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Fabric Response to COVID-19 Ozone Sterilization

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Abstract

Limited availablilty of personal protective equipment (PPE) during the current COVID-19 pandemic has led to frequent unsafe reuse of personal protective clothing by healthcare workers and the public. The application of ozone gas to sterilize PPEs for reuse has been proposed. However, the potential damage inflicted on the fabrics has not been reported in the scientific literature. A study was conducted to investigate the changes in fabric elasticity that may be associated with a two-hour exposure to ozone gas at a concentration of 17 ppm. No significant material degradation was found. The results suggest that use of ozone gas to sterilize PPEs for reuse against COVID-19 virus can be effective.

Keywords: Fabric elasticity; Ozone sterilization; PPE Reuse

1 Background

The current coronavirus pandemic has sparked global efforts to develop new and creative approaches in solving shortages of personal protective equipment needed by medical workers treating COVID-19 patients and by the public attempting to reduce the spread of the virus within their community. While currently available personal protective equipment is intended for single-use only, safe and effective disinfection might be able to allow reuse, thus addressing the personal protective equipment shortage.

Ozone is a disinfectant known to kill bacteria and viruses upon contact [1-11]. Ozone (O_3) is an unstable gas that degrades back into its original stable state of Oxygen (O_2) by forming a reactive free oxygen atom that oxidizes organic and inorganic compounds. Ozone gas can reach poorly accessible spaces such as dense textile materials that other methods such as hydrogen peroxide vapors, laser light or UV radiation, etc., cannot. Ozone gas does not produce harmful residues since residual ozone always converts back to oxygen (O_2) within a few minutes. Therefore, this method appears to provide an optimal solution for sterilizing personal protective equipment against the COVID-19 virus.

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However, there are unanswered questions with regards to the potential damage that ozone might inflict on textile materials [12, 13]. Elasticity reflects the structural integrity of a fabric material and such damage can impact its elasticity characteristics [14, 15]. To investigate this matter further, a pilot study was conducted to evaluate the potential impact of ozone exposure on changes in fabric elasticity.

2 Methods and Procedures

2.1 Ozone Chamber

A cordless ozone generator was placed inside a 20 Liter chamber and used for the exposure tests. An equilibrium concentration of 17 ppm was maintained. A digital detector monitored the ozone concentration continuously. The ozone concentration profile for the chamber is illustrated in Fig. 1. The equipment components are listed in Table 1. Additional technical and performance information about the system is described in more detail elsewhere [16].

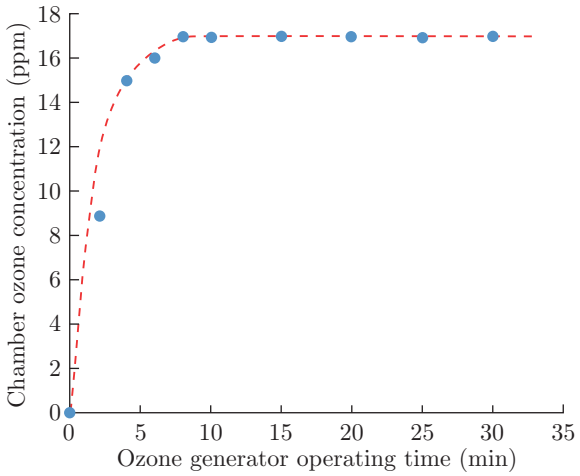

Fig. 1: Ozone concentration profile for the exposure chamber

2.2 Fabric Samples

Eight separate fabric samples were evaluated in this study. Each sample was 20 mm wide and 100 mm long. They were obtained from previously used clothing. The samples consisted of various combinations of Polyester, Cotton, Rayon, Spandex, Nylon and Silk. A summary of the compositions is presented in Table 2.

2.3 Elasticity Measurements

Fabric stretch was determined using two reference markers placed on each sample 60 mm apart prior to loading. The design of the apparatus is shown in Fig. 2. Samples were exposed to six sequential loading conditions including 53 g, 104 g, 157 g, 211 g, 253 g and 323 g. The initial (control) tests were conducted outside of the ozone chamber. Afterwards, fabric samples were