#5903

Measuring Respiratory Irritancy of Emissions

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INTRODUCTION

The test method developed for evaluation of the potency of airborne irritant chemicals, ASTM E 981, is being used to evaluate the potency of outgassing from commercial products. The key to the test is in the observation that the fifth cranial nerve of most animals has specialized nerve endings that are activated by irritant chemicals.

The precise details of the reflex response to this activation are species dependent: in humans there is the well-known series of symptoms of eye, nose, and throat irritation, headache and fatigue, and the less well publicized changes of heart rate, blood pressure, and kidney function. The parallel response in mice is a change in respiratory rate and pattern. The mouse response is reproducible, stable, and proportional to the potency of the irritant.

The method being used is an established toxicological procedure that has been used for three decades to make predictions about the effects of these chemicals on humans. The validity of the test data for prediction of human responses has been thoroughly established and repeatedly published. The test animals (Swiss Webster mice) are somewhat less sensitive than humans, so an extrapolation from the animal data allows us to predict the response of the much more sensitive human. As a result, the amounts of material and concentrations used may be higher than immediately seems "realistic."

TESTS

The method is being used as published. The generation system for the test atmosphere, not specified by the ASTM procedure, is a closed glass chamber in which a test sample is equilibrated for 30 minutes before the collected atmosphere is delivered to the test animals by means of a peristaltic pump. The sample is typically heated to a temperature of 30°C by an external heat source.

To study any atmosphere, the baseline respiratory rate of the animals is first determined and set equal to 100% (Figure 1). The rate during a 60-minute exposure is described as a percentage of the baseline rate. To obtain a concentration response curve, a series of tests is conducted in which the sample size is varied (Figures 2 through 5). In order to summarize data, the point of maximum response is determined for each experiment and that percent change is plotted against the concentration on a log scale (Figures 6 through 9).

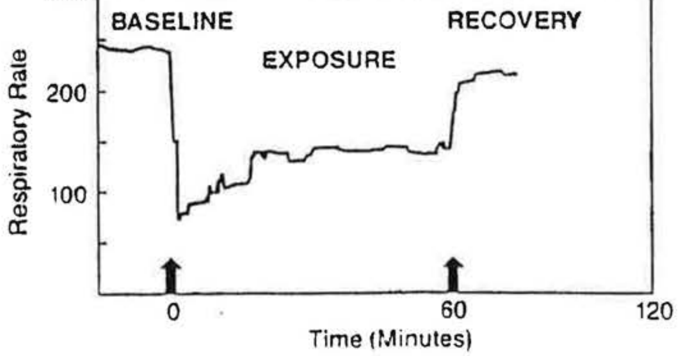

Figure 1 Respiratory response to irritant (mean of 4 mice)

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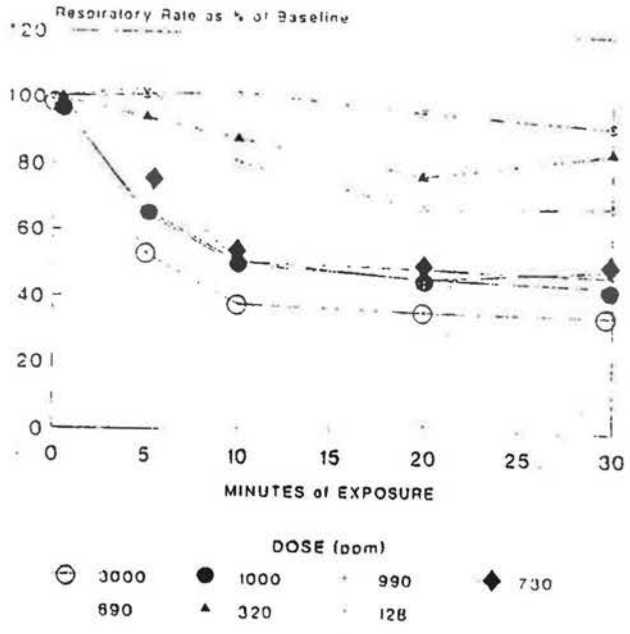


