Inter-organization Correspondence

B.F.Goodrich

TO	FIELD POINT OR AKRON DEPARTMENT & BLDG. NO.	DATE YOUR LETTER
R. W. Strassburg	Akron; Bldg. WHB-4; Dept. 0001	
FROM	**FIELD POINT OR AKRON DEPARTMENT & BLDG. NO.**	**DATE THIS LETTER**
M. M. O'Mara	Avon Lake Technical Center	August 22, 1974

SUBJECT

Diffusion of Air-VCM Through Plastic Work Suits

Introduction

You submitted two production work suits to our laboratory for measurements on the diffusion of VCM through these protective suits. One was a yellow material consisting of plasticized PVC; the other was a white material, identified by J. W. Ryan, of our infrared laboratory, as a polyethylene coated composition.

Approach

As an initial approach we used an existing piece of equipment which was designed to measure the transport rate of gases through plastic membranes. The method is an ASTM procedure (D 1434-63) and is called "Gas Transmission Rate of Plastic Film and Sheeting". The method is based on Fick's law:

$$q = \underline{p}\,\frac{A \cdot \Delta p}{t}$$

where q = gas transport rate

$\underline{p}$ = proportionality constant referred fo as the permeability constant

A = area of the sample

t = thickness of the sample

Δp = pressure differential across the membrane

In the ASTM method, $\underline{P}$ is usually determined as a function of temperature. In this way an Arrehnius plot can be determined and the energy of activation of the permeation process can be made. In terms of the problem at hand, this type of data (i.e. activation energy) is not suitable. Absolute transport data are required to answer the questions relating to the use of these suits in the field. We therefore determined diffusion (i.e. transport) rates as a function of pressure for the two materials submitted by you.

Procedure

The ASTM D 1434-63 method was followed using the Permeability Console Model CS-135. A 1.0 mm diameter capillary tube was used for measuring gas permeability. All measurements were made at 23°C. using a 152ppm vinyl chloride in air standard. All test samples were 9.97 in.^{2} in area.

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Results

(A) white polyethylene coated material

Gas transport was so rapid through this material at Δp = 1 lb./in.^{2} that meaningful measurements could not be made. This material should not be considered a "protective" device.

(B) yellow plasticized PVC coated material

The following diffusion rate data were collected at the following pressures (Δp):

	Diffusion Rate (cm^3/sec.)(1)	
ΔP, lbs./in.^{2}	9.97 in.^{2} area	3402 in.^{2}(2)
20	0.86×10^{-4}	0.029
30	1.15×10^{-4}	0.039
58	2.19×10^{-4}	0.075

(1) not corrected to S.T.P.
(2) this is the approximate area of the entire suit

A plot of the data is shown in Figure 1.

