Diffusion and Concentration Profiles for Loading DL-propanolol in a Crosslinked Drug Carrier, Poly(N-isopropyl acrylamide) Hydrogel

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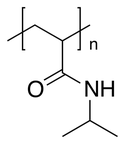
NanoFactory

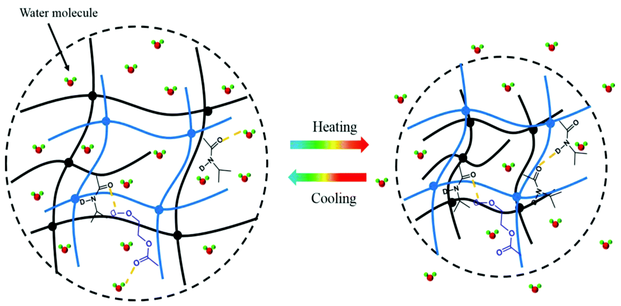
Introduction

Nanoencapsulation of drug/small molecules in nanocarriers (NCs) is a very promising approach for development of nanomedicine.

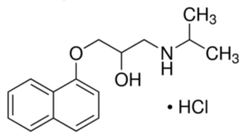
As drug carriers, hydrogels feature the ability to hold a large quantity of a hydrophilic drug with highly tunable release profiles by adjusting the physicochemical properties of the polymer.

➢ **Poly(N-isopropyl acrylamide) Hydrogel[1]**





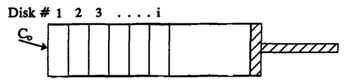
➢ **DL-Propranolol Hydrochloride[2]**

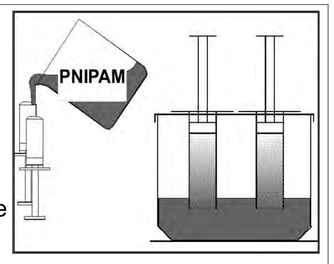


Objectives

- ➢ To study the diffusion of DL-propranolol hydrochloride in a thermoreversible gel
- ➢ To calculate the diffusion coefficient
- ➢ To obtain how much drug is encapsulated
- ➢ To obtain how long takes for drug to diffuse through PNIPAm nanoparticles
- ➢ To obtain concentration profile in the gel
- ➢ To compare experimental results with results obtained from simulation using COMSOL

Methods[3,4]

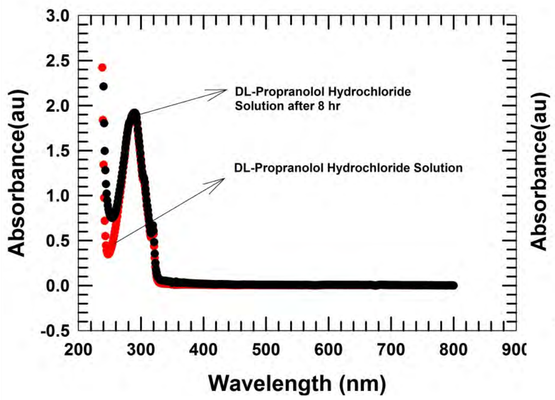




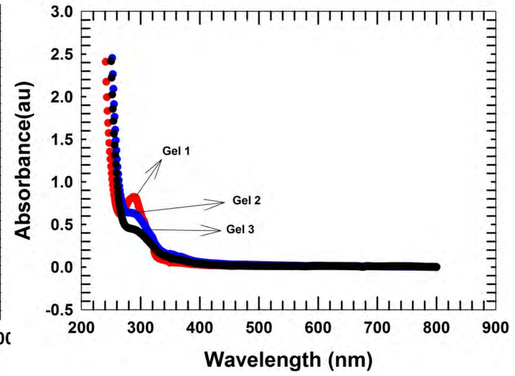
- ➢ Cut fronts off of syringe casing
- ➢ An appropriate solution/gel contact time
- ➢ Cut off gel into 1cm thicknesses
- ➢ Heat gel slices and analysis of obtained liquor
- ➢ Use spectrophotometer to analyze the solution

(DL-propranolol hydrochloride at 289 nm)