Figure 2 Sensory irritation from floor adhesive

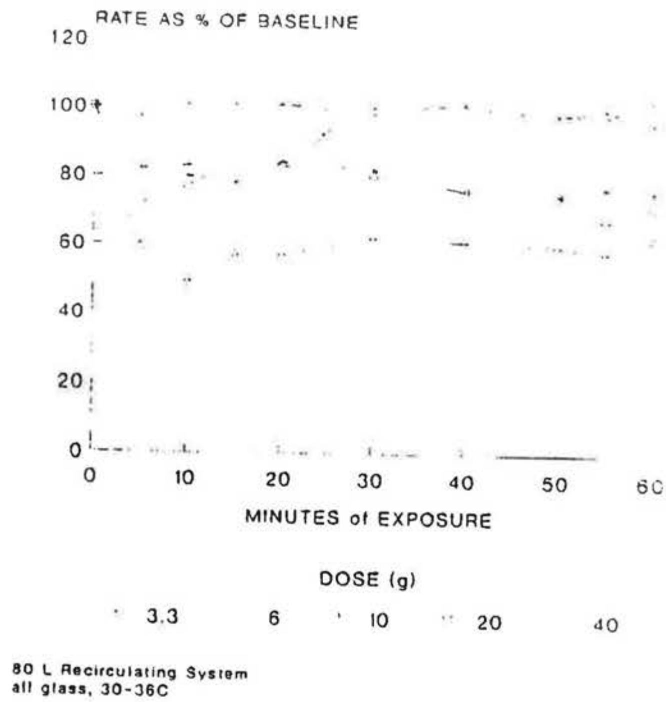


Figure 3 Sensory irritation from floor wax

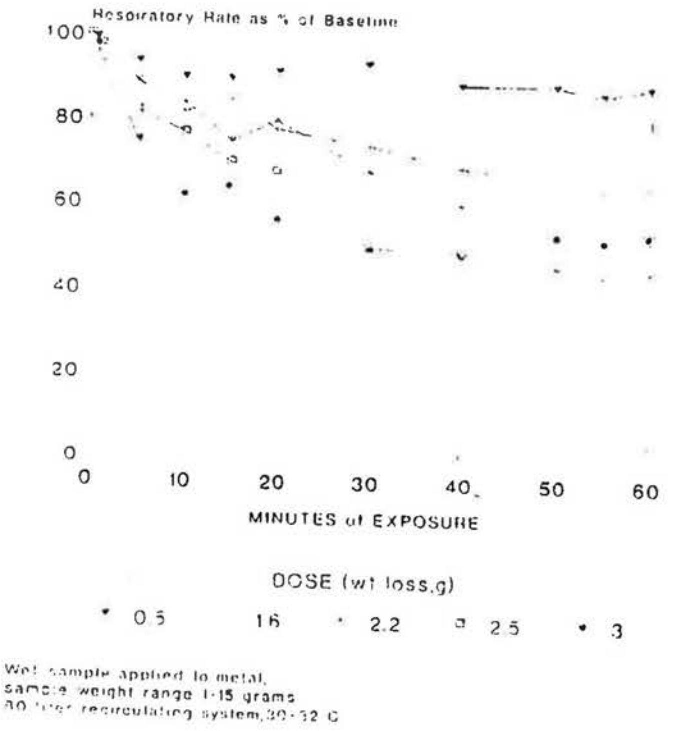


Figure 4 Sensory irritation from urethane finish

