SECT. II.—OTHER SELECTED PAPERS.

(*Paper No. 4322.*)

(*Abridged.*)

“Experiments on Grease-Interceptors.”

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INTRODUCTORY.

THESE experiments were carried out for the War Office by Mr. A. A. G. Malet, M. Inst. C.E., Sanitary Adviser to the Chief Engineer of the Southern Command, the Author being in direct charge of the investigations. The objects sought were twofold, namely, to ascertain the most efficient form of grease-interceptor, and to determine the minimum working water-capacity required to give a maximum efficiency in retaining the greasy matter contained in the flush discharges from the wash-up sinks in mess kitchens, regimental institutes, and cook-houses.

Further information was sought as to the effect on the efficiency of interceptors of the constant overflow of greasy water from the sinks into the interceptor instead of its discharge in bulk.

The most important reason for wishing to recover the grease from the waste discharges was that of economy and efficiency in the working of the camp sewage-disposal systems, with especial regard to the working of the purification-works.

From this point of view, it was necessary to intercept the greasy water at, or as near as possible to, the point of discharge, in order to prevent the grease from being deposited in the drains, eventually causing these to become blocked unless frequently cleaned. It was in the filters, however, that grease did the greatest damage, the medium becoming rapidly clogged, with the result that it had to be taken out at very much more frequent intervals than would otherwise have been necessary. A filter with a theoretical duty of 45 gallons per cubic yard per day, has been known to clog after being in action only 1 month. The work entailed in changing and burning the medium, to make it suitable for future

use, was very expensive and had to be avoided as much as possible, both for this reason and because it was a considerable time before the fresh medium was able to take its full share in cleansing the effluent. Again, the grease was liable to reduce the efficiency of the land irrigation areas, thus increasing the charges for maintaining them in good order. It was decided, therefore, to carry out a series of laboratory experiments, using an emulsion strong enough to give sufficient grease for accurate weighing.

In actual practice, there was generally 6 gallons of hot water, at an average temperature of 41° C., in one sink (waste plug inserted) while cold water was slowly running into the adjoining sink (waste plug removed). Four pairs of sinks were usually in use at a time and could be discharged simultaneously, the total discharge of hot water being taken at 24 gallons, 12 gallons of cold water being added during the period of washing. The resultant volume of 36 gallons was taken as the Standard Flush Discharge.

With the exception of climatic variations, the tests were conducted on similar lines, in order that the efficiency figure should represent the true comparative capacity of each type of interceptor for retaining the grease from the liquid discharged through it.

GENERAL ARRANGEMENT.

The equipment necessary for conducting the tests was housed in a corrugated-iron building, while the interceptor under test, the discharge chamber and the chambers in which the dippings for the inflow and outflow samples were taken, were outside this building.

To facilitate the process by which the inflow dippings were taken, and to increase their accuracy by steadying the flow, the outlet of the 4-inch pipe leading into the inflow sample chamber was fitted with a tapered lead spout.

The outflow discharge was comparatively steady, and it was possible to take the dippings at this point direct from a 4-inch pipe.

The grease emulsion from the tubs, which were placed inside the building, discharged into a shallow chamber, common to the three tubs, forming the head of a 4-inch open channel, and placed outside the building. This channel was unavoidably crooked, as the building and the manhole were already built, and the interceptor had to be placed between them. The discharges passed along this channel, through the inflow sample chamber and the interceptor under test, into the outflow sample chamber, and, thence, through a "P" trap into the manhole on the line of the

existing sewer. The outflow sample dippings were taken before the flow passed through this trap.

The grease, in the form of a cake, was obtained after boiling down the skimmings, gradually collected over a period of about 1 year, from the interceptors at cook-houses in use in the camps. It was recovered after each test, reboiled and dried, and used over and over again. The fact that it was practically free from foreign matter was the most important difference between the actual tests and the practice in the camps. The sink discharges at cook-houses generally contained tea-leaves, meat, vegetables and other detritus. But, as it was impossible to reproduce this condition with any degree of accuracy in the tests, and as the object of the experiments was to find the most efficient interceptor for retaining grease, without regard to the amount of detritus collected, it was decided to use clean grease. It is of interest to note that the grease collected from the camps and used in these experiments had a coagulation point of 35° C.

