

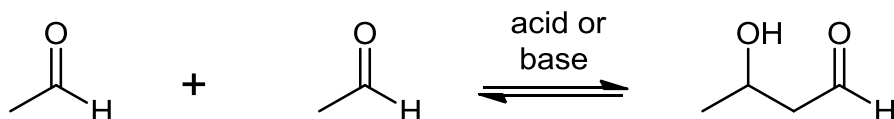
ORGANIC SYNTHESIS: ALDOL CONDENSATION REACTION

TECHNIQUES REQUIRED: [Filtration \(Vacuum\)](#), [Recrystallisation](#), [Melting Point Determination](#)

OTHER DOCUMENTS: [Experimental Procedure](#), [Report Template](#), [Spectra](#)

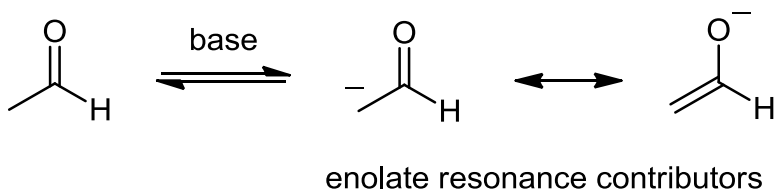
INTRODUCTION

In an "*aldol addition*" reaction an enol or enolate of an aldehyde or ketone reacts with a second aldehyde or ketone forming a new carbon-carbon bond which makes the aldol reaction an important reaction for organic synthesis. Originally, the aldol reaction used ethanal (see below) and therefore the product contained both an **aldehyde** and an **alcohol** functional group; thus it became known as the **aldol** reaction.



The aldol addition demonstrates how carbonyl compounds can react as both an electrophile and a nucleophile. The aldol reaction requires an aldehyde or ketone that contains at least one α -hydrogen (the α -hydrogen is on the carbon adjacent to the C=O group) since the α -hydrogen is required in order to form the enol or enolate.

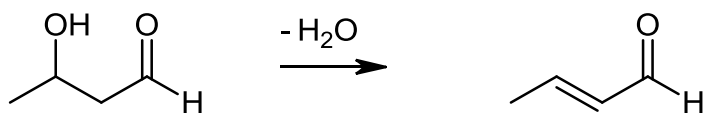
In the base-catalysed aldol reaction, the relatively acidic hydrogen on the α -carbon (typical pKa 16-20) is deprotonated by a base to form the enolate. The enolate reacts as a carbon nucleophile that can then react with the electrophilic carbonyl carbon of another aldehyde or ketone molecule. Depending on the strength of the base used, the extent of deprotonation can be controlled. If a strong base is used (such as lithium diisopropylamide, LDA) then deprotonation is quantitative (100%). If weaker bases such as hydroxide or alkoxides are used, then there is equilibrium deprotonation (*i.e.* only a small amount of enolate is present at any one time).



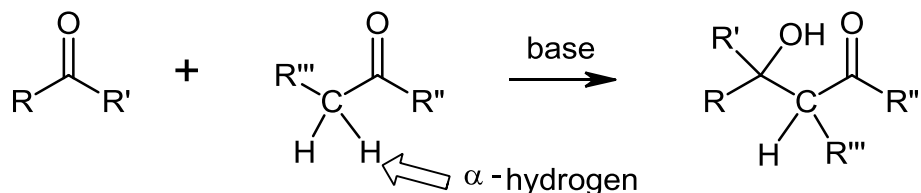
The equilibrium for the aldol reaction can lie in the direction of reactants or products, depending on their structure and the reaction conditions. The aldol product can often undergo elimination of water

ALDOL.2

(i.e. dehydration) to give an α,β -unsaturated aldehyde or ketone, that contains a conjugated carbonyl group. The overall process is then referred to as an "aldol condensation".

