The Toxicity of the Fogs Formed by Dropping Pydraul F-9, Aroclor 1248 and Tricresyl Phosphate, Upon the Surface of a Heated Inconel (Project 49)

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March 11, 1953

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The Toxicity of the Fogs Formed by Dropping Pydraul F-9, Aroclor 1248 and Trioresyl Phosphate, Upon the Surface of a Heated Inconel

(Project 49)

Scope

The purposes of this investigation were to determine the immediate toxicity of Pydraul F-9 and two other hydraulic fluids, Aroclor 1248 and trioresyl phosphate, (1) when vaporized at moderately elevated temperatures and (2) when inhaled, by animals of several species, as fogs formed by dropping them upon Inconel, maintained at temperatures of approximately 1250° and 1050° F. (677° and 566° C.), these temperatures being, respectively, somewhat above and somewhat below the fire point. A supplementary statement concerning the immediate toxicity of these materials when maintained in contact with the skin of rabbits is included at the end of this report.

Conclusions

1. Animals of several species survived without signs of intoxication when exposed to air laden with Pydraul F-9, Aroclor 1248 or trioresyl phosphate for 7 hours per

day on each of several days. The concentrations of the materials in the air and the numbers of days of exposure were as follows: Hydraul F-9, 3.8 micrograms per liter, 5 days; Aroclor 1248, 43.1 micrograms per liter, 4 days; and tricresyl phosphate, 61.5 micrograms per liter, 8 days.

2. The inhalation of vapors of Hydraul F-9, Aroclor 1248 and tricresyl phosphate formed at moderately elevated room temperatures induced minor changes in the lungs of the animals. Respiratory exposure to either Hydraul F-9 or tricresyl phosphate induced moderate increases in the numbers of histiocytes within the lung parenchyma and the air passages of cats, while corresponding exposure of other species to either Hydraul F-9 or Aroclor 1248 induced interstitial pneumonitis and apparently contributed to the severity of this lesion as it is observed, not infrequently, in control animals. Intercurrent infection, unrelated to the experimental procedure, obscured interpretation of the morbid changes in the tissues of a guinea pig and 2 rabbits exposed to the vapor of tricresyl phosphate, one of which died 4 days after the last period of exposure. The viscera of the rats and mice were normal. Rabbit F907, the only animal of the group exposed to Aroclor 1248 from which tissues were subjected to microscopic examination, had fatty degeneration and necrosis of the

hepatic parenchyma. Other animals that were exposed to vapors from Pydraul F-9, Aroclor 1248 or trioresyl phosphate exhibited no histologic alterations of the viscera, aside from the lung, which could be ascribed to the toxic action of the materials under investigation.

3. The fogs of these materials arising from contact with Inconel at either 1250° or 1050° F. were immediately irritating to the mucous membranes of animals. Exposure for 20 minutes to the fog of Aroclor 1248 induced labored respiration, but in the case of the other materials this became evident only after exposure for almost an hour.

4. All animals survived when exposed for 15 or 20 minutes to the fogs formed from Pydraul F-9 or trioresyl phosphate, at either 1050° or 1250° F., but exposure for corresponding periods of time to the fog from Aroclor 1248 resulted fatally. In general, guinea pigs and mice died more promptly than rats and rabbits.

5. Guinea pigs and mice suffered greater over-all mortality than did rats and rabbits when exposed to the fogs formed from any one of the three materials. Aroclor 1248 was more toxic than either trioresyl phosphate or Pydraul F-9 irrespective of the species of animals by which toxicity was tested.

6. The fog of Aroclor 1248 formed by contact with Inconel at 1250° F. was more toxic than that formed when

the temperature was 1050° F. The fog of Pydraul F-9 appeared to be slightly more toxic when generated at the higher temperature, but the converse was true of fogs from tricresyl phosphate.

7. Halving the rate of delivery of the liquid upon the heated metal tended to lessen the mortality induced by inhalation of a resulting fog, but this was not true in all instances.

8. Microscopic examination of tissues from animals that died as a result of exposure to the fogs of Pydraul F-9, Arocolor 1248 and tricresyl phosphate revealed pulmonary lesions characterized by intra-alveolar edema and hemorrhage, diffuse hyperemia, emphysema and extensive deposition of carbon in the bronchi. There was also parenchymatous degeneration of the liver, kidney and brain. Tissues from the animals that survived revealed only pulmonary lesions manifested by interstitial pneumonitis and infiltration of carbon-laden histiocytes throughout the alveoli and bronchi. The lungs of animals that were exposed for the shortest periods were normal, as were those killed 28 days or longer after the last period of exposure.

9. The minimum lethal dose of undiluted Pydraul F-9, when maintained in contact with the intact skin of rabbits according to the 24-hour sleeve method of Draize,

Woodard and Calvery, was greater than 3.6 ml. per kg. and less than 6.0 ml. per kg., of body weight. The corresponding value for trioresyl phosphate was between 1.6 and 2.5 ml. per kg. Aroclor 1248 was not lethal in the dosage of 9.4 ml. per kg. Pydraul F-9 and Aroclor 1248 are more toxic if applied to the abraded skin.

Materials

Pydraul F-9 is a clear, light amber, oily liquid which has a not unpleasant sweet odor. Its viscosity at 100° F. and 210° F., respectively, is 58.0 and 6.0 Centistokes; its specific gravity at 25°/25° C. is 1.266, its pour point +5° F.

Trioresyl phosphate is a colorless, odorless liquid, the viscosity of which at 0° and 25° C., respectively, is 1256.14 and 88.6 Centistokes. Its molecular weight is 368.4, its specific gravity at 25°/25° C., 1.162, its flash point 470° F. (243° C.), its crystallization point is less than -35° C., and its boiling point 420° C. The sample used was made from cresylic acid in which there was less than 3 per cent of the ortho isomer.

Aroclor 1248 is a straw-colored liquid which has a slightly sweet odor. It is more viscous than trioresyl phosphate. Aroclor 1248 is biphenyl chlorinated to the

extent of 48 per cent. Its molecular weight is 192, and its density is 1.44 g. per ml. at 30° C. (86° F.) and 1.19 g. per ml. at 300° C. (572° F.). Its viscosity ranges from 112 centipoises at 30° C. to 0.47 at 300° C., and it distills between 340° and 375° C., its vapor pressure being 0.00037 mm., 0.16 mm., 2.9 mm. and 360.0 mm. of mercury at 37.8° C., 100° C., 150° C. and 300° C., respectively, according to McArdle, Garrett and Benignus (Ind. Eng. Chem. 41:1341, 1949). These authors have quoted the National Board of Fire Underwriters to the effect that "decomposition of the product (Aroclor 1248) was not appreciable at temperatures below 400° C. (752° F.) but became increasingly apparent at higher temperatures." The compound has a flash point of 193° to 196° C., but no fire point in the Cleveland open cup.

When either Hydraul F-9 or Aroclor 1248 was dropped into an Inconel tube maintained at approximately 1250° F. (677° C.) the liquid burned momentarily with a bright yellow-white or orange-white flame, and then burst into a dense cloud of black smoke. Much glossy carbon was deposited on the sides of the manifold leading to the chamber, which rapidly became filled with dense grey smoke. This soon turned jet black, apparently because of the formation of flakes of carbon as soot. At 1050° F. (566° C.), these liquids smouldered and burst into a

dense grey-white fog, in which were small amounts of carbon soot. In all instances the odor was acrid and pungent. When dropped into the Inconel tube heated to either 1250° or 1050° F. tricresyl phosphate gave rise to a characteristic phenolic or cresylic odor and behaved as did the other two materials when dropped upon metal at the higher temperature. At temperatures below 1025° F., tricresyl phosphate appeared to smoulder without flaming.

Experimental Methods

Equipment. The animals were confined in a 223-liter cylindrical steel chamber coated on the inside surface with a baked plastic. Unless a heavy fog was present the behavior of the animals could be observed through a sheet of clear pliable plastic membrane, which sealed the otherwise open front end of the chamber. An interposed heavy wire-mesh screen prevented the animals from breaking the plastic membrane. The contaminated air entered the chamber near the top of the rear wall on which was mounted a circulating fan. Effluent air was withdrawn through an outlet located towards the front of the lower part of the chamber by maintaining a slight negative pressure.

Volatilization of the Materials Without Decomposition. For the volatilization of either tricresyl phosphate or Aroclor 1248, two flat-bottomed cylindrical bubbling towers

(2.94" x 13") in parallel (Figure 2) were employed, a fritted glass thimble (0.94" x 3.75") being immersed in the liquid contained in each. These towers were kept in a bath of Nujol maintained at 109° C. Air passed through the two bubbling towers at rates of 5.0 and 6.3 liters per minute, respectively, as measured by a rotameter in each line, the streams merging in a glass tube leading to a manifold immersed in a cooling bath before entering the chamber.

At the start of the experiment 550 milliliters of either tricresyl phosphate or Aroclor 1248 were placed in each of the two bubbling towers. In the case of tricresyl phosphate, it was found that the concentration of vapor within the chamber became less on the second day of exposure and still less on the third. It is thought that the tricresyl phosphate might have hydrolyzed somewhat during the course of standing overnight, possibly from moisture absorbed from the air passing through it during the day. In order to maintain the concentrations as uniform as possible, the material remaining in the towers was replaced with a fresh supply on the fourth day of the experiment. Had sufficient material been on hand, this would have been done daily in order to attain a somewhat higher average concentration throughout an experiment. This difficulty did not arise in the case of the Aroclor 1248.

It was necessary to employ other equipment for the volatilization of Pydraul F-9 because of extensive foaming in the bubblers. Therefore, the Pydraul F-9 was maintained at temperatures ranging from 109° to 112° C. in a glass well heated by nichrome wire (Figure 1). Air at the rate of 20 liters per minute, as measured by a rotameter, passed over the surface of the heated liquid and then through a manifold cooling bath before entering the chamber. A volume of 190 ml. of fresh Pydraul F-9 was added to the well daily, of which about 170 ml. remained at the end of the day.

Generation of a Fog From a Heated Inconel Surface. A rotameter for measuring the flow of air, a furnace for volatilizing and decomposing the liquid, a semi-potentiometer (see below), a cooling manifold, and the chamber for exposing the animals are shown in Figure 3. In these experiments the smaller rotameter, to the right in the photograph, was not employed, and all air (20 liters per minute) that entered the chamber was passed through the furnace. The cooling coils were packed in the bath shown and surrounded by crushed ice.

The body of the furnace consisted of a 26-inch length of cold-drawn, seamless Inconel tubing, having an outside diameter of 1.5 inches and a wall-thickness of 0.049 inch. Pydraul F-9, trioresyl phosphate or Aroclor 1248

was dropped upon the inner surface of the tube from a burette through an Inconel tube welded to the upper surface of the heated tube near its midpoint. This side tube had a length of 6 inches, an outside diameter of 0.675 inch, and a wall-thickness of 0.091 inch. Another piece of inconel tubing 3 inches in length and having an outside diameter of 0.430 inch and a wall-thickness of 0.049 inch, was also welded to the upper portion of the furnace tube, to permit the insertion of a thermocouple in such a manner as to measure the temperature at the upper interior surface of the furnace. The distance from center to center of the two smaller tubes, which were parallel to one another and perpendicular to the furnace proper, was 1.75 inches.

The outside of the furnace was wrapped with 2 layers of molding mica. The middle 10-inch portion of the length of the furnace was electrically heated by means of 20 feet (9 wrappings to the inch) of A. W. G. Number 20 Tophet "C" wire, which has a resistance of 0.659 ohms per foot at 60° F. The wire was insulated with approximately 0.75 inch of diatomaceous earth and wrapped on the outside with asbestos cloth.

The temperature of the wall was measured by an iron-constantan thermocouple attached to a semi-potentiometer calibrated against a student potentiometer. The thermocouple was in contact with the upper part of the furnace

about 1 inch downstream from the point at which the droplets of material fell upon its lower interior surface.

After the furnace had been brought to the desired temperature of either 1050° F. or 1250° F., the hydraulic fluid was dropped from a burette at the rate of 0.067 to 0.245 ml. per minute (cf. Table 4), 0.100 to 0.167 ml. per minute being the usual rate.

Sampling and Analysis of Contaminated Air. When the undecomposed materials were metered into the air in the chamber, 4 samples of air each day were passed from the chamber, at the rate of 3.4 liters per minute, through 2 absorption towers (2.25" x 13" outside diameter), each containing 100 ml. of an appropriate solvent. Redistilled ethyl alcohol was used in collecting tricresyl phosphate or Arocolor 1248, while hexane was used for Pydraul F-9. The sample passed through a coarse fritted glass disc (1.13" in diameter) immersed in the solvent and placed parallel to the bottom of the tower and about 0.2" above it. The content of Pydraul F-9, Arocolor 1248 or tricresyl phosphate so collected was determined by measuring, by means of a Beckman spectrophotometer, the ability of the solution to transmit ultraviolet radiations of wave lengths 246 mμ, 246 mμ and 264 mμ, respectively.

A curve relating the transmission at 246 mμ to the concentration of Pydraul F-9 in hexane over the range of 4.7 to 71 micrograms per ml. is shown in Figure 5. A comparison of the corresponding curves for Aroclor (Figure 6) and trioresyl phosphate (Figure 7), are also shown.

The alcohol used as solvent for Aroclor and trioresyl phosphate was freed from ultraviolet-absorbing impurities by the following procedure: About 1750 ml. of 95 per cent ethyl alcohol were permitted to stand overnight with 10 g. of pellets of KOH and 7 g. aluminum foil (0.003"). The mixture was then refluxed for half an hour and distilled at 78.50° C., the first 20 ml. being rejected.

In experiments involving the exposure of animals to the products formed on thermal decomposition of Pydraul, Aroclor or trioresyl phosphate for no longer than 7 hours, from 3 to 6 samples of air were collected from the chamber for analysis, depending upon the length of the period of exposure. When exposure was repeated on the following day, a corresponding number of samples was collected on the second day. Analyses were made for one or more of the following materials: phosgene, hydrochloric acid, free cresols and carbon monoxide.

