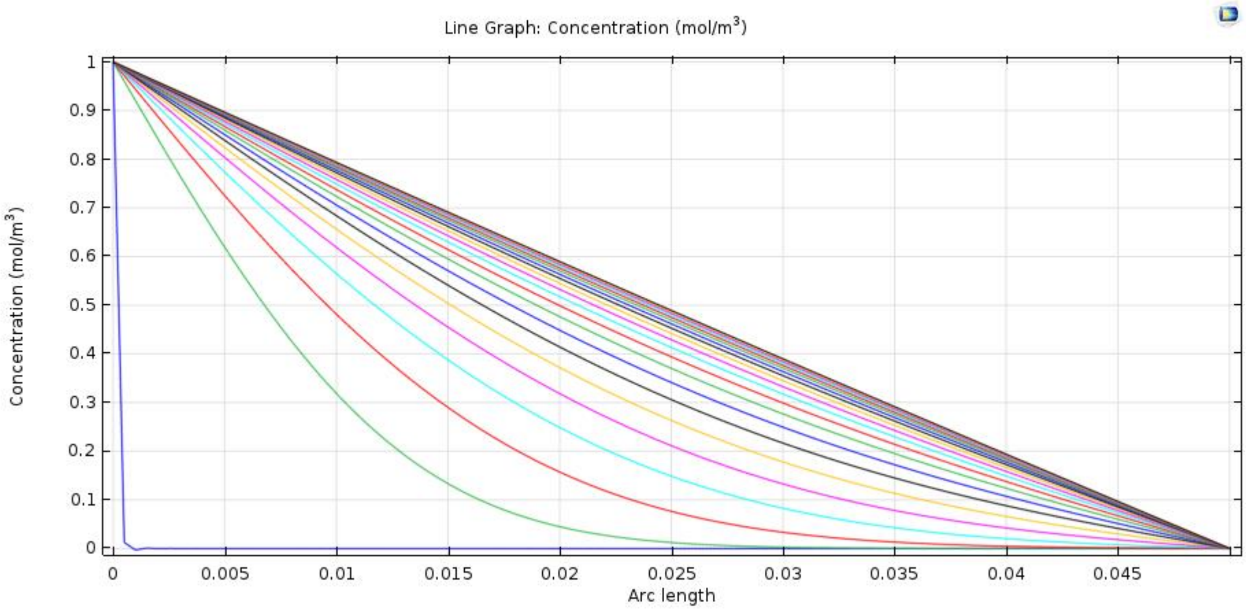
# Diffusive mass transfer

**Problem 1:**



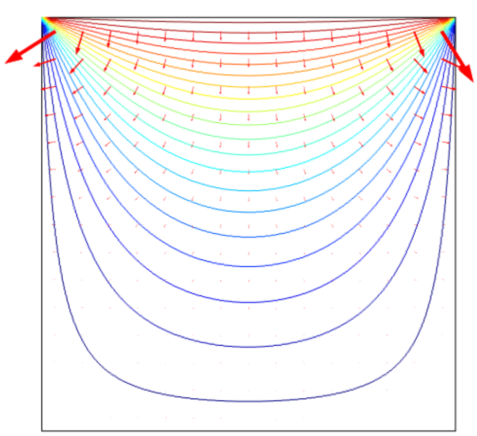

Solution final time is 1,000,000 sec. Time between curves is 50,000 sec.

Time scale using $L^2/D$ = 2,500,000. Note that solution is equilibrated before we reach $L^2/D$, but that the simple estimate gives us the right number of zeros.

