A GOOD LOOK AT THE PROBLEM OF DUNDER DISPOSAL

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Abstract.

The paper deals with the handling of dunder, without going into details of its purification, although mentioning them. It attempts to indicate lines of approach to the problem of dunder disposal for mills in different topographical and geographical situations and signposts the route the solution should take.

Introduction.

All the sugar mills in South Africa and Rhodesia are, to comply with the Water Acts, having to put their houses in order in the matter of dunder disposal, and most of them are tackling the problem seriously. The S.M.R.I. is very much involved in the matter, and has expert advice to offer, particularly on the subject of actual purification. It is on the more general aspects of the problem that this paper deals, however, and the finer technical points are left to those better equipped to deal with them.

Huletts have five mills in Natal and one in Rhodesia, each with its problem of liquid waste disposal, and, to achieve a uniformity of approach in the investigation, is having a good look at the dunder problem in each mill through the eyes of its Civil Engineering Department.

With conditions at six mills to study it has been possible to learn much about the practical side of the problem, while a limited amount of knowledge of the theories behind purification processes has been gained through the literature and through the experiments that have been conducted in association with the S.M.R.I. at Darnall. In addition, some months ago the writer was privileged to have been given the opportunity of visiting various factories overseas where the purification of trade effluents is being actively practised, and now feels that a brief account of what he has been looking at, and thinking about, will be of interest to members, and, hopefully, useful as well.

Ideal arrangement

The general set-up at Umfolozi for dealing with its dunder is as near perfect as can be achieved, and the best use has been made of the favourable local topography, which includes the elevation of the mill and its siting relative to the river.

The concept of a large dam into which all liquid wastes can gravitate, then pass through a purification plant and finally flow into a second large holding dam pending final disposal is undoubtedly ideal, and a search for a solution along these lines should be the first line of approach in the consideration of any mill's dunder disposal problem particularly when irrigation is out of the question.

Problem in practice.

Few mills occupy sites that allow effluent handling arrangements as neat as these, and the problem becomes more complicated. It can conveniently be considered under three headings, viz. collection, treatment and disposal.

1. Collection.

Not a lot need be said about this aspect, as there is theoretically no difficulty in getting the wastes to one point. It should be as clean as possible when it gets there, i.e. with minimum of oil, bagasse particles, and other suspended matter, and the receiving dam should be large enough to accommodate all surges from the factory, so that any purification plant that follows can expect to receive effluent at a reasonably constant rate and strength.

For a period of almost two seasons at Darnall the cooling pond was used as a receiving dam, and all dunder, including floor washings and boiler blowdown, was pumped into it.

The resulting mixture gave an acceptable irrigation water of C.O.D. 500 to 800, and pH over 6, but the pond became progressively more smelly as the season progressed, and it was desirable that other arrangements be made. These entail the use of some old ponds as receivers of the neat dunder from the factory, and from these ponds the dunder flowed at a constant rate to mix with the overflow from the cooling pond prior to treatment and disposal.

This worked well, except that the pH of the mixture from the two dams fell to a level much lower than that of the effluent from the cooling pond when all the dunder was pumped into it and mixed there. This was at first puzzling until it was realized that the cooling pond effluent pH was being controlled, so now it is necessary to regulate the pH of the neat dunder separately.

2. Treatment.

Treatment of the dunder is necessary to ensure that if any of it reaches a public stream it will not pollute it, and perhaps the most important requirement is that the oxygen demand it exerts on its environment should not be excessive. The oxygen demand can be expressed in different ways according to the type of test, but the one most commonly in use here is the Chemical Oxygen Demand test, and the General Standard lays down for it a value of 75 ppm, which is relaxed to 120 ppm in some cases. As the mixed effluent has normally a C.O.D. of 500 to 800, but two or three times greater in times of trouble, it is obvious that treatment ot reduce the C.O.D. is very necessary if any of it is likely to reach a watercourse.

This is best carried out by biological means, and the two processes available,are biological filtration and activated sludge.

These are defined by J.W. Funke[1] of the C.S.I.R. as follows:-

"Biofiltration.

The biofilter uses a bed of stones over which the wastes to be treated are sprayed. This practice simulates the purification process of a stream flowing over a rocky bed. The stones provide a base for micro organisms, which, in the presence of air circulating through the filter bed, attack the organic matter of the effluent, using it for food. As these organisms multiply they tend to break off from the stones and must, therefore, be removed in a setting tank, which is placed after the biofilter.

Activated sludge treatment.

The activated sludge process provides no fixed medium comparable with the stones of the biofilter for the anchoring of micro organisms. Instead the micro organisms are suspended in the effluent, being kept in suspension by air. The air supplies the oxygen necessary for biological activity, and is supplied by mechanical means using wheels, discs, brushes, or compressed air.

The process is kept in operation by withdrawing and settling the treated effluent, a portion of the settled biologically activated sludge being recycled to mix with the inflowing waste.

A modification of the activated sludge process is the Extended Aeration Process, in which the aeration period is extended in order to oxidize to CO not only the organic matter of the waste but also the sludge produced.

The need for sludge disposal can therefore be considerably reduced or even eliminated."

There are several types of activated sludge plants to choose from, all of which have their champions, and in all of them the power requirements for the removal of C.O.D. is much the same, being of the order of 1,8 kg of C.O.D. removed per kilowatt hour.

Funke describes the aerobic processes by the equations:

$$\text{Organics} + O_2 + NH_3 + P \rightarrow \text{Microbial cells} + CO_2 + H_2O$$

$$\text{Microbial cells} + O_2 \rightarrow co_2 + NH_3 + p.$$

Both biological filtration and activated sludge treatment successfully reduced the C.O.D. of sugar wastes, and in a choice between the methods for a particualr application several factors should be considered. They can briefly and suitably be explained by listing some advantages and disadvantages of the activated sludge system, as opposed to biofiltration.