When Arocolor 1248 was to be determined, the samples of air were collected in an evacuated glass bulb 21.455 liters in capacity. The Arocolor in the sample was absorbed in 100 ml. of redistilled ethyl alcohol, the latter being released into the bulb from an auxiliary bulb by opening an interposed stopcock. In the first few analyses, it was found necessary to free the alcoholic solutions from carbon soot by filtration, but subsequently the need for so doing was eliminated by the insertion of a plug of glass wool between the chamber and apparatus for collection. Suitable aliquot portions of the alcoholic solution were employed in the analyses.

When phosgene was to be determined, the air withdrawn from the chamber was passed at the rate of 6.8 liters per minute first through a column 1.5" x 0.5" of 60 to 80 mesh zinc dust, next through a fritted glass disc immersed in 100 ml. of a 4 per cent aqueous solution of sodium hydroxide contained in a cylindrical tower 13" in height and 2.25" in outside diameter, and lastly through an impinger similarly immersed in a like volume of alkaline solution in a second tower of the same dimensions. Samples of air to be analyzed for hydrochloric acid were collected similarly except for the omission of the column of zinc dust (cf. Jacobs, Analytical Chemistry of Industrial Poisons Hazards and Solvents, p. 305, 306,

1941). After an aliquot portion (15 ml. or less) of the solution had been made acid to phenolphthalein with 10 per cent nitric acid (1 vol. of HNO_3 S.G. 1.42 diluted to 7 volumes with water), and diluted to 25.0 ml. in a volumetric flask, 3 drops of 0.1 N silver nitrate were added. The transmission of light of wave length 500 mμ through this turbid solution in a 50 mm. cell was measured in a Beckman spectrophotometer in comparison with that through a similar cell containing a chloride-free solution prepared in a corresponding manner. A curve relating the transmission at 500 mμ to the concentration of sodium chloride over the range of 20 to 320 micrograms per 25 ml. is shown in Figure 8. One milligram of sodium chloride is equivalent to 0.0461 mg. of phosgene or to 0.6238 mg. of hydrochloric acid.

The cresols were determined colorimetrically after coupling with diazotized sulfanilic acid by methods for the meta isomer described by Posnot and Haman (Anal. Chem. 20:951, 1948), and for the para isomer by Schmidt (J. Biol. Chem. 179:211, 1949). Samples of air for the determination of either tricresyl phosphate or free cresols (meta and para isomers) were passed at the rate of 6.8 liters per minute for 30 to 45 minutes through a fritted-glass disc scrubber and impinger in series as in the case of phosgene. In this instance, each tower

contained 100 ml. of a 1 per cent sodium hydroxide solution. In analyzing for the free cresols, 1 ml. of a 20 per cent sodium carbonate solution was added to an aliquot of 6 ml. or less contained in a 10 ml. glass-stoppered graduated cylinder. After the solution had been diluted to 8 ml., 2 ml. of diazotized sulfanilic acid were added. The latter was prepared by adding 0.75 ml. of a 5 per cent solution of sodium nitrate to 0.75 ml. of a solution of sulfanilic acid contained in a 25 ml. volumetric flask previously cooled in an ice-bath. The sulfanilic acid solution was prepared by dissolving 4.5 g. of the acid in 45 ml. of concentrated hydrochloric acid and diluting it to 500 ml. with water. After the partially diazotized solution had been cooled for 5 minutes, an additional 3 ml. of sodium nitrate solution were added and further cooled for 15 minutes, then diluted to 25 ml. The solution was prepared daily and kept cold. Curves relating the transmission of light of wave lengths 425 mμ and 500 mμ to the concentration of meta cresol over the range of 3 to 49 micrograms per 100 ml. are shown in Figure 9. In making the necessary measurements, the comparison-cell contained a solution similarly prepared except for the omission of cresol. Corresponding curves for para-cresol over the range of 10 to 120 micrograms per 100 ml. are shown in Figure 10. By the use of the following

simultaneous equations, the amount of meta and para cresol could be calculated.

For the determination of meta cresol (ɾ):

p-cresol + 4.31 M-cresol = apparent p-cresol (425 mμ)

p-cresol + 1.13 M-cresol = apparent p-cresol (500 mμ)

3.18 M-cresol = difference in apparent p-cresol at the 2 wave lengths

(Y) M-cresol = $\frac{\text{difference in apparent p-cresol}}{3.18}$

For the determination of para cresol (Y):

M-cresol + $\frac{1}{4.13}$ p-cresol = apparent M-cresol (425 mμ)

M-cresol + $\frac{1}{1.13}$ p-cresol = apparent M-cresol (500 mμ)

0.653 p-cresol = difference in apparent M-cresol at the 2 wave lengths

(Y) p-cresol = $\frac{\text{difference in apparent M-cresol}}{0.653}$

The validity of this method for the simultaneous determination of the two isomers was demonstrated by the following determinations on samples containing both of them in known amounts. Analysis of a sample prepared to contain 12.30Y of m-cresol and 9.962Y of p-cresol yielded 13.50 and 9.95Y, respectively. A second sample prepared to contain 24.60Y of M-cresol and 9.96Y of the para isomer yielded 25.90Y and 10.7Y, respectively.

The results designated as free cresols in Table 4 represent the sum of the two isomers. From 60 to 70 per

cent of the total amount of free cresols present in the chamber, as the result of decomposition at 1050° F., was found to consist of the meta isomer, but when the temperature of the furnace was 1250° F., only the meta isomer was present. Since a sample of tricresyl phosphate, analyzed after hydrolysis, contained approximately 65 per cent of the meta and 35 per cent of the para isomer, it appears likely that the latter underwent decomposition to unidentified fragments at the higher temperature.

For the determination of undecomposed tricresyl phosphate present in the chamber, a 5 ml. aliquot portion of the sample, collected in the manner indicated for the determination of cresols, was hydrolyzed by refluxing it for an hour with 10 ml. of 45 per cent aqueous sodium hydroxide; it was then acidified with concentrated hydrochloric acid and distilled until 300 ml. had been collected. The usual cresol method was then applied to the distillate.

Carbon monoxide was determined by a modification of the method of Bland (Aust. J. Exper. Biol. and Med. Sci. 18:35, 1940). The samples were collected by passing air at the rate of 4.7 liters per minute for 5 minutes through the absorption train shown in Figure 4 by means of a Cast Rotary Blast and Suction Pump located beneath the table and not shown in the photograph. The first U-tube contained glass beads and a 10 per cent aqueous solution of

lead acetate, while the second U-tube, which contained sulfuric acid (S.G. 1.84) and glass beads, was surmounted by a long, narrow tube packed from top to bottom with successive layers of silica gel (impregnated with a cobalt salt to indicate the presence of moisture), magnesium perchlorate (Anhydrone), a sodium hydrate asbestos absorbent (Ascarite) and a second layer of magnesium perchlorate. Air issuing from the top of this tube passed through a tube containing iodine pentoxide heated to 115° C. Iodine liberated by the reaction

$$I_2O_5 + 5CO \longrightarrow 5CO_2 + I_2$$

was collected in a bubbler containing 5 ml. of a 3 per cent aqueous solution of potassium iodide. The rate of flow was measured by an upright manometer as shown in Figure 4. The contents of the bubbler were titrated with 0.001 N arsenious acid, employing starch as indicator,

$$H_3AsO_3 + I_2 + H_2O \longrightarrow H_3AsO_4 + 2HI$$

One milliliter of 0.001 N arsenious acid ≡ 0.070025 mg. of CO. In calculating the results, allowance was made for the previously determined traces of free iodine in the volume of the solution of potassium iodide present in the bubbler.

Each of the following concentrations of the various contaminants of the air of the chamber, expressed as

p.p.m. by volume in air at 84° F. and 745 mm. of mercury, is equivalent to the concentration of 1 mg. per liter.

Compound	1 mg./l. = p.p.m.
Phosgene	255.9
HCl	693.3
Triorosyl phosphate	68.6
Cresol	233.8
Carbon monoxide	902.7
Aroclor 1248	131.7

Experimental Results

Exposure to Undecomposed Vapors. A group of animals, consisting of a cat, 2 guinea pigs, 5 mice, 2 rabbits and 3 rats, survived when exposed to air laden with 3.8 micrograms of Hydraul F-9 per liter for 7 hours on each of 5 consecutive days (Table 1). All animals of a group similarly constituted, except for the omission of one rat, survived when exposed to air containing 43.1 micrograms of Aroclor 1248 for 7 hours on each of 4 consecutive days (Table 2). Except for one rabbit (F798) that died from causes unrelated to exposure 4 days after the 8th exposure, those of a 3rd group survived when subjected to the inhalation of air bearing 61.5 micrograms of triorosyl phosphate for 7 hours on each of 8 days over a period of

10 days (Table 3). Changes in weight were usually small (Tables 1 - 3), and no signs of intoxication were observed.

Microscopic examination of the lungs from animals exposed to Pydraul F-9, and killed 10 or 13 days after the 5th period of exposure, revealed the occurrence of interstitial pneumonitis in the rat, mouse, guinea pig and rabbit. The cat exhibited moderate numbers of histiocytes, containing dark-brown granular pigment, within respiratory bronchioles and alveolar ducts. The remaining viscera were normal.

Animals exposed to the vapor of Aroclor 1248 also had interstitial pneumonitis. The lungs of a cat which had been subjected to exposure to the vapor of Aroclor 1248 were normal. There was no evidence of injury to the other viscera of the various species. The liver of a rabbit (F907), the only one examined microscopically, exhibited severe fatty degeneration and foci of necrosis.

Microscopic examination of tissues from a rabbit (F798) that died 4 days after the 8th exposure to tricresyl phosphate disclosed the presence of a severe parasitic infestation in the liver. Another rabbit that was killed 3 days after the 8th period of exposure had incurred severe parasitic infestation of the liver. A guinea pig had acute lobular pneumonia, unrelated to the experiment. In the lungs of a cat were considerable

numbers of histiocytes, containing dark-brown granules. The viscera of the rats and mice were normal.

Exposure to Products Arising From Pydraul F-9, Aroclor 1248, or Triorsyl Phosphate When in Contact with Inconel at 1250° or 1050° F. The duration of exposure, the changes in weight, and the fate of individual animals that were subjected to the inhalation of the products arising from the contact of Pydraul F-9 with Inconel at 1250° and 1050° F. are presented in Tables 5 and 6, respectively. Corresponding data from animals exposed to the fogs from Aroclor 1248 or triorsyl phosphate are given, respectively, in Tables 7 and 8 and in Tables 9 and 10. The data relevant to mortality among all groups have been summarized in Table 11.

Mortality. Careful examination of the data demonstrate certain general facts. It is apparent, in terms of over-all mortality, that guinea pigs and mice were more susceptible to each of the three materials than were rats and rabbits (Table 12).

The same criterion was employed for comparison of the fogs that were formed at 1250° and 1050° F. The fog generated from Aroclor 1248 at 1250° F. was more toxic than that formed at 1050° (Table 13). In the case of Pydraul F-9, the toxicity of the fog formed at the higher temperature appeared to be slightly greater than that

generated at the lower. The temperature of decomposition was of little importance in determining the toxicity of the fog formed from tricresyl phosphate, since that which resulted from the higher temperature was apparently slightly less toxic than that formed at the lower temperature.

A comparison of the three materials under corresponding conditions indicates that the fogs formed from Aroclor 1248 were more toxic for guinea pigs, rabbits and mice, but not for rats, than were those formed from Pydraul F-9 or tricresyl phosphate (Table 12). Aroclor 1248 is also the most toxic of the three materials if the shortest period of exposure that is lethal is taken as the criterion. Regardless of the temperature of decomposition, all animals survived when subjected to the fog formed by Pydraul F-9 or tricresyl phosphate for 15 or 20 minutes, but exposure of like duration to the fog created by the thermal decomposition of Aroclor 1248 often resulted fatally.

In order to ascertain the effect of different rates of delivery of the liquid into the Inconel tube while the rate of flow of air through the tube was kept constant, Aroclor 1248 and tricresyl phosphate were delivered at two different rates (Tables 4 and 11). The mortality associated with reduction of the rate of delivery was relatively low in many instances.

Signs and Pathology of Intoxication. Although in these experiments the fogs filled the chamber to such an extent that it was impossible to observe the animals throughout the period of exposure, a few signs of intoxication could be observed. The fogs were immediately irritating to the mucous membranes of the animals, as evidenced by their closure of the eyes, twitching of the nose, crying, coughing and sneezing. Labored respiration and irritation of the superficial tissues of the eyes appeared later. Dyspnea was observed after 20 minutes of exposure to Aroclor 1248, but this did not appear until the animals had been exposed to the other materials for almost an hour. Whenever cats were exposed excessive salivation was evident, and frequently long strands of thick mucus drooled from the mouth. Black soot covered the hair of animals exposed to fogs generated at the higher temperature (1250° F.).