The preparation of the emulsion was carried out in the following manner :—

The required weight of grease was placed in a 3-gallon bucket, and broken into small lumps. Water from the boilers, at a temperature between 80° and 100° C. was then added in sufficient quantity to melt the grease. Care was taken at this stage to make sure that the emulsion was consistent and did not contain any lumps. The bucket was then filled with water at such a temperature that the emulsion had a temperature between 40° and 42° C. Sufficient water at the same temperature to make, with the 3 gallons of emulsion already prepared, the required volume for discharge, was placed in one or more of the tubs, and the emulsion was added in proportion to the volume in each tub when more than one of these was used.

Three boilers were used for heating the water required in the tests, and each had a gross water-capacity of 27 gallons, and a working water-capacity of 24 gallons. They were economical in fuel-consumption, and proved highly efficient for boiling water rapidly. One of them was tested, with the result that 14 lbs. of coal raised the temperature of 24 gallons of water from 15° to 100° C. in 1 hour and 40 minutes from the time the fire was lighted. After this it was a simple matter to keep an adequate supply of hot water for preparing the doses of grease emulsion.

The three tubs used for discharging the emulsion were cut down from 40-gallon casks to give a maximum working water-capacity of 27 gallons. At the bottom of each tub an ordinary sink waste

with plug and chain was fitted, and from this outlet a 2-inch pipe discharged into the chamber already mentioned.

GENERAL DESCRIPTION OF THE EXPERIMENTS.

The interceptors used in the experiments were of the types in general use during the war in the camps throughout the Southern Command. Various manufacturers were invited to send their grease-interceptors to be tested, but it is not proposed to refer to these in detail, or to give the results of the tests. It is of interest to mention, however, that in no case did any market type prove as efficient as the Southern Command interceptor of equal working water-capacity.

To enable the twofold object of the experiments to be attained, the grease-interceptors were divided into two classes, according to whether their working water-capacity was less than the Standard Flush Discharge (36 gallons), or greater than this discharge (up to 250 gallons).

The objects, as already stated, were to ascertain under what internal arrangement the interceptor would produce the best results, and the minimum working water-capacity required for an interceptor to give the maximum efficiency with a fixed flush discharge.

(1) *Grease-Interceptors of Working Water-Capacity of Less than 36 Gallons.*—To facilitate comparison with the types already on the market, these interceptors were of 10, 13, and 20 gallons capacity. They were made in proportion to each other, and, in order to test their efficiency, the internal arrangements were varied. True comparative results were obtained by varying the volume of the emulsion discharges in direct proportion to the capacities. The standard strength of the emulsion was 0·55 per cent., which is greatly in excess of that of the actual sink discharges. Tests were also made with discharges of double the standard strength, and it was found that such variation did not greatly affect the efficiency figure.

Experiments were carried out in which the volumes of emulsion discharge were two or three times the capacity of the interceptors, and also in which the flow was similar to that in a sink continually overflowing into the interceptor.

(2) *Grease-Interceptors of Working Water-Capacities Greater than 36 Gallons.*—The interceptors of this class which were tested had capacities of 250, 200, 150, 100, and 50 gallons.

In addition to experiments carried out on the standard flush

discharge basis with the objects already given, tests on three interceptors (150, 100, and 50 gallons) were made by discharging 6 volumes of 18 gallons each, as quickly as these could be prepared. One hour was the average time taken to complete this experiment, and in the method of discharge an endeavour was made to reproduce the action in an interceptor when three sinks, of 6 gallons each, were emptied simultaneously at 10-minute intervals for 1 hour.

Operations at the Interceptor.—Immediately before the commencement of a test, the temperatures of the air and of the water in the interceptor were taken.

The test began by the discharge of water, at a temperature of 41° C., equal in volume to the standard discharge of 36 gallons in the case of the interceptors mentioned in (2), and equal to the capacities of the interceptors referred to in (1).

The temperature of the liquid in the interceptor was again taken 20 minutes after each discharge.

At intervals of about 30 to 35 minutes after the discharge of the water, three discharges of grease emulsion were passed through the interceptor.

Samples of the inflow and the outflow, made up of eight dippings each, were obtained for each of these discharges, and the temperatures of the liquid in the interceptor were taken. The interval between the dippings varied with the volume of the emulsion discharged. Four discharges, one of water and three of grease emulsion, constituted one test.

Operations in the Laboratory.—The Werner-Schmidt process was used to determine the percentage of grease in the inflow and outflow samples. An average of these percentages in the inflow samples gave figures of 1 and 0.5 per cent., which have been taken as the standard percentages of emulsion actually reaching the interceptor in each test.

