R. K. Hinderer
(Revised AN-1770
deleted
Not copied

AN EVALUATION OF A SERIES OF NATURAL AND SYNTHETIC MATERIALS BY INCAPACITATION BIOASSAY TESTING: A SPECIAL REPORT TO THE NATIONAL BUREAU OF STANDARDS

by

G. F. Smith

BFGoodrich Chemical Division
Avon Lake Technical Center
Avon Lake, Ohio 44012

September 1977

Introduction

During the past few years pressure has been building to control the acceptability of materials on the basis of combustion toxicological performance. This is in response to the high rate of fire deaths in the United States and the NFPCA's stated goal to reduce the fire death rate by 50% within the next generation. Potentially there are many pathways leading to a reduction of the fire death rate such as utilization of fire detection and suppression systems, improved fire service and increased public awareness, as well as control of and safe use practices for materials. However, building code groups have not been able to begin regulation of materials on the basis of combustion toxicological performance because no accepted test method is available.

The National Bureau of Standards is currently developing a bioassay testing protocol to be used by code groups to control the acceptability of materials on the basis of combustion toxicological performance. At the present time no formal document has been released by the NBS.

In the absence of any widely accepted bioassay testing protocol, BFGoodrich initiated a program to determine some of the characteristics of the combustion toxicological performance of the materials which BFGoodrich produces. This report describes the results of some of this work. This report is being made to the NBS anticipating that it may be useful to the NBS in its efforts to develop a bioassay testing protocol.

Incapacitation, as measured in the rotating cage experiment, is a bioresponse which is well suited for the evaluation of the combustion toxicological performance of materials. The usefulness of this bioresponse results from the following critical features which it has been found to possess:

1.) The incapacitation bioresponse, as measured in the rotating cage, is very sensitive to the differences of materials. In comparison to the mortality bioresponse, it has been found that mortality is much less sensitive to the differences of materials than is incapacitation. This is seen in the relative steepness of the incapacitation dose-response curves and the mortality dose-response curves. Furthermore, the susceptability of test animals to develop exposure induced disease which often leads to mortality can confuse the interpretation of mortality results. Nevertheless, post exposure mortality data provides some measure of post exposure problems. A complete material evaluation must be based on the incapacitation hazard as well as the potential for post exposure problems.

2.) Incapacitation, as measured in the rotating cage experiment, clearly identifies materials which induce excessive or unusual toxicological response- super toxic materials. The utility of a bioresponse for the evaluation of the combustion toxicological performance of materials depends strongly on its capability to detect super toxic materials.

3.) The incapacitation bioresponse is easily coupled with analytical measurements of the combustion gas atmosphere to which the test animals are exposed. This makes it possible to determine which components of the combustion atmosphere are most important in inducing bioresponse. We have found that for many materials, for example wood and PVC, CO is the main incapacitating component of the combustion products.

Experimental

A diagram of the combustion-inhalation chamber is given in Figure 1.

The physical system consists of a 40 liter inhalation chamber and a 20 liter combustion chamber interconnected by an air circulation system. Eight liters per minute of 50% relative humidity fresh air enters the combustion chamber, 16 liters per minute transfers from the combustion to the inhalation chamber, 8 liters per minute returns from the inhalation to the combustion chamber, 8 liters per minute is exhausted. The partial recirculation of the atmosphere which is used in this procedure permits the fulfillment of three critical criteria: 1.) the animals are exposed to air no hotter than 32°C; 2.) test animal anoxia is prevented since the % O_2 does not go below 18%; and 3.) a pseudo-stable atmosphere of combustion products is generated. The duration of the exposure is fifteen minutes for each experiment. Since all exposures are of the same duration, meaningful comparisons of post exposure mortality data can be made. The fifteen minute time period of the experiment is important for another reason. During combustion, PVC releases HCl early, further heating results in the evolution of CO. It is important that the test animals be exposed to the products of all phases of the decomposition process. The fifteen minute exposure allows nearly complete combustion to occur.

In all experiments, thermal decomposition of the sample is carried out at 2.5 watts/cm^2 smoldering combustion. The sample heater is built from nichrome ribbon electrical resistant heating elements. Future work will make use of a range of radiant heat flux exposures as well as both smoldering and flaming combustion.

