DECONTAMINATION OF GREASY OR OILY SURFACES WITH DETERGENTS

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(Received October 12, 1967)

Presented by Dr. I. SZEBÉNYI

1. Introduction

Various methods are available for the decontamination of surfaces infected with radioactive matter. The efficiency, and the suitability, of the preparations used for decontamination can be studied by comparative tests carried out in the laboratory.

An essential feature of the evaluation of laboratory results is the method of preparation and decontamination of the samples. A common practice is the preparation of plates of the same size, from the material studied, and the simplest way of staining is by allowing a few drops of an aqueous solution of some active substance to fall on the surface of the plates. Decontamination is carried out mainly according to a variant of the wet method: a decontamination solution is poured onto the plate, or its surface is rubbed with a wad of cotton wool, etc. [1—9]. So, SIEMASKO in a study concerning dry packing materials [8] used the solutions of ^{32}P, ^{90}Sr, ^{95}Zr, ^{131}I, ^{137}Cs, ^{141}Ce, and ^{144}Pr isotopes. He used silica gel of grain sizes less than 100 microns as the carrier of the labeled compounds, and stained surfaces of about 100 cm^2 with these powders. For decontamination he applied a vacuum cleaner, and scrubbing with a brush under a jet of water. The preparations he used were various detergents, polyphosphate and hydrochloric acid. He found that decontamination was independent of the nature of the radioactive substance applied in the form of such powders. Radioactive dusts merit especial attention also because these adhere strongly to greasy or oily surfaces, or form stable suspensions in the lubricating substances within engines. In the course of our study we attempted to find how efficacious detergents are when used for the removal of radioactive impurities from the surface of metals.

2. Experimental

Silver phosphate labeled with ^{32}P, and ^{110m}Ag, respectively, and zinc ammonium phosphate labeled with ^{32}P were prepared. These compounds were suspended in lubricating grease, or in motor oils and the surface of iron or aluminium plates was smeared with them. Decontamination was carried

out in an apparatus provided with a stirrer, and the role of the several parameters was studied.

From the labeled compound, previously powdered in the dry state, one part by weight was admixed with three parts by weight of a standard lubricating grease (ZS-75). This mixture was homogenized, and kept in a dark place.

The other type of model contaminant consisted of one part by weight of the active compound comminuted in one part by weight of motor oil (MM-60) and diluted with further portions of this oil to give homogeneous mixtures of chosen compositions. According to examinations under microscope, the particle sizes of the active compound varied between 3 and 50 microns. Homogenization was always carried out at room temperature.

The plates, either iron or aluminium, were 45 mm×35 mm×1 mm; one side was coated with a synthetic varnish paint; the non-coated side of the iron plates was treated with alkali and allowed to rust for two weeks, or was used in the tests without any treatment. On the average about 50 mg of the grease or oil mixture was applied to the surface of the plates with a flat bristle brush.

The activity of the samples was measured with an automatic energy-selective counter, type NK-108, with a 50 mm dia. and 5 mm thick plastic scintillator as its sensing element.

The samples to be measured were placed into a fixed framework, thus assuring a constant 30 mm distance between plate and crystal. The activity

Table I

Detergents used in the experiments

Ser. No.	Trade name of the detergent	Active ingredients	Form
1	TIP—67	Alkylphenol polyglycol ether, alkyl-aryl sulphonate, triethanolamine and its ammonium salt	Liquid
2	*Prawozell* W—ON 100	Alkylphenol polyglycol ether	
3	*Sterogenol*	Cetyl pyridinium bromide + alcohol	Liquid
4	*Stop* car shampoo	Octyl-naphthalene sulphonic acid mono-ethanolamine ammonium-di- and monohydrogen phosphate	Liquid
5	*Evatriol*	Ammonium salt of laurylalcohol sulphate and triethanolamine salt of dodecylbenzene sulphonate	Liquid
6	*Ultra* dish washer	Sodium dodecylbenzene sulphonate, sodium tripolyphosphate, sodium sulphate	Powder
7	*Ipamin SG* P—6	Ester of sperm acids with P—6 polyethylene glycol	Liquid
8	*Ipafor LN*	Ester of sperm acid with P—18 polyethylene glyco	Liquid

of the indicator substance was so adjusted that with a 300 cpm background noise the counting rate should fall into the 10^4 to 10^5 cpm range.