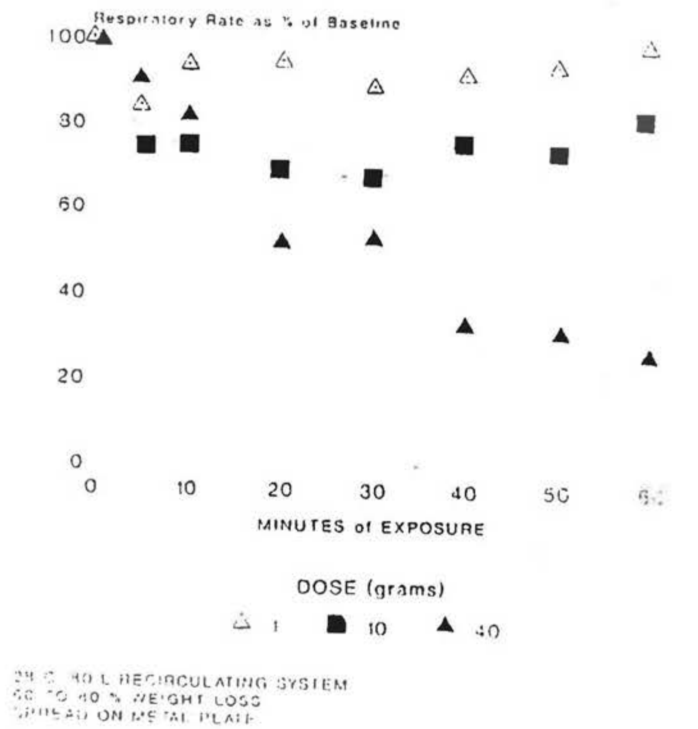


Figure 5 Sensory irritation from contact cement

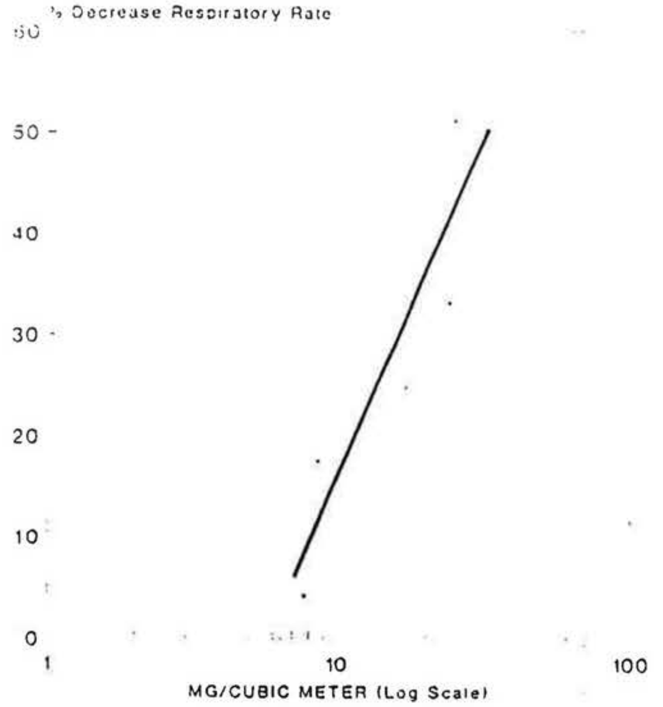
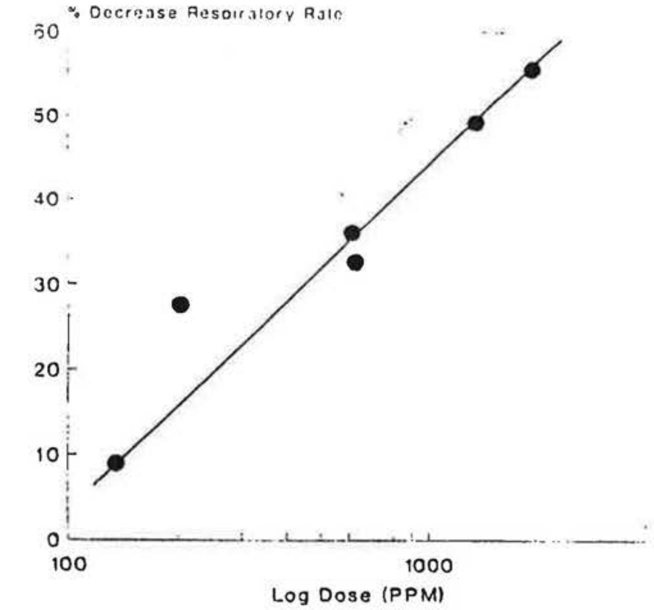
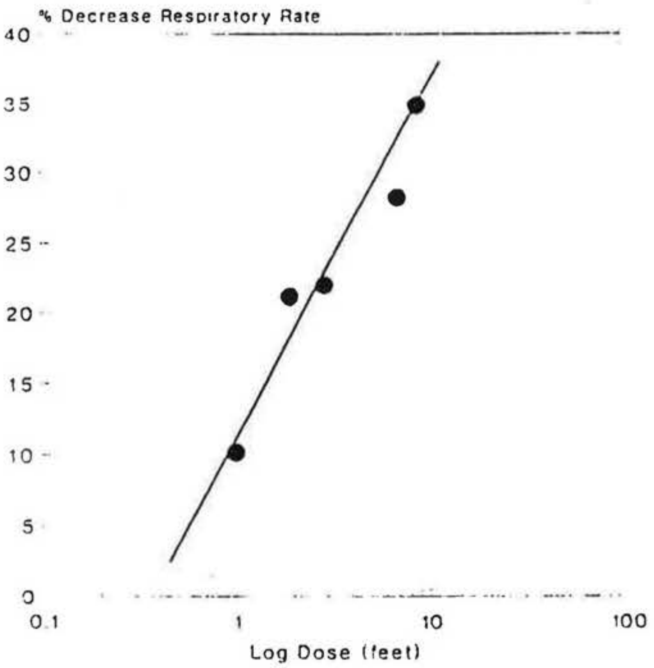


