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INDUSTRIAL TOXICOLOGY

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chronic damage to mild exposure, including the incidence of Bright's disease among painters. Smyth and Smyth (4), in testing the effect of turpentine on animals at a concentration of 715 parts per million, found no significant blood changes nor any pathology indicating that this concentration was unsafe. Chapman (5) could find no evidence of chronic renal injury in rats exposed to the fumes of turpentine over a long period of time and concludes that neither turpentine nor paint acts as a renal irritant predisposing the human kidney to glomerular nephritis. Nelson and his associates (6) found that 75 parts of turpentine per million of air caused nose and throat irritation in several people and 175 parts per million was intolerable to the majority.

Analysis

Inasmuch as turpentine, even in the low concentrations present as an aerial contaminant, yields colors with various reagents, a number of procedures of this type may be applied to its detection and estimation, provided suitable air samples can be taken. Turpentine, for instance, produces color reactions with furfural, salicylic aldehyde, and other higher aldehydes in sulfuric acid. When turpentine vapors are absorbed in sulfuric acid and oxidized by chromic acid, the carbon dioxide evolved may be used as a measure of the turpentine present. Estimation may also be made based on the amount of color produced. Turpentine also gives an initial pink color with vanillin in hydrochloric acid which rapidly changes to a blue-green color which is stable after about 30 minutes. By warming, as small a quantity as 0.02 milligram of turpentine may be detected. Snider (7) has found that steam-distilled wood turpentine may be detected when present in gum spirits of turpentine by determining the benzaldehyde present. Benzaldehyde is found only in steam-distilled wood turpentine and not in either gum spirits or sulfate wood turpentine.

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VINYL CHLORIDE

Characteristics

Vinyl chloride, chloroethylene, $\text{CH}_2=\text{CHCl}$, is a colorless gas which condenses below -13.9°C ., freezes at -159.7°C ., boils at -13.9°C ., has a density $d_{20/20}$ of 0.9121, and a vapor pressure of 2,300 millimeters of mercury at 20°C . Its limits of inflammability are 4.0 to 21.7 per cent by volume of air. Vinyl chloride may be prepared by the chlorination of ethylene followed by the elimination of hydrogen chloride. The latter is accomplished industrially by passing the vapor of ethylene dichloride over such contact catalysts as alumina, activated charcoal, or pumice at high temperatures. The process in present use for the technical preparation of vinyl chloride depends upon the direct addition of hydrogen chloride to acetylene in the presence of mercury salts. All compounds containing the vinyl group $\text{CH}_2=\text{CH}-$ polymerize readily. Vinyl chloride polymerizes on exposure to sunlight and in the presence of peroxides and catalytic substances. The polymers are unusually strong and resistant to water. These polymers are thermoplastic but require the addition of plasticizers in order to speed the softening rate and prevent decomposition. Polymerization, which is activated by the molecular absorption of energy, proceeds rapidly with the formation of chain products which may be interrupted by ring-closure of the two end molecules, by union with the second chain,

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or by the addition of a foreign substance. As a consequence a large number of polymers and copolymers having a wide range of physical properties has received industrial attention. The range of the vinyl chloride polymers is increased by copolymerization with vinyl acetate in which the vinyl chloride content varies from 85 to 95 per cent and the molecular weight from 8,500 to 23,000. Polyvinyl chloride forms a series of thermoplastic resins having many of the properties of rubber when modified by various plasticizers. These substances are processed similarly to rubber although they require no vulcanization. The plasticized polyvinyl chloride resins do not deteriorate on contact with air, light, or ozone. They are also moisture resistant and not affected by immersion in strong mineral acids or strong alkalis.

Industrial Uses

The copolymers of vinyl acetate and vinyl chloride have found extensive use as lithographic varnishes and enamels and coatings for all types of bases, such as cloth, silk, and paper. Polyvinyl chloride has been used as a rubber substitute in many industries, being applied mostly in solution form (1). The plastics igelite and vinylite are polymerization products of vinyl chloride and are used for insulating cables, making X-ray films, and foils. In addition to wire and cable coating material, the polyvinyl resins have received extensive application as liners for tin cans and have practically displaced all other plastics in safety glass for automobiles (2). Vinyl chloride is also used as a refrigerant.

Toxicity

Patty, Yant, and Waite (3) investigated the physiological properties of vinyl chloride and found that it is less harmful than carbon tetrachloride and chloroform and is similar in action to ethyl chloride. The symptoms produced by inhalation exposure are principally those of narcosis. The respiration varies from an initial rapid, jerky type to a later slow, shallow type. While very high concentrations of 20 to 40 per cent by volume will kill guinea pigs in a short period

of time, 0.5 per cent may be breathed for several hours without acute disturbances of a serious nature. Vinyl chloride does not possess warning properties of the odor or irritation type, but in high concentrations (5 per cent) gives warning by producing symptoms of dizziness and disorientation in advance of any harmful effects.

Analysis

No method has been developed specifically for the determination of low concentrations of vinyl chloride as an aerial contaminant. The usual procedures for the determination of chlorinated hydrocarbons could be applied, however, in the absence of interfering or complicating substances. Patty and his associates (3) used an explosion pipette (with electrolytic gas to energize the explosion), followed by absorption of the explosion products.

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XYLENE

Characteristics

Xylene, xylol, dimethylbenzene,



is a homologue of benzene. It exists in three forms—the *o*, *m*, and *p*. As used commercially, xylene is a mixture of the three with the *m*-xylene predominant. The first two isomers are colorless liquids, while *p*-xylene is a solid consisting of colorless monoclinic crystals. All are insoluble in water but soluble in alcohol or ether. The highest fraction of "light oil" obtained from the distillation of coal tar contains the xylenes. The following physical characteristics serve to differentiate the isomeric forms of xylene: Boiling point: *o*-, 144.05° C.; *m*-, 139.30° C.; *p*-,