Examination of animals that died during or shortly after exposure to the fogs of Hydraul F-9, Aroclor 1248 or tricresyl phosphate revealed extensive pulmonary congestion and, in occasional animals, foci of pulmonary hemorrhage. Many also had foci of black pigment that appeared to be carbon distributed throughout the lung tissue. Microscopically, the lesions consisted of marked hyperemia of the lung, common to all exposed animals

examined, and in many there was intra-alveolar hemorrhage and edema. The carbon pigment was distributed chiefly within the bronchi and, in some instances, completely occluded their lumens. Pulmonary emphysema was present frequently. In 5 guinea pigs and 2 rabbits that died during exposure there was, in addition, an acute purulent bronchitis, apparently a reaction to bronchial irritation. Lethally poisoned animals exhibited parenchymatous degeneration of the liver, kidney and brain with regularity, in addition to the pulmonary lesions. The viscera of animals that died 7 to 10 days after brief periods of exposure revealed pulmonary lesions similar to those already described except that there was more phagocytosis of carbon particles. Animals that survived were killed after intervals varying from 1 week to 2 months. There were no significant lesions of viscera other than lung. Two cats of the 5 exposed to the fog of Pydraul F-9 were examined microscopically. The viscera of Cat A381 were normal, while the lungs of Cat A374 were the site of profuse intraluminal bronchial deposits of black granular material and interstitial pneumonitis. The lung of Cat A371, which had been subjected to 2 periods of exposure to the fog of tricresyl phosphate, was characterized by similar pulmonary changes. Guinea Pig A862, killed 22 days after 2 periods of exposure to tricresyl phosphate

vaporized at 1250° F., was found to have numerous histiocytes loaded with carbon pigment in the lungs, as well as a severe interstitial pneumonitis. Other species of animals had a similar interstitial pneumonitis. However, animals that had suffered the shortest periods of exposure, and animals killed 28 days or longer after exposure, exhibited normal viscera.

The Concentrations of Identified Decomposition Products Formed at the Higher and Lower Temperatures. Although only a part of the materials metered into the Inconel tube could be accounted for in the air in the chamber, some very tentative statements concerning the composition of the air may be made. Although large amounts of soot were formed, no attempts were made to measure the amount of free carbon or of carbon dioxide. More unidentified materials were present when the decomposition was effected at the higher temperature, irrespective of the nature of the liquid dropped into the tube.

In the case of Pydraul F-9, less hydrochloric acid and more free cresols were present when the temperature of contact was 1050° F. than when it was 1250° F. (Table 4).

When the temperature of contact with Pydraul was 1050° F., the concentrations of hydrochloric acid and phosgene, measured together in terms of hydrochloric acid, ranged from 0.35 to 0.67 p.p.m., but when the temperature

was 1250° F. the corresponding values ranged from 11 to 22 p.p.m. Free cresols were more abundant at the lower temperature, being present to the extent of 11 or 12 p.p.m., whereas only 0.09 to 0.15 p.p.m. were found when the temperature was 1250° F.

In experiments with Arcolor 1248, much more undecomposed material was found present when the temperature of contact was 1050° F. than when it was 1250° F., 121 to 286 p.p.m. being found in the former cases and only 10 to 16 p.p.m. in the latter. Only rarely was more than one p.p.m. of phosgene found regardless of the temperature, the values reported as hydrochloric acid and phosgene representing predominantly the former. Less hydrochloric acid was present at the lower temperature, there being 11 to 17 p.p.m. in this case and 84 to 102 p.p.m. when the temperature was 1250° F. The values reported for carbon monoxide are probably somewhat low because the rotameter employed for the collection of the samples had not been calibrated for use under the conditions of these experiments. Nevertheless, it seems apparent that when the Inconel was kept at the higher temperature the amounts of carbon monoxide found tended to increase as the duration of the experiment increased; much less variation was encountered when the Inconel was kept at 1050° F.

In the case of trioresyl phosphate, more of the undecomposed material and more free cresols were present in the chamber when the temperature of the Inconel was lower. The values reported (Table 4) for trioresyl phosphate, as determined by hydrolysis and the colorimetric determination of the resultant cresols, may be somewhat low, since results several fold higher could be obtained by measuring the ultraviolet absorption at 264 mμ of alcoholic solutions of spot samples collected in an evacuated balloon. Determinations by this means may, however, have given high results, since filtration failed to remove a slight smoky turbidity.

Discussion

It is unlikely that any of the fatalities in these experiments could be attributed solely to the presence of phosgene, since, according to Flury and Zernik (Harmful Gases, Berlin, 1931, p. 222), mice must be exposed for several hours to the concentration of 1.25 p.p.m. if any are to be killed, while only 70 per cent of a group of mice died when exposed for 20 minutes to air bearing 20 p.p.m. On numerous occasions the mice in our experiments died when exposed for but one hour to an atmosphere that contained less than 1 p.p.m. of phosgene. Flury and Zernik state also that rabbits survived following exposure for 50 minutes to the concentration of 50 p.p.m., but that 75 per cent of another group died when exposed for twice that period. Fox and Cullumbine (Br. J. Pharmacol. and Chem. 2:38, 1947) report that 8 of 12 rats died after being exposed for 10 minutes to 0.23 mg. of phosgene per liter of air (57.5 p.p.m.), although the concentration of 0.080 mg. per liter (20.5 p.p.m.) was not lethal for rats when inhaled for 10 minutes.

In the concentration of 1.3 to 2.0 mg. per l. (1174 to 1805 p.p.m.), carbon monoxide caused no significant signs of intoxication in mice exposed for 6 hours by Cherno and Liberman (Farmakol. i. Toksikol. 10 (No. 3):22,

1947; C. A. 42:2679, 1948), although 20 to 40 per cent of a group of mice died as a result of a like period of exposure to the concentration of 6 mg. of carbon monoxide per l. (5416 p.p.m.). Since the mice in our experiments died under conditions which were much less severe with respect to carbon monoxide, it is evident that this compound by itself was not responsible for their death. Comparable information with respect to other species of animals is not readily available, although Moss, Jackson and Seiberlich (Arch. Ind. Hyg. and Toxicol. 4:62, 1951) have reported that the concentration of 5,000 p.p.m. was required to kill a rat in 30 minutes.

Rabbits and guinea pigs survived when subjected to the inhalation of the vapors of hydrogen chloride in the approximate concentration of 250, 700 and 1,000 p.p.m., over the respective periods of 7, 2 and 0.08 hours (Treon et al., Arch. Ind. Hyg. and Toxicol. 2:716, 1950). In these same experiments, some of the guinea pigs and rabbits died when exposed for 0.5 to 5.0 hours to concentrations of hydrochloric acid ranging from 1,000 to 400 p.p.m. Again, hydrochloric acid does not seem to be the sole agent responsible for the deaths encountered in the present experiments.

Data pertaining to the toxicity of cresols in air are not available; however, Deichmann, Kitamiller and

Witherup (Am. J. Clin. Path. 14:73, 1944) found that only after 20 periods of exposure, each of 7 hours, to the vapor of phenol in the air in the concentration of 0.1 to 0.2 mg. per l. did any respiratory distress or fatalities develop among a group of 12 guinea pigs. Rabbits and rats survived much longer. Since it is likely that the vapors of meta- and para-cresol are comparable in toxicity, it does not appear that the deaths reported herein are attributable to cresol.

Supplementary Statement

The Application of Pydraul F-9, Arcolor 1248 and Triorsyl Phosphate Upon the Skin of Rabbits

Experimental Methods. In accordance with the technique of Draize, Woodard and Calvery (J. Pharm. Exper. Therap. 82:377, 1944), one of a series of graded dosages of each of the undiluted materials, Pydraul F-9, Arcolor 1248 and triorsyl phosphate, was maintained for 24 hours in contact with the intact skin of one of a group of rabbits. In this method, the hair was clipped from an area of skin 6 to 7 inches wide and completely encircling the trunk of each rabbit. In other groups, the outermost layer of skin was abraded by scratching thin furrows 7.5 cm. in length and a few millimeters apart with an hypodermic needle.

In either case, the entire trunk was covered with a sleeve of dental rubber dam which fitted tightly at the cephalad and caudad edges of the clipped area and loosely over the intervening area. During the 24-hour period of contact the rabbit was kept in stocks. At the end of the 24 hours, the material was removed from the skin of the animals by washing with water and a sulfonated oil, "pH6".

In addition to the three materials mentioned previously, a product designed to fulfill the same purpose,

Gargoyle DTE, was investigated. Gargoyle DTE (Socony) is said to be a petroleum base hydraulic fluid containing minute amounts of a rust inhibitor and an oxidation inhibitor. Gargoyle DTE has the specific gravity (API) of 31.1, a maximum pour point of 20° F., a minimum flash point of 395° F., a fire point of 497° F. Its viscosity at 100° F., 130° F. and 210° F. is 225, 116 and 48.5 S.S.U., respectively.

Experimental Results. The pertinent data of the experiments relating to Pydraul F-9, Arocolor 1248, tricresyl phosphate and Gargoyle DTE are given in Tables 14, 15, 16 and 17, respectively. Table 18 summarizes the essential information in the preceding tables.

Two rabbits died following the application of 9.4 ml. of Pydraul F-9 per kg. of body weight upon the intact skin of each, whereas only 1 of 3 rabbits died when the dosage was 6.0 ml. per kg. Three rabbits survived when each was subjected to the application of 3.6 ml. per kg. The dosage of 6.0 ml. per kg. was lethal to 3 rabbits when applied upon their abraded skin (Table 14).

Two rabbits died following the application of 6.0 ml. of Arocolor 1248 per kg. of body weight upon abraded skin of each, whereas only 1 of 3 rabbits died when the

dosage was 9.4 or 9.0 ml. per kg. The dosage of 9.4 ml. per kg. was tolerated by 3 rabbits when applied upon their intact skin (Table 15).

The application of tricresyl phosphate upon the intact skin resulted in the death of a rabbit given 9.4 ml. per kg. and in that of another given 6.0 ml. per kg. When the dose was reduced to 2.5 ml. per kg., 1 of 3 rabbits died, whereas 3 rabbits, each given the dosage of 1.6 ml. per kg., survived (Table 16).

Five rabbits with intact skin and 3 rabbits with abraded skin survived following the application of 9.4 ml. of Gargoyle DTE per kg. upon their skin (Table 17).

In no instance was the intact skin of the rabbits injured by the application of these materials. Nothing remarkable occurred when Gargoyle DTE was applied upon the abraded skin; however, the abraded skin became very slightly erythematous after Pydraul F-9 or Aroclor 1248 had been applied.

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Table 1

The Mortality, Length of Survival, and Changes in Weight of Animals Exposed to the Vapor of Pydraul F-9 in Air

(Concentration of Pydraul F-9: 0.00377 mg./l.)

(Duration of Exposure: 5 x 7.0 Hours)

Identification Number	Initial Weight kg.	Change in Weight Expressed as Percentage of Initial Weight		Fate	Length of Survival After Exposure Before the Animals Were Killed Days
		During Period of Exposure	After Period of Exposure		
Cat A359	2.504	-2.4	-	Survived	10
Guinea Pig A740	0.989	-1.4	+ 1.3	Survived	10
Guinea Pig A741	0.981	-3.1	- 0.5	Survived	13
2 Mice	Av. 0.0198	-	-	Survived	10
3 Mice		-	-	Survived	13
Rabbit F824	2.038	-5.4	+11.8	Survived	10
Rabbit F825	1.963	-0.9	-	Survived	10
Rat D539	0.248	+1.2	+15.7	Survived	10
Rat D540	0.209	+3.3	+ 3.8	Survived	13
Rat D541	0.252	-1.6	+ 1.2	Survived	13

Table 2

The Mortality, Length of Survival, and Changes in Weight of Animals Exposed to the Vapor of Aroclor 1248 in Air

(Concentration of Aroclor 1248: 0.0431 mg./l.)

(Duration of Exposure: 4 x 7.0 Hours)

Identification Number	Initial Weight kg.	Change in Weight Expressed as Percentage of Initial Weight		Fate	Length of Survival After Exposure Before the Animals Were Kille Days
		During Period of Exposure	After Period of Exposure		
Cat A378	4.300	- 2.8	- 3.0	Survived	6
Guinea Pig A757	0.988	- 4.8	0	Survived	6
Guinea Pig A758	0.939	- 4.2	- 2.3	Survived	6
5 Mice	Av. 0.0178	+12.4	-	2 Survived 3 Survived	6 7
Rabbit F906	2.044	- 6.4	+ 6.7	Survived	6
Rabbit F907	2.144	+ 1.7	+13.1	Survived	7
Rat E283	0.179	+11.7	-	Survived	6
Rat E284	0.170	+14.7	+11.2	Survived	7

Table 1

The Mortality, Length of Survival, and Changes in Weight of Animals Exposed to the Vapor of Tricresyl Phosphate in Air

(Concentration of Tricresyl Phosphate: 0.0615 mg./l., 4.2 p.p.m.)

(Duration of Exposure: 8 x 7.0 Hours)

Identification Number	Initial Weight kg.	Change in Weight Expressed as Percentage of Initial Weight		Fate	Length of Survival After Exposure Before the Animals Were Killed (K) or Died (D) Days
		During Period of Exposure	After Period of Exposure		
Cat A353	3.226	+ 5.6	0	Survived	3 K
Guinea Pig A733	0.889	+ 1.6	-	Survived	3 K
Guinea Pig A734	0.811	- 0.5	+ 4.8	Survived	10 K
5 Mice	Av. 0.0164	+13.4	-	2 Survived 3 Survived	3 K 10 K
Rabbit F797	1.779	+ 4.6	0	Survived	3 K
Rabbit F798	1.841	+ 6.5	-	Survived	4 D (1)
Rat D536	0.130	+14.6	+ 6.2	Survived	3 K
Rat D537	0.140	+ 7.1	+25.7	Survived	10 K
Rat D538	0.129	+28.7	-	Survived	10 K

(1) Death due to parasitic infestation of liver unrelated to exposure.