Figure 6 Sensory irritation—floor wax



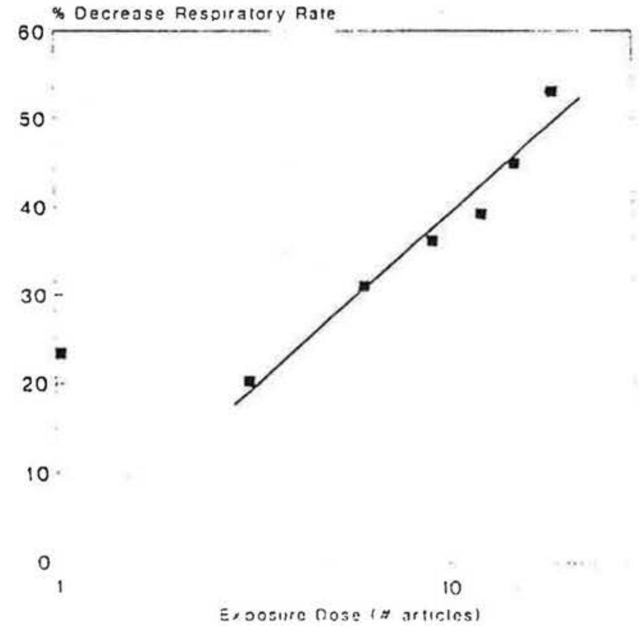
Paper treated by percussion and cutting
Dose measured by FID as methane
80L recirculating System, 34-38C

Figure 7 Sensory irritation—carbonless paper



ter recirculating system
33C carpet remnant

Figure 8 Sensory irritation—commercial carpet



35 to 39C, 80L recirculating system
product sold for use in auto

Figure 9 Sensory irritation—room freshener

RESULTS

Because the effects of fifth cranial nerve activation by irritant chemicals are very close to the symptoms reported in indoor air quality complaints, it seems relevant to investigate the use of this test method as a tool for looking at products used indoors. It could be very useful to determine in advance whether outgassing from a product was potent as a human irritant. To learn that after the fact can be an expensive education.

The products that have been tested during this exploration include a wide variety of wet and dry samples. The wet samples have included floor wax, paints, and several adhesives. Among the dry products, we have studied floor tile, vinyl wall covering, fabrics, carpet, carbonless paper, and room freshener with typical results presented in Figures 2 through 9. Several general observations have been made; the test is not sensitive to odor—1,000 grams of an aromatic fabric elicited no response over the 60-minute exposure period (Figure 10). The total hydrocarbon level of the test atmosphere is not indicative of the irritancy of the product under study.

The products tested were selected because they are often mentioned in connection with air quality concerns. Outgassing from some, but not all, products in each category has shown substantial irritant potency. There are significant differences between products for a single end use—see the comparison of two vinyl wall coverings in Figure 11. Clearly it would be possible to use these techniques to assist in the selection of products when the need is to minimize the potential for irritation in a specific end use. Since product data are not currently available in some great compendium in the sky, nor will generic data be useful, specific studies would need to be directed toward the question posed.

The test as it is being conducted is not directly linked to human irritation sensations without extrapolation that takes into

