SIMPLE LARGE-SCALE INCINERATION IN THE TROPICS.

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The efficient, economical and rapid disposal of municipal garbage in the tropics is always an interesting and difficult problem, and the health of the community will depend to a large extent on its correct solution.

In all tropical countries we are exposed to the ravages of diseases spread by flies and other insects.

The aim of any tropical sanitarian is, amongst others, to keep down (a) the fly population; (b) the rat population.

If we can keep the numbers of both these pests under control and within reasonable limits it is evident that we shall have progressed very long way on the road to victory.

Municipal garbage, containing as it does a very large proportion of organic matter in the form of waste food, provides an ideal breeding ground for both flies and rats, when collected for ultimate disposal.

Flies breed in such refuse in countless numbers in warm countries; in addition, it provides a "home from home" for the rat, together with free and easily gained food for his ever-increasing family.

The rat has merely to make his burrow and his home in the accumulated mass of garbage. When he needs food all that he has to do is to make a run in any direction.

No method of refuse disposal, short of dumping it into deep water, salt or fresh, or incineration, will prevent rats breeding therein.

The question of rat breeding has to be most seriously studied, as if this point were overlooked, an outbreak of plague might result. Such a state of affairs is likely to happen in a large and busy African port which is constantly receiving from other ports ships in quarantine on account of plague.

The same difficulty obviously applies to fly breeding with this small difference, that whilst we can get 100 per cent efficiency in preventing rats breeding in the garbage, we cannot get the same high percentage in the case of flies, without indulging in perhaps unjustifiable expense. We can, however, reduce fly breeding to an almost negligible extent, and that by simple and relatively inexpensive methods.

In maritime towns like Seccondee, etc., in Equatorial Africa one tries to combine refuse disposal and lagoon reclamation, so that the system of refuse disposal may, to a certain extent, pay for itself in the course of time, and, in any case, immediately reduce the mosquito breeding area.

No system of dumping into shallow lagoon water will ever be made a
success, either from a general point of view, or more especially from a rat and fly prevention aspect. Such a system could be used in an emergency during the rains for periods of a few days at a time, but never for longer without danger and nuisance arising.

Assuming therefore that the refuse cannot be dumped into deep sea water—and this we cannot do in Secondee on account of the surf and the cost—we are left, for practical purposes, with incineration as the only practical means of dealing with it.

As soon as one mentions incineration, thoughts immediately arise of various costly forms of destructors, all of them running into thousands of pounds to construct and to maintain afterwards. An M.O.H. advocating such costly schemes is not usually successful in his pleading. A large, permanent and costly destructor has a very great further disadvantage, and that is, that such a destructor is absolutely permanent in its situation, whilst the advancing edge of the lagoon reclamation is continually and rapidly getting farther and farther away from it.

It will then inevitably be found that the destructor is so badly sited, and so far from the edge, that it becomes too costly to transfer the by-products of ash, etc., from the destructor to the lagoon edge.

Therefore, in designing an incineration scheme for such work, one must keep mobility in mind as well as expense.

Quite apart from the latter consideration, it is clear that for African labour and management the simpler the incinerator is the better; a simple form will almost certainly, in the long run, give a much higher percentage of efficiency than something theoretically more perfect—but complicated.

It may be said that it is not possible to devise a cheap and simple form of incinerator for large quantities of town refuse. I can state, however, that this has been done here with the greatest ease and success; despite the fact that we have to contend with heavy tropical rain in the wet season.

The refuse that we have to dispose of consists of food refuse, sugar cane and palm kernels, garbage of all sorts with an innumerable number of tins and bottles, all mixed up together, and combined with a very high proportion of earth and sand. Some loads will contain possibly fifty per cent of sand and unburnable material in the form of grit, etc.

It will thus be seen that even a Horsfall type of destructor might not produce appreciably better results than the method I am about to describe. If all the sand, grit, etc., were put into any form of destructor it would probably be rapidly choked with the resulting clinker.

In addition to the actual incineration, one has also to consider weather protection and drying sheds for the refuse; these may be very costly to erect.

I inaugurated a simple and inexpensive form of incineration in Secondee which has now been in use for some eight months. In devising such a scheme I had to keep in mind (a) cost, (b) practicability, (c) durability.