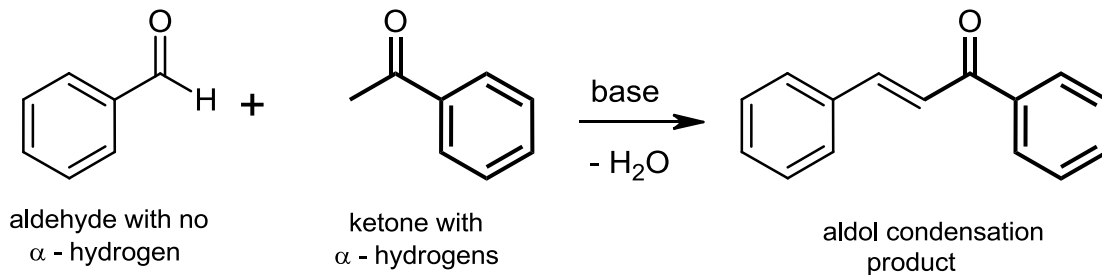


The example using ethanal shown above only involves one starting material and is therefore referred to as a "self condensation". "Mixed" or "crossed" aldol condensations occur when two different molecules containing carbonyl groups are combined.

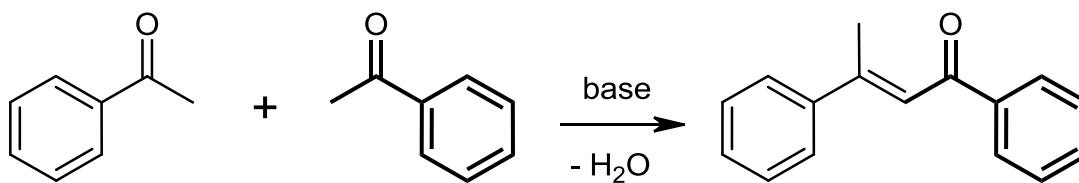


A generic mixed aldol reaction where two different carbonyl-containing molecules are mixed together.

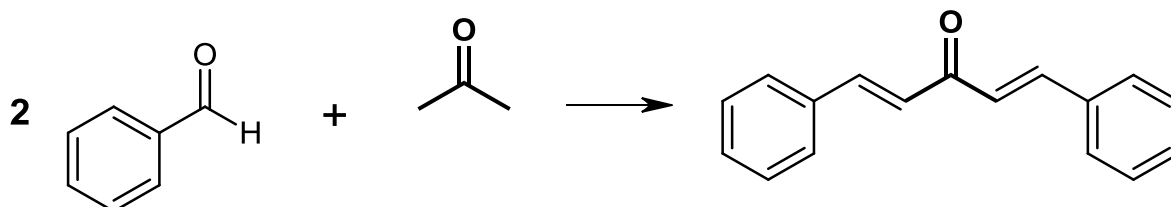
In terms of the scope of the reaction, the R-groups can be alkyl, aryl or H. This ability to join different aldehydes and ketones together with some degree of control is what gives this process its synthetic value. Typically, a mixed aldol condensation is only practical if one of the compounds has no α -hydrogens – thus only one enol or enolate is generated and so there is only a single nucleophile formed. The mixed aldol reaction typically occurs between an aldehyde that has no α -hydrogens, and a ketone. Thus, the nucleophile is generated solely from the ketone. The aldehyde is usually more reactive towards nucleophiles than the ketone, further reducing the possibility of the ketone undergoing unwanted self-condensation. Minimizing any unwanted self-condensation of the ketone can also be achieved by taking care with the order in which the reagents are added. In the example below, the ketone would be added to a mixture containing the aldehyde and the base. This means that the ketone enolate forms in the presence of excess aldehyde.



In contrast, prolonged contact between the ketone and base in the absence of the aldehyde can result in self-condensation of the ketone (in this case an unwanted side reaction).



In this experiment you will be reacting two equivalents of benzaldehyde with propan-2-one, according to the following general scheme:



This product can be used as a sunscreen as the conjugated system including the aromatic, alkene and carbonyl units create a chromophore that allows the molecule to absorb high energy uv radiation and so preventing the uv radiation from damaging the skin.

REFERENCES

1. Organic Chemistry On-Line Learning Center Chapter 18;
<http://www.chem.ucalgary.ca/courses/351/Carey5th/Ch18/ch18-0.html>