

INSTRUCTOR: In this tutorial we look at the reactions that oxidize aldehydes. Recall that aldehydes contain a carbonyl group bonded to only one other carbon group and a hydrogen atom. The carbonyl group in an aldehyde is always at the end of a chain or branch with at least one hydrogen atom bonded to the carbonyl group.

Aldehydes are oxidized to carboxylic acids, compounds that contain both a carbonyl group and a hydroxyl group. Several reagents, including potassium dichromate — $\text{K}_2\text{Cr}_2\text{O}_7$ — and Tollens' reagent — a mixture of silver oxide and ammonium hydroxide — oxidize aldehydes to carboxylic acids.

The aldehyde butanal, for example, is converted to a carboxylic acid, butanoic acid. This reaction converts the CH bond in an aldehyde to a CO bond. In some cases, aldehydes are even sensitive to the oxygen in the air. For this reason, aldehydes are often stored protected from the air and unintended oxidation reactions.

Ketones, in contrast to aldehydes, resist oxidation altogether. Since ketones do not have a hydrogen atom bonded to the carbonyl group, they are not oxidized under the same conditions as aldehydes are. Potassium dichromate, $\text{K}_2\text{Cr}_2\text{O}_7$, oxidizes aldehydes as we've just seen, but it also oxidizes other functional groups such as alcohols.

Tollens' reagent, however, can selectively oxidize aldehydes. Only aldehydes react with Tollens' reagent. All other functional groups are unreactive. In addition to occurring only with aldehydes, a reaction between Tollens' reagent and an aldehyde produces a distinct color change. Let's watch this reaction.

As the silver ion is converted to silver metal, the silver metal becomes visible. In this case, the silver metal precipitates as a mirror like coating on the inner surface of the reaction flask. Because of this color change, Tollens' reagent is often used to determine if an aldehyde functional group is present on a molecule. The silver color indicates that indeed an aldehyde is present.

Let's try an example problem. What product forms when this compound is treated with $\text{K}_2\text{Cr}_2\text{O}_7$? Notice that this compound is an aldehyde. It has both the carbonyl group at the end of a chain and one hydrogen atom bonded to it. The product is therefore a carboxylic acid and has a new CO bond.

Let's try another one. What product forms when this molecule reacts with potassium dichromate? Notice that this is a ketone. The carbonyl carbon is not bonded to a hydrogen atom and does not undergo oxidation, so there is no reaction.