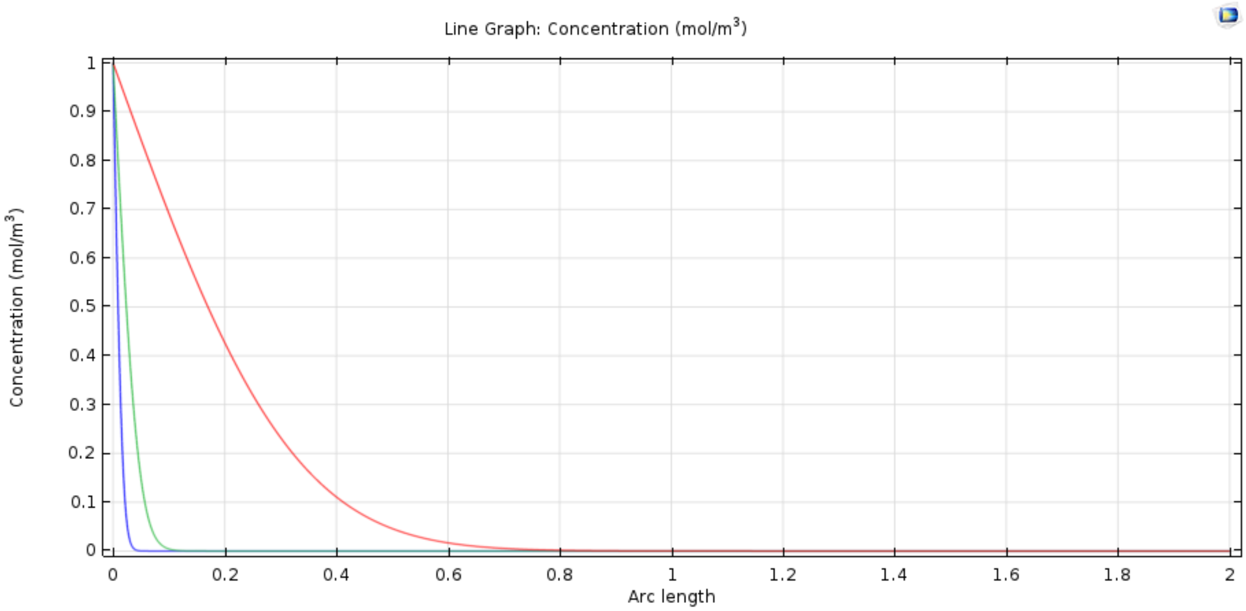
To make the solution dimensionless we can transform the domain to be $0<x<1$, and the constant D would become one. In this dimensionless form, we would integrate the equation for 1 unit of time and would expect to see the solution at equilibrium by this time.

Without comsol, we would easily find that the equilibrium state is a line between 0 and 1.

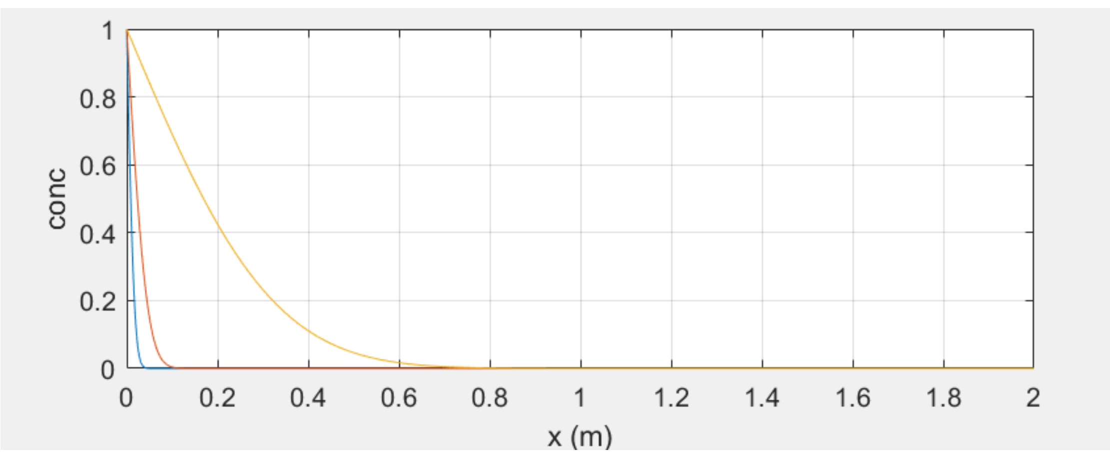
**Problem 2:**



**Problem 3:**

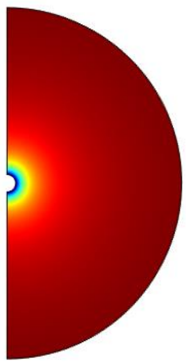



Lines are for 1 day, 1 week, and 1 year. Here is the analytical solution. Comparison looks pretty solid. If we exported the data and overlaid the two plots, they would be an exact match.

