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HOW TO DEAL WITH THE SLUDGE PRODUCED BY WASTEWATER TREATMENT PLANTS IN THE SOUTH PACIFIC

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Sludge is an inevitable by-product in all the processes whereby sewage is purified. Its processing and disposal have always been a difficult problem.

In the South Pacific, land is at a premium. With the appearance of treatment plants in this part of the world, we are entitled to ask certain questions: should fresh or stabilized sludge be flushed out to sea or dumped in the lagoon ? In an island environment, can it be used for productive ends ?

I. Fresh (or primary) sludge and biological sludge

A distinction is generally made between two kinds of sludge produced: a) from mineral or organic waste contained in untreated water and not easily biodegradable, and b) by transformation of dissolved or colloid polluting substances by micro-organisms. They are:

- fresh or primary sludge;
- biological sludge.

We shall waste no time on the fresh sludge collecting at the bottom of primary sedimentation tanks. It is of a greyish appearance and contains organic matter which readily ferments.

Biological sludge may vary greatly according to the kind of processing given to the raw sewage:

- Trickling filters and biodiscs — (Immediate recycling at the treatment plant. Stabilization in digester.

- Activated sludge (Stabilization
- Treatment systems where the load is slight, or in the event of prolonged exposure to air (Dehydration.

In this latter case, it is assumed that the sludge contains minerals enough to be de-watered without prior biological treatment.

II. Disposal of fresh sludge

Clearly, it may well be asked whether it would not be well to dispose of the sludge when fresh, so as to obviate the need for processing. Let us consider the various disposal techniques:

2.1 Use as fertilizer or for purposes of soil regeneration

Liquid sludge, fresh or digested, is a potential threat to public health. It should not, for this reason, be used as a fertilizer or for soil regeneration, except possibly for large-scale plantations or on building land where the risk of direct contact with man is very slight.

2.2 Lagoons (oxidation ponds)

These may be natural or artificial. Numerous Pacific islands possess suitable areas, especially immediately upstream or up-river from mangrove swamps, where fresh and salt water meet.

There are certain conditions to be scrupulously observed. Thus, the pond must be some distance from inhabited areas. Conditions must be such that the sewage can be left in the pond long enough. Close attention, too, must be given to the risk of pollution, either to a beach in the neighbourhood, or to an underlying water layer.

2.3 Burial

This process requires a good deal of spare land well away from human settlements. Should this condition be met, the fresh sludge can be poured into trenches (4 to 8 inches) which are filled in and covered over as the work advances. This procedure, however, is scarcely practicable in small low-lying islands.

2.4 Land reclamation

This process can be employed with fresh sludge, liquid or dehydrated over vacuum filters, but for sanitary reasons the reclaimed area must be speedily covered over with earth or other suitable material (a layer at least 12 inches thick). Like the preceding method, this one too would seem scarcely practicable on low-lying islands.

2.5 Controlled dumping

It sometimes happens that fresh sludge is mixed with rubbish, and the resulting mixture is disposed of in controlled dumps. The procedure is perfectly acceptable, provided the following conditions be observed:

- Not more than a fraction of the total sludge produced by the local people should be so used. The total sludge produced locally cannot be added to the domestic refuse produced in the same way. The reason is that sludge contains a high percentage of water, and if all the sludge were to be added, the fermentation of the rubbish would be disturbed.

III. Processing of sludge

If fresh, liquid sludge cannot be disposed of, prior processing must be envisaged. But then the problem arises: how are we to get rid of the dried sludge so produced ?

Be it observed in addition that the more complicated a system is, the higher will be the operating costs and the capital expenditure required. Pacific islands do not always have the necessary financial resources or the technical know-how.

