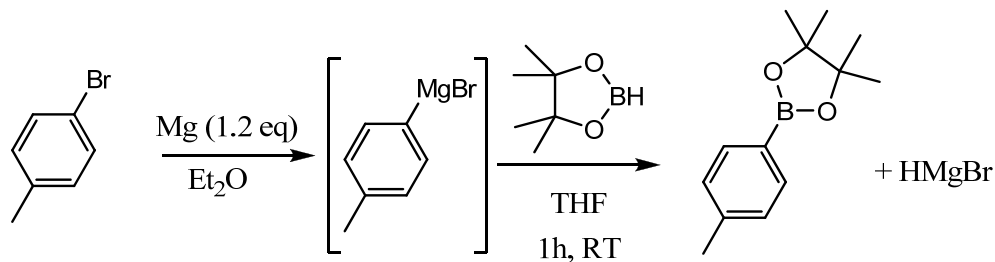


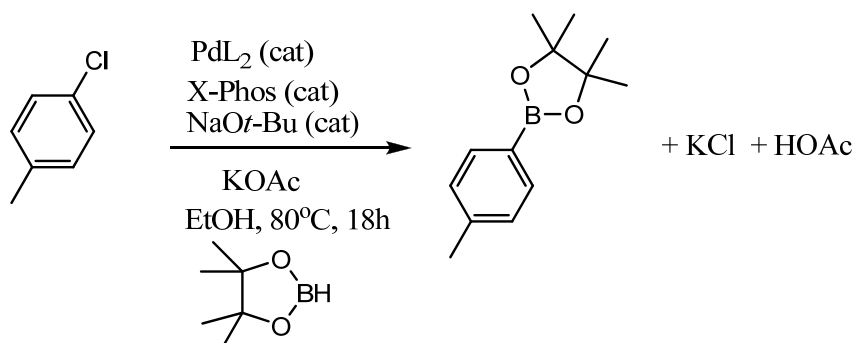
Chem 253—Green Chemistry in-class problems

One way to build complex molecules, such as pharmaceuticals and pesticides, is by utilizing a Suzuki coupling reaction. This versatile and Nobel Award-winning coupling reaction requires precursors with a carbon-boron bond, usually borate esters. They can often be problematic to synthesize. Below you will find two different approaches to the synthesis of borate esters.

Classic Borate Ester Synthesis



Modified Borate Ester Synthesis



Note: the combination of Pd, X-Phos and sodium *tert*-butoxide create the catalyst for the modified reaction. They are used at a level of 1 mol % in the system, and are recycled from one reaction to the next.

- 1) (10 pts) Calculate the atom economy for each reaction. You can ignore catalysts, since their amounts are small and they are generally reused. How do you deal with solvents in these calculations?
- 2) (6 pts) Using the 12 principles of Green Chemistry and the information from last week's lecture, give three of the principles which have been used in the modified synthesis, and explain the specifics of how these alterations make the modified reaction "greener" than the classic synthesis.
- 3) (4 pts) You have created a new pesticide. Based on what you know about green chemistry, what general factors do you have to consider about the manufacturing process in order to assess how to make the greenest possible reaction?