Five of the plates to be tested were placed in the appropriate frames and immersed into 2 litres of the decontamination solution. The glass vessel used for this was of 145 mm dia. and 185 mm height. A forced circulation of the solution was maintained by a twin-propeller stirrer of which the revolutions per minute were regulated through a resistance built into the motor or a toroid transformer, and continuously checked with the aid of a stroboscope.

The trade or proprietary names of the detergents tested in our experiments are listed in Table I.

Each measured value represents the average of five, obtained with five plates. The efficiency in decontamination is expressed as the per cent ratio of the residual counting rate referring to the initial one.

3. Evaluation of the tests

In the comparative study of the several detergents, labeled silver phosphate was used, the suspension of which contained 25 per cent of this compound. In preliminary tests we found that in the case of the lubricating grease contaminant only one or two of the detergents produced any effect, therefore, comparative tests were carried out with motor oil suspensions. Experiments comprised a 10 minute decontamination period at 20°C, the detergent solution was agitated at 400 r.p.m. Based on results, the detergents tested may be classified as follows (cf. Tables II and III).

A) Efficacious are the detergents that reduce initial activity to its 19 to 22 per cent level when applied in a concentration of 1 per cent (TIP—67, and *Prawozell*).

B) Medium efficiency is ascribed to detergents which in the form of a 1 per cent solution effect decontamination to an about 60 per cent level (*Ultra* dishwashing powder, *Evatriol*, *Sterogenol*).

C) Inefficacious detergents; these cannot be recommended for the decontamination of greasy or oily surfaces (*Stop*, *Ipafor LN*, *Ipamin SG* P—6).

The central alignment of the stirrer, and the r.p.m., are factors that appreciably affect the reproducibility of measurements. The character of the curves (cf. Fig. 1) suggests that residual activity cannot be further diminished by raising r.p.m. above a definite number. Curves 1 and 2 refer to decontamination with TIP—67 (3 g per litre), curves 3 and 4 to that with *Prawozell* (1 g per litre). Sample plates 1, 2, and 3 were marked with radioactive zinc ammonium phosphate in motor oil, and in a mixture of motor oil and lubricating

Table II

Efficiency of TIP—67 in solutions of various concentrations

Composition of the decontamination solution	Counting rate, 10^3 cpm		Residual activity, per cent	Average
	before decontamination	after decontamination		
Tap water 20°C	71	52	73	73
	52	42	82	
	44	29	69	
	41	26	65	
	78	59	77	
0.5 g/litre	104	41	40	44
	99	50	50	
	89	41	46	
	87	37	42	
	97	41	42	
1 g/litre	68	11.5	17	18
	68	14.3	21	
	48	8.2	17	
	47	8.6	19	
	49	7.3	15	
10 g/litre	108	15.6	14	13
	109	14.2	13	
	106	16.8	15	
	106	13.3	13	
	86	8.5	10	

Table III

A comparison of detergents

Trade name of the detergent	Residual activity, in per cent, at various concentrations in g/litre				
	0.5	1	3	6	10
TIP—67	44	18	—	15	13
Prawozell	25	22	17	—	15
Sterogenol	50	39	34	33	33
Stop	—	65	52	50	44
Evatriol	—	37	30	29	28
Ultra	—	42	34	29	26
Ipamin SG P—6	—	—	70	66	55
Ipafor LN	—	—	66	62	57
Tap water			77		

grease; sample 4 was contaminated with a 25 per cent suspension of silver phosphate in motor oil. The decontamination solution was 20 per cent strong.

The role of the contaminant, and that of the duration of decontamination, at a stirrer speed of 400 r.p.m., were studied with a solution of 3 g per litre of TIP—67 (cf. Fig. 2). Curves 1 and 2 refer to silver-, and zinc phosphate, respectively, in motor oil. The activity of the samples is reduced by about 90 per cent within a relatively short time, i.e. in about 3 to 5 minutes. Then the quantity of the active substance still present practically does not change any longer.

