

Properties and Uses

Physical properties :

Commercial carbon disulfide often possesses a strong disagreeable and fetid odor due to the presence of very small amounts of strong smelling organic sulfur compounds. The pure product has an odor that is somewhat pleasing and ethereal in nature.

Carbon disulfide is highly flammable, having an explosive range, percent by volume in air, from 1.25 to 50. The flash point is -30°C and auto ignition occurs at 100°C or even lower under certain conditions. Thus carbon disulfide will flash if the liquid is brought into contact with open steam pipes. Its solubility in water is 0.22 g/100 ml at 22°C . It is an effective solvent for many organic compounds.

Thermally, carbon disulfide is a rather stable compound, as would be inferred from its thermodynamic properties. The strength of the C-S bond is 131.7 Kcal. The compound is quite sensitive to light, especially if impurities are present, and will change to a yellowish color in a few days if left in diffuse sunlight.

Physical Constants for carbon disulfide :

| Property | Numerical Value |
|--|--------------------------|
| Freezing Point | -111.6°C |
| Boiling Point | 46.25°C |
| Critical volume | 1.745 ml/g |
| Vapor density (air = 1) | 2.62 |
| Refractive index (25°C) | 1.6294 |
| Latent heat of fusion, H_m | 1,050 cal/g-mol |
| Latent heat of vaporization, H_v 298°K | 6,550 cal/g-mol |
| Heat of formation, H_f 298°K | 27,580 cal/g-mol |
| Entropy, S_M 298°K | 20,900 cal/g-mol |
| Heat of combustion, H_c | 56.84 cal/g-mol |
| Viscosity, cP (at temp, $^{\circ}\text{C}$) | 0.3453(0) |
| | 0.3032(15) |
| | 0.2916(20) |
| | 0.2660(35) |
| Surface tension, dyne/cm at temp, $^{\circ}\text{C}$ | 33.07(20) |
| | 33.25(30) |
| | 30.79(40) |
| Density at (temp, $^{\circ}\text{C}$), g/ml | 1.2931(0) |

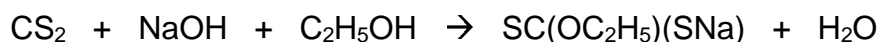
| | |
|------------------------------|---------------|
| Density at (temp, ° C), g/ml | 1.2632(15) |
| | 1.2559(25) |
| | 1.2250(46.25) |

Chemical Properties:

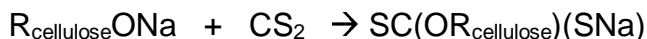
Carbon disulfide reacts to some extent with aqueous alkali to form a mixture of carbonate and thiocarbonate,



With alcoholic alkali, reaction with carbon disulfide takes place readily with the formation of xanthates,

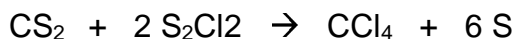
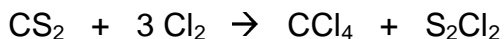


Alkali phenolates react with carbon disulfide to form alkali xanthates (sodium cellulose dithiocarbonate),



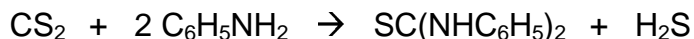
The solid xanthate, thus formed, is dissolved in caustic soda solution to form "viscose" solution. From this solution regenerated cellulose (viscose rayon) is prepared by neutralization with acid.

Another important reaction is the chlorination of carbon disulfide to produce carbon tetrachloride. Chlorine in the presence of iron as a catalyst, sulfur dichloride (SCl_2), and sulfur monochloride (S_2Cl_2) are used as chlorinating agents. The reaction proceeds in two steps, as follows:



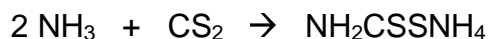
Carbon tetrabromide is formed in a similar fashion by the action of bromine on carbon disulfide. Treatment of carbon disulfide with chlorine and trace of iodine gives trichloromethanesulfonyl chloride, CCl_3SOCl . Reduction of the latter compound with stannous chloride or tin and hydrochloric acid produces thiophosgene, CSCl_2 . This compound is useful as an intermediate of many organic sulfur compounds.

Carbon disulfide reacts with boiling aniline to form thiocarbanilide according to the equation,

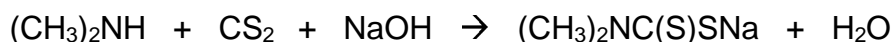


Thiocarbanilide is used in dyes, as a vulcanization accelerator, and in synthetic organic pharmaceuticals, etc. carbon disulfide also reacts with primary and secondary amines to give substituted ammonium salts of N-substituted dithiocarbamic acids, $\text{RNHCS-SNH}_3\text{R}$ and $\text{R}_2\text{NCSSNH}_2\text{R}_2$.

