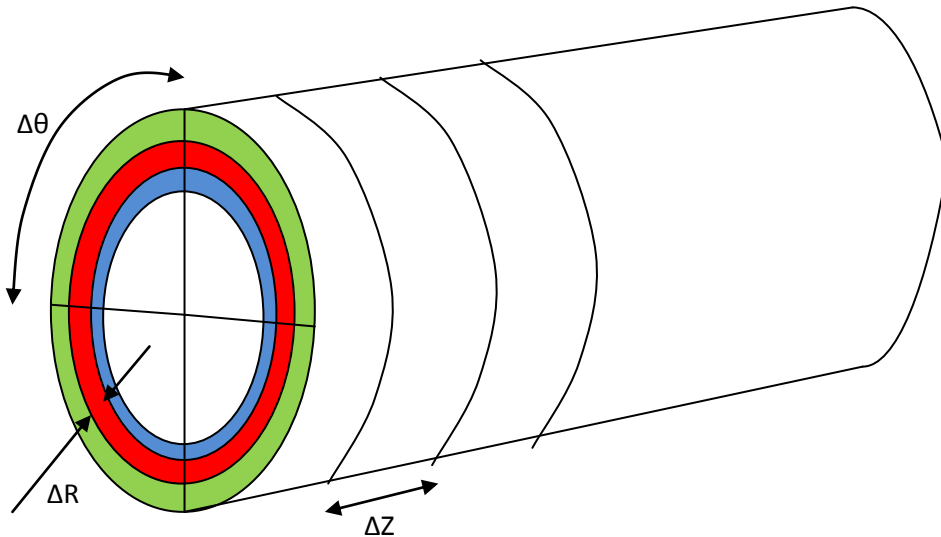Professor Garvey

I am trying to model the heat transfer down a pipe, with one end heated, using ODE45. The pipe is broken down into nodes.

So above is a crude diagram of a pipe. It is broken up into nodes, decided by Δθ, ΔZ and Δθ.

The different colours are to represent different "radial slices".

If one end is heated by a candle, say the end we can see, then I want to model the temperatures of each node transiently using ODE45.

In the script that calls ODE45, I have created an array called T.

T is of the size T = (dR, Da, Dz) where a is angle:

MATLAB CODE:

```
T = ones(nr,nq,nl); %Temperature array of nodes
T(:,:,:) = 298; %filling it with initial temperatures

Tx = T(:);%column vector
Q0 = Tx'; %row vector
```

Q0 is now my initial conditions row vector. In other words every node starts with an initial temperature of 298 degress Kelvin.

I am then calling ODE45

```
[t,Q] = ode45('steady_state_transfer',[0 10],Q0);
```

Summarize to this point:
As I understand so far, I have a row vector Q0 holding my initial conditions. When I call ODE45 it sets Q to be the same size as Q0? Is this correct?

ODE45 calls the function `steady_state_transfer`

The function "steady_state_transfer" holds the following information:

It starts with:

```
function Qdot = steady_state_transfer(t, Q)
```


```
global  %All global variables here
```

Now this is where I am confused.
I don't understand how to solve for all the nodes at once.
I understand I need a state vector and a rate vector.

My state vector holds all the Temperatures of all nodes and is Q I think?

My rate vector is Qdot(1) and is the equation that will be used for all of the nodes.

I need to check some conditions to see whether the transfer to the node from a particular direction is convection or conduction, so at this point I have some if statements that decide the type of transfer.

The Qdot equation then uses these conditions to build the equation correctly for a particular node:


```
        if a == 1; %controlling angle mapping
                T1 = T(i,nq,z);
            else T1 = T(i,a-1,z);
            end
            if a == nq;
                T3 = T(i,1,z);
            else T3 = T(i,a+1,z);
            end

            if i == 1;%Controlling radius position
                T4 = 0;
                T_Kill = 0;
            else T4 = T(i-1,a,z);
            end
            if i == nr;%convection from T2
                T2 = Tambient;
            %set T2 heat transfer to convective or conductive
                transfer = convective;
            else
                T2 = T(i+1,a,z);
            end
            if z == 1;%Controlling slice down pipe
                T5 = Thot;%Thot is from end plates;
            else T5 = T(i,a,z-1);
```

```matlab
                end
                if z == nl;
                    T6 = Tambient;%Here Tambient is temperature of cold
end plate;
                else T6 = T(i,a,z+1);
                end
```

Don't worry about reading the above, but T1 – T6 are the six surrounding nodes to the node that is currently being calculated.

The current node is T(i,a,z).

After that I state the equation of Qdot(1), and run it. But it is incorrect, and I know it is because I am incorrectly explaining to ODE45 to calculate for all nodes. But I am not sure how to do this.

I have attached the matlab code, I hope my error is easily spottable.

Thank you very much

Alex