(i)/C\_2; % Effective emission coefficient

epsilon\_F(i)=1-exp(-K(i)\*L); % Flame emissivity

Q\_rad(i)=epsilon\_F(i)\*sigma\*T\_F(i)^4\*X\_F\*(1-epsilon\_1)-epsilon\_L\*sigma\*T\_L(i)^4;

end

for i = 1 : 1800

if Q\_rad(i)>0

Q\_rad(i) = epsilon\_F(i)\*sigma\*T\_F(i)^4\*X\_F\*(1-epsilon\_1)-epsilon\_L\*sigma\*T\_L(i)^4;

else

Q\_rad(i) = 0;

end

end

for i = 1 : 1800

if i <= t\_s

V\_L(i) = 1/(rho\_d\*L\_v+C\_d\*rho\_d\*(T\_L(i)-T\_0))\*(4\*K\_1/D\*(T\_F(i)-T\_L(i))+K\_2\*(T\_F(i)-T\_L(i))+Q\_rad(i));% Burning speed

else

V\_L(i) = 0;

end

end

for i = 1:1800

C\_11(i)=T\_L(i)-T\_0;

C\_21(i)=T\_L(i)-C\_11(i);

end

for i = 1:1800

G\_r(i) = 9.8\*alpha\_v\*(T\_L(i)-T\_B(i))\*(H-R(i))^3/upsilon\_d^2;

if G\_r(i) > 4.6\*10^5

N\_u(i) = 0.061\*(G\_r(i)\*pr)^(1/3);

else

N\_u(i) = 0.212\*(G\_r(i)\*pr)^(1/4);

end

end

for i = 1:1800

lamda(i) = h\*(H-R(i))/ N\_u(i);

end

for i = 1 : 1800

if i <= t\_s % If the remaining fuel thickness is greater than or equal to 0

T\_B(i) = C\_11(i)\*exp(-rho\_d\*C\_d\*max(V\_L)/(lamda\_d+lamda(i))\*(H-R(i)))+C\_21(i);

else

T\_B(i) = C\_11(t\_s)\*exp(-rho\_d\*C\_d\*max(V\_L)/(lamda\_d+lamda(t\_s))\*(H-R(t\_s)))\*exp(-0.002\*(i-t\_s))+293;

end

end

end

m = 1800; % Calculation time

n = 21; % Measuring points

T = zeros(m,n);

T(1,:) = 293; % Initial condition

T(:,21) = 293; % Boundary condition

dz = 0.025; % Cell length

dt = 1; % Time interval

rho\_c = 2400; % Density of concrete

for i = 1 : 1799

if H - R(i) > 0

for j = 1 : 20

if j == 1

T(i+1,1)=(T\_B(i)-T(i,1))\*2\*h\_1/(rho\_c\*(840+420\*T(i,1)/850)\*dz)-(T(i,1)-T(i,2))\*2\*(1.6-0.6\*T(i,1)/850)/rho\_c\*(840+420\*T(i,1)/850)\*dz^2+T(i,1);

else

T(i+1,j)=(0.008\*T(i,j)+6)\*dt/(dz^2\*10^6)\*(T(i,j+1)+T(i,j-1))+(1-2\*(0.008\*T(i,j)+6)\*dt/(dz^2\*10^6))\*T(i,j);

end

end

else

for j = 1 : 20

if j == 1

T(i+1,1)=(293-T(i,1))\*2\*h\_2/(rho\_c\*(840+420\*T(i,1)/850)\*dz)-(T(i,1)-T(i,2))\*2\*(1.6-0.6\*T(i,1)/850)/rho\_c\*(840+420\*T(i,1)/850)\*dz^2+T(i,1);

else

T(i+1,j)=(0.008\*T(i,j)+6)\*dt/(dz^2\*10^6)\*(T(i,j+1)+T(i,j-1))+(1-2\*(0.008\*T(i,j)+6)\*dt/(dz^2\*10^6))\*T(i,j);

end

end

end

end