The flasks containing the samples were heated until the liquid boiled and the grease was completely melted, after which they were vigorously shaken.

Fifty cubic centimetres of a 5 per cent. solution of a compound, consisting of pure tragacanth gum and arrowroot, were then added to the inflow sample, and a similar quantity of a 1 per cent. solution of the same compound were added to the outflow sample, and the flasks were again shaken. The reason for using solutions of different strengths was that, in the event of any of the compound remaining in the grease at the conclusion of the experiments, the weight of the grease would be increased proportionately in both the inflow and the outflow, and the resulting efficiency figure would not be materially affected.

Four boiler test-tubes (two being marked for inflow and two for outflow) containing 10 cubic centimetres of each sample, were weighed when cold, and the weight of the emulsion recorded. To each of these were added 10 cubic centimetres of pure hydrochloric acid, and the whole was carefully boiled until the liquid turned brown, thus indicating that all foreign matter was destroyed and the grease set free.

When cold, the contents of the test-tubes were poured into four 50-cubic-centimetre separating-funnels, and ether (prepared from methylated alcohol) was added.

The funnels were thoroughly shaken and left for a few minutes, so that the ether which rose to the surface of the acid could be drained away. The ether was then poured into one of the four flasks of known weight and marked for inflow and outflow to agree with the test-tubes. The flasks were placed in a water-bath and the ether evaporated, caught, and stored for further use. The flasks, when dried and cooled, were again weighed, and the weight of grease was recorded.

Having thus obtained the weight of grease in a known weight of emulsion sample, the percentage of grease in the emulsion was calculated and the efficiency figure for the test was determined from the formula, $\frac{100(p-t)}{p}$ where p and t are the percentages of grease in inflow and outflow samples respectively.

Temperature of the Interceptors.—The average temperature of the interceptors during the discharges of emulsion was usually between 30° and 35° C. In the 250-gallon interceptor the temperature was as low as 20°, and in the 20-gallon type it was as high as 37°; but there seems to be no relation whatever between the temperature of the air and the resulting efficiency figure. This is no doubt due to the fact that grease will rise to the surface of the water and float at any temperature, though, when the liquid is comparatively cold, it will form into larger lumps and thereby gain greater buoyancy than if the temperature of the water is higher than 35° C.

Earlier Experiments.—Before the laboratory experiments were started, an attempt was made to test the interceptors under working conditions. Different types were erected in various cook-houses and kitchens, and the grease, collected over certain definite periods, was weighed. It was thus hoped to obtain true comparative results, and though these were obtained, it was not possible to compare the figures. The attempt justified itself, however, because it brought clearly to notice the value or otherwise of certain details as well as the fact that the best-designed interceptor will fail owing to

the method of working on the part of the men in the cook-house, or to the laxity of those responsible for its cleaning.

These earlier experiments will not be enlarged on here, but some of the recommendations embodied in the design of the interceptor, shown in *Fig. 1*, are influenced by observations then recorded.

RECOMMENDATIONS.

(1) The experiments prove without doubt the necessity for a baffle placed on the floor of the interceptor, over which the liquid passes, thereby assisting the natural tendency of the grease to accumulate on the surface. This baffle is especially necessary where the volume of the emulsion discharges is large as compared with the capacity of the interceptor, as, for example, if it equals that capacity.

(2) Comparison between the horizontal inlets in respective interceptors demonstrated the value of the submerged vertical inflow. The improvement thus effected, is probably due to the upward reaction from the floor and the elimination of all initial forward impetus in the flow of the liquid through the interceptor.

(3) It is very desirable to reduce to a minimum baffles which project above top water-level, as they are inconvenient when the grease is skimmed off and the interceptor is cleaned. All baffles should be fixed, as it was found in practice that movable baffles were often either put back in wrong positions, or omitted after cleaning. These investigations emphasize the use of only two baffles, one to be placed on the floor over which the emulsion passes, and the other at the outlet end, projecting at least 3 and 4 inches above top water-level in the case of large and small interceptors respectively (*Figs. 1 and 2*).

(4) The fundamental principle in the construction of an efficient interceptor requires the velocity of flow to be reduced as much as possible. As the section of the waterways determines the velocity, these should be made as large as possible. The top edge of a floor baffle and the bottom edge of a hanging baffle should lap by at least a quarter the depth of the interceptor.