Table 4

Concentrations of Various Decomposition Products in Air of Chamber in the Several Experiments

Material in Contact With Inconel	Variation in Temperature of Inconel ° F.	Experiment Number	Material Added ml./min.	Expressed as mg./l. on Upper Line and p.p.m. on Lower Line					
				Aroclor	Phosgene	HCl (uncorrected for Phosgene	Tricresyl Phosphate	Free Cresols	Carbon Monoxide
Pydraul	1240 - 1256	1	0.143	-	-	0.0328 22.7	-	0.00065 0.15	-
Pydraul	1245 - 1260	2	0.133	-	-	0.0180 12.5	-	0.00052 0.12	-
Pydraul	1240 - 1250	3	0.167	-	-	0.0164 11.4	-	0.00038 0.09	-
Pydraul	1245	4	0.245	-	-	0.0155 10.7	-	-	-
Pydraul	1245	5	0.220	-	-	-	-	—	-
Pydraul	1040 - 1055	6	0.132	-	-	0.0005 0.35	-	0.0459 10.7	-

Table 4 (Page 2)

Material in Contact With Inconel	Variation in Temperature of Inconel °F.	Experiment Number	Material Added ml./min.	Expressed as mg./l. on Upper Line and p.p.m. on Lower Line					
				Aroclor	Phosgene	HCl (uncorrected for Phosgene)	Tricresyl Phosphate	Free Cresols	Carbon Monoxide
Pydraul	1047 - 1052	7	0.125	-	-	0.0012 0.83	-	0.0485 11.3	-
Pydraul	1049	8	0.113	-	-	0.00096 0.67	-	0.0487 11.4	-
Pydraul	1049	9	0.148	-	-	-	-	0.0513 12.0	-
Pydraul	1047	10	0.100	-	-	-	-	-	-
Aroclor	1247 - 1256	1	0.113	0.124 16.3	0.00203 0.52	0.121 83.9	-	-	0.24 216.7
Aroclor	1247 - 1252	2	0.144	0.111 14.6	0.0186 4.8	0.147 101.9	-	-	0.0366 33.0
Aroclor	1249 - 1252	3	0.125	0.0778 10.2	0.0012 0.31	-	-	-	0.0016 1.4

Table 4 (Page 3)

Material in Contact With Inconel	Variation in Temperature of Inconel ° F.	Experiment Number	Material Added ml./min.	Expressed as m./l. on Upper Line and p.p.m. on Lower Line					
				Aroclor	Phosgene	HCl (uncorrected for Phosgene)	Tricresyl Phosphate	Free Cresols	Carbon Monoxide
Aroclor	1252	4	0.130	0.102 13.4	-	-	-	-	0.00077 0.7
Aroclor	1249	5	0.069	0.0573 7.5	0.0109 2.8	0.0143 9.9	-	-	0.0252 22.7
Aroclor	1252	6	0.067	0.0387 5.1	0.0015 0.4	-	-	-	0.0386 34.8
Aroclor	1049 - 1053	8	0.121	2.17 285.8	0.00035 0.09	0.0224 15.5	-	-	0.0260 23.5
Aroclor	1049 - 1053	7	0.122	1.80 237.1	0.00071 0.18	0.0154 10.7	-	-	0.0308 27.8
Aroclor	1049 - 1051	9	0.121	1.37 180.4	0.00037 0.09	0.0253 17.5	-	-	0.0146 13.2
Aroclor	1049	10	0.120	1.24 163.3	-	0.0190 13.2	-	-	0.0220 19.9

Table 4 (Page 4)

Material in Contact With Inconel	Variation in Temperature of Inconel ° F.	Experiment Number	Material Added ml./min.	Expressed as m.g./l. on Upper Line and p.p.m. on Lower Line					
				Aroclor	Phosgene	HCl (uncorrected for Phosgene)	Tricresyl Phosphate	Free Cresols	Carbon Monoxide
Aroclor	1051	11	0.120	0.918 120.9	-	-	-	-	0.021 19.0
Aroclor	1049 - 1051	12	0.058	1.60 210.7	0.00052 0.13	0.0171 11.9	-	-	0.025 23.2
Aroclor	1050 - 1052	13	0.068	1.31 172.5	-	0.0107 7.4	-	-	0.012 11.6
Tricresyl Phosphate	1240 - 1258	15	0.144	-	-	-	-	0.0049 1.1	-
Tricresyl Phosphate	1249 - 1252	2	0.122	-	-	-	0.0013 0.9	0.00266 0.6	0.029 26.4
Tricresyl Phosphate	1247 - 1253	1	0.121	-	-	-	0.0038 6.0	0.00158 0.4	0.034 31.1
Tricresyl Phosphate	1257	4	0.233	-	-	-	-	0.00676 1.6	-
Tricresyl Phosphate	1249	6	0.210	-	-	-	-	-	-

Table 4 (Page 5)

Material in Contact With Inconel	Variation in Temperature of Inconel ° F.	Experiment Number	Material Added ml./min.	Expressed as m.e./l. on Upper Line and p.p.m. on Lower Line					
				Aroclor	Phosgene	HCl (uncorrected for Phosgene)	Tricresyl Phosphate	Free Cresols	Carbon Monoxide
Tricresyl Phosphate	1245	8	0.071	-	-	-	-	0.0011 0.3	-
Tricresyl Phosphate	1258	7	0.072	-	-	-	-	-	-
Tricresyl Phosphate	1045 - 1057	14	0.130	-	-	-	-	0.011 2.6	-
Tricresyl Phosphate	1049 - 1051	13	0.125	-	-	-	-	0.098 23	-
Tricresyl Phosphate	1025	3	0.120	-	-	-	0.550 37.8	0.0565 13	0.025 22.6
Tricresyl Phosphate	1053	10	0.175	-	-	-	-	-	-
Tricresyl Phosphate	1051	11	0.195	-	-	-	-	-	-
Tricresyl Phosphate	1049 - 1051	9	0.088	-	-	-	-	0.35 81	-
Tricresyl Phosphate	1051	12	0.082	-	-	-	-	-	-

Table 2

The Mortality, Length of Survival, and Changes in Weight of Animals Exposed to Aerosols Formed by Spraying Hydraul F-9 Into an Inconel Tube Heated to a Temperature of 1250° F. (677° C.)

Experiment Number	Duration of Exposure Hours	Identification Number	Initial Weight Kg.	Change in Weight Expressed as Percentage of Initial Weight		Fate as Noted at End of Last Period of Exposure	Length of Survival of Animals That Died (D) or Were Killed (K) After Last Period of Exposure
				During Period of Exposure	After Period of Exposure		
1	6.0 + 6.25	Cat A374	2.945	-10.0	+11.2	Survived	7 days K
	6.0	Guinea Pig A759	0.820	- 1.2	-	Died	-
	6.0 + 6.25	Guinea Pig A760	1.020	-11.1	+ 1.8	Survived	7 days K
	6.25	3 Mice	Av.0.024	-	-	Died	-
	6.0 + 6.25	2 Mice					
	6.0 + 6.25	Rabbit F932	2.620	- 6.8	+10.0	Survived	7 days K
	6.0 + 6.25	Rabbit F933	2.550	- 4.2	+ 4.9	Survived	7 days K
	6.0	Rat E301	0.207	- 1.0	-	Died	-
	6.0	Rat E302	0.208	- 1.4	-	Died	-
2	6.75	Cat A379	3.170	- 9.9	+ 3.3	Survived	2 months K
	6.75	Guinea Pig A761	0.450	- 1.8	-	Died	-
	6.75	Guinea Pig A762	0.445	0	-	Died	-
	6.75	Mouse A435	0.025	- 8.0	+16.0	Survived	15 days K
	6.75	3 Mice	Av.0.020	-	-	Died	-
	6.75	Rabbit F934	2.267	0	+11.2	Survived	8 days K
	6.75	Rabbit F935	2.270	0	+ 8.4	Survived	8 days K
	6.75	Rat E303	0.180	- 2.2	-	Died	-
	6.75	Rat E304	0.205	- 4.9	-	Died	-

Table 5 (Page 2)

Experiment Number	Duration of Exposure Hours	Identification Number	Initial weight kg.	Change in Weight Expressed as Percentage of Initial Weight		Fate as Noted at End of Last Period of Exposure	Length of Survival of Animals That Died (D) or Were Killed (K) After Last Period of Exposure
				During Period of Exposure	After Period of Exposure		
3	3.1	Cat A370	3.080	- 7.5	+10.0	Survived	7 days K
	3.1	Guinea Pig A763	0.485	- 2.7	-	Died	-
	3.1	Guinea Pig A764	0.480	- 7.1	+ 9.2	Survived	7 days K
	3.1	3 Mice	Av.0.015	-	-	Died	-
	3.1	2 Mice	Av.0.0175	-	-	Survived	15 days K
	3.1	Rabbit F936	2.170	0	+ 6.4	Survived	7 days K
	3.1	Rabbit F937	2.470	- 6.6	-	Survived	2 days D
	3.1	Rat E305	0.200	- 3.5	-	Died	-
	3.1	Rat E306	0.200	- 1.0	-	Died	-
4	0.9	Cat A381	2.325	- 1.9	+ 4.8	Survived	9 days K
	0.9	Guinea Pig A765	0.440	- 1.6	-	Died	-
	0.9	Guinea Pig A766	0.410	0	+ 5.9	Survived	15 days K
	0.9	4 Mice	Av.0.017	-	-	Died	-
	0.9	1 Mouse	0.015	0	+53.3	Survived	14 days K
	0.9	Rabbit F938	1.998	0	+27.1	Survived	15 days K
	0.9	Rabbit F939	2.030	0	+27.6	Survived	15 days K
	0.9	Rat E307	0.205	- 6.8	+25.4	Survived	14 days K
	0.9	Rat E308	0.188	-10.6	+32.4	Survived	15 days K
5	0.25	Guinea Pig A767	0.450	- 2.2	+ 8.4	Survived	24 days K
	0.25	Guinea Pig A768	0.460	- 4.8	+10.7	Survived	24 days K
	0.25	5 Mice	Av.0.0156	0	+ 8.3	Survived	28 days K
	0.25	Rabbit F940	2.115	- 4.4	+37.9	Survived	28 days K
	0.25	Rabbit F941	2.050	0	+28.5	Survived	28 days K
	0.25	Rat E309	0.187	-14.4	+36.9	Survived	28 days K
	0.25	Rat E310	0.188	- 6.5	+30.3	Survived	28 days K

Table 6

The Mortality, Length of Survival, and Changes in Weight of Animals Exposed to Aerosols Formed by Dropping Hydraul F-y Into an Inconel Tube Heated to a Temperature of 1050° F. (566° C.)

Experiment Number	Duration of Exposure Hours	Identification Number	Initial Weight kg.	Change in Weight Expressed as Percentage of Initial Weight		Rate as Noted at End of Last Period of Exposure	Length of Survival of Animals That Died (D) or Were Killed (K) After Last Period of Exposure
				During Period of Exposure	After Period of Exposure		
6	6.5 + 6.8	Cat A376	3.085	- 7.3	- 4.2	Survived	3 months K
	6.5	Guinea Pig A769	0.450	- 5.3	-	Survived	16 hours D
	6.5	Guinea Pig A770	0.408	- 7.1	-	Died	-
	6.5 + 6.8	1 Mouse)		-	-	Died	-
	6.5 + 6.8	1 Mouse)	Av.0.0184	-	-	Survived	3 days D
	6.5 + 6.8	3 Mice)		-	-	Survived	7 days K
	6.5 + 6.8	Rabbit F942	2.190	-	-22.6	Survived	17 days D
	6.5 + 6.8	Rabbit F943	2.140	-14.4	-	Survived	4 days D
	6.5 + 6.8	Rat E311	0.235	-20.4	-	Survived	3 days D
	6.5 + 6.8	Rat E312	0.208	- 4.8	+33.2	Survived	24 days K
7	6.8	Guinea Pig A771	0.490	- 5.9	-	Died	-
	6.8	Guinea Pig A772	0.465	- 1.3	-	Died	-
	6.8	3 Mice)		-	-	Died	-
	6.8	1 Mouse)	Av.0.017	-	-	Survived	3 days D
	6.8	1 Mouse)		-	-	Survived	5 days D
	6.8	Rabbit F944	2.055	- 5.1	+ 6.4	Survived	24 days K
	6.8	Rabbit F945	2.140	0	+23.5	Survived	28 days K
	6.8	Rabbit F946	2.410	-	-12.1	Survived	6 days D
	6.8	Rat E326	0.230	-13.0	+24.6	Survived	29 days K
	6.8	Rat E327	0.280	- 8.6	-28.6	Survived	1 month D

Table 6 (Page 2)

Experiment Number	Duration of Exposure Hours	Identification Number	Initial Weight kg.	Change in Weight Expressed as Percentage of Initial Weight		Fate as Noted at End of Last Period of Exposure	Length of Survival of Animals That Died (D) or Were Killed (K) After Last Period of Exposure
				During Period of Exposure	After Period of Exposure		
8	3.4	Guinea Pig A773	0.400	- 3.1	-	Died	-
	3.4	Guinea Pig A774	0.435	- 3.4	-	Died	-
	3.4	3 Mice)		-	-	Died	-
	3.4	1 Mouse)	Av.0.023	-	-	Survived	6 days D
	3.4	1 Mouse)		-	-	Survived	6 days K
	3.4	Rabbit F953	2.080	-26.2	+50.0	Survived	1.6 months K
	3.4	Rabbit F954	2.250	-23.1	+49.4	Survived	18 days K
	3.4	Rabbit F955	1.940	-11.6	+38.1	Survived	28 days K
	3.4	Rat E328	0.230	- 7.4	+24.7	Survived	27 days K
	3.4	Rat E329	0.230	-12.6	+35.7	Survived	27 days K
9	0.9	Guinea Pig A775	0.430	- 1.6	-36.2	Survived	19 days D
	0.9	Guinea Pig A776	0.405	- 3.2	-	Survived	1 day D
	0.9	2 Mice)		-	-	Died	-
	0.9	3 Mice)	Av.0.0162	-	-	Survived	4 days K
	0.9	Rabbit F956	1.934	0	+27.5	Survived	28 days K
	0.9	Rabbit F957	2.180	- 0.7	+28.5	Survived	28 days K
	0.9	Rabbit F958	1.870	-17.3	+36.6	Survived	1.6 months K
	0.9	Rat E330	0.260	0	+30.8	Survived	27 days K
	0.9	Rat E331	0.230	0	+34.8	Survived	27 days K
10	0.25	Guinea Pig A777	0.845	- 7.2	+11.7	Survived	1.7 months K
	0.25	Guinea Pig A778	0.695	- 6.2	+ 6.0	Survived	1.7 months K
	0.25	5 Mice	Av.0.0122	0	-	Survived	34 days K
	0.25	Rabbit F959	2.040	- 0.7	+35.5	Survived	28 days K
	0.25	Rabbit F960	2.095	0	+43.5	Survived	28 days K
	0.25	Rabbit F961	1.735	0	+29.9	Survived	28 days K
	0.25	Rat E332	0.200	- 7.5	+37.5	Survived	29 days K
	0.25	Rat E333	0.235	-10.6	+42.1	Survived	29 days K

Table 7

The Mortality, Length of Survival, and Changes in Weight of Animals Exposed to Aerosols Formed by Dropping Aroclor 1248 Into an Inconel Tube Heated to a Temperature of 1250° F. (677° C.)

