A NEW TECHNIQUE FOR THE APPLICATION OF DUST-LAYING OILS TO HOSPITAL BED-CLOTHES

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The treatment of bed-clothes with dust-laying oils for the purpose of reducing dust-borne infection in hospital wards has recently been investigated in some detail (van den Ende, Edward, and Lush, 1941); van den Ende and Thomas, 1941; Thomas and van den Ende, 1941). It was found that the application of from 3 to 7% of liquid paraffin or of technical white oil to bed-clothes caused a very large reduction of dust-borne bacteria in the air of hospital wards. Two distinct methods of applying the oil to bed-clothes were studied by these authors: (a) impregnation with oil dissolved in a volatile organic solvent; (b) impregnation with concentrated oil-in-water emulsions.

Neither of these processes permits accurate control of quantities, while, from an economic point of view, both methods entail a recovery process for the unused oil, and would present considerable difficulty in large-scale operation in a hospital laundry. Early in 1942 Dr. van den Ende, of the National Institute for Medical Research, invited the co-operation of the British Launderers' Research Association with regard to this difficulty, and an investigation was carried out in these laboratories in which the use of dilute aqueous emulsions for oiling was considered in detail. As a result of this work an efficient and economic process has been evolved and applied on a large scale. It is the purpose of this paper to present the theoretical considerations and practical details of the process.

Experimental

A process in which aqueous emulsions of oil are used has obvious advantages over a process in which it is necessary to employ an inflammable solvent. Palmer and Blow (1938) have advocated the use of cation-active agents for the deposition of mineral oil on to wool during certain stages of manufacture, but it is not possible to ascertain from their published data whether complete exhaustion of the emulsion was obtained. During a previous investigation carried out in these laboratories on the influence of cation-active emulsifiers such as cetyl pyridinium bromide upon the electric charge of oil drops (Powney and Wood, 1940), it was found that high positive charges could be established on the drops at extremely low concentrations; furthermore, it was found that at these very low concentrations the electric charge on many non-oily surfaces (usually negative) underwent a relatively insignificant change. It was thought, therefore, that this effect might possibly be utilized to obtain the complete discharge of a dilute oil emulsion on to fabrics.

Oiling of Wool Fabrics

Preliminary small-scale tests on wool showed that it was possible completely and rapidly to exhaust a dilute oil-in-water emulsion stabilized with a certain concentration of cetyl pyridinium bromide. The amount of oil which can be applied to wool fabric in this manner may be adjusted to almost any requirement. It is necessary for an effective discharge that the liquor shall be maintained in a slightly alkaline state—e.g., at pH 8—as under this condition the cation-active agent is rapidly adsorbed by the wool. It should be emphasized that, by this method, only that amount of oil which is actually required on the fabric is added to the machine, the final waste liquor being virtually clear water. For convenience, concentrated 20% oil emulsions were prepared, and were diluted according to the amount of oil required on the fabric.

Example

100 g. wool fabric.

1,000 c.cm. soft water at 100° F.

25 c.cm. positively charged stock oil emulsion stabilized by "fixanol C."

The fabric was squeezed by hand in this liquor for approximately 10 minutes, after which time all the oil had apparently been taken up by the wool, the resulting liquor being quite clear. The fabric was then hydro-extracted and air-dried. If the deposition of oil was complete there would have been 5% of oil (based on the dry weight of the fabric) present on the wool. The oil content of the sample was ascertained by means of extraction with petroleum ether:

Oil on fabric (calculated)	5%
" " " (found)	4.8%

Practically all the oil had therefore been desposited on the fabric.

Oiling of Cotton Fabrics

By using the above method with cotton fabrics some difficulty was experienced in obtaining complete deposition of oil from the positively charged emulsion. This was overcome by using half the requisite amount of oil as a positively charged emulsion, and subsequently adding the remainder of the oil as a negatively charged emulsion.

Example

100 g. cotton fabric.

1,000 c.cm. soft water at 100° F.

17.5 c.cm. positively charged stock oil emulsion stabilized by "fixanol C."