Something had to be constructed which could be worked with ease by
unskilled African labour, and which could be readily reconstructed or
repaired if it became necessary to do so. It had in addition to be of such a
nature that one could

(1) Move all or part of it to a new site; or (2) reconstruct it at another
site at little or no cost.

We have in this part of Africa a form of red earth, which, after being
damped and puddled, is called "swish." This sets hard like a terracotta brick of loose texture, and is used by the native population for
making houses and fish ovens.

I decided to make my incinerators out of this material as it had several
advantages—

(1) The local labour understood how to make and use the material; (2)
it is on the spot; (3) costs nothing except the labour to dig it.

There are thirty incinerators in use at the main dump, and these are all
of the same type.

Each incinerator is made of "swish," circular in form.

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<thead>
<tr>
<th>Inside diameter</th>
<th>Height</th>
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<td>3 feet</td>
<td>4 feet 2 inches</td>
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There are two openings for ventilation on opposite sides, each the
exact size of the bottom of a kerosine tin (in point of fact in constructing
them a kerosine tin is built in and then withdrawn). The object of this is
to enable the boys to stop the leeward hole without difficulty, as such tins
are common on the dump.

The grate consists of iron bars of any convenient size or shape
placed four inches apart—this distance apart is important, as, if they are
too close they cannot be raked or cleaned—and one foot above the ground.

The thickness of the walls is seven to nine inches. They run straight
up and down inside. They are slightly tapered in at the top outside (see
sketch).

They are built, native fashion, in layers and allowed to set, and take
three days to complete.

After they have dried a coating of coal tar is applied and allowed to
dry, though, indeed, the incinerators can be used before the tar is dry. If
cracks develop they are patched and tarred.

This produces a rock-hard, weatherproof structure, which stands the
rain well.

It should be noted that increasing the size of the incinerator will not
increase its efficiency. Rather the reverse. As I make it, the maximum
draught and burning capacity are obtained.

At first we made them by hand and eye alone; this, while satisfactory
up to a point, led to rather wide divergencies from standard pattern, and
the workmen needed watching if uniformity was to be obtained.

I therefore approached the P.W.D., and got them to make, on pay
ment, a complete inside mould of an incinerator.
This is made out of light mahogany, in three sections, i.e., one bottom section up to grate level and two top sections. The top portion had to be divided into two, as it was too heavy to lift out in one piece.

With this mould incinerators can be built "while you wait" so to speak.

Four or more bottom sections are laid down on the first day and left to set. On the second day the bars are laid on, and the first half of the top completed; on the third day the structure is completed. It is then given three days or so to set and dry, depending on wind and sun, after which it is tarred. The wood mould is oiled before use, and is withdrawn immediately a section is completed. The builders do not find any difficulty in doing this; they like the mould immensely, and say that it saves trouble. Its use trebles or quadruples their power of construction.

If any incinerator cracks badly or gets damaged it is simply knocked down and rebuilt at once.
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The heat generated in these incinerators requires to be felt to be realized. They burn furiously, and at times their interior is just a glowing incandescent mass. The quality of the ash produced is excellent.

We had exceptionally heavy rains this year, and we carried on all through, burning refuse all the time. For some four days only, during the worst period, did we have to resort to dumping into three feet of lagoon water, and even then we continued burning refuse.

During this time the garbage coming down in the lorries was a wet, sodden mass, and most depressing to look at. Still, this state of affairs only lasted for a very short period, and now, despite the usual occasional heavy local showers, we burn with ease upwards of thirty-six Ford one-ton lorry loads per day.

I considered what might happen when the rains broke and realized that it would be necessary to provide some system of protecting the garbage and keeping it dry during the rainy periods. This has been done as follows:

The Town Council voted me the sum of £100, and with this I constructed for each two incinerators a drying shed, made of bush timber and thatch, by specially engaged labour. Each shed stands some nine feet behind the incinerators and is placed so that the prevailing wind will blow from it to the incinerator.

The dimensions of the sheds are as follows:

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<th>Height (a) to central ridge pole</th>
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<tr>
<td>(b) from floor to eave</td>
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<td>..</td>
<td>8 feet</td>
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<tr>
<td>Length</td>
<td>..</td>
<td>..</td>
<td>9 feet 6 inches</td>
</tr>
<tr>
<td>Width</td>
<td>..</td>
<td>..</td>
<td>7 feet 6 inches</td>
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The four corner poles are sunk sixteen inches deep and the whole are braced together by cross-ties. Closely thatched roof, sides and a door are then added. The gable end on the “rainy” side is filled in; the door is also placed on that side. Thus the structure is weatherproof in time of rain. The floor is raised six inches above ground level (to keep it dry) and made of rammed and tarred “swish.”

