Skittles® in Water: From First Grade to Fick's Law

There is nothing like a visually stunning class demonstration to engage a class full of engineering students. Here is a quick one to introduce diffusion. It was adapted from a 1st grade class activity and applied in Chemical Engineering Separations. While this could easily be shown via document camera, students especially enjoy doing it themselves.

1. Scatter 10 - 12 Skittles® on a level disposable plate, leaving at least 0.5 inch of spacing between candies.
2. Gently pour a small amount of water into the plate until about half of the candy's height is submerged.
3. Watch as the dye begins to diffuse away from the individual Skittles®.

Figure 1 shows a 60 second time lapse of the experiment beginning just after the water was poured. Once the experiment has ended (and any leftover Skittles® are consumed), have students consider the following questions (sample answers provided):

1. Why did the dye move through the water?

   Initially the water is pure and the dye moves easily away from the candy via diffusion. Diffusion occurs from random motions of molecules. The universe will drive toward mixing in order to maximize entropy.

2. Why did the dye stop moving?

   When two dye progression fronts reach each other, the driving force for continued mixing is reduced (thermodynamics). Movement of the large dye molecules through water will also be hindered by the presence of other dye molecules blocking their way (transport).

3. Why are flux (J_A) and concentration gradient ($\frac{dC_A}{dz}$) inversely related in Fick's Law (Eq.1)?

   Molecules are driven to diffuse in the direction of lower concentration in the same way heat is driven to move to lower temperature. This means the concentration gradient is negative (low - high) when flux (flow rate/area) is positive.

$$J_A = -D_{AB}\frac{dC_A}{dz} \tag{1}$$

This simple, 10 minute class demonstration provides students with a visual depiction of how concentration can both initiate and hinder diffusion. It has proven to be a memorable and engaging way to introduce mass transport and Fick's Law in a Separations course.

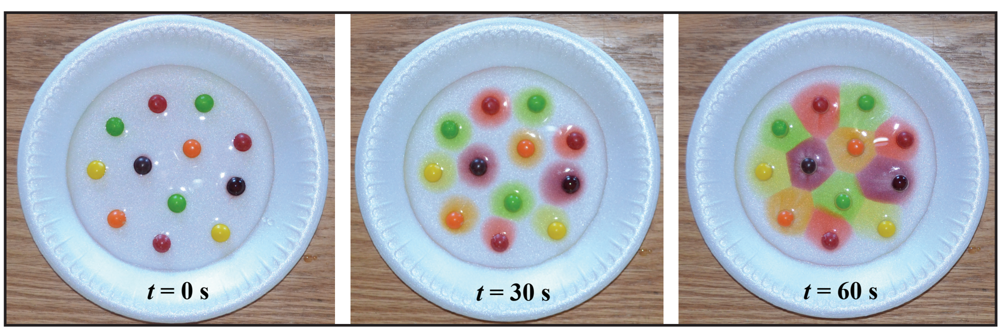

Figure 1. *Time lapse images of the Skittles® in water experiment. At time 0 s, water is poured over the Skittles®. After 30 s, dye has diffused away from each skittle creating a ring of colored solution around every candy. When the dye rings of individual candies intersect at 60 s, the diffusion process slows leaving distinctly separated regions of differing colors.* ❐

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