3.1 Processing

Sludge may first of all be "treated", that is to say, rendered suitable for de-watering on a vacuum filter. Three techniques may be used:

3.1.1. Thickening

The aim of this is to remove the excess water and to render the solid matter more homogeneous. Sludge may be thickened:

a) by decanting (equipment required: decanting plant, sedimentation tank and waste-weir), a process based on gravity;

b) by mechanical mixing (equipment required: tank equipped with vertical vanes);

c) by pressure (equipment required: ventilated pressure-vat to cause the sludge to floculate).

3.1.2 Chemical coagulation

The aim is to bring about an insoluble floculation which will cause an agglomeration of suspended particles and colloidal matter, by introducing reagents. What reagents will be used depends on cost and availability:

- Sulphuric acid
- Aluminium
- Copper chlorate
- Ferrous sulphate
- Iron oxyde, with or without lime.

The reagent is well mixed with the sludge by slow stirring for a minute or two, before the sludge is ready for filtering. Ferric chloride is the reagent most commonly employed.

3.1.3. Elutriation

This is a process whereby the digested sludge is washed to reduce its alcalinity and the quantity of reagent required. To this end, water, or the effluent from the treatment plant, is used, with stirring or the blowing through of air for twenty seconds, and recycling of the supernatant liquid.

The process calls for counter-current plant and paired tanks similar to secondary sedimentation tanks. In these, the washing water and the sludge enter at opposite ends.

By this process, up to 80% of the overall alcalinity in the sludge can be removed, and the ferric chloride needed for chemical coagulation reduced by at least 65 to 80%.

IV. Sludge dehydration

The sludge, processed or not, now has to be dried. There are three possible processes: drying beds, vacuum filters, and centrigugation.

If the sludge has been properly digested, it can be dried on sand beds, which will bring the water-contents down from 90 to 95% to roughly 70%.

On the other hand, fresh sludge demands vacuum filtration after processing. After processing, the water-content is 92% to 95%, and sometimes even higher. Vacuum filtration brings this down to 70%. The resulting cake can then be incinerated if desired. This is a useful way of getting rid of it.

4.1 Drying beds (see diagram)

A fairly large area is required:

- primary decanting only: 10.8 ft^2 (1 m^2) for 20 users;
- trickling filters with secondary decantation: 10.8 ft^2 for 10 users;
- activated sludge: 10.8 ft^2 for 6 users.

When the digested sludge is spread on a well-drained bed of sand and gravel, the gases it contains, whether they be free or dissolved, tend to be given off and draw solid matter after them. This leaves a layer of relatively clear liquid in the lower part of the sludge, which liquid will drain off through the sand fairly easily. Thereafter evaporation is facilitated by the cracks due to horizontal contraction. In the Pacific, such beds will be in the open air, since evaporation in so warm a climate is very effective.

4.2 Vacuum filters

This artificial drying method can be strongly recommended when:

- space is limited;
- smells and flies have to be vigorously eliminated;
- the composition of the digested sludge is such as to render drying on natural beds difficult.

Vacuum-filtering is a technique of mechanical drying. One of the most commonly used vacuum filters is the "Komline Sanderson" (see diagram).

If properly treated sludge is spread in a thin layer over a suitable filtering material, its water-content can be speedily and considerably reduced. This is what happens with a vacuum filter.

The filter essentially consists of a drum on which is mounted a filtering material (normally a sheet of cotton, wool, synthetic fibre or plastic, or a grid of stainless steel, or even a double layer of springs or spirals of the same material). A system of valves and pipes provides a vacuum on the inner surface of the filtering material. The sludge sticks to the drum while the water is extracted.

Operating costs, including processing costs, are higher than with drying beds. But the process obviates the need for digestion, simplifies disposal problems and reduces the space required by the plant. At the same time, the system is not subject to the whims of the weather.

All in all, the system could well be used by urban sewage disposal plants in a number of Pacific islands.

4.3 Centrifugal separation

High-speed centrifugal separation will reduce humidity to such an extent that 65 to 70% of the dehydrated sludge consists of solid matter.