I have seen two inches of rainfall in under two hours, and with this construction there was no wetting of the garbage. The incinerators were burning during the rain, and a few that had gone out were started immediately the rain ceased.

All the “houses” are tied, the one to the other, by bamboo poles, from eave to eave, and thus the whole line of houses is a connected unit which has so far been able to defy tornados.

The width of the house has been arranged so that a one-ton Ford lorry can easily back up to the edge of the raised floor and tip its contents therein. The drivers have no difficulty in doing this.

I have now devised a protecting roof for each incinerator made out of
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General View showing "Lay out."

Close up showing Rain Covers, etc.
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light corrugated iron sheets, of a very simple and inexpensive type. Each consists of 2 sheets of 32 gauge 6 feet long, riveted together with an additional 6-inch strip to increase the width. These are then bent in the middle at an angle of 125 degrees and supported by a light wood frame.

In case of rain, each is just lifted by two boys and placed on the top of the circular incinerator and so completely protects it from rain. We thus have a very simple form of weather protection at negligible cost, and one eminently suited to unskilled labour. The headman at the dump is very pleased with them, as previous to their use he had to collect old galvanized iron sheets, etc., etc., and cover his incinerators as best he could.

The general principles which have made this system a success are:—

(a) One boy, one job and no other job; (b) each boy is made an expert through daily practice; (c) if any boy falls sick, the newcomer easily learns his job by merely imitating his companions, and is usually as proficient as they are within a few days.

There are: 15 incinerator boys who each run 2 incinerators; 5 barrow boys, 1 boy on the "travelling edge" (see later), and 1 headman constantly employed.

Each incinerator boy is supplied with: 1 digging fork, 1 rake, and 1 shovel, so that no boy has to borrow from another. This is an absolute essential.

Each one is responsible for one "house" and two incinerators and the surrounding area.

The barrow boys wheel away tins, bottles and "small stuff," each boy clearing six incinerators. They take this to the "travelling edge" (see later).

The remaining boy, armed with a rake, is stationed on the "travelling edge" and there deals with the barrow-loads of tins, bottles, "small stuff" and ash which make the "travelling edge."

We deal at this dump alone with an average of twenty-three and a half lorry loads per day, and have disposed of up to thirty-six. The garbage is familiar to any African resident; a tightly packed mass of tins, bottles, straw, refuse food, sand, palm nuts, and every other possible item of refuse one can imagine. It is covered with flies.

Each lorry is allotted a definite number of dustbins in the town. The lorry crew clear, or partly clear them, drive to the dump, "reverse in" to a "house," unload, pull out, and return for more. The incinerator boy pitches the garbage forward into the "house" if any has fallen out, so that in the case of rain he can shut the door easily. He then goes round to the front with his fork, teases and shakes the refuse, shaking out what the boys call "small stuff" consisting of sand, palm nuts, small stones and sometimes fly larvae in large numbers. The burnable refuse is placed in baskets and put in the incinerator where it presents no further problem.

Large tins and bottles are thrown by the boy to one side and subsequently taken away by the barrow boys. A heap of "small stuff" is also gradually accumulated.
The hot burning ashes from the incinerator are taken out with a shovel, placed over the "small stuff." Alternating layers of "small stuff" and ashes thus form a heap which the barrow boys eventually remove.

The reason for thus mixing "small stuff" and ashes is that in the former there are many fly larvae, and at first flies were prevalent at the dump. Having thought over this problem I eventually decided that the mixing of hot acrid ashes would kill the majority of larvae and eggs. This has proved to be the case and if the mixing is done carefully the majority of larvae are found cooked. On the other hand if the boys are careless quite a large number will survive. Thus the prevention of fly-breeding is largely dependent on this work. When it is properly done, twelve to sixteen flies per square yard is an average hatch: determined as detailed below.

With regard to fly-breeding I have conducted the most careful experiments, and find that very few flies breed in the neighbourhood of this "travelling edge" if the mixing is done properly at the incinerator. I have constructed a light-tight box, 1 yard square, 6 inches deep, with a 2-inch hole in the centre, over which is placed one of the ordinary large sized unspillable ink pots with detachable central cone.