Results

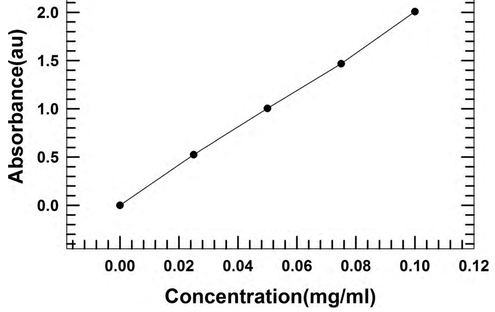


Reservoir, before and after



Gel slices as function of distance along the gel

➢ **Calibration: Beer's Law Plot of DL-Propranolol Hydrochloride at 289 nm**



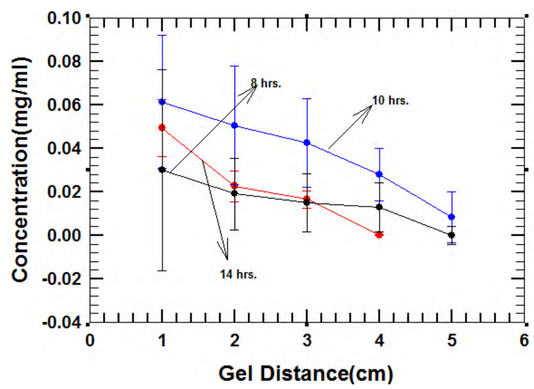
$$\frac{C_i}{C_o} = 1 - erf\left(\frac{x}{2\sqrt{D_i t}}\right)$$

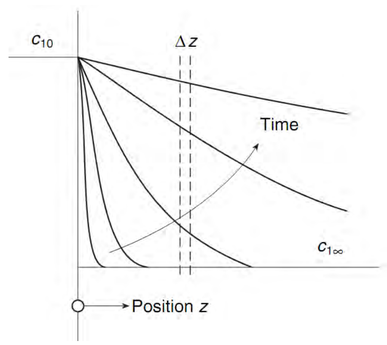
Where
C_i= Concentration of Drug in each disk
C_0= Concentration of (Solution/Gel Surface)

$$K_{p,eq} = \frac{[\text{Drug in plug}]}{[\text{Drug in supernant solution}]}$$

Diffusion coefficient(cm^2/s)	Partition coefficient (K_{eq})
3.941e-05	0.495

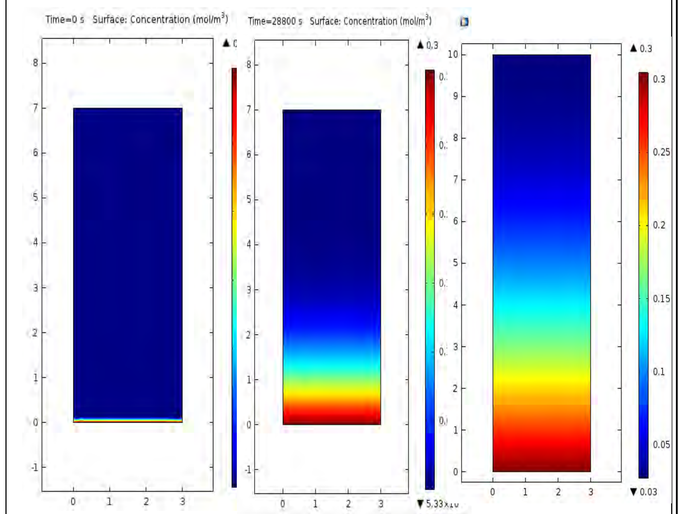
➢ **Comparison of Experimental Results vs. Literature [5]**





➢ COMSOL Simulation

At t=0 s **At t= 8 hrs.** **At t= 472 hrs.**



Conclusions

- ➢ Good agreement of experimental results with expected model
- ➢ Obtained parameters such as diffusion coefficient, partition coefficient and use of them for continuing experiments

Future work

- ➢ Try to load the drug into PNIPAm nanoparticles using a fiber film contactor
- ➢ Tune the conditions to obtain optimum drug loading
- ➢ Develop a model for mass transfer and heat transfer for the reactor in a microfluidic environment.

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7. *Joseph H Himes*

References:

1. Zhang,J.T., J. Appl. Polym. Sci., 2008
2. Lago, J. Funct. Biomater. 2011.
3. Haglund,B.O. , J. Chem. Educ.,1996
4. Upadrashta, S.M., J. Pharm. Sci., 1993.
5. Cussler, E.L., Cambridge University Press, 2007