The most satisfactory separators for this purpose are those fitted with an extended cylindro-conical bowl, the lengthening of the bowl being due to an increase in the length of its conical part. By this means, the cake finally obtained can be rendered even drier.

V. Disposal of dried sludge

Now that the sludge has been duly dried, whether by natural or by artificial means, what can we do with it ?

It can be recuperated for agricultural purposes (if the rural conditions on the island concerned are suitable), or disposed of in controlled dumps (we have already dealt with this in connection with fresh sludge), or incinerated.

5.1 Recuperation for agricultural purposes

Dried sludge, a capital fertilizer, is made up as follows:

- Minerals 50 to 55%
- Organic matter 45 to 50%
- Organic nitrogen 1.8 to 3.5%
- pH 7.3 to 7.9%.

Its mineral ingredients are essentially as follows:

- Silica SiO_2 52%
- Calcium CaO 18%
- Iron Fe_2O_3 6%

the remainder consists of SO, MgO, K_2O, P_2O_5, and miscellaneous.

When air-dried, it can be removed over distances of seven miles or so for use, and over even longer distances when dried artificially.

5.2 Incineration

The combustible part of sludge is made up of organic matter, with great heating power:

- So-called primary sludge 5,900 to 6,700 therms
- Digested sludge 5,300 to 5,900 therms.

Sludge is turned into ash by combustion at temperatures between 650 and 850°C. This can be done either in a cyclone burner or in a Flash-type oven used in association with an artificial-drying device.

The system calls for:

- a device for elimination of gaseous residue and sparks;
- possibly, too, an additional heat-input by the use of auxiliary fuel.

Whenever any sludge is reduced to ash, organic matter and the pathogenic bacteria originally contained therein are virtually destroyed. The resulting ash can then either be used for an earth-fill or simply tipped in the neighbourhood. It is valueless as fertilizer and practically useless for soil regeneration purposes.

There is to-day an increasing tendency to incinerate sludge after artificial drying, without either digestion or stabilization. However, the process is more suitable for fairly big urban sewage-disposal plants where skilled labour is available.

VI. CONCLUSIONS

In the light of the above, there is a great field for choice. The final decision will be dictated by local, geographical, economic and social conditions.

If resources are such that fresh sludge can be disposed of, then there will be no need for digestion, processing and drying. But in such circumstances the methane given off during digestion will be lost as well as the fertilizer available after drying, and there can never be any certainty that public health will not be at risk.

If both space and money are available, digesters can be installed and drying beds laid out. It is important for the Pacific islands that they should recuperate humus.

If space is limited, if a great deal of money is available, and if public health conditions, especially in densely-populated urban areas, demand, a treatment-plant will be constructed without digesters, but with a system for processing fresh sludge before artificial drying. The dried sludge will then be used for agricultural purposes, if the market exists, or incinerated, or disposed of in controlled dumps.

Thus, no matter what local circumstances prevail, there is a solution. In future, sludge-disposal ought not to constitute an insoluble problem for communities which have decided to provide sewage treatment of any kind at all.