The procedure in this instance was to squeeze the cotton fabric for 2 to 3 minutes in this liquor and then to add 17.5 c.cm. of a negatively charged stock oil emulsion stabilized by "teepol."† On further squeezing up to 10 minutes deposition was again apparently complete. The fabric was hydro-extracted and dried as before. In this instance the oil content of the dry fabric should have been 7% if all the oil had been deposited:

Oil on fabric (calculated)	7%
" " " (found)	6.9%

Large-scale Operation

At this stage the results of the preliminary laboratory experiments appeared to be satisfactory enough to warrant the operation of the process on a large scale. Arrangements were therefore made for a series of tests to be carried out in scarlet fever and measles wards at the L.C.C. North-Western Hospital in order to ascertain how the incidence of cross-infection was affected by the use of oiled bed-clothes and ward hangings. The British Launderers' Research Association undertook to oil all the necessary articles at its Research Station after they had been washed and rinsed at the hospital laundry. During a period of four months some four tons of articles, including sheets, blankets, pillow-cases, counterpanes, bed-jackets, nightgowns, bibs, restrainers, nurses' gowns, black-out curtains, screens, etc., were treated in normal laundry washing machines.

Oiling takes place after the goods have been correctly washed and rinsed, and it is emphasized that level oiling cannot be obtained if fabrics are washed in hard water, whereby deposition of calcium and magnesium soaps occurs. The last rinsing water is adjusted to a predetermined volume by observing the height of the water in the dip gauge on a standard rotary washing machine, typical processes for the oiling of woollen and cotton articles being given below.

Two aqueous emulsions of technical white oil were prepared; the positively charged emulsion employed "fixanol" as the stabilizing agent at an approximate concentration of 2%, while the negatively charged emulsion employed "teepol" as the stabilizing agent at an approximate concentration of 3%. The

* "Fixanol C" is a cation-active agent of the cetyl pyridinium bromide type manufactured by Imperial Chemical Industries Ltd. The paste contains approximately 50% of active material.

† "Teepol" is an anion-active agent based on the sodium salts of sulphated secondary alcohols of average chain length 13.2 carbon atoms. The product contains approximately 22% of active material, and is manufactured by Technical Products Ltd.

quantity of oil used in each case was equivalent to 20% of the mixture by volume, and it was finely dispersed by employing an emulsifier which operated on the jet principle. These strong emulsions tended to cream on standing, and it was essential to stir thoroughly before removing the requisite quantities for addition to the washing machine. There would appear to be no reason, however, why more concentrated emulsions containing up to 40 to 50% of oil should not be prepared; and the tendency to cream might be considerably minimized by using a more efficient homogenizer.

Process A—for Oiling Woollen Goods

1. Size of rotary washing machine, 34 in. by 54 in.
Dry weight of load, 70 lb.
2. Adjust the quantity of softened water used in the last rinse so that, when the machine is running with the load in, the gauge glass registers a dip of 10 in.
3. Adjust temperature of water to 100° F.
4. Add stock "fixanol" emulsion (20% oil content)—1½ gallons.
5. Run machine for 10 minutes, interrupting the rotation periodically to minimize any tendency of the goods to shrink.
6. Stop machine and unload.
7. Hydro-extract and dry in the normal manner.

This process will give a level deposition of oil equivalent to 5% of the weight of the goods.

Process B—for Oiling Cotton Articles

1. Size of rotary washing machine, 34 in. by 54 in.
Dry weight of load, 100 lb.
2. Raise temperature to 100–120° F.
3. Add stock "fixanol" emulsion (20% oil content)—1½ gallons.
4. Run machine for 2 to 3 minutes without interrupting the rotation.
5. Add stock "teepol" emulsion (20% oil content)—1½ gallons.
6. Run machine for a further 7 to 8 minutes without interrupting the rotation.
7. Stop machine and unload.

This process will give a level deposition of oil equivalent to 6% of the weight of the goods.