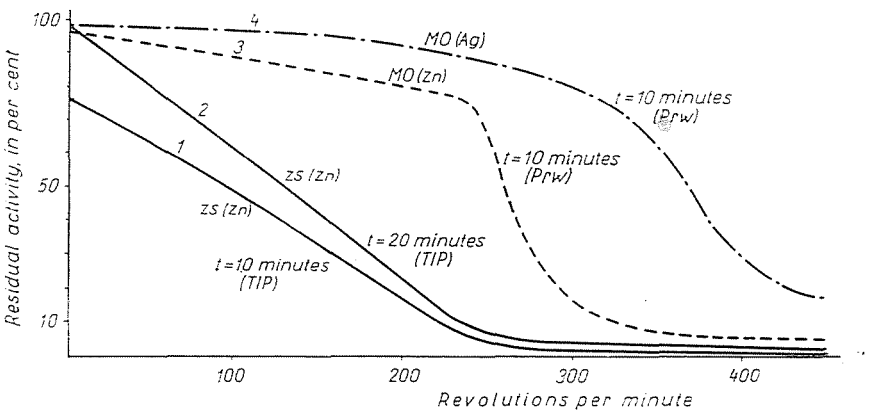

Fig. 1. Correlation between the r.p.m. of the stirrer and the residual activity

Samples with silver phosphate in lubricating grease could be decontaminated but rather slowly and the process could not be speeded up even by elevating the temperature of the detergent solution (cf. curves 3 and 4).

The effect of the character of the surface is shown by graphs in Fig. 3. Various surfaces were experimented on: (1) polished and non-polished iron, rusty plates (2 and II); plates coated with a synthetic varnish paint (3 and III); aluminium plates (4 and IV).

Plates were smeared with ^{110m}Ag-phosphate in oil; the decontamination solution contained 3 g of TIP—67 per litre, and 5 g *Ultra* per litre (II, III, IV); stirring was at 400 r.p.m.

According to expectation, the coated, then the aluminium, surfaces could be decontaminated within the shortest time, and the rusty surfaces took the longest. The exponential character of the curves indicates that with an adequate detergent the bulk of the activity could be removed within the first five minutes from almost any kind of surface.

Data in Tables IV and V show the effect of the temperature of the decontamination solution. Experimental conditions were the same as those

mentioned in the preceding paragraph. It can be seen that in the interval between 20°C and 60°C decontamination is not significantly affected by temperature. However, an important role must be conceded to the nature of the contaminant.

Table IV

Effect of temperature of the detergent solution
TIP—67, 3 g/litre; contaminant in lubricating grease;
decontamination time 10 minutes, at 400 r.p.m. stirring

Temperature °C	Counting rate, 10^2 cpm		Residual activity, per cent	Average
	before	after		
	decontamination			
20	123	120	98	98
	113	109	97	
	102	100	98	
	91	89	98	
	100	97	97	
40	63	52	81	76
	58	39	67	
	50	37	74	
	69	55	79	
	78	62	80	
60	87	62	72	73
	116	93	80	
	130	102	79	
	121	80	66	
	87	60	69	
40 tap water	83	80	96	95
	76	72	95	
	78	76	98	
	61	58	95	
	80	75	94	

Information about the accuracy of the measurements is given in Tables II, IV and V. Residual activity of samples treated in the same way can be measured within about a 20 per cent margin of deviation. This is mainly due to the fact that there is no uniform distribution of the contaminant on the surfaces, and no uniform dissolution therefrom. The effect of this uneven

