WASTE WATER INVESTIGATIONS IN PLANTS

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ABSTRACT

To gain sufficient knowledge about the waste problems in an industrial plant it is necessary to complete the measurements from the discharge pipe with a net-work of measurements inside the plant. Such investigations inside plants consist of planning, preparing, measuring, calculation and reporting. By studying a report from a thorough plant investigation, measures for reduction of water consumption and waste flow can usually be suggested. This means better control of the production and less expensive external treatment of the waste-water.

INTRODUCTION

Let us begin by imagining the view of the rear end of an industrial plant—the main sewer discharging waste water into the recipient. Behind this sewer can be any type of industrial production.

Even if the plant behind the sewer is anonymous, it is easily in practice to analyse the waste content and gain from this material a good knowledge about the production in the industry concerned. Sampling and measurement of flow can be done in different ways but will not be dealt with in detail here. If the waste water, however, is analysed and measured for a period of about a week, it may be possible to gain a reasonable knowledge of the maximum and minimum flow as well as the waste load. Often such figures are looked upon as quite sufficient for planning a waste treatment plant for an industry. That means that the consultant just takes the water coming from the industry without any discussion of the production and the internal measures for treatment of the wastes. In some cases, the authorities can only tell the degree of treatment necessary to render the effluent sufficiently clean before discharge into the recipient. This may be looked upon as a very easy and practical way to approach the waste problem.

Such an attitude taken by consultants and authorities shows, however, a very high confidence in the factory, because behind this sewer there is a net-work of sewers. They are transporting many kinds of wastes from the different departments forming the plant in question. These departments more or less depend on each other. They have streams of raw material, products, byproducts and wastes of different kinds in a special pattern mostly typical for every single plant.

In modern industry some kind of pollution control is carried out at the main

sewer. This is done to make sure for the authorities that the industry does not exceed the permitted discharge values.

Sometimes, when the discharge has a tendency to increase, there may be some kind of internal measurements done by the factory itself. Such measurements are mostly made step by step. I have seen reports from internal measurements covering each separate department of the factory during a whole year. At the same time the production of the industry had changed may times, which meant that the different pieces of investigation could not be put together at all.

It is our opinion that even big concerns best serve their interests by keeping laboratory capacity just for controlling certain main discharge points from their industries. When anything more has to be done in the industry, for example when the main discharge seems to exceed the permitted figures, or when the industry is planning to increase the capacity, then they had better ask specialists to do the job.

There are many advantages for industry to use a central organization for plant investigations. One of these advantages is that such an organization becomes a bank of knowledge of the problems arising in the practical field. Serious problems can be brought to the research people for solution. Ideas used in handling of wastes in one plant or in one industrial branch can be transferred to other industries with similar problems. This is a practical co-operation which is possible as nobody regards measures against pollution as part of the competitive struggle.

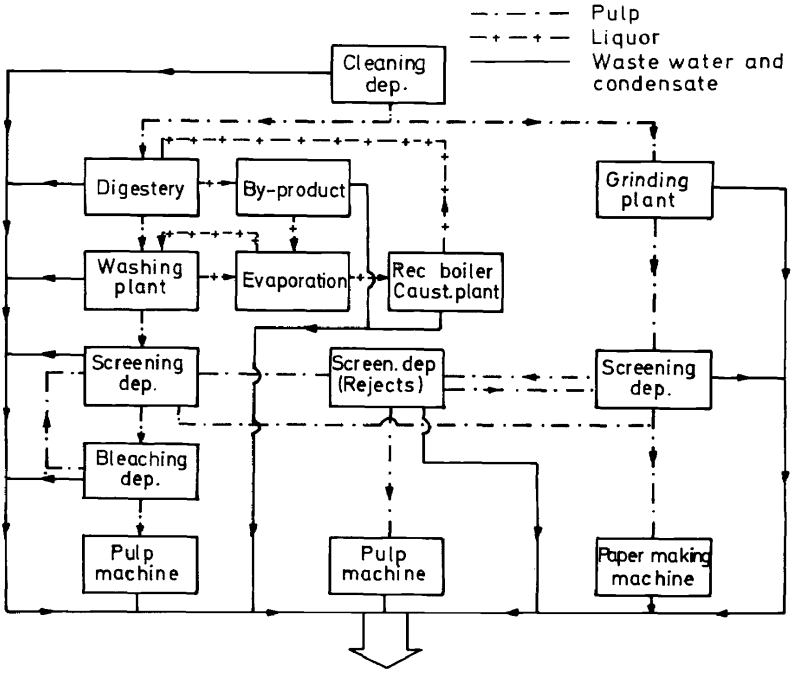

Figure 1. Scheme of a pulp mill with the main flows of pulp, liquor, condensates and waste water

First of all, however, such an organization as our service company can keep a staff experienced in different industrial processes, in the complicated way of measuring waste flows in plants, and in finding out the sewer pattern in the different departments.

By using an authentic case I will show our way of solving plant investigation problems. The case shown is a pulp and paper industry.

PLANNING OF THE INVESTIGATION

The first and very important step in the investigation is to define the problem and in this example I will pay attention to only two departments. The same job has naturally to be done within the others. It is usual that nobody in the industrial plant is quite familiar with the internal sewer system. Sewers which should only contain cooling water can be substantially polluted. A pipe can be replaced with another carrying the waste-water somewhere other than is shown in the blue-print.