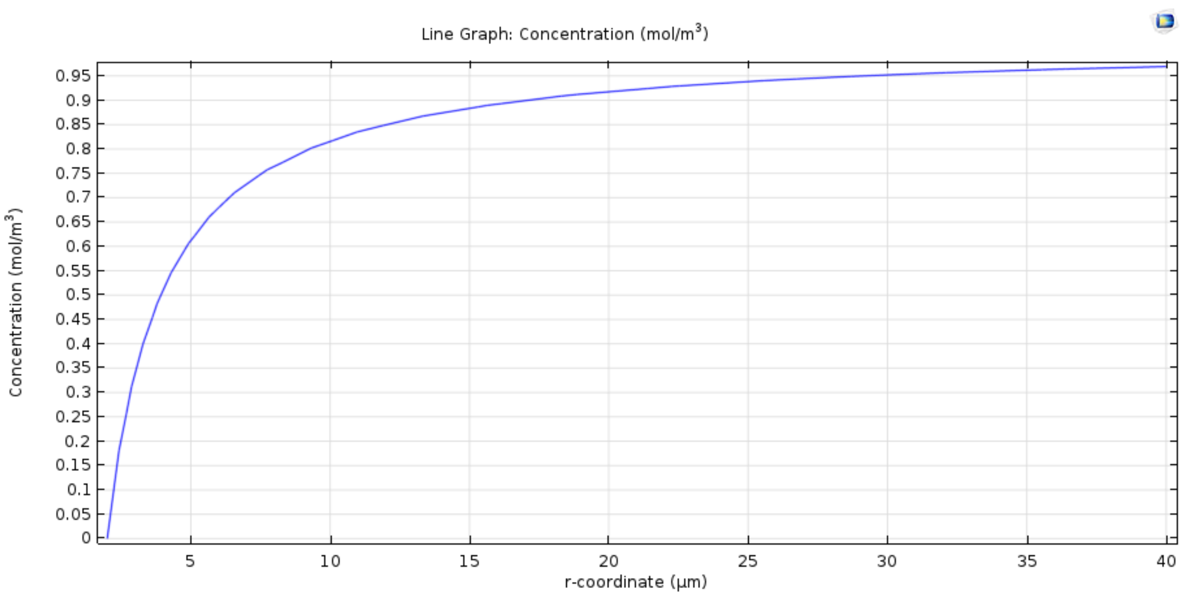


**Problem 4:**

Image from Comsol.



1D plot from Comsol



Equilibrium state is

$$\nabla^2 c = 0$$

In spherical coordinates where we have axial symmetry this becomes

$\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial c}{\partial r}\right)$=0

or

$\frac{\partial}{\partial r}\left(r^2\frac{\partial c}{\partial r}\right)$=0

Integrating once

$\left(r^2\frac{\partial c}{\partial r}\right)$=C1

$$\frac{\partial c}{\partial r} = \frac{C1}{r^2}$$

Integrating again

$c = \frac{-C1}{r}$+C2

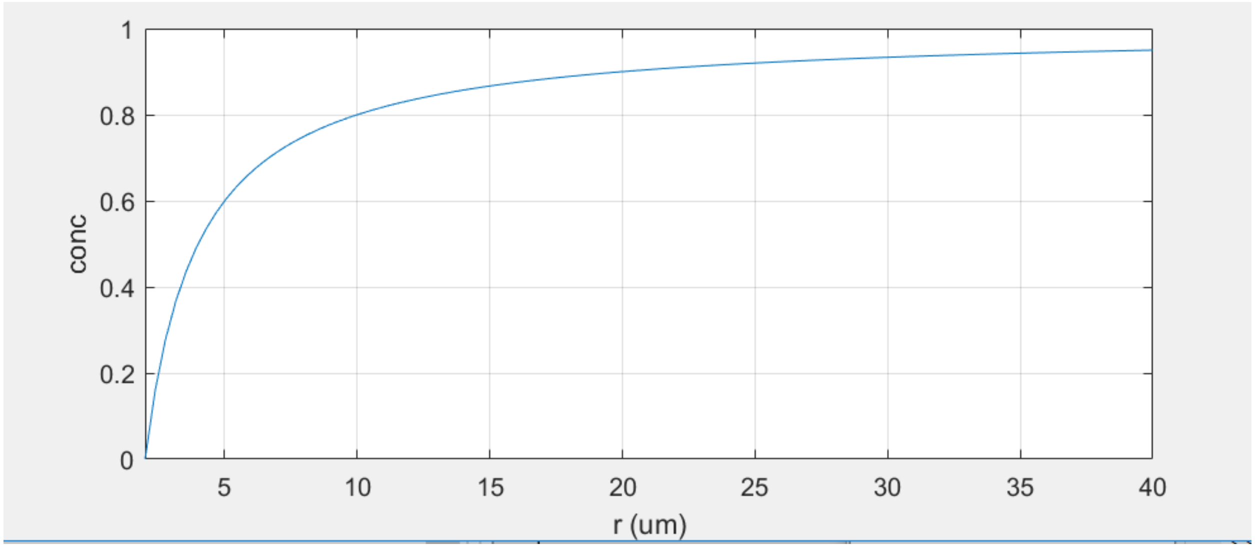
Applying boundary conditions.