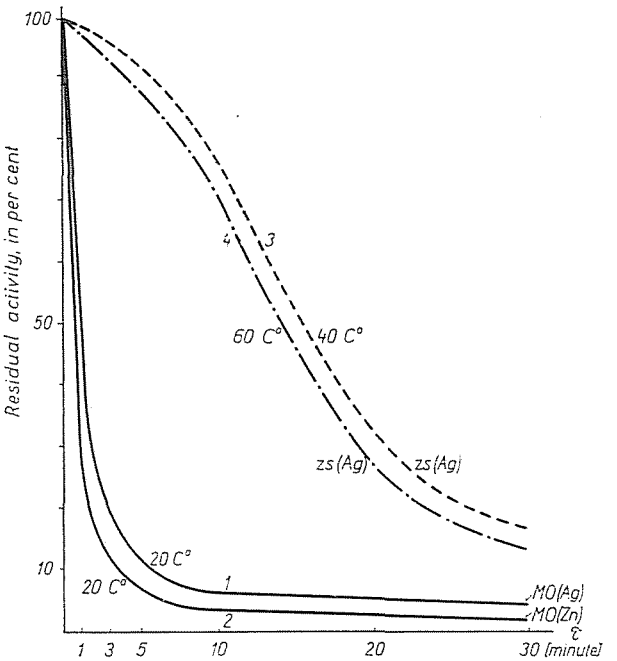

Fig. 2. Rate of removal of the contaminant

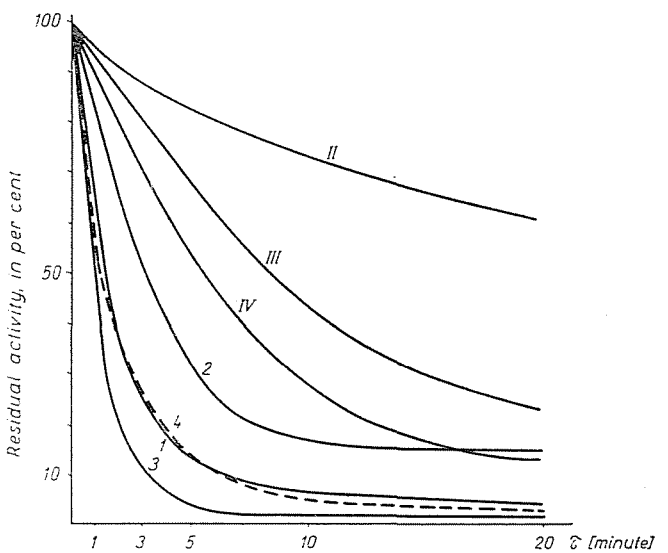

Fig. 3. Effect of surface quality on the rate of decontamination

Table V

Effect of the temperature of the detergent solution TIP—67, 3 g/litre; contaminant in motor oil; decontamination time 10 minutes; stirring at 400 r.p.m.

Temperature °C	Counting rate, 10^3 cpm		Residual activity, per cent	Average
	before decontamination	after decontamination		
2	98	54	55	56
	71	41	58	
	68	38	56	
	100	48	48	
	82	54	66	
20	170	21.5	13	12
	193	19.3	10	
	189	23.3	12	
	160	17.6	11	
	197	28.5	14	
40	118	5.9	5	6.6
	101	6.7	7	
	112	7.6	7	
	90	7.0	8	
	111	7.1	6	
60	121	4	3	4.6
	130	7.8	6	
	100	3	3	
	86	4.3	5	
	122	7.3	6	
20 tap water	133	102	77	71
	126	77	61	
	108	80	74	
	114	76	67	
	119	95	80	

distribution was also studied. A radiation source, 8 mm in diameter, was prepared with the contaminant. This was placed in the centre, and in the corners, of the plate of a given size, and then shifted diagonally, thus activity measurements at various sites were carried out. In reference to that found in the centre, activities measured at the corners were less by 25 per cent.

As a conclusion: the efficiency of various detergents could be studied to a satisfactory degree of accuracy with the method discussed. With certain modifications, this method may serve for the comparative study of detergents. In an apparatus of a given size, variation of the intensity of agitation, in function of the nature of the contaminant, significantly affects the level of residual radiation. Among the detergents on the market in Hungary, TIP—67 can be applied to good effect in decontamination operations.

Summary

Radioactive dust easily adheres to greasy or oily surfaces, or becomes suspended in lubricating substances within engines. A study has been carried out to elucidate the efficacy of detergents in the removal of such contaminations from the surface of metals. Radioactive silver phosphate, and zinc ammonium phosphate, were homogenized in lubricating grease and in motor oil. Smeared with these labeled substances, plates of iron, and of aluminium, 35 mm × ×45 mm, served as the samples which were then decontaminated by solutions of various deter gents in an apparatus provided with a stirrer. The effect of the following factors has been studied: quality and concentration of the detergent, revolutions per minute of the stirrer, time of decontamination, nature of the surface, temperature of the detergent solution. Activities before and after decontamination were measured. With the method described, residual activities on the plates could be measured to 20 per cent accuracy. The accuracy of the measurements has been shown to be rather sensitive to variations of the r.p.m. of the stirrer. It could be stated that TIP—67 is the most efficacious among the detergents tested; the active ingredients of TIP—67 are: an alkylphenol polyglycol ether, an alkyl-aryl sulphonate, an alkyl sulphate, triethanolamine and its ammonium salt. This method, with modifications, is also suitable for a comparative study of detergents.

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