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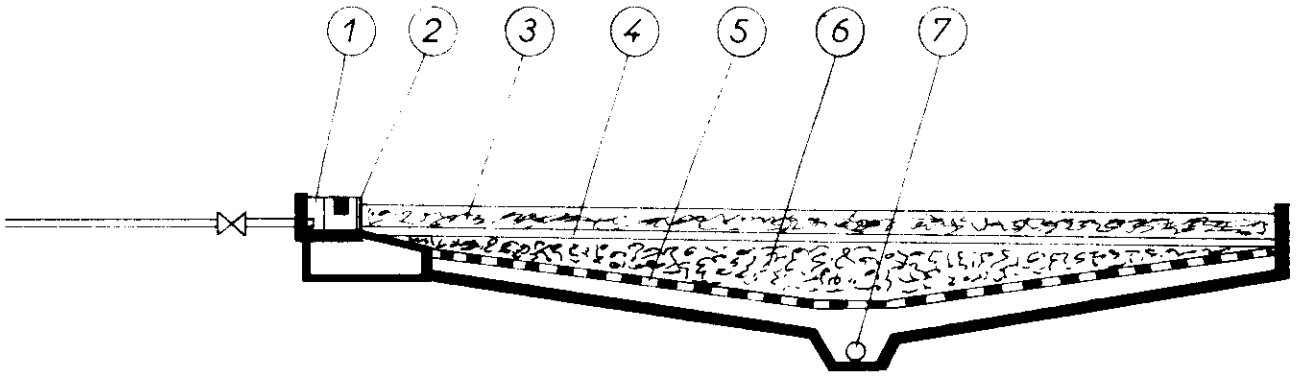
DRYING BEDS - LITS DE SECHAGE

(Cross section - Vue en coupe)



1 Inlet channel - Caniveau de distribution

2 Handstops - Vannette en bois

3 Sludge drying - Boue en cours de sèchage

4 Sand or ashes - Sable ou cendres 10 cm

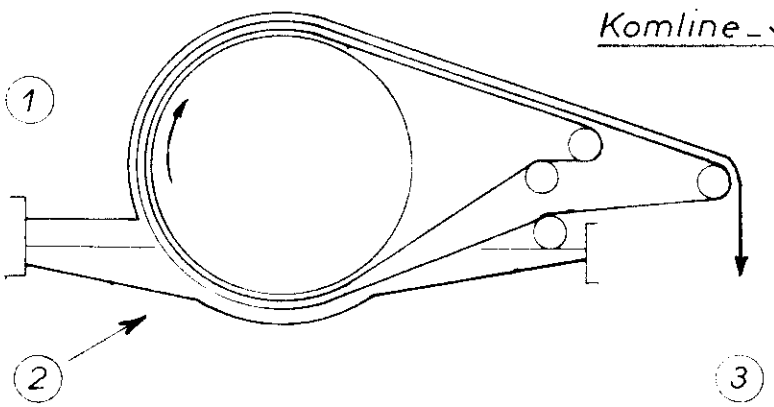
5 Drainage for each bed - Drainage de chaque lit

6 Clinker - Mâchefer 20 à 30 cm

7 Outlet pipe - Collecteur de drainage

Schéma du filtre Komline - Sanderson

Komline - Sanderson filter



1 Rotative mesh drum - Tambour rotatif

2 Liquid sludge - Boues humides

3 Deshydrated sludge - Boues deshydratées

		Classification
30.	Plant Pest Control. January 1971	Tropical Crops
31.	The Effect of Cultural Method and Size of Planting Material on the Yield of Colocasia esculenta. February 1971	Tropical Crops
32.	Shell-fish and Public Health. April 1971	Public Health Engineering
33.	Weed Control. August 1971	Tropical Crops
34.	Taro. August 1971	Agricultural Research
35.	Transmission of Virus Samples. August 1971	Plant and Animal Quarantine
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37.	Training Programmes for Out of School Rural Youth. March 1972	Agricultural Education and Extension
38.	Control of Aedes aegypti, the Vector of Dengue. September 1972	Vector Control
39.	Coconut Water as an Emergency Parenteral Fluid. September 1972	
40.	Viral Hepatitis. October 1972	Hepatology
41.	The Processing of Sewage by Rotating Biochemical Filter (Bio-discs). December 1972	Public Health Engineering
42.	The Monitoring of Sewage Treatment Plants. December 1972	Public Health Engineering
43.	The Fifth FAO Regional Conference on Animal Production and Health in the Far East. December 1972	Livestock Production and Health
44.	The Septic Tank. January 1973	Public Health Engineering
45.	How To Deal With the Sludge produced by Wastewater Treatment Plants in the South Pacific. January 1973	Public Health Engineering