Experiment Number	Duration of Exposure Hours	Identification Number	Initial Weight kg.	Change in Weight Expressed as Percentage of Initial Weight		Fate as Noted at End of Last Period of Exposure	Length of Survival of Animals That Died (D) or Were Killed (K) After Last Period of Exposure
				During Period of Exposure	After Period of Exposure		
1	7.0	Guinea Pig A779	0.415	- 1.2	-	Died (1)	-
	7.0	Guinea Pig A780	0.475	- 1.1	-	Died (1)	-
	7.0	5 Mice	Av.0.0154	-	-	5 Died	-
	7.0	Rabbit F962	2.105	- 1.7	-	Died (2)	-
	7.0	Rabbit F963	2.205	- 1.4	-	Died (2)	-
	7.0	Rabbit F964	1.960	0	-	Died (2)	-
	7.0	Rat B334	0.220	- 6.8	-	Died	-
	7.0	Rat B335	0.250	- 6.0	-	Died	-
2	3.0	Guinea Pig A782	0.430	-	-29.8	Survived	9 days D
	3.0	Guinea Pig A783	0.440	- 4.5	-	Died (3)	-
	3.0	5 Mice	Av.0.0152	- 6.6	-	5 Died	-
	3.0	Rabbit F980	1.750	-19.1	+ 7.4	Survived	27 days D
	3.0	Rabbit F981	1.800	- 9.2	-	Survived	6 days D
	3.0	Rabbit F982	1.865	-	-	Died	-
	3.0	Rat B336	0.265	- 1.9	-	Died	-
	3.0	Rat B337	0.240	- 4.2	-	Died	-

Experiment Number	Duration of Exposure Hours	Identification Number	Initial Weight Kg.	Change in Weight Expressed as Percentage of Initial Weight		Rate as Noted at End of Last Period of Exposure	Length of Survival of Animals That Died (D) or Were Killed (K) After Last Period of Exposure
				During Period of Exposure	After Period of Exposure		
3	1.0	Guinea Pig A764	0.415	- 4.1	-	Survived	7 hours D
	1.0	Guinea Pig A765	0.370	-	-36.2	Survived	2 days D
	1.0	1 Mouse)		-	-	Survived	5 minutes D
	1.0	1 Mouse)	Av.0.016	-	-	Survived	1 day D
	1.0	1 Mouse)		-	-	Survived	6 days D
	1.0	1 Mouse)		-	-	Survived	8 days D
	1.0	Rabbit F963	1.765	0	+28.7	Survived	23 days K
	1.0	Rabbit F964	1.785	0	+27.3	Survived	23 days K
	1.0	Rabbit F965	1.580	0	+25.0	Survived	23 days K
	1.0	Rat A338	0.245	- 7.4	+36.3	Survived	24 days K
	1.0	Rat A339	0.265	-10.6	+30.9	Survived	24 days K
4	0.33	Guinea Pig A706	0.460	- 0.7	-	Survived	1 day D
	0.33	Guinea Pig A707	0.460	-	-28.0	Survived	9 days D
	0.33	5 Mice	Av.0.0182	-22.0	-	Survived	1 day D
	0.33	Rabbit F965	2.075	- 1.1	+ 3.6	Survived	8 days K
	0.33	Rabbit F966	1.364	-	-13.2	Survived	10 days D
	0.33	Rabbit F967	1.960	- 1.0	-	Survived	8 days K
	0.33	Rat E340	0.220	0	+ 4.5	Survived	13 days K
	0.33	Rat E341	0.225	0	+ 5.8	Survived	13 days K

Experiment Number	Duration of Exposure Hours	Identification Number	Initial Weight kg.	Change in Weight Expressed as Percentage of Initial Weight		Rate as Noted at End of Last Period of Exposure	Length of Survival of Animals That Died (D) or Were Killed (K) After Last Period of Exposure
				During Period of Exposure	After Period of Exposure		
5	3.0	Guinea Pig A788	0.440	-	-42.0	Survived	9 days D
	3.0	Guinea Pig A789	0.415	-	-53.3	Survived	10 days D
	3.0	4 Mice)	Av.0.0190	-25.5	-	Died	-
	3.0	1 Mouse)		-	-23.7	Survived	4 days D
	3.0	Rabbit F968	2.160	- 7.1	-13.6	Survived	22 days K
	3.0	Rabbit F969	1.895	- 3.9	+19.7	Survived	22 days K
	3.0	Rabbit F970	1.870	- 1.1	+ 8.1	Survived	7 days K
	3.0	Rat B342	0.280	- 4.6	+ 5.8	Survived	12 days K
	3.0	Rat B343	0.215	- 4.7	-	Died	-
6	1.0	Guinea Pig A790	0.605	- 5.5	-11.2	Survived	1.6 months K
	1.0	Guinea Pig A791	0.425	- 9.5	+ 7.5	Survived	1 month K
	1.0	5 Mice	Av.0.0142	0	+68.9	5 Survived	28 days K
	1.0	Rabbit F971	1.795	0	+24.0	Survived	22 days K
	1.0	Rabbit F972	1.950	0	+32.8	Survived	1.4 months K
	1.0	Rabbit F973	1.800	0	+17.3	Survived	22 days K
	1.0	Rat B344	0.330	0	+ 3.6	Survived	23 days K
	1.0	Rat B345	0.295	0	+21.6	Survived	23 days K

(1) 2.25 hours from the start of exposure.
(2) 6 hours from the start of exposure.
(3) 1.5 hours from the start of exposure.

Table 2

The Mortality, Length of Survival, and Changes in Weight of Animals Exposed to Aerosols Formed by Dropping Aroclor 1248 Into an Inconel Tube Heated to a Temperature of 1050° F. (566° C.)

Experiment Number	Duration of Exposure Hours	Identification Number	Initial Weight kg.	Change in Weight Expressed as Percentage of Initial Weight		Rate as Noted at End of Last Period of Exposure	Length of Survival of Animals That Died (D) or Were Killed (K) After Last Period of Exposure
				During Period of Exposure	After Period of Exposure		
8	7.0	Guinea Pig A794	0.435	- 2.3	-	Died	-
	7.0	Guinea Pig A795	0.460	- 2.2	-	Died	-
	7.0	4 Mice)		-	-	4 Died	-
	7.0 + 7.0	1 Mouse)	Av.0.0236	-	-	Survived	12 hours D
	7.0 + 7.0	Rabbit F977	2.060	- 9.2	-	Died	-
	7.0 + 7.0	Rabbit F978	2.200	-10.0	-	Died	-
	7.0	Rabbit F979	2.175	- 5.2	-	Died	-
	7.0	Rat E361	0.260	- 7.7	-	Died	-
	7.0 + 7.0	Rat E362	0.295	-	-32.6	Survived	5 days D
7	7.0	Guinea Pig A792	0.450	0	-	Died	-
	7.0	Guinea Pig A793	0.420	- 1.2	-	Died	-
	7.0	2 Mice)		-	-	2 Died	-
	7.0	1 Mouse)	Av.0.019	-24.5	-	Survived	5 days D
	7.0	2 Mice)		-	-	Survived	28 days K
	7.0	Rabbit F974	1.965	- 8.5	-	Survived	5 days D
	7.0	Rabbit F975	1.865	- 9.4	+41.2	Survived	1.3 months K
	7.0	Rabbit F976	2.005	- 8.1	+19.4	Survived	1.3 months K
	7.0	Rat E359	0.305	- 2.6	-	Died	-
	7.0	Rat E360	0.310	- 3.2	-	Died	-

Table 8 (Page 2)

Experiment Number	Duration of Exposure Hours	Identification Number	Initial Weight kg.	Change in Weight Expressed as Percentage of Initial Weight		Fate as Noted at End of Last Period of Exposure	Length of Survival of Animals That Died (D) or Were Killed (K) After Last Period of Exposure
				During Period of Exposure	After Period of Exposure		
9	3.5	Guinea Pig A796	0.390	-	-	Died	-
	3.5	Guinea Pig A797	0.415	-	-	Died	-
	3.5	3 Mice)		-	-	3 Died	-
	3.5	1 Mouse)	Av.0.019	-	-	Survived	10 days D
	3.5	1 Mouse)		-	-	Survived	20 days K
	3.5	Rabbit F986	2.320	-13.8	+15.6	Survived	1 month K
	3.5	Rabbit F987	2.250	-	- 4.3	Survived	5 days D
	3.5	Rabbit F988	2.385	- 0.6	-	Died	-
	3.5	Rat A363	0.290	- 3.4	+23.1	Survived	1.1 months K
	3.5	Rat A364	0.240	-10.0	+26.2	Survived	1.1 months K
10	1.0	Guinea Pig A798	0.455	- 2.2	-	Died	-
	1.0	Guinea Pig A799	0.430	- 3.5	-	Survived	2.8 hours D
	1.0	5 Mice	Av.0.0190	- 2.2	+37.9	Survived	20 days K
	1.0	Rabbit F989	2.040	-	- 6.9	Survived	6 days D
	1.0	Rabbit F991	2.260	- 3.5	+17.3	Survived	1 month K
	1.0	Rat A365	0.315	- 4.8	+24.8	Survived	1.1 months K
	1.0	Rat A366	0.305	- 4.9	+16.4	Survived	14 days K
11	0.33	Guinea Pig A800	0.410	-	-45.1	Survived	10 days D
	0.33	Guinea Pig A801	0.455	- 1.8	-	Died	-
	0.33	5 Mice	Av.0.050	-28.8	+48.8	Survived	19 days K
	0.33	Rabbit F994	2.095	-11.2	+24.3	Survived	1 month K
	0.33	Rabbit F995	2.120	- 3.2	-21.4	Survived	1.3 months K
	0.33	Rabbit F996	2.190	-	-26.1	Survived	12 days D
	0.33	Rat A367	0.280	0	+29.6	Survived	1.1 months K
	0.33	Rat A368	0.255	0	+38.7	Survived	1.1 months K

Experiment Number	Duration of Exposure Hours	Identification Number	Initial Weight kg.	Change in Weight Expressed as Percentage of Initial Weight		Fate as Noted at End of Last Period of Exposure	Length of Survival of Animals That Died (D) or Were Killed (K) After Last Period of Exposure
				During Period of Exposure	After Period of Exposure		
12	3.5	Guinea Pig A802	0.460	- 3.3	-	Died	-
	3.5	Guinea Pig A803	0.450	- 2.2	-	Died	-
	3.5	5 Mice	Av.0.017	0	+22.4	Survived	16 days K
	3.5	Rabbit F997	2.210	- 7.2	+20.5	Survived	29 days K
	3.5	Rabbit F998	2.080	- 5.5	+11.3	Survived	29 days K
	3.5	Rabbit F999	2.090	-	- 5.7	Survived	5 days D
	3.5	Rat E369	0.255	0	+10.9	Survived	1 month K
	3.5	Rat E370	0.235	0	+26.7	Survived	1 month K
13	1.0	Guinea Pig A804	0.425	- 2.4	-	Survived	3 hours D
	1.0	Guinea Pig A805	0.405	- 1.0	-	Survived	3 hours D
	1.0	3 Mice)	Av.0.017	0	-	Survived	16 days K
	1.0	1 Mouse)		-	-	Survived	7 days D
	1.0	Rabbit G2	2.340	-18.6	+40.6	Survived	37 days K
	1.0	Rabbit G3	2.410	- 6.6	+24.8	Survived	29 days K
	1.0	Rabbit G4	2.345	- 3.2	+12.4	Survived	29 days K
	1.0	Rat E371	0.230	- 6.5	+ 9.6	Survived	32 days K
	1.0	Rat E372	0.215	- 2.3	+ 7.4	Survived	32 days K

Table 2

The Mortality, Length of Survival, and Changes in Weight of Animals Exposed to Aerosols Formed by Dropping Tricresyl Phosphate Into an Inconel Tube Heated to a Temperature of 1250° F. (677° C.)