$c(r = \infty) = 1 \;\; therefore\; C2 = 1$

$c(r = a) = 1 \; therefore\; C1 \; = a$

Final result

$$c(r) = 1 - \frac{a}{r^2}$$



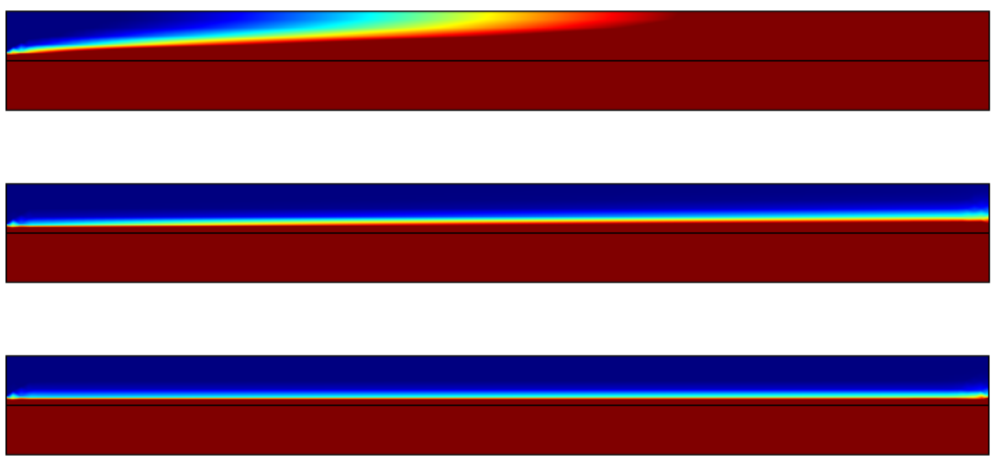
# Convective mass transfer

**Problem 1:**

D = 0.01, 0.001, and 0.0001 from top to bottom. All taken at t=20. Channel is 50 units long.

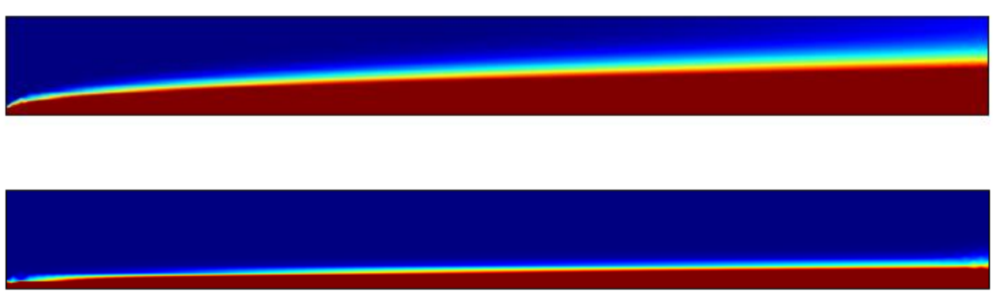
**Problem 2:**

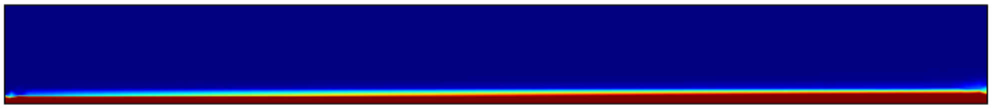
D=0.01, 0.001, and 0.0001 at steady state



**Problem 3:**

D=0.01, 0.001, and 0.0001 at steady state





**Problem 4:**

All snapshots taken at t=20

D=1

D=0.1

D=0.01

D=0.001