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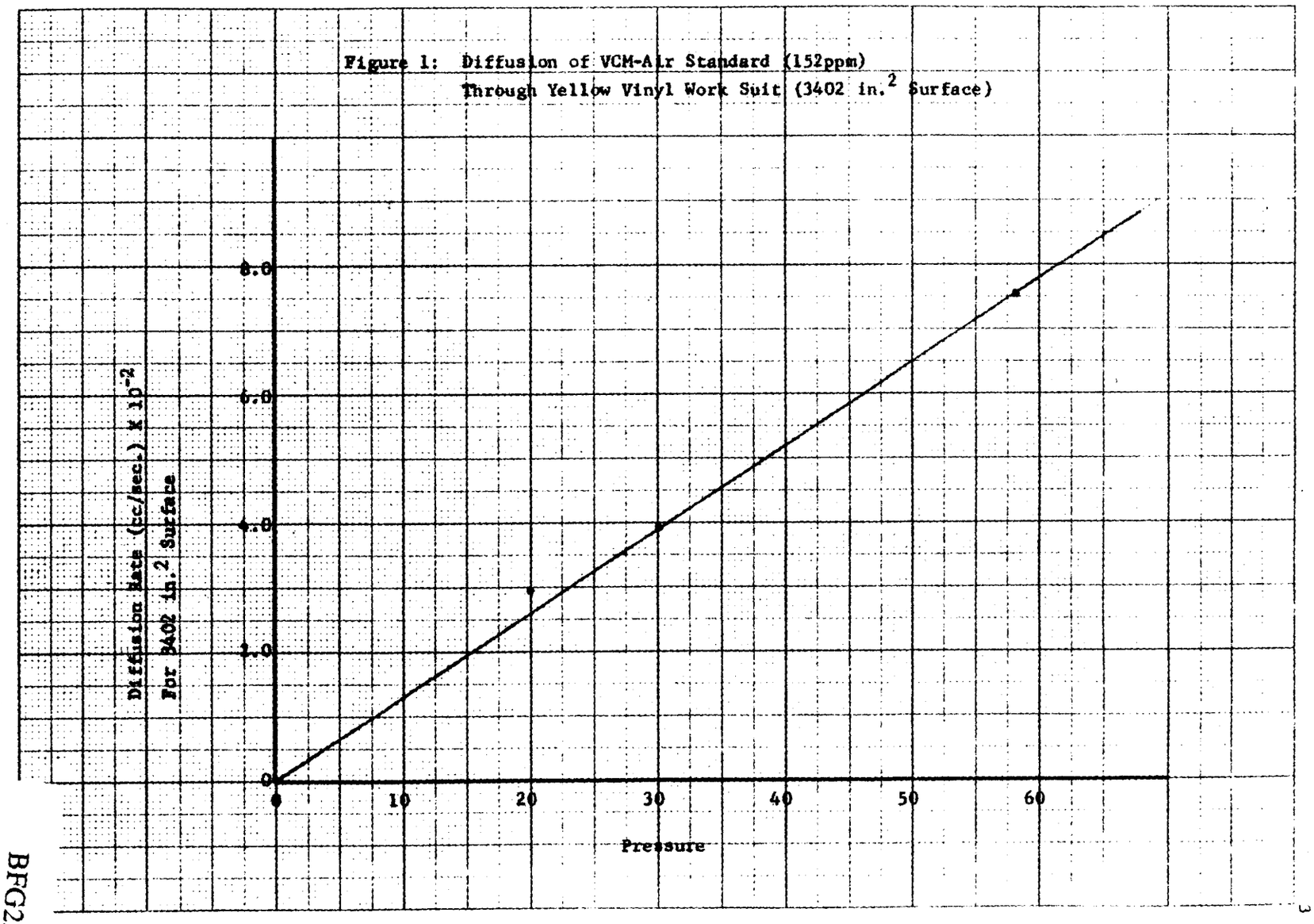


Figure 1: Diffusion of VCM-Air Standard (152ppm) Through Yellow Vinyl Work Suit (3402 in.^{2} Surface)

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Discussion

It should be noted from Fick's law that a pressure differential must exist before diffusion will take place. The pressure differentials shown in the data table and in Figure 1 range from over 1 atmosphere to about 4 atmospheres. Even at this higher value, the diffusion rate of the standard gas through the entire suit is 0.075 cc/sec. Assuming that the VCM in the air standard migrates at the same rate as the air (it is probably lower) then the absolute amount of VCM migrating into the suit over a 7 hour day is 0.287 cc (0.734 mg). Under normal operating conditions there will be no diffusion of vinyl chloride through this protective suit.

Future Testing

It is obvious that this type of test offers an excellent method for screening potential candidates for use as a protective covering. A quick field test can also be carried out which will screen out those materials which are not impervious to air migration. I noticed that one could actually breathe (with difficulty) through the white polyethylene coated material. If a material cannot pass this test then it should not be considered for further evaluation.

Flammability

One of the serious problems with any of these materials is their inherent flammability. Generally they burn much more rapidly and generate more heat than normal work clothing. Unmodified polyethylene on unmodified cellulose should not be tolerated under any conditions as wearing apparel. I suggest that all candidates be submitted to our laboratory for fabric flammability testing. Testing requirements are six 14" X 4" samples. If stitching is present in the suit, the six test specimens should include the stitching along the vertical.

Mike

M. M. O'Mara

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