# OLI Tips #23

Updated: August 30, 2018

CSTR v. Plug Flow Reactors

There is a long-standing confusion in the OLI/Software about the residence time and stages in the reactor. This document will help explain the confusion.

For processes that have reaction kinetics, the OLI software requires the change in time that occurs during a reaction. OLI first computes the equilibrium condition before the reaction occurs (time = 0, initial state) and then a separate equilibrium calculation after the reaction occurs.

The extent of reaction, the amount of material reacted, is the area under the curve. But OLI can not directly evaluate a curve like the one below. For example, take a reaction that is fairly quick and takes one hour. The rate curve may look like this:
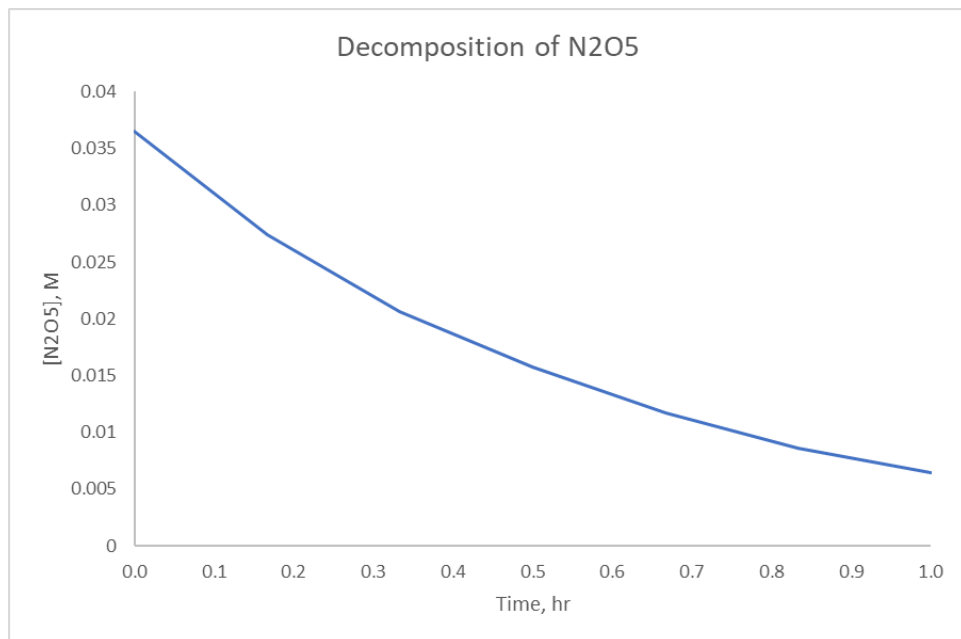

(LibreTexts, 2017)

For a residence time of 1 hour and 1 stage we draw a line.
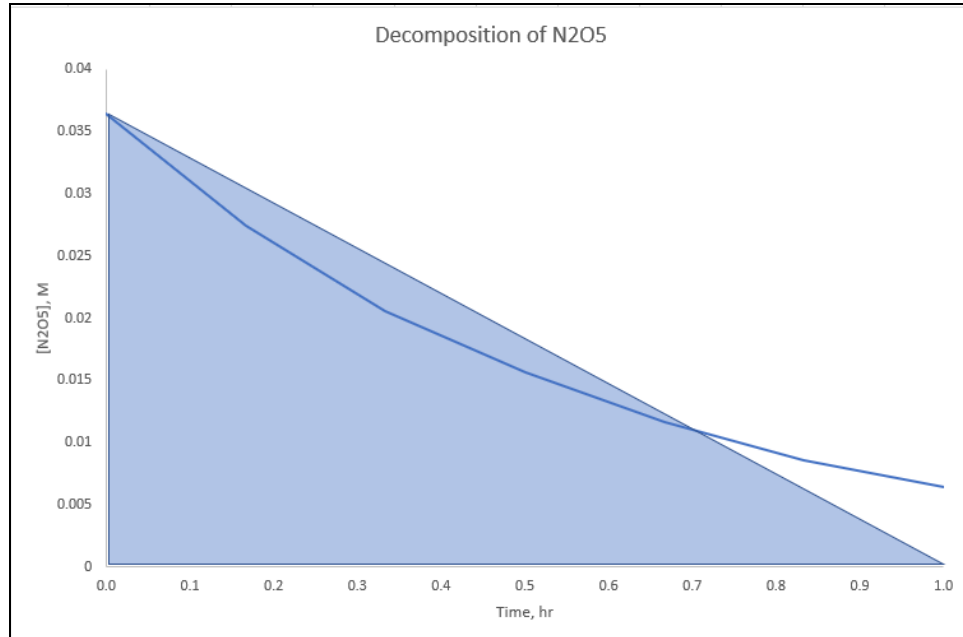
You can see for this approximation, the extent of reaction (the area of the triangle) does not match the actual area under the curve. The interval (or stage) of 1 introduces a significant amount of error. This is the default CSTR assumption.

