This page looks at the reduction of nitriles to primary amines using either lithium tetrahydridoaluminate(III) (lithium aluminium hydride) or hydrogen and a metal catalyst.

The reduction of nitriles using LiAlH$_4$

Despite its name, the structure of the reducing agent is very simple. There are four hydrogens ("tetrahydido") around the aluminium in a negative ion (shown by the "ate" ending). The "(III)" shows the oxidation state of the aluminium, and is often left out because aluminium only ever shows the +3 oxidation state in its compounds. To make the name shorter, that's what I shall do for the rest of this page.

The structure of LiAlH$_4$ is:

In the negative ion, one of the bonds is a co-ordinate covalent (dative covalent) bond using the lone pair on a hydride ion (H-) to form a bond with an empty orbital on the aluminum.

The overall reaction

The nitrile reacts with the lithium tetrahydridoaluminate in solution in ethoxyethane (diethyl ether, or just "ether") followed by treatment of the product of that reaction with a dilute acid. Overall, the carbon-nitrogen triple bond is reduced to give a primary amine. Primary amines contain the \(-\text{NH}_2\) group. For example, with ethanenitrile you get ethylamine:

$$\ce{CH_3CN + 4[H] \rightarrow CH_3CH_2NH_2}$$

The reduction of nitriles using hydrogen and a metal catalyst

The carbon-nitrogen triple bond in a nitrile can also be reduced by reaction with hydrogen gas in the presence of a variety of metal catalysts. Commonly used catalysts are palladium, platinum or nickel. The reaction will take place at a raised temperature and pressure, but the exact details vary from catalyst to catalyst.

For example, ethanenitrile can be reduced to ethylamine by reaction with hydrogen in the presence of a palladium catalyst.

$$\ce{CH_3CN + 2H_2 \rightarrow[Pd] CH3CH2NH2}$$
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