Excerpts from Published Studies of TEG (or PG) Used as a Disinfectant

Lethality Against Pathogens

• TEG vapor under laboratory conditions has been shown to exert a rapid lethal action on such common respiratory disease pathogens as pneumococci types I and II, beta hemolytic streptococci (groups A and C), alpha streptococci, staphylococci, meningococci, and Haemophilus influenzae, influenza virus (PR-8 strain), meningopneumonitis virus; and psittacosis virus. [1, (2), (3), (4), (5), (6)]

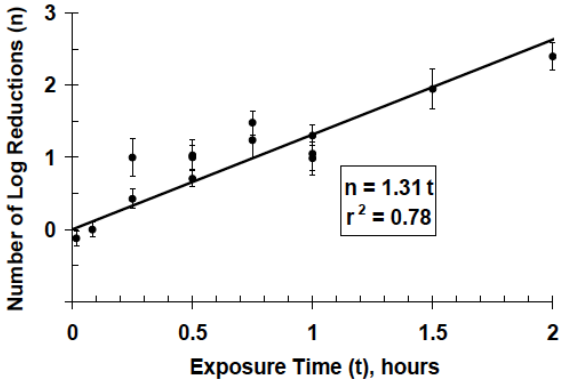
• TEG vapor increases the natural die-off rate of [surface] influenza viruses by a factor of 16. [7]

• In a 10,000 ft^3 room, .003-.005 mg/L [3-5 mg/M^3] of TEG vapor instantly kills airborne bacteria.[8, (9)]

• It was found that under optimum conditions (15 to 40 percent relative humidity and 40 to 100 percent saturation of glycol vapor at room temperature) bactericidal action was very rapid. Eighty to 90 per cent of the bacteria were killed within the first minute or two of exposure and by 3 or 4 minutes the air samples were essentially sterile. [10]

• FAA Study - If a pandemic were to occur, both surface and air disinfection could take place simultaneously even while people occupied the space. Although an objection could be raised due to the potential health risk of using TEG vapor for air disinfection, this concern is likely unwarranted, because TEG is an odorless chemical of no known toxicity, and human exposure to TEG is already widespread. TEG vapor is used as a bacteriostat to kill odor-causing bacteria for the purpose of air sanitation and deodorization. It was first registered for use in hospitals as an air disinfectant in 1947. Present application scenarios include spraying TEG inside offices, schools, hotels, lobbies, theaters, reception rooms, sleeping rooms, bathrooms, and hospital rooms. [11]

• Figure 2 - Surface decontamination of influenza viruses with triethylene glycol saturated air. [12]



Mechanics of Disinfection

• TEG inactivates viruses and bacteria because it is very hygroscopic; it condenses on bacteria- and virus-containing particles until its concentration becomes sufficiently high to be germicidal. [13]

• Triethylene glycol, the properties of which were investigated in detail, can act as a germicidal aerosol, in the sense that glycol vapor distils over from droplets which consist mainly of glycol to those containing bacteria which originally have no glycol. [14]

Human Toxicology

• ANSI established Long Term Exposure Limits at 10 mg/M^3 (8-hr TWA), and Peak Exposure Limits at 40 mg/M^3. [15]

• Where animal or human inhalation toxicity data exist for the glycols, whether as a vapor or an aerosol, the conclusions of the studies are consistently that no significant inhalation hazard is posed at levels 5 to 10 times the maximum found in theatrical productions. [16]

• The recommended exposure guidelines presented in this report are both highly conservative and readily achievable. They are conservative because there is no evidence that concentrations 10 or 20 times higher will produce adverse health effects in healthy individuals. [17]

• PG & TEG are non-toxic in much greater concentrations than required for air sterilization. [18]

• In environments where no means of control of the glycol concentration are available, the presence of a slight fog will be the only indication that adequate amounts of vapor are present in the air. Aside from esthetic reasons, there is no harm inherent in such a fog.[19]

• Upon reviewing the available toxicity information, the [EPA] Agency has concluded that there are no endpoints of concern for oral, dermal, or inhalation exposure to triethylene glycol. This conclusion is based on the results of toxicity testing of triethylene glycol in which dose levels near or above testing limits (as established in the OPPTS 870 series harmonized test guidelines) were employed in experimental animal studies and no significant toxicity observed. [20]

• According to the EPA, "the Agency has no risk concerns for triethylene glycol with respect to human exposure. Based on a review of the available toxicology data, the Agency has concluded that triethylene glycol is of very low toxicity by the oral, dermal, and inhalation routes of exposure. The toxicology database is adequate to characterize the hazard of triethylene glycol, and no data gaps have been identified. There are no indications of special sensitivity of infants or children resulting from exposure to triethylene glycol." [21]

