

CONDENSATION AND ADDITION

There are only a few products manufactured in any considerable tonnage by condensation and addition (Friedel-Crafts) reactions, but those that are find use in several different intermediates and particularly in making high-quality vat dyes.

The agent employed in this reaction is usually an acid chloride or anhydride, catalyzed with aluminum chloride. Phthalic anhydride reacts with chlorobenzene to give *p*-chlorobenzoylbenzoic acid and, in a continuing action, the *p*-chlorobenzoylbenzoic acid forms β -chloroanthraquinone.

Since anthraquinone is a relatively rare and expensive component of coal tar and petroleum, this type of reaction has been the basis for making relatively inexpensive anthraquinone derivatives for use in making many fast dyes for cotton.

Friedel-Crafts reactions are highly corrosive, and the aluminum-containing residues are difficult to dispose.

DEHYDRATION

Dehydration is the removal of water or the elements of water, in the correct proportion, from a substance or system or chemical compound. The elements of water may be removed from a single molecule or from more than one molecule, as in the dehydration of alcohol, which may yield ethylene by loss of the elements of water from one molecule or ethyl ether by loss of the elements of water from two molecules:



The latter reaction is commonly used in the production of ethers by the dehydration of alcohols.

Vapor-phase dehydration over catalysts such as alumina is also practiced. Hydration of olefins to produce alcohols, usually over an acidic catalyst, produces substantial quantities of ethers as by-products. The reverse reaction, ethers to alcohols, can be accomplished by recycling the ethers over a catalyst.

In food processing, dehydration is the removal of more than 95% of the water by use of thermal energy. However, there is no clearly defined line of demarcation between *drying* and *dehydrating*, the latter sometimes being considered as a supplement of drying.

The term *dehydration* is not generally applied to situations where there is a loss of water as the result of evaporation. The distinction between the terms drying and dehydrating may be somewhat clarified by the fact that most substances can be dried beyond their capability of restoration.

Rehydration or *reconstitution* is the restoration of a dehydrated food product to its original edible condition by the simple addition of water, usually just prior to consumption or further processing.

DEHYDROGENATION

Dehydrogenation is a reaction that results in the removal of hydrogen from an organic compound or compounds, as in the dehydrogenation of ethane to ethylene:



This process is brought about in several ways. The most common method is to heat hydrocarbons to high temperature, as in thermal cracking, that causes some dehydrogenation, indicated by the presence of unsaturated compounds and free hydrogen.

In the chemical process industries, nickel, cobalt, platinum, palladium, and mixtures containing potassium, chromium, copper, aluminum, and other metals are used in very large-scale dehydrogenation processes.

Styrene is produced from ethylbenzene by dehydrogenation (Fig. 1). Many lower molecular weight aliphatic *ketones* are made by *dehydration*

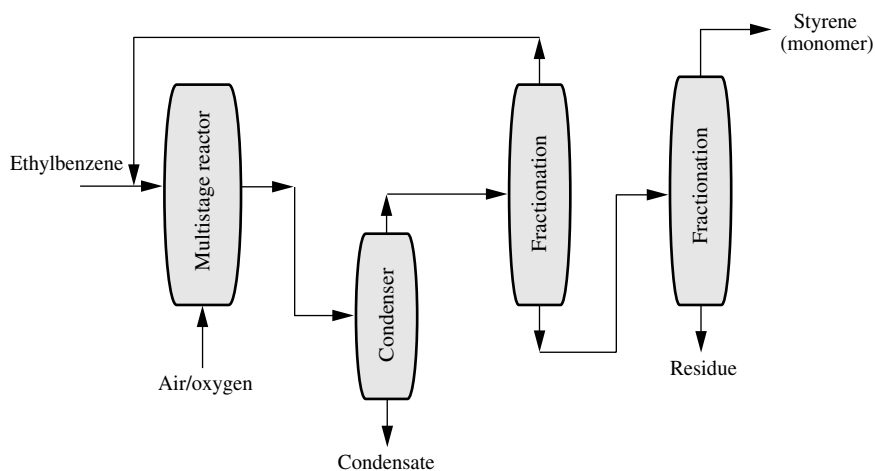
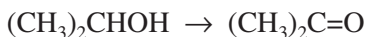


FIGURE 1 Manufacture of styrene from ethylbenzene.

of alcohols. Acetone, methyl ethyl ketone, and cyclohexanone can be made in this fashion.



Acetone is the ketone used in largest quantity and is produced as a by-product of the manufacture of phenol via cumene. Manufacture from *iso*-propanol is by the reaction:



This reaction takes place at 350°C and 200 kPa with copper or zinc acetate as the catalyst; conversion is 85 to 90 percent. Purification by distillation follows.

The dehydrogenation of *n*-paraffins yields detergent alkylates and *n*-olefins. The catalytic use of rhenium for selective dehydrogenation has increased in recent years since dehydrogenation is one of the most commonly practiced of the chemical unit processes.

See Hydrogenation.