Experiment Number	Duration of Exposure Hours	Identification Number	Initial Weight kg.	Change in Weight Expressed as Percentage of Initial Weight		Fate as Noted at End of Last Period of Exposure	Length of Survival of Animals That Died (D) or Were Killed (K) After Last Period of Exposure
				During Period of Exposure	After Period of Exposure		
15	2 x 7.0	Cat A371	3.611	- 6.5	+ 1.2	Survived	7 days K
	2 x 7.0	Guinea Pig A862	0.444	- 4.0	+11.9	Survived	22 days K
	7.0	Guinea Pig A863	0.438	- 2.3	-	Died	-
	2 x 7.0	5 Mice	Av.0.0154	-	-	5 Died	-
	2 x 7.0	Rabbit G178	2.963	- 6.4	+12.9	Survived	17 days K
	2 x 7.0	Rabbit G179	2.543	0	-15.6	Survived	14 days D
	2 x 7.0	Rabbit G180	2.791	- 4.9	+19.6	Survived	16 days K
	7.0	Rat E479	0.406	- 2.2	-	Died	-
	7.0	Rat E480	0.450	-	-	Died	-
2	7.0	Guinea Pig A808	0.410	- 4.9	-38.0	Survived	30 days D
	7.0	Guinea Pig A809	0.495	- 1.4	-	Died	-
	7.0	5 Mice	Av.0.017	- 8.0	-	5 Died	-
	7.0	Rabbit G8	1.945	- 6.2	+38.6	Survived	27 days K
	7.0	Rabbit G9	2.010	- 2.7	+22.1	Survived	27 days K
	7.0	Rabbit G10	2.075	0	+33.5	Survived	27 days K
	7.0	Rat E375	0.195	-14.9	-	Died	-
	7.0	Rat E376	0.225	-12.0	-	Died	-

Experiment Number	Duration of Exposure Hours	Identification Number	Initial Weight kg.	Change in Weight Expressed as Percentage of Initial Weight		Rate as Noted at End of Last Period of Exposure	Length of Survival of Animals That Died (D) or Were Killed (K) After Last Period of Exposure
				During Period of Exposure	After Period of Exposure		
1	3.5	Guinea Pig A806	0.500	- 2.6	-	Died	-
	3.5	Guinea Pig A807	0.420	-	-	Died	-
	3.5	2 Mice)		-	-	2 Died	-
	3.5	1 Mouse)	Av.0.017	-10.0	-	Survived	22 days D
	3.5	2 Mice)			+33.3	Survived	34 days K
	3.5	Rabbit G5	2.270	0	+14.8	Survived	28 days K
	3.5	Rabbit G6	2.110	0	+37.4	Survived	28 days K
	3.5	Rabbit G7	2.140	- 0.5	+20.7	Survived	28 days K
	3.5	Rat E373	0.220	0	+ 2.3	Survived	34 days K
	3.5	Rat E374	0.215	0	+ 2.3	Survived	34 days K
4	1.0	Guinea Pig A822	0.445	- 1.6	-	Died	-
	1.0	Guinea Pig A823	0.430	- 9.3	-	Died	-
	1.0	5 Mice	Av.0.0150	-	+57.3	Survived	22 days K
	1.0	Rabbit G22	2.095	- 2.0	+32.2	Survived	19 days K
	1.0	Rabbit G23	1.995	- 2.3	-19.5	Survived	12 days D
	1.0	Rabbit G24	2.110	- 5.9	+20.8	Survived	28 days K
	1.0	Rat E399	0.215	- 6.0	+ 8.4	Survived	1.1 months K
	1.0	Rat E400	0.210	- 3.8	+16.7	Survived	1.1 months K
6	0.33	Guinea Pig A842	0.905	- 1.1	+ 4.4	Survived	8 days K
	0.33	Guinea Pig A843	0.800	0	+ 3.9	Survived	8 days K
	0.33	5 Mice	Av.0.022	0	+14.5	Survived	11 days K
	0.33	Rabbit G114	2.450	0	+15.7	Survived	8 days K
	0.33	Rabbit G117	2.250	- 9.1	+32.9	Survived	1.1 months K
	0.33	Rabbit G118	2.260	- 5.2	+ 7.3	Survived	8 days K
	0.33	Rat E437	0.175	- 5.7	+23.4	Survived	8 days K
	0.33	Rat E438	0.205	0	+20.4	Survived	8 days K

Table 9 (page 3)

Experiment Number	Duration of Exposure Hours	Identification Number	Initial Weight kg.	Change in Weight Expressed as Percentage of Initial Weight		Rate as Noted at End of Last Period of Exposure	Length of Survival of Animals That Died (D) or Were Killed (K) After Last Period of Exposure
				During Period of Exposure	After Period of Exposure		
6	3.5	Guinea Pig AG46	1.060	0	+ 6.3	Survived	7 days K
	3.5	Guinea Pig AG47	0.770	-7.8	+13.2	Survived	7 days K
	3.5	2 Mice)		-	-	2 Died	-
	3.5	2 Mice)	Av.0.024	-	-38.0	Survived	7 days D
	3.5	1 Mouse)		-	-	Survived	7 days K
	3.5	Rabbit G129	2.235	-0.2	- 7.0	Survived	7 days K
	3.5	Rabbit G130	1.920	0	+ 0.3	Survived	7 days K
	3.5	Rabbit G131	1.985	0	+ 5.2	Survived	7 days K
	3.5	Rat E441	0.315	-	-	Died	-
	3.5	Rat E442	0.335	-7.5	+ 9.6	Survived	7 days K
7	1.0	Guinea Pig AG44	0.855	0	+ 2.1	Survived	8 days K
	1.0	Guinea Pig AG45	0.870	0	+ 3.1	Survived	8 days K
	1.0	5 Mice	Av.0.023	-6.0	+18.5	Survived	8 days K
	1.0	Rabbit G119	2.440	-6.8	+19.1	Survived	25 days K
	1.0	Rabbit G120	2.325	0	+10.4	Survived	8 days K
	1.0	Rabbit G121	2.470	-7.3	+35.8	Survived	1.1 months K
	1.0	Rat E439	0.195	-5.1	+24.6	Survived	8 days K
	1.0	Rat E440	0.190	0	+23.7	Survived	8 days K

Table 10

The Mortality, Length of Survival, and Changes in Weight of Animals Exposed to Aerosols Formed by Dropping Tricresyl Phosphate Into an Inconel Tube Heated to a Temperature of 1050° F. (566° C.)

Experiment Number	Duration of Exposure Hours	Identification Number	Initial Weight Kg.	Change in Weight Expressed as Percentage of Initial Weight		Rats as Noted at End of Last Period of Exposure	Length of Survival of Animals That Died (D) or Were Killed (K) After Last Period of Exposure
				During Period of Exposure	After Period of Exposure		
14	7.0	Guinea Pig A860	1.035	- 4.8	-	Died	-
	7.0	Guinea Pig A861	0.563	- 6.0	-	Died	-
	7.0	5 Mice	Av.0.0208	-23.1	-	Died	-
	2 x 7.0	Rabbit G163	2.393	- 4.8	-	Died	-
	2 x 7.0	Rabbit G164	2.029	-12.3	-	Survived	1 hour D
	2 x 7.0	Rabbit G165	2.005	-10.7	-	Died	-
	7.0	Rat R471	0.454	-10.1	-	Died	-
	7.0	Rat R472	0.474	- 5.9	-	Died	-
13	7.0	Guinea Pig A858	0.430	- 4.2	-	Died	-
	7.0	Guinea Pig A859	0.410	- 1.2	-	Died	-
	7.0	3 Mice)		-	-	Died	-
	7.0	2 Mice)	Av.0.016	-	-	Survived	13 days K
	7.0	Rabbit G151	2.040	- 7.7	+16.9	Survived	12 days K
	7.0	Rabbit G152	2.525	-10.5	+13.5	Survived	13 days K
	7.0	Rabbit G153	2.035	- 6.4	-	Died	-
	7.0	Rat R463	0.470	- 4.0	-	Died	-
	7.0	Rat R464	0.455	- 2.2	-	Died	-

Experiment Number	Duration of Exposure Hours	Identification Number	Initial Weight kg.	Change in Weight Expressed as Percentage of Initial Weight		Rate as Noted at End of Last Period of Exposure	Length of Survival of Animals That Died (D) or Were Killed (K) After Last Period of Exposure
				During Period of Exposure	After Period of Exposure		
3	3.5	Guinea Pig A818	0.434	- 1.8	-	Died	-
	3.5	Guinea Pig A819	0.430	- 3.3	-	Died	-
	3.5	1 Mouse)	-	-	-	Died	-
	3.5	3 Mice)	Av.0.0138	-19.3	+44.9	Survived	26 days K
	3.5	Rabbit G17	2.150	- 1.6	-19.0	Survived	7 days D
	3.5	Rabbit G18	1.804	- 2.5	+23.0	Survived	20 days K
	3.5	Rabbit G19	2.180	- 2.8	+12.2	Survived	20 days K
	3.5	Rat E393	0.193	- 4.1	+20.7	Survived	25 days K
	3.5	Rat E394	0.197	0	+12.7	Survived	25 days K
10	1.0	Guinea Pig A852	1.110	-11.1	+ 3.0	Survived	8 days K
	1.0	Guinea Pig A853	1.280	-	- 3.4	Survived	2 days D
	1.0	3 Mice)	-	-	- 8	Died	-
	1.0	2 Mice)	Av.0.018	-22.2	+19.5	Survived	7 days K
	1.0	Rabbit G142	2.166	-	-47.8	Survived	26 days D
	1.0	Rabbit G143	2.835	-	-43.0	Survived	17 days D
	1.0	Rabbit G144	2.470	- 2.0	+ 6.7	Survived	8 days K
	1.0	Rat E454	0.160	- 5.0	+19.4	Survived	9 days K
	1.0	Rat E455	0.160	- 6.9	-	Died	-
11	0.33	Guinea Pig A854	0.446	- 5.5	+15.9	Survived	9 days K
	0.33	Guinea Pig A855	0.465	- 1.7	+ 5.6	Survived	9 days K
	0.33	5 Mice	Av.0.0190	-13.7	+17.9	Survived	10 days K
	0.33	Rabbit G145	2.400	- 2.2	+ 3.5	Survived	8 days K
	0.33	Rabbit G146	2.333	- 6.4	+11.6	Survived	8 days K
	0.33	Rabbit G147	2.395	0	+10.9	Survived	8 days K
	0.33	Rat E456	0.450	- 6.0	+ 2.4	Survived	9 days K
	0.33	Rat E457	0.450	- 9.1	+17.8	Survived	9 days K

Experiment Number	Duration of Exposure Hours	Identification Number	Initial Weight kg.	Change in Weight Expressed as Percentage of Initial Weight		Fate as Noted at End of Last Period of Exposure	Length of Survival of Animals That Died (D) or Were Killed (K) After Last Period of Exposure
				During Period of Exposure	After Period of Exposure		
9	3.5	Guinea Pig A850	0.920	- 3.0	+ 0.9	Survived	8 days K
	3.5	Guinea Pig A851	1.035	- 0.2	-	Died	-
	3.5	3 Mice)	Av.0.017	-11.9	-	Died	-
	3.5	2 Mice)		-21.4	+21.4	Survived	7 days K
	3.5	Rabbit G139	2.145	- 9.0	+ 6.3	Survived	9 days K
	3.5	Rabbit G140	2.430	- 4.9	0	Survived	14 days K
	3.5	Rabbit G141	2.460	0	+ 0.8	Survived	4 days K
	3.5	Rat E444	0.360	- 6.7	-	Died	-
	3.5	Rat E445	0.330	-10.6	+ 8.8	Survived	9 days K
12	1.0	Guinea Pig A856	0.750	- 5.2	+ 1.2	Survived	6 days D
	1.0	Guinea Pig A857	0.510	- 5.3	-17.6	Survived	29 days D
	1.0	5 Mice	Av.0.017	0	+11.8	Survived	9 days K
	1.0	Rabbit G148	2.688	- 8.1	+10.2	Survived	8 days K
	1.0	Rabbit G149	2.400	- 2.0	+16.4	Survived	8 days K
	1.0	Rabbit G150	2.170	- 1.8	+15.2	Survived	23 days K
	1.0	Rat E458	0.460	- 4.8	+ 3.0	Survived	9 days K
	1.0	Rat E459	0.430	- 6.5	+ 4.9	Survived	9 days K

Compound and Temperature of Contact	Duration Hours	Mice	Rats	Guinea Pigs	Rabbits	Cats	Experiment Number
Aroclor Decomposition 1050° F.	7.0 + 7.0	5/5	2/2	2/2	3/3	-	8
	7.0	3/5	2/2	2/2	1/3	-	7
	3.5	4/5	0/2	2/2	2/3	-	9
	1.0	0/5	0/2	2/2	1/2	-	10
	0.33	0/5	0/2	2/2	1/3	-	11
	3.5*	0/5	0/2	2/2	1/3	-	12
	1.0*	1/4	0/2	2/2	0/3	-	13
Tricresyl Phosphate Decomposition 1250° F.	2 x 7	5/5	2/2	1/2	1/3	0/1	15
	7.0	5/5	2/2	2/2	0/3	-	2
	3.5	3/5	0/2	2/2	0/3	-	1
	1.0	0/5	0/2	2/2	1/3	-	4
	0.33	0/5	0/2	0/2	0/3	-	6
	3.5*	4/5	1/2	0/2	0/3	-	8
	1.0*	0/5	0/2	0/2	0/3	-	7
Tricresyl Phosphate Decomposition 1050° F.	2 x 7	5/5	2/2	2/2	3/3	-	14
	7.0	3/5	2/2	2/2	1/3	-	13
	3.5	1/4	0/2	2/2	1/3	-	3
	1.0	3/5	1/2	1/2	2/3	-	10
	0.33	0/5	0/2	0/2	0/3	-	11
	3.5*	3/5	1/2	1/2	0/3	-	9
	1.0*	0/5	0/2	2/2	0/3	-	12

*Rate of liquid delivery was about one-half of that in other experiments of similar duration.