• The chemical nature of glycols is such that prolonged or repeated contact with a glycol mist is likely to dry-out moist tissues (i.e., the mucous membranes of the upper respiratory tract and, possibly, the eye). [22]

• Individuals with pre-existing respiratory conditions may be more prone to experience respiratory irritation when exposed to theatrical fogs. [23]

Other Hazard Considerations

• The vapor-phase of TEG required for air sterilization are completely free of fire hazard. The presence of water in combination with glycol greatly reduced it combustibility [24]

• Since only .005 mg. per liter [5mg/M^3] of TEG is required for germicidal action, it offers no fire or explosive hazard. [25]

• TEG has no known deleterious effects on fabrics, books or other surfaces in the environment in which it is present. [26]

Environmental Considerations

• For air saturated with TEG at 25 to 29 degrees C, the disinfection rate [of surface influenza virus] was about 1.3 log(10) reductions per hour, about 16 times faster than the measured natural inactivation rate under ambient conditions. [27]

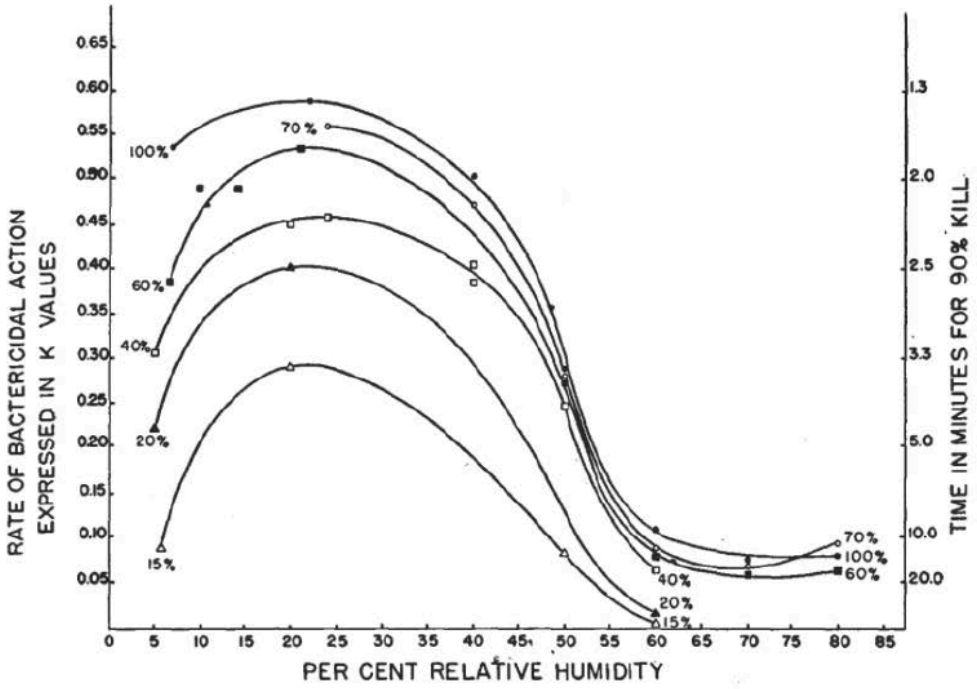
• Optimal conditions for the rapid action of the [TEG] glycol vapor at ordinary room temperatures were found to be relative humidities of 15 – 40 percent and vapor saturations of 40 – 100 percent. In such atmospheres freshly atomized bacteria were killed in two to three minutes; 80 percent or more of them were destroyed in the first minute. [28]

• A relative humidity of 25 - 60 per cent is desirable for optimum bactericidal action, but killing of air-suspended microorganisms occurs in a humidity range of 20 - 80 per cent.[29, (30), (31), (32), (33), (34)]

• A minimum quantity of water is necessary for rapid lethal action. [35]

• Although natural air and convection currents in a space tend to distribute the vapor to a certain degree, it is felt that some means of air agitation [fan] is desirable [36]

• Figure 5 – Influence of relative humidity on the death rate of *Streptococcus hemolyticus*, group C, at various per cent saturations of triethylene glycol vapor. [37]



TEG / PG Comparison

• TEG was found to be more suitable than PG due to lower concentrations being required [38, (39)]

Vaporizer Useage

• For small vaporizing units, the output should vary from a minimum of 0.5 gm. to at least 2.0 gm. per hour of liquid glycol vaporized per 1,000 cu. ft. of volume to be treated [17 – 71 mg/M^3/hr]. [40]

• When glycol vaporization is to be applied to large areas, such as entire wards or laboratories, the most practical solution is to incorporate a large vaporizing unit or units into the air conditioning system. [41]

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