We will now turn this into a plug flow reactor (multiple CSTR's) and see what happens. We will break the curve into 5 segments.
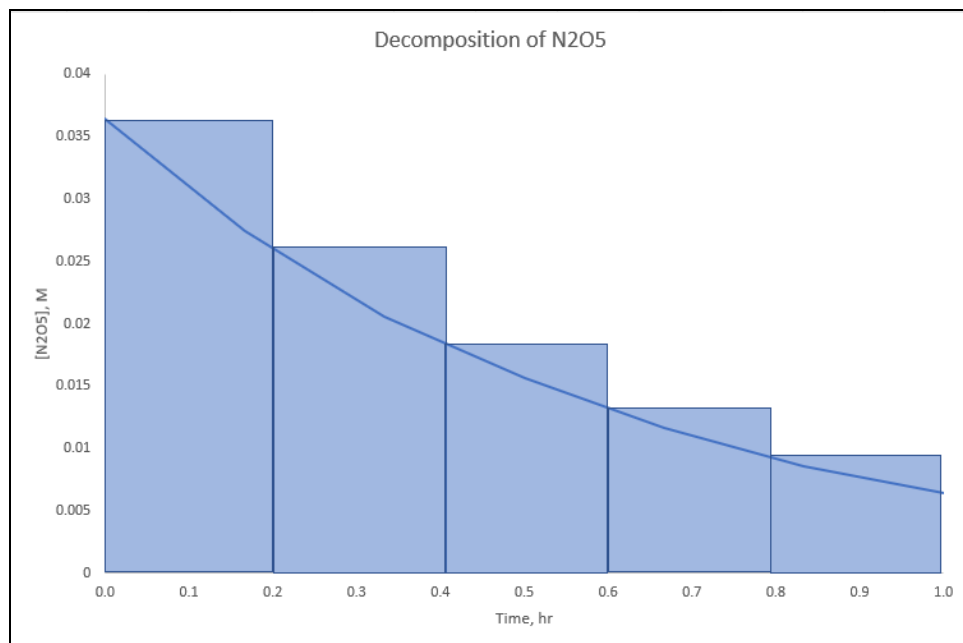
This now accounts for all the area under the curve but introduces some overpredictions. The task now is to see how many increments (stages, intervals, etc.) are needed. OLI recommends dividing the hold-up time (in this case 1 hour) by 10 to determine the number of intervals.

Decomposition of N2O5
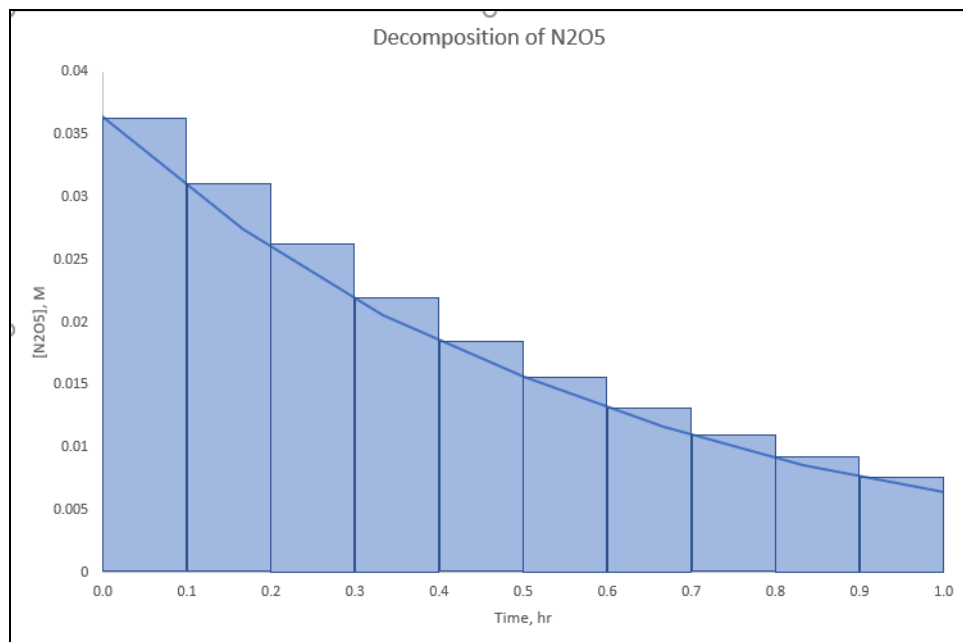
As you can see, adding more stages decreases the error, more of the area under the curve is accounted for in this diagram. As you increase the number of stages, the error decreases but the computational time increases.

References

LibreTexts. (2017, May 18). *Using Graphs to Determine Integrated Rate Laws*. Retrieved from LIbreTexts, Chemistry:
https://chem.libretexts.org/Textbook_Maps/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Kinetics/Experimental_Methods/Using_Graphs_to_Determine_Integrated_Rate_Laws