(5) With the baffle placed 6 inches from the outlet end, a small compartment is formed from which the effluent can be drawn, either by a horizontal pipe in the case of those interceptors that discharge over a trapped gully, or by the top edge of a "P" trap in the case of the interceptors which are connected directly to the drainage system. This compartment is to all intents and purposes outside the interceptor, and it follows that any increase in the

velocity of the flow after reaching this point will not affect the

Fig. 1.

SUGGESTED STANDARD DESIGN FOR SMALL CREASE INTERCEPTOR WITH STAND TO BE PLACED UNDER SINKS AND TO TAKE OVERFLOW DISCHARGES.

efficiency of the interceptor, and, consequently, the sectional

Fig. 2.

STANDARD DESIGN FOR LARGE INTERCEPTORS.
To be sited outside Wash-ups and to take Flush Discharges.

NOTE.
The spacing of the interceptors
should be such as to insure
the capacity of the sludge sump
in each case.

DIMENSIONS OF INTERCEPTORS.

CAPACITY OF SUMP	LENGTH OF INTERCEPTOR	BREADTH	DEPTH OF TAIL TO BOTTOM OF WELL TO INLET PIPE TOP OF INLET PIPE	FLUSH TO FLOOR	FLUSH TO FLOOR	FLUSH TO FLOOR	FLUSH TO FLOOR
1000	6' 0"	2' 0"	2' 0"	1' 0"	1' 0"	1' 0"	1' 0"
920	5' 6"	2' 0"	2' 0"	1' 0"	1' 0"	1' 0"	1' 0"
73	5' 0"	2' 0"	2' 0"	1' 0"	1' 0"	1' 0"	1' 0"
64	4' 6"	2' 0"	2' 0"	1' 0"	1' 0"	1' 0"	1' 0"
51	4' 0"	2' 0"	2' 0"	1' 0"	1' 0"	1' 0"	1' 0"

area of the waterway may be reduced to that given by a circular pipe of small diameter, say 3 or 4 inches. It should be noted that where the baffle at the outlet end is omitted and the outlet pipe is submerged, this compartment is brought inside the intercepting portion of the interceptor.

It should also be noted that, where a "P" trap is used as a weir over which the effluent flows, the liquid contents of the interceptor, when the latter is being cleaned, can be baled into the trap and thus save both the labour and the obnoxious practice of pouring the liquid on the ground near the interceptor.

(6) It is important that all floor washings from the cook-houses, etc., should be excluded from the interceptor, because of the rapid silting up which is thus caused, and the reduction of the capacity of the interceptor, if it is not properly cleaned at regular and frequent intervals. In any case where a large interceptor (50 gallons or more) is installed, it should be provided with a sump sited between the inflow end and the floor baffle, and the capacity of this sump should be in excess of the normal working water-capacity of the interceptor.

(7) (a) *Interceptor to take Flush Discharges.*—From the results of the experiments, it has been shown that where the working water-capacity of an interceptor is three times the volume of each discharge or more, the resulting efficiency is approximately 100 per cent. This rule can therefore be taken as a guide for fixing the capacity of an interceptor. At the same time, it is advisable to keep it small so as to minimize as much as possible the risk of the liquid in the interceptor becoming septic, through lack of attention on the part of the persons responsible for its cleaning.

(b) *Interceptor to take Overflow Discharges.*—An efficiency of 98 per cent. was obtained in the case of the 20-gallon standard interceptor which was tested on the basis that the working water-capacity of the interceptor is equal to six times the volume discharged per minute. The discharges were 3 gallons per minute, but these were not absolutely overflow discharges, and consequently gave less regular velocities than would be obtained with a true overflow.

(8) It is essential that discharges which include floor washings should be passed over a grating, in order to catch the coal, cinders, dirt, etc., before they enter the interceptor. The most efficient article for this purpose was found to be a galvanized iron plate, 12 inches by 12 inches, with $\frac{1}{4}$ -inch diameter holes pierced in it at $1\frac{1}{2}$ -inch centres.

(9) In order to facilitate the cleaning of large interceptors, it is

advisable to have the highest water-level in the interceptor not lower than the level of the surrounding ground, as the cleaning operation consists, mainly, of emptying the interceptor of water by pumping or baling, and of removing the solid matter which accumulates in the sump.

The Author in conclusion wishes to thank Mr. A. A. G. Malet for his advice during the experiments and the preparation of this Paper, as well as for obtaining the permission of the War Office for the Paper to be written.

The Paper is accompanied by five Tables and by ten drawings, from which the Figures in the text have been prepared.