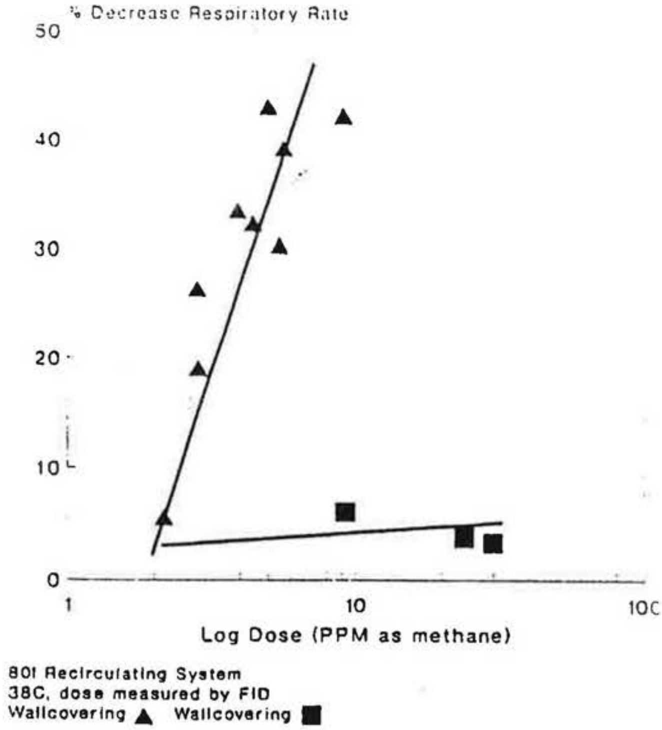


Figure 11 Sensory irritation—comparison of wall coverings

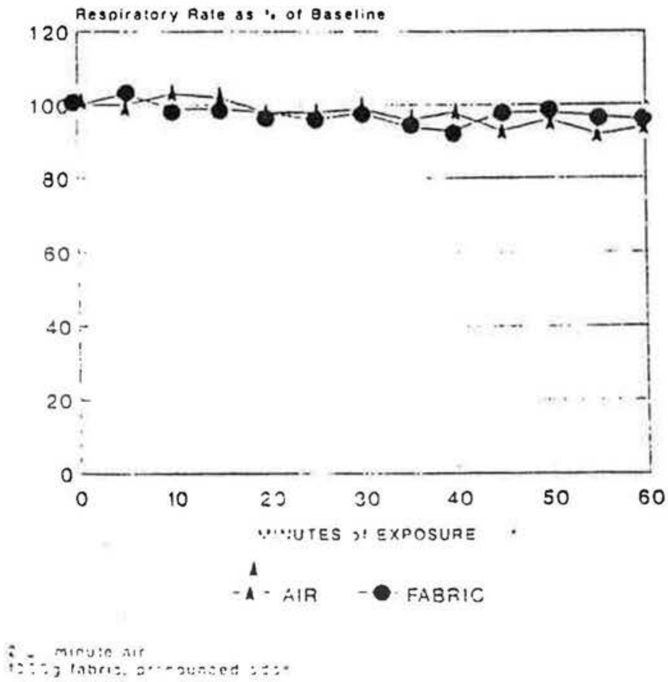


Figure 10 Effect of exposure to clean air or aromatic fabric

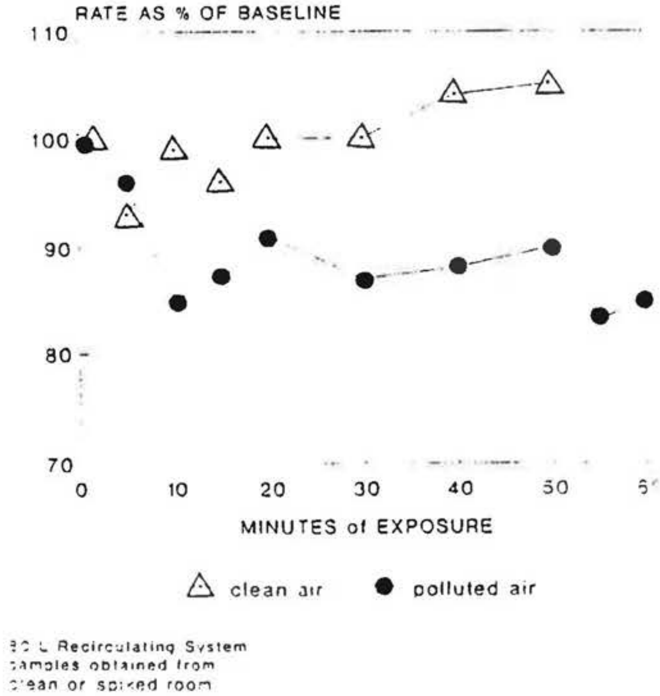


Figure 12 Sensory irritation—test of room air

consideration all details of specific product use. However, an application that would be easily applied to situations of actual use is to study room air for its irritant potency.

Gas samples from a contaminated room, collected by air bag, were compared for irritant potency against the atmosphere of a neighboring room (Figure 12). The difference from the baseline was significant (defined by ASTM E 981 as anything greater than a 12% change in respiratory rate), with the contaminated room causing a 20% change in respiratory rate of the test animals. In an additional experiment, air from a room having a mold contamination problem was found to be very active upon testing.

CONCLUSION

ASTM E 981 is a toxicology test method that was developed to evaluate the potency of airborne irritant chemicals. It has been adapted for use with commercial products and allows direct comparison of the irritant potency of outgassing from the products. We have demonstrated that, at least in some cases, it is possible to test air samples from contaminated spaces to numerically define an ambient irritancy level. The data can be extrapolated to predict the human response.