Advantages

1. Economy of land.
2. Freedom from fly and odour nuisance.
3. Very small loss of head through works.
4. Relatively low capital cost.

Disadvantages

1. High running costs. Since sugar mills produce their own electricity, the importance of this factor is subject to different view points.
2. Increased quantity of sludge for disposal.
3. Special precautions necessary, particularly with sugar wastes, to avoid bulking of sludge, which means the formation of a type of sludge that does not settle easily and is difficult to separate from the final effluent.
4. Highly skilled operation, since control decisions have to be made.
5. Sensitivity of process to overload. When the system goes wrong it has to be stopped for rectification, whereas overdosing a biofilter only results in a deterioriation of the quality of the effluent.

In sugar circles, activated sludge treatment is undoubtedly at the top of the popularity poll at the moment, but, having seen it operating side by side with a biofilter at Darnall, with the biofilter in an unglamourous poor relation role, this unqualified popularity is not entirely justified. It might be mentioned that the biofilter consistently removes 1 kg of C.O.D. per m^3 of stone media per day.

There is obviously a great deal more that can be said on the subject of choice of plant for purification, but that is beyond the scope of this paper, and any situation would require its own economic study, which would, no doubt, be the final arbiter.

Finally under the heading of "Treatment", some characteristics of plants visited overseas, and where figures were freely available, may be mentioned:

1. Plastic media biofilter at a brewery. B.O.D. removed 1,66 kg/m^3 of plastic per day.
2. Alternating Double Filtration plant, treating liquid wastes at a cereal factory.
   Based on the spoken word of the operator, and the writer's estimate of the dimensions from which the volume of stone was calculated. B.O.D. removed 1,0 kg/m^3 of stone per day.
3. Plastic media biofilter at a synthetic fibre factory. B.O.D. removed 5,4 kg/m^3 of plastic per day.
4. Aeration plant at a beet sugar factory in England. B.O.D. removed 1,24 kg/m^3 of pond volume per day and 1,57 kg/Kwh of power.
5. Aeration pilot plant at a beet sugar factory in Belgium. B.O.D. removed 22,5 kg/m^3 of aerated volume per day, and 2,0 kg/Kwh of power.

3. Disposal.

The extent to which it is necessary to treat mill effluent depends on the arrangement for its final disposal.

Obviously it would be very wasteful to treat it to comply with the General Standard if it subsequently is to be used in farming or industry, and the question of final disposal is really the first point to settle when a pollution problem is being attacked.

Where industries are situated near large cities with their own sewerage works they are often allowed to discharge their effluents into the city sewers provided they comply with certain minimum standards, while discharge into river estuaries and the sea is also permitted under conditions. This applies particularly in the densely populated areas of the U.K. and Europe.

Such facilities are not available to our mills, however, and as the mouths of most rivers flowing past the mills, if they are flowing at all, are associated with holiday resorts, disposal into rivers of any but the cleanest effluent is clearly not permissable.

It is considered that disposal by spray irrigation represents the best solution, and provided the effluent supplied to the farmer is not acidic, so that it will not destroy the pump, pipes, and irrigation equipment, and is reasonably free of oil and suspended matter, and provided the spray area is well chosen, one feels that no other form of treatment is really necessary. With regard to the danger of run-off the interesting fact has emerged at Darnall that though spraying with strong effluents for some time, the C.O.D. of the run-off into the river has been, in every test, below 75 ppm.

Results of the tests made to date are as follows:

DATE	C.O.D. of spray water	C.O.D. of run-off	Remarks
25.1.72	950	50	
14.2.72	2270	30	Diluted by rain
3.3.72	1580	65	

These tests have only been carried out over a short period and cannot be considered as being conslusive, but they point to the fact that adequate reduction in C.O.D. of any run-off of sugar mill effluent is achieved provided it has a reasonably long path to travel before reaching a river, its path simulating an attenuated biofilter. This is indeed a glimpse of the obvious, but it is reasuring to see that it is actually happening.

Conclusion.

Accepting the truth of the above paragraph and that even in high rainfall areas, irrigation will seldom be devoid of any value, and that N and P constituents of biologically treated effluents are not acceptable in water courses, though they are of benefit to plants, one's thoughts on the simplest method of dealing with dunder can be summarized as follows:

1. Collect all dunder, ensuring capacity for surges, remove oil and suspended matter, and correct the pH, so that the dunder is acceptable to the irrigators.
2. Pump continuously to a dam serving a spray irrigation system. This dam should be of sufficient capacity to hold in an emergency a few days supply of dunder, and the scheme should be designed so that irrigation during daylight only need be necessary for a part of the week to ensure that all dunder is disposed of.
3. Only if spray irrigation is quite impossible to provide, or is too expensive, need treatment by biological means be considered.
4. Last, but by no means least, do not leave the management of the dunder disposal arrangements to the least intelligent mill employee for whom a job has to be found.

Recommended Reading

L.B. Escritt — Sewerage and Sewage disposal.
J.B. White — The Design of Sewers, Sewage Treatment Works.
Rose E. McKinney — Microbiology for Sanitary Engineers.
Cox and Hemens — A Guide to Water and Effluent Management at Sugar Mills.
A.B. Wheatland and A.M. Bruce — Biological Treatment of Industrial Waste Waters.

REFERENCE

1. **Funke, J.W.** (1969) A guide to water conservation and water reclamation in industry, C.S.I.R. Pretoria, 99 pp.