Table 11

Summary of Mortality Among Groups of Animals Subjected to Aerosols Formed by Dropping Pydraul F-9, Aroclor 1248 or Tricresyl Phosphate Into a Heated Inconel Tube

Compound and Temperature of Contact	Duration Hours	Mice	Rats	Guinea Pigs	Rabbits	Cats	Experiment Number
Pydraul Decomposition 1250° F.	6.0 + 6.25	5/5	2/2	1/2	0/2	0/1	1
	6.75	3/4	2/2	2/2	0/2	0/1	2
	3.1	3/5	2/2	1/2	1/2	0/1	3
	0.9	4/5	0/2	1/2	0/2	0/1	4
	0.25	0/5	0/2	0/2	0/2	-	5
Pydraul Decomposition 1050° F.	6.5 + 6.8	2/5	1/2	2/2	2/2	0/1	6
	6.8	5/5	1/2	2/2	1/3	-	7
	3.4	4/5	0/2	2/2	0/3	-	8
	0.9	2/5	0/2	2/2	0/3	-	9
	0.25	0/5	0/2	0/2	0/3	-	10
Aroclor Decomposition 1250° F.	7.0	5/5	2/2	2/2	3/3	-	1
	3.0	5/5	2/2	2/2	3/3	-	2
	1.0	4/4	0/2	2/2	0/3	-	3
	0.33	5/5	0/2	2/2	1/3	-	4
	3.0*	5/5	1/2	2/2	0/3	-	5
	1.0*	0/5	0/2	0/2	0/3	-	6

Table 12

Incidence of Mortality in Relation to Material and Species Regardless of the Temperature of the Inconel

Species	Total Number of Animals That Died/Total Number Exposed		
	Hydraul F-9	Arcolor 1248	Triorosyl Phosphate
	%	%	%
Mice	28/49 (57.1)	37/63 (58.7)	32/69 (46.4)
Guinea Pigs	13/20 (65.0)	24/26 (92.3)	17/28 (60.7)
Rabbits	4/24 (16.2)	16/38 (42.1)	9/42 (21.4)
Rats	8/20 (40.0)	9/26 (34.6)	11/28 (39.3)

Table 13

Incidence of Mortality in Relation to Material, Species, and Temperature of Inconel

Species	Number of Animals That Died/Number of Animals Exposed	
	1250° F.	1050° F.
Aroclor 1248		
	%	%
Mice	24/29 (82.8)	13/34 (38.2)
Guinea Pigs	10/12 (83.3)	14/14 (100.0)
Rabbits	7/18 (38.9)	9/20 (45.0)
Rats	5/12 (41.7)	4/14 (28.6)
Total	46/71 (64.8)	40/82 (48.8)
Pydraul F-9		
	%	%
Mice	15/24 (62.5)	13/25 (52.0)
Guinea Pigs	5/10 (50.0)	8/10 (80.0)
Rabbits	1/10 (10.0)	3/14 (21.4)
Rats	6/10 (60.0)	2/10 (20.0)
Total	27/54 (50.0)	26/59 (44.1)
Tricresyl Phosphate		
	%	%
Mice	17/35 (48.6)	15/34 (44.1)
Guinea Pigs	7/14 (50.0)	10/14 (71.4)
Rabbits	2/21 (9.5)	7/21 (33.3)
Rats	5/14 (35.7)	6/14 (42.9)
Total	31/84 (36.9)	38/83 (45.8)

Table 14

The Toxicity of Hydraul F-9 When Maintained Continuously for Twenty-four Hours in Contact With the Skin of Rabbits by the Sleeve Method of Draize, Woodard and Calvery

(Applied undiluted)

Identification Number	Condition of Skin	Dose ml./K.	Initial Weight kg.	Loss of Weight Expressed as Percentage of Initial Weight	Rate	Length of Survival After the Material Was Applied
G-333	Intact	9.4	2.060	36.1	Died	7 days
G-339	Intact	9.4	2.390	17.4	Died	3 days
G-340	Intact	6.0	2.275	19.8	Died	20 days
G-419	Intact	6.0	1.630	9.9	Survived	9 days; killed
G-421	Intact	6.0	2.018	9.6	Survived	9 days; killed
G-420	Intact	3.6	2.100	8.1	Survived	23 days; killed
G-438	Intact	3.6	2.262	3.8	Survived	16 days; killed
G-439	Intact	3.6	2.285	3.7	Survived	16 days; killed
G-455	Abraded	6.0	2.090	36.5	Died	19 days
G-457	Abraded	6.0	1.986	4.3	Died	44 hours
G-458	Abraded	6.0	1.686	15.2	Died	3 days

Table 15

The Toxicity of Aroclor 1248 When Maintained Continuously for Twenty-four Hours in Contact With the Skin of Rabbits by the Sleeve Method of Draize, Woodard and Calvery

(Applied undiluted)

Identification Number	Condition of Skin	Dose ml./kg.	Initial Weight kg.	Loss of Weight Expressed as Percentage of Initial Weight	Fate	Length of Survival After the Material Was Applied
G-438	Intact	9.4	2.310	19.3	Survived	21 days; killed
G-440	Intact	9.4	2.310	3.9	Survived	21 days; killed
G-441	Intact	9.4	2.053	26.2	Survived	31 days; killed
G-422	Abraded	9.4	1.865	9.2	Survived	44 days; killed
G-424	Abraded	9.4	1.922	35.2	Died	8 days
G-443	Abraded	9.0	1.970	14.8	Survived	29 days; killed
G-444	Abraded	6.0	2.196	19.2	Died	6 days
G-456	Abraded	6.0	1.862	12.7	Died	21 hours

Table 16

The Toxicity of Tricresyl Phosphate When Maintained Continuously For Twenty-four Hours in Contact With the Skin of Rabbits by the Sleeve Method of Draize, Woodard and Calvery

(Applied undiluted)

Identification Number	Condition of Skin	Dose ml./kg.	Initial Weight kg.	Loss of Weight Expressed as Percentage of Initial Weight	Fate	Length of Survival After the Material Was Applied
G-628	Intact	9.4	2.487	15.5	Died	2 days
G-337	Intact	6.0	2.460	16.1	Died	2 days
G-334	Intact	2.5	2.190	21.0	Survived	20 days; killed
G-344	Intact	2.5	2.360	38.2	Died	7 days
G-345	Intact	2.5	2.125	9.8	Survived	8 days; killed
G-423	Intact	1.6	1.620	13.2	Survived	9 days; killed
G-442	Intact	1.6	1.809	11.3	Survived	21 days; killed
G-445	Intact	1.6	2.158	5.9	Survived	16 days; killed

The Toxicity of Carboyle DTE when Maintained Continuously for Twenty-four Hours in Contact with the Skin of Rabbits by the Sleeve Method of Draize, Woodard and Calvery

(Applied undiluted)

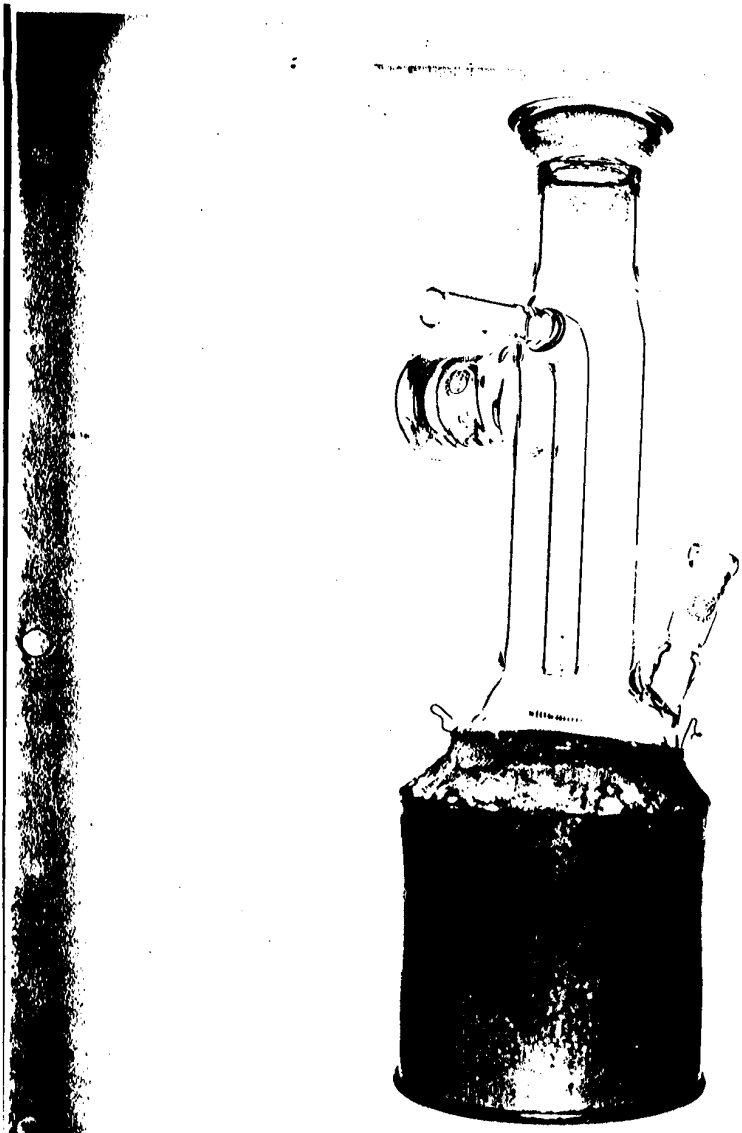
Identification Number	Condition of Skin	Dose ml./kg.	Initial Weight kg.	Loss of weight Expressed as Percentage of Initial Weight	Fate	Length of Survival After the Material was Applied
G-329	Intact	9.4	2.470	12.9	Survived	14 days; killed
G-331	Intact	9.4	2.345	11.9	Survived	16 days; killed
G-341	Intact	9.4	2.030	14.2	Survived	20 days; killed
G-342	Intact	9.4	2.210	17.6	Survived	19 days; killed
G-343	Intact	9.4	2.160	10.2	Survived	8 days; killed
G-332	Abraded	9.4	2.140	6.6	Survived	9 days; killed
G-352	Abraded	9.4	2.450	10.4	Survived	20 days; killed
G-354	Abraded	9.4	2.255	20.2	Survived	20 days; killed

Summarized Data on the Immediate Toxicity of Pydraul F-9, Aroclor 1248, Tricresyl Phosphate and Gargoyle DTE When Maintained Upon the Skin of Rabbits According to the Sleeve Method of Dreize, Woodard and Calvery

Dosage ml./kg.	Number that Died/Number Given the Material						
	Pydraul F-9		Aroclor 1248		Tricresyl Phosphate	Gargoyle DTE	
	Intact	Abraded	Intact	Abraded	Intact	Intact	Abraded
9.4	2/2	-	0/3	1/3	1/1	0/5	0/3
6.0	1/3	3/3	-	2/2	1/1	-	-
3.6	0/3	-	-	-	-	-	-
2.5	-	-	-	-	1/3	-	-
1.6	-	-	-	-	0/3	-	-