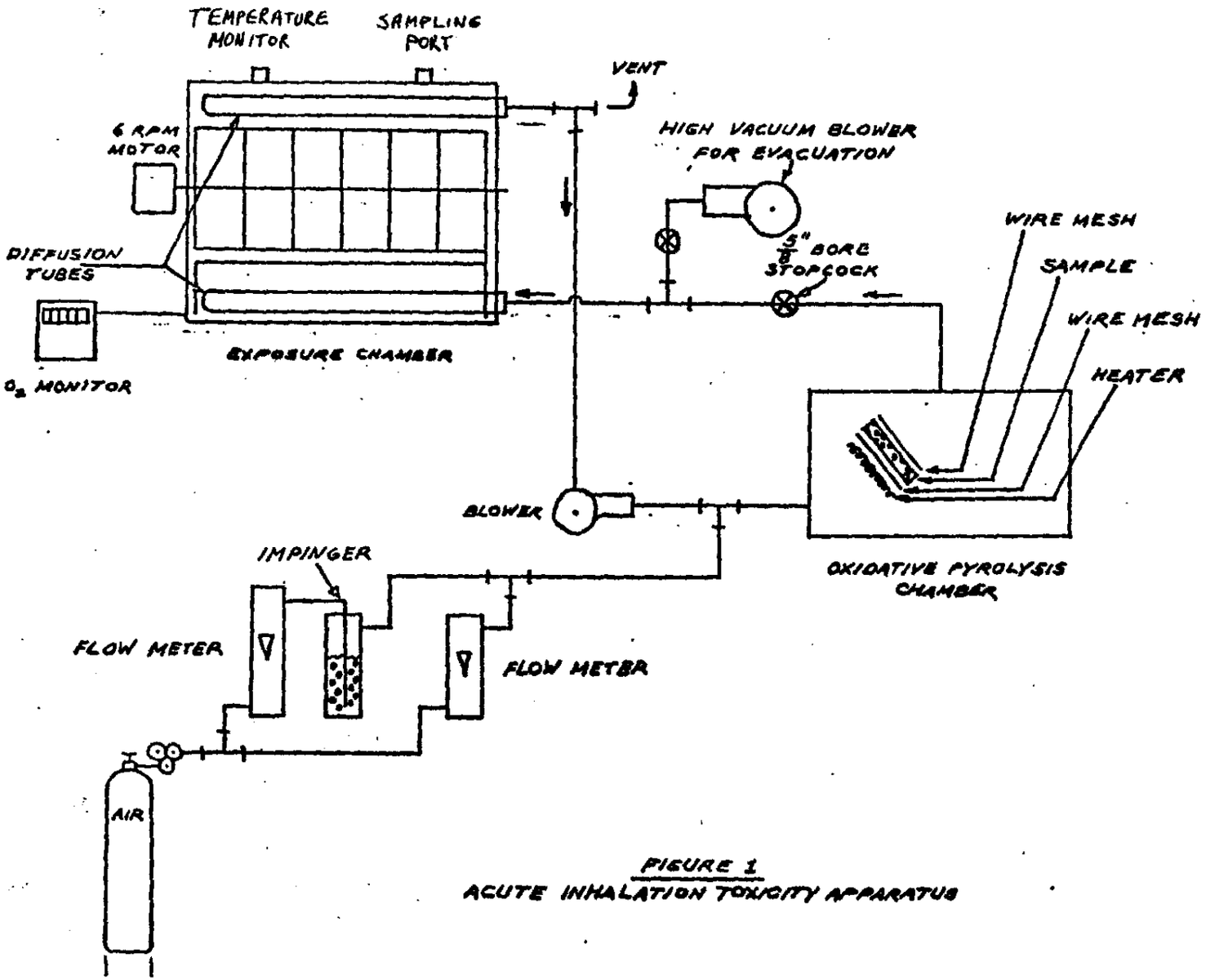

FIGURE 1
ACUTE INHALATION TOXICITY APPARATUS

BFG22055