The box (taking care of course that there are no flies inside) is placed over the newly-deposited mixed ashes and "small stuff." The bottom is sealed round and the box is fastened down with sticks and wire. My theory was (and it is correct) that any fly hatching out would immediately be attracted by light, go into the inkpot and be trapped there; similar to what happens in my fly-trapped pits for excreta disposal.

Sufficient counts have not been made up to date to arrive at conclusive data.

The next step is that large tins, galvanized iron, bottles, etc., are removed to the lagoon edge and there dumped, dealing with small portions at a time. This I call the "travelling edge," as it moves forward rapidly.

The tins, etc., are flattened out, placed in layers to a depth of some 1½ feet. On top of this the mixed "small stuff" and ashes are placed and levelled, eventually forming, as is clearly shown in photograph, a closely packed floor of grey black ashes covering over the tins, etc. It becomes more and more consolidated with the daily traffic upon it. The edge of tins, etc., moves forward, is covered by ashes, etc., and moves again.

The edge at all times remains clean cut and sharp at the water's edge, except at the actual spot where the tins are being deposited. Our rate of progress forward is really amazing, and we are reclaiming a great deal of ground.

Close to where we are working there are several small islands. These islands are great breeding places for mosquitoes, and the intention is to go round the edge of each island, reclaiming it and making it level with ashes, etc., and then subsequently to fill in the middle.

Mosquitoes breed in crab-holes, and these are less frequent where the tins, bottles, etc., are covered with ashes.
The scheme is a marked success. The whole system works like a well ordered machine and the dump is an extraordinarily tidy place.

One can go there at any hour and find the refuse being deposited, sorted, burnt and ashes and bye-products taken away with clocklike regularity.

Each boy knows he has his job to do, and that except in the most grave emergency he will not, at a slack moment for him, be called upon to do any other work. That is to say the principle accepted by each boy is, if he gets on with his job and burns his garbage quickly he is not then called upon to assist some other boy who is lazy.

The headman exercises general supervision and allots lorry loads, as they come in, to each incinerator or "boiler" as the boys call them. This avoids all friction and jealousy.

The boys are most happy and contented, and there is quite keen competition for work on this dump.

In general I do not claim that this system is perfection, or that a better cannot be devised, but I do say (a) that it is practical and does what is required; (b) that it meets a deeply felt want in many places; (c) that its first cost is negligible, as I only paid some £65 for fifteen "houses"; (d) that its running cost is relatively small—i.e., some £600 per annum.

A large Horsfall destructor would cost more than a thousand pounds (that in itself involving a yearly charge for interest).

It would need a skilled European supervisor (probably at a salary of
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some £400 per year), and a number of labourers, which, at the present moment, I am unable to estimate.

A Horsfall, moreover, would be immobile, while it would be easy on the other hand to transfer all the "houses" intact, at a couple of days' notice, 100 yards nearer to the "travelling edge," following its forward movement. Thirty incinerators could be constructed on the new site in some twelve days by the use of the mould, or in one month by hand and eye alone.

It seems almost certain that the destruction of millions of flies' eggs and larvae, and the destruction of rat food, are bound to have a most beneficial effect upon the general health of any tropical town.

This type of incinerator is one that is well adapted for village use, as Africans are accustomed to "swish," and any headman once shown the method could make one.

Any rat that wishes to get food at the dump must "step lively." He cannot approach the houses till dark, and he must leave early and cross a big open space. No rat will continue to do this.

By the use of these and other incinerators of the same pattern on other sites, together with my fly-trapped excreta pits, which are the subject of another article, the fly population here has been reduced enormously.

In other words, the numbers are so few as to pass unnoticed. The gain, both as regards health and comfort, is inestimable.

The very small number of flies to be seen in the municipal markets on exposed food has been a very striking feature since the inception of this scheme.

I wish to thank Dr. M. E. O'Dea, the Honourable the Director of Medical and Sanitary Services, Gold Coast, Accra, for permission to publish this article, and to thank Dr. G. Hungerford, late Acting Director of Medical and Sanitary Services, and Dr. G. J. Pirie, the Deputy Director of Sanitary Services, for the interest they have taken in this work.