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TITLE

VESICANT FILMS AND FOAMS

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EXPERIMENTAL STATION
SUFFIELD, ALBERTA

TECHNICAL MINUTE NO. 11

VESICANT FILMS AND FOAMS

A limited number of laboratory experiments have been carried out on the preparation of "floating vesicants" whose purpose is the contamination of water. Following Porton's experience in this field very little success was encountered and the work was dropped. The purpose of this Minute is to place on record what has been done. Attempts were made to float the mustard in both foams and oil films, which are discussed separately.

FOAMS

The general requirement was understood to be for a liquid or solid mixture, consisting of the vesicant and a foam producing base, which when dropped on a water surface would produce a foam stable and vesicant over a period of hours. It was hoped that the rate of hydrolysis of the vesicant could be cut down below the normal rate on water by the protective action of the foam body.

Most success was achieved by using a modified Foamite mixture (modified by the addition of saponin to the same base as used in fire fighting equipment) which gave a thick foam containing 17% by wt. of mustard (based on the powder) and which finally settled to a thick scum at the end of 45 minutes. It is to be noted that this was the maximum life obtained, and the attempts to overcome this limitation by the addition of stabilizing agents to the foam proved unsuccessful.

Another serious limitation encountered was in the amount of mustard this mixture could 'take-up' - unless this was present in low enough proportions to leave the powder fairly free-flowing the latter would not spread on water and sufficient coverage was no obtained. The H content of the actual foam would of course be much lower than that in the foamite mustard mixture. Experiments indicated that if this foam mixture was projected more than a few inches below the surface, separation of the ingredients tended to occur giving rise to a poorer foam.

EXPERIMENTAL

The mixtures as outlined in Table I were prepared by mixing the powdered ingredients, adding the desired amount of pure mustard to the mixture and distributing the latter fairly uniformly by shaking. The mixture was then spread over the surface of water in a 2 litre beaker and stirred gently. The time until the foam collapsed to a thin scum was then noted. For a few physiological tests, pieces of serge 1 cm square were moved around in the foam, removed and bound in contact with the arm of the observer.

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TABLE I FOAM COMPOSITIONS

Composition	Time to Collapse	Remarks
(1) Soda Alum Saponin	20 minutes	Foam not very smooth. Rapidly broken by slight agitation of water.
(2) Saponin	20 minutes	Very light foam. Does not 'hold' H.
(3) Foamite: Soda Alum Licorice	25 minutes	Foam not smooth- settles to scum.
(4) Foamite-Saponin: Soda Alum Licorice Saponin	45 minutes	Best foam produced. very smooth and settles to thick scum. Can hold 17% of H in mixture. N.B. Stability proportional to Saponin contents up to 10%.
(5) Duponol: Sodium lauryl sulphonate	24 hrs.	Very light foam on shaking with water. Does not hold H however - collapses rapidly when latter added. Note. Duponol offers no advantage when added to above mixtures.
(6) Foamite Saponin P V A	45 minutes	No advantage over PVA or Agar-agar do not form protective film except on surface. Foam collapses internally to lea[ve] a surface 'crust' which remained for 12 hours. No increase in stability in foam as a whole.
(7) Foamite Saponin Agar-agar	45 minutes	(see remarks for (6) and (7) above)
(8) Foamite Saponin with H-imulsion	2 hours	H was emulsified in aqueous triethanolamine stearate before addition to foam mixture. This was to produce a more uniform dispersion of H for physiological testing. Not practical for field application.

FILMS

It was desired to develop a vesicant film possessing the following properties:

(a) Density < 1 to float on water.
(b) Low loss of vesicant by hydrolysis.
(c) Low loss of vesicant by evaporation.

It was expected that the oil would have quite an effect on reducing (b) below the normal rate for the pure vesicant.

Preliminary consideration concerning the choice of oil indicated that Diesel or fuel oils would be most suitable. The densities are of the order of 0.85 opposed to o.89 to 0.92 for the more abundant vegetable oils such as Castor, cottonseed, etc. Hence a much higher percentage of H might be incorporated and still keep the density at $\triangle \ngtr$ 0.95 aimed at.

The vesicants used were H.S. HT and T. the latter being tried as a result of its rate of hydrolysis and evaporation being reported much lower than mustard.

EXPERIMENTAL

By means of a micropipette the oil vesicant solution was placed carefully on the surface of distilled watwr in a 2 litre beaker to give a concentration of vesicant of 20 grms per sq. metre. For physiological testing small squares of khaki serge 1 cm, we e placed through the film, removed and placed on the subjects' arm. This was repeated at intervals of ½, 1, 2, 4, and 8 hours to test for permanence of vesicancy.

TABLE I OIL FILM RESULTS

OIL VESICANT SOLUTION	DENSITY	REMARKS
H- Diesel Oil 40/60	$\triangle$ = .96/20°C	Incomplete films obtained- tendency to lens formation.
S- Diesel Oil 40/60	$\triangle$ =93/20°C	
HT- Diesel Oil	Insoluable (< 5%)	
T 724 Diesel Oil	Insoluable	
T 724 Diesel/Toluene 50/50	$\triangle$ =95	Only partial film obtained. Tendency to lens formation

DENSITY LIMITATION

A few trial experiments indicated that a homogeneous film could not be easily produced or, after forming, would not remain unbroken on water with gentle agitation, unless this density equalled 0.9 or less, that above this density the buoyant force was not strong enough to overcome the contracting forces of surface tension.

This imposes a serious limitation on the concentration of H ($\triangle$ = 1.34) permissable in diesel oil and effectivelu precludes the usse of the natural vegetable oils with densities of 0.89 up. Even using H/Diesel Oil, the concentration of H for a density of 0.90 is 14% which is too low.

PHYSIOLOGICAL

No definite conclusions can be drawn owing to uncertainty of sampling technique and to the small number of tests made. The results in two cases conflicted with the chemical analysis of samples taken similarly. Indications were however that (1) a good blister was obtained from a foam containing less than 2% total H. (2) T showed good stability in an oil film after 23 hours.

This Minute was prepared by Mr. J.W. Dale of the O.M.& E Section.

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