Figure 2

MONS 056052



MONS 056053

Figure 1

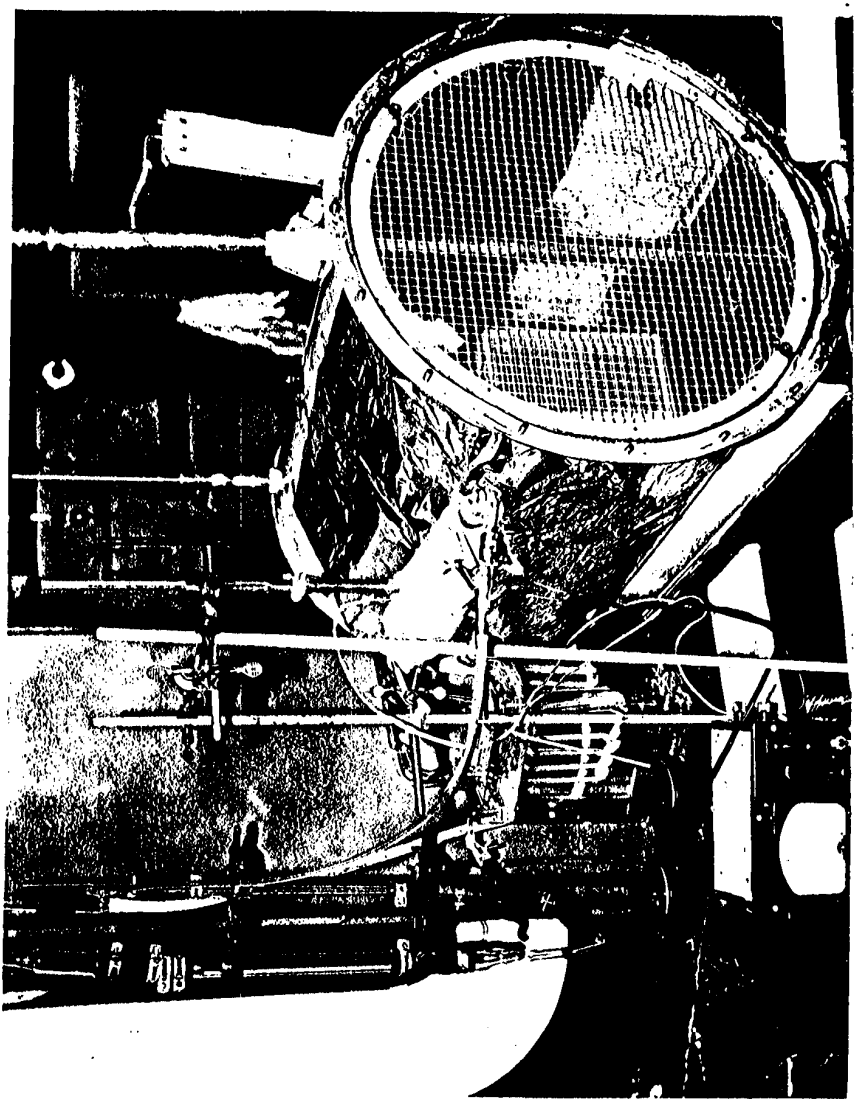


Figure 3

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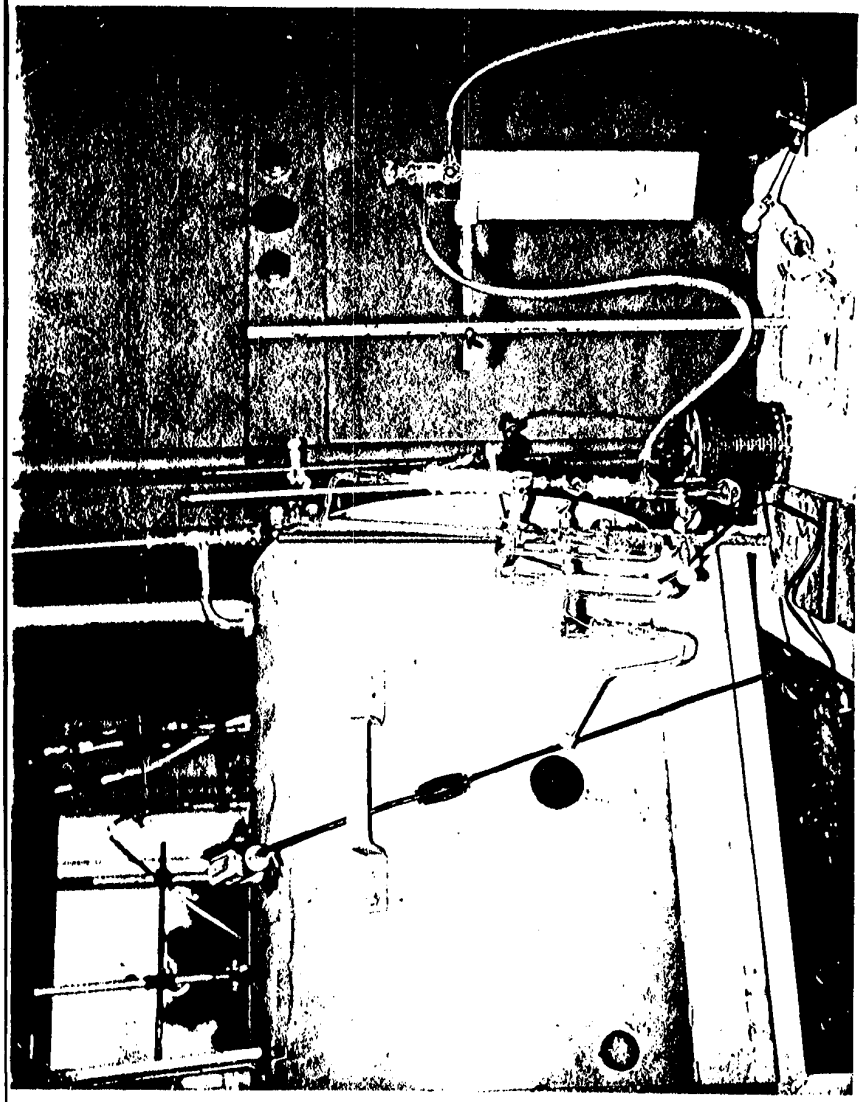

Figure 4

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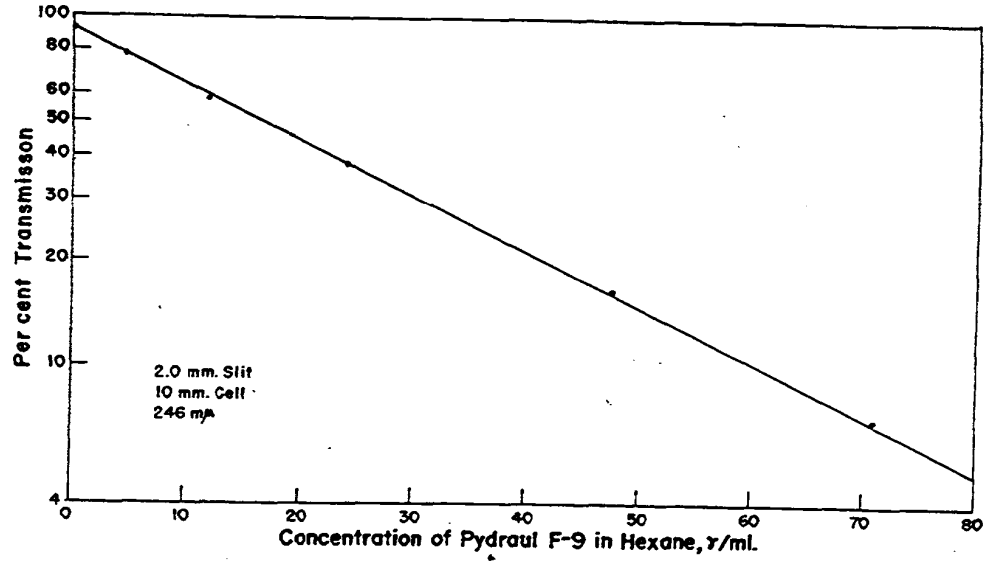
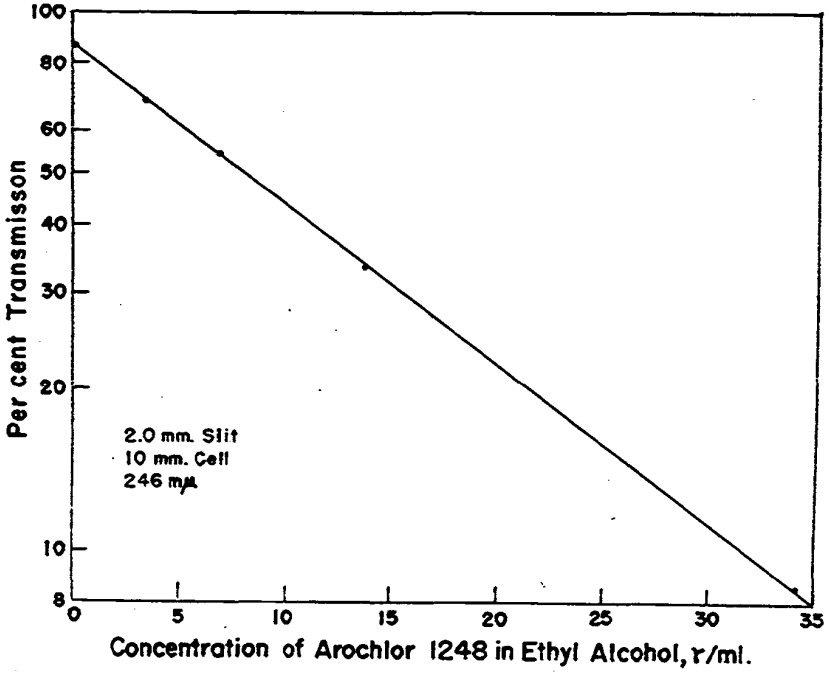


Figure 5



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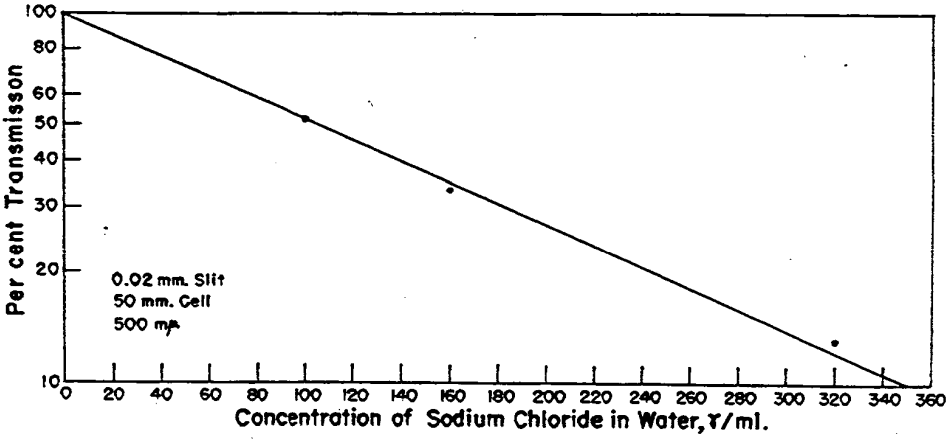
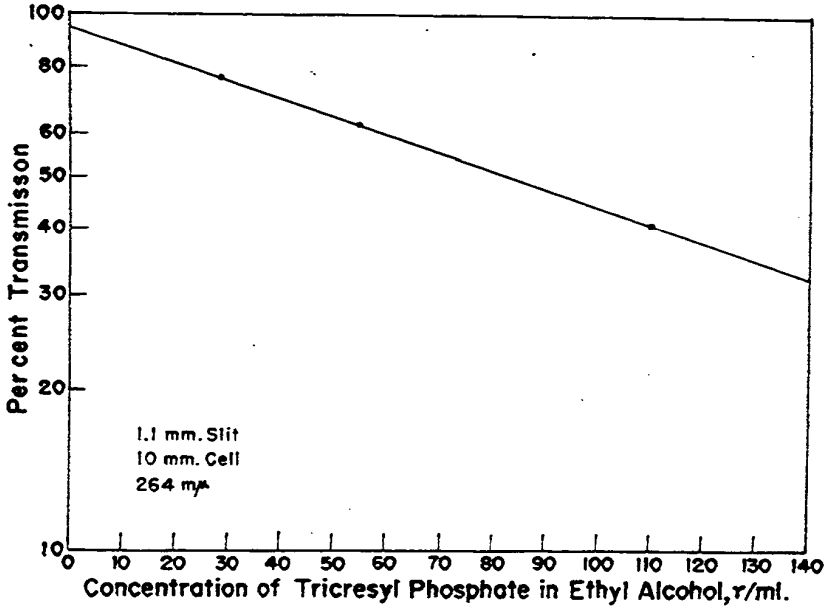


Figure 8



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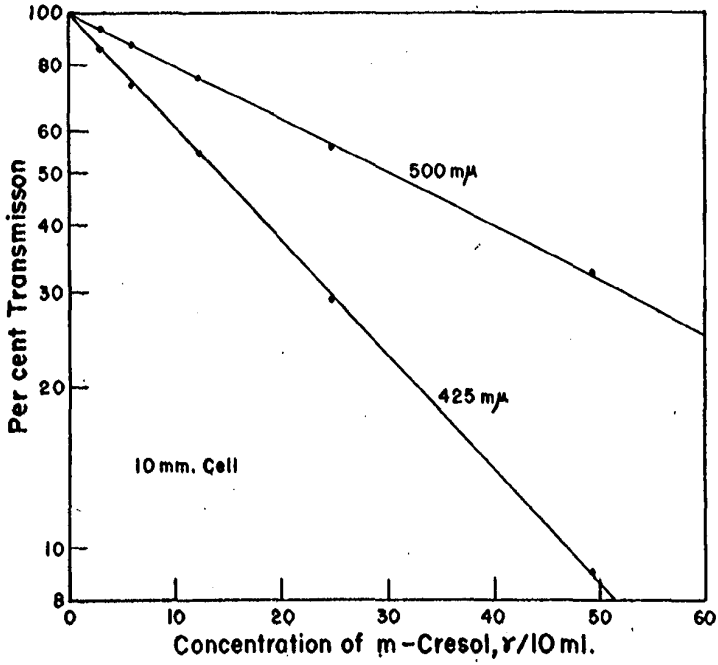

Figure 9

MONS 056060

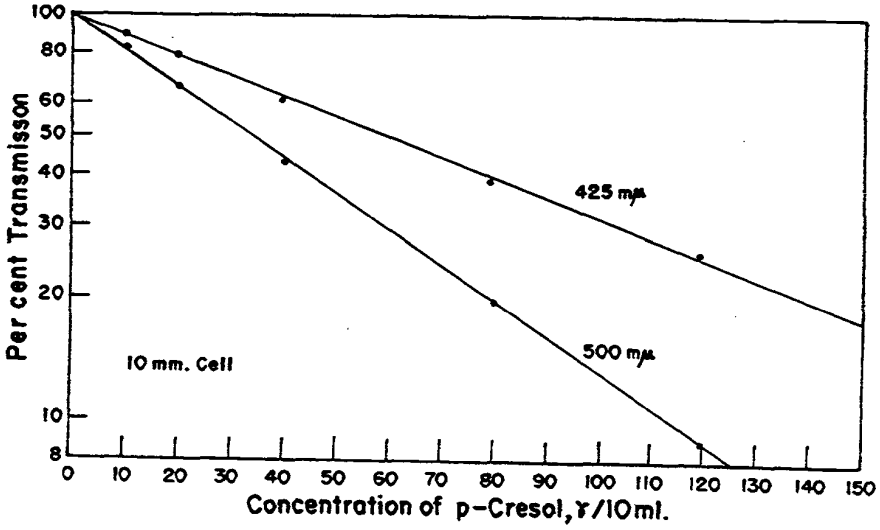

Figure 10

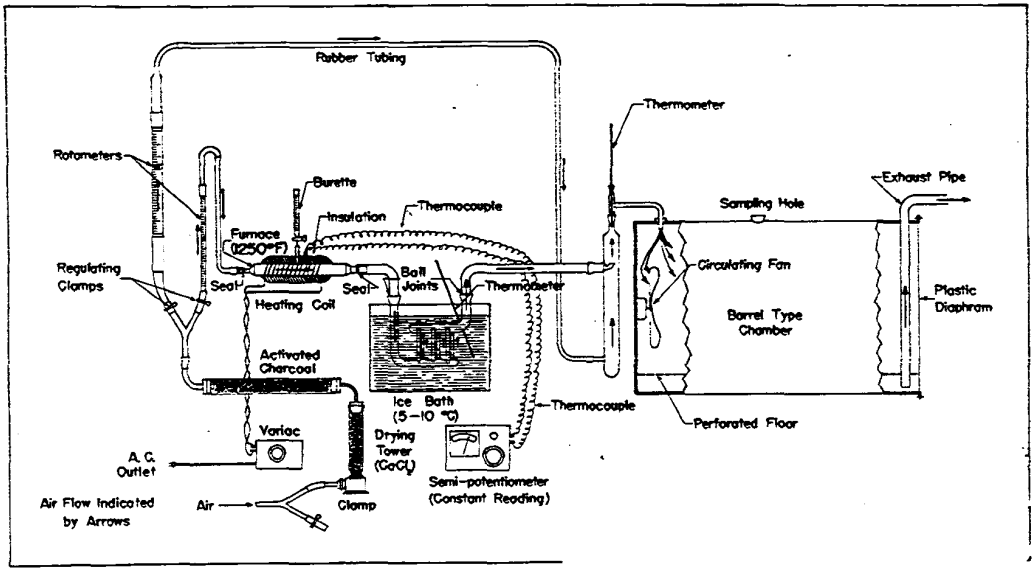

FIGURE 11.