During the present hospital trial it was found that the majority of the "woollen" articles to be treated were in fact composed of a mixture of wool and cotton; in view of this it was necessary to use Process B for such articles, since it was found that if Process A, for pure woollens, was used there was an uneven distribution of oil between the wool and the cotton components. The use of Process A for articles of pure wool is optional, since they can also be effectively oiled by Process B. It must be stressed here that the successful operation of this type of oiling process depends largely upon its being preceded by an efficient laundry washing and rinsing procedure. This is particularly true if adequate rinsing of the load has not been carried out, or if there is an accumulation of lime soaps on the articles owing to the use of unsoftened water. Apart from these considerations there is no reason why the oiling should not be carried out by the normal laundry staff, and if the machines used are afterwards rinsed out with hot water no difficulty should be encountered with subsequent washes. After hydro-extraction the load can be finished by the normal methods. No appreciable amount of oil is lost during the calender-drying of cotton articles. There is a slight but unimportant decrease of oil content when blankets and other woollen articles are autoclaved at 5-lb. steam pressure. Thus wool test-pieces having an average oil content of 5.2% showed an average oil content of 5.07% after treatment in an autoclave at 5-lb. steam pressure for one hour.

Accumulation of Oil

Over a period of successive oilings and washings it was found that there was a definite accumulation of oil in the case of woollen articles, which can only be given a low-temperature wash. Mineral oil such as technical white oil is well known to be extremely difficult to remove completely from textile fibres, and it is therefore not surprising that a progressive building up should occur. It is not desirable that the oil content should rise appreciably above about 5 to 7%, and the degree to which this accumulation may occur will depend largely upon the efficiency of the particular washing process. It is therefore not possible to give any general recommendation by which it can be prevented. A fairly steady degree of oiling can probably be maintained if in the initial

oiling treatment an increased amount of emulsion is used and in all subsequent treatments the amount of emulsion is reduced below that given in the process chart. If laboratory facilities are available the most satisfactory method of control is to incorporate a wool and a cotton test-piece in the respective types of load and to remove, after each oiling, a sample for Soxhlet extraction with petroleum ether. In this way any serious accumulation of oil can readily be detected and appropriate adjustments in the amounts of emulsions used can be made.

Discussion

During the present investigation it has been found possible, by the use of suitable emulsifiers, to oil hospital bed-clothes, etc., to any required degree by means of very dilute oil-in-water emulsions. The particular advantage of the present process over that previously described by van den Ende and Thomas is that complete exhaustion of the emulsion takes place, and there is therefore no necessity for applying any oil-recovery process to the used liquor. Both positively charged and negatively charged oil emulsions have been employed, either separately or in equivalent amounts. The cation-active emulsifier "fixanol C" and the anion-active emulsifier "teepol" have been used in the present investigation, but there is no reason why other commercial emulsifiers of similar types should not be used. The methods described are applicable on a large scale in any hospital laundry that observes a correct washing technique.

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OILED FLOORS TO CONTROL RESPIRATORY INFECTION

AN ARMY EXPERIMENT

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The use of spindle oil to lay the dust on floors and so diminish the number of bacteria in the air was described by van den Ende, Lush, and Edward (1940), and by Thomas (1941). The importance of such air-borne organisms in the spread of respiratory and cross-infections has been emphasized by many writers (Cruikshank, 1935, 1941; White, 1936; Allison and Brown, 1937; M.R.C. War Memo. No. 6, 1941). It therefore appeared of some importance to see if oiling of floors could be used to cut down the spread of air-borne infections among soldiers in barracks. An experiment to test this possibility was suggested and arranged by Col. W. W. S. Sharpe, and was carried out between Dec., 1942, and March, 1943. It gave encouraging results, and, as the general conclusions seem to have aroused some interest (*British Medical Journal* leader, 1943), it may be of value to give a short account of the details.

Conditions of the Experiment

The experiment involved the men in two Army units, A and B, each of which was a large training centre occupying one complete barracks. Oiling of floors was carried out in unit A, while in unit B, which served as a control, the floors were untreated. The two barracks were almost identical in structure, and the men in each lived and worked under closely comparable conditions. The medical officers of units A and B were well known to each other and were able to agree on common standards for the diagnosis of respiratory infection. This was taken to include all cases arising *de novo* which fulfilled either one or both of the following criteria: (1) An upper respiratory