Ammonium dithiocarbamate is prepared by the addition of carbon disulfide to a solution of alcoholic ammonia,



Sodium dimethyl dithiocarbamate is manufactured by the reaction of carbon disulfide with dimethylamine and caustic,



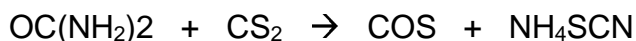
Carbon disulfide reacts with various compounds to produce carbon oxysulfide. Thus, carbon oxysulfide is formed by heating magnesium oxide with carbon disulfide,



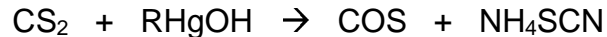
Sulfur trioxide or chlorosulfonic acid oxidizes carbon disulfide according to the following reaction:



Urea and carbon disulfide react at 110°C to give carbon oxysulfide and ammonium thiocyanate,



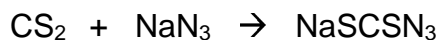
Carbon disulfide is partially desulfurized by an alkyl mercuric hydroxide,



Dithio acids (RCSSH) are formed from carbon disulfide through reaction with Grignard reagents,

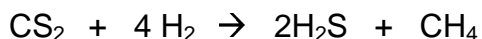
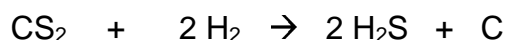


Liquid carbon disulfide reacts at 40-50° C with aqueous solutions of sodium azide to form sodium azidodithiocarbonate,

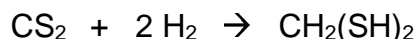


This reaction has been used to detect small concentrations of carbon disulfide in air or other media.

The main reactions involved in the reduction of carbon disulfide at high temperatures are the following:



At lower temperatures the reduction of carbon disulfide yields various organic sulfur compound. Eg:



Carbon disulfide reacts almost quantitatively with water vapour at high temperatures to form hydrogen sulfide,



Uses:

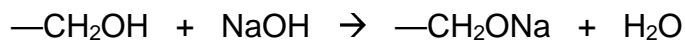
Formerly, the principal use of carbon disulfide was as a solvent for the extraction of oils, fats, waxes and other substances from various materials. This use, however has decreased greatly in recent years due to the flammability and toxicity of the compound. Other solvents, including carbon tetrachloride and other chlorinated hydrocarbons such as trichloroethane, have largely replaced carbon disulfide in this field.

The greater part of the carbon disulfide produced today is used as a raw material for the manufacture of regenerated cellulose. The two major products manufactured from regenerated cellulose are viscose rayon and cellophane. A considerable amount of carbon disulfide is also used in manufacturing carbon tetrachloride. Carbon disulfide is also used in the cold vulcanization of rubber and in making rubber accelerators and resins. The manufacture of xanthates and the use of carbon disulfide as an insecticide are among other applications of carbon disulfide.

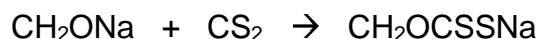
Manufacture of Viscose Rayon :

Carbon disulfide is used majorly for the manufacture of viscose rayon. Viscose is manufactured by the action of carbon disulfide and caustic soda on cellulose.

Cotton linters or wood pulp are steeped with caustic soda solution and then xanthating the alkali cellulose with carbon disulfide. In the first step the hydroxy methyl group of the cellulose undergoes the following reaction:



The alkali cellulose thus formed is aged and treated with carbon disulfide,



The resulting cellulose xanthate is treated with dilute sodium hydroxide solution to form a colloidal viscose solution which is filtered and aged. The final product, regenerated cellulose, is produced by extruding the aged solution through suitable orifices into an acid bath (sulfuric acid and sodium sulfate) to form the regenerated cellulose as filaments or sheeting, sodium sulfate and carbon disulfide.

Manufacture of Carbon Tetrachloride :

Carbon disulfide has an advantage in carbon tetra chloride production in that essentially no by products are formed. The chlorination of methane on he

other hand produces other chlorinated methanes and hydrogen chloride as by products.

Carbon disulfide in the Rubber industry :

carbon disulfide is also used in the cold vulcanization of rubber and in making rubber accelerators and floatation chemicals. A large number of patents and publications have appeared which deal with the production of resinous materials from condensation reactions of carbon disulfide, amines and other compounds such as aldehydes, dienes, carboxylic acids and isocyanates.

Carbon disulfide as a fumigant :

Various mixtures of carbon disulfide have been used fumigation e.g, with pyridine and nitrobenzene, with potassium thiocarbonate, with CCl_4 and monochlorobenzene emulsions with water etc. Typically, carbon disulfide is employed in fumigants in admixture with chlorinated hydrocarbons.

Recently, carbon disulfide has been used as a solvent in oil wells plugged with wax or with iron sulfide and free sulfur. In the latter application, the well is first acidized to remove iron salts, after which carbon disulfide is used to dissolve the remaining free sulfur.