Especially in old industries this planning job for the plant investigation can therefore be very laborious and take considerable time.

This planning results in a detailed programme covering sampling points, sampling frequency and type of sampling device as well as type of flow measuring devices. This programme is sent to the industry before the investigation takes place.

As many points as possible have to be controlled by automatic samplers and here we use a type developed by one of our pulp and paper mills. This sampler can take proper samples even when the water has a high content of fibre. It is controlled by compressed air. Every single sample amounts to 50 ml and it is possible to take a sample down to every fifth second if necessary.

Mostly the sampling is controlled by the water flow. This parameter is, however, often very difficult to get with a sufficient degree of accuracy. Every effort has to be made to get this important factor measured.

This means that the industry has to install different kinds of ski-boards and we give them exact information on how these measuring devices have to be placed and to be constructed at the different points. However, instruments for flow measurement—air bubbling and recording devices—are installed by us before starting the investigation.

After having followed the different streams in the evaporation department, our people have been able to produce a scheme over the streams of black liquor, gases, condensates, cooling water and drainage water in the department. Behind this strict figure you may imagine all the pipe-lines and open sewers running in an industrial department.

The evaporation plant is a heartpoint in pulp mills where spent liquor is so concentrated that it burns like fuel. Condensates are formed and the possibility of leakages of more or less concentrated liquor to the drain is obvious.

It has happened that the total stock of chemicals in circulation has disappeared from kraft mills just through this department. In the planning of the plant investigation this department is therefore of special interest and as many as seven points are put on the investigation scheme. The different symbols show which kind of measuring devices have to be installed for the test.

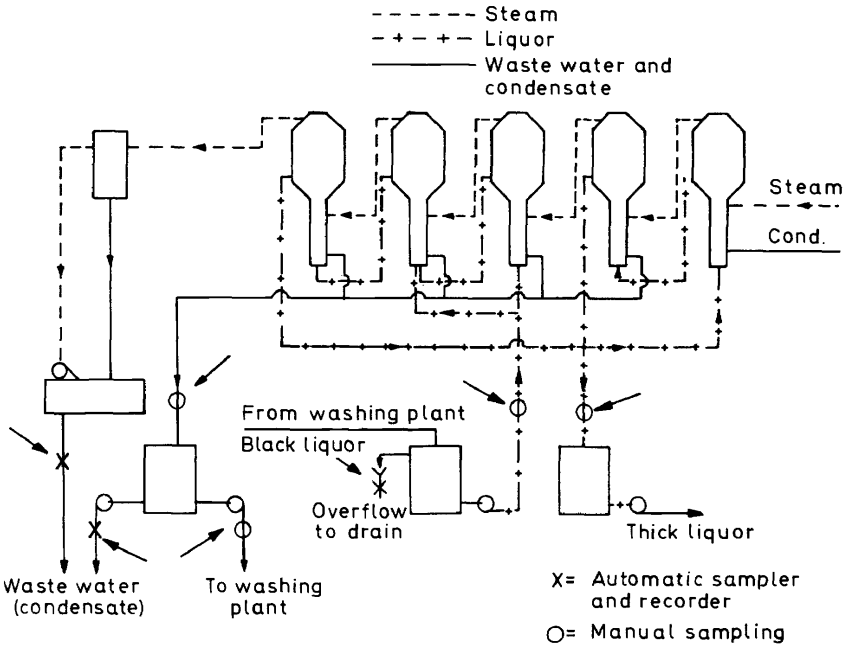

Figure 2. Scheme of the evaporation department in a pulp mill with different flows and proposed sampling points

The other department shown in detail is part of the bleaching plant. In the figure is a bleaching tower, two filters and some pumps. The equipment is located on different stories with drains to the main sewer.

It has happened that fibre suspension has disappeared from departments of this kind because a tile has been broken in the filter vat. It is not even unusual that pulp flows over the filter vats, on the floor. Then the usual thing happens—somebody is there with a rinse hose—and the pulp runs down the drain. As it was in this case hardly possible to measure the flow with ordinary methods the concentration was measured over the filter.

Three points are put at the investigation scheme for this department to control the process. The fourth is to control the drainage from the department.

These two examples—chosen from less complicated departments—may show what a net of sampling points we have to arrange for a proper plant test. In many industries it is necessary to cover a cycle of operations by the investigation as they are forming different kinds of wastes. This means that the investigation programme sometimes has to be repeated in different seasons as, for example, in the food processing industry.

All plant investigations will, however, consist of one long term sampling in main sewers and probably one or a few key-stations during three to five 24-hours periods. This investigation has two main purposes. Firstly to reduce the effect of short time discharges on the over all result. Secondly to make any scamping impossible. The real in-plant investigation on all points selected during

the planning work is run during 24 hours or the whole time of the day the plant is running and discharging waste water.

The sampling scheme can vary from sampling once every four hours to automatic sampling steered by the waste water flow. This is naturally dependent on how important the different flows are. Also those samples taken automatically are mostly mixed for every four hours. Sometimes, when it is impossible to measure the water flow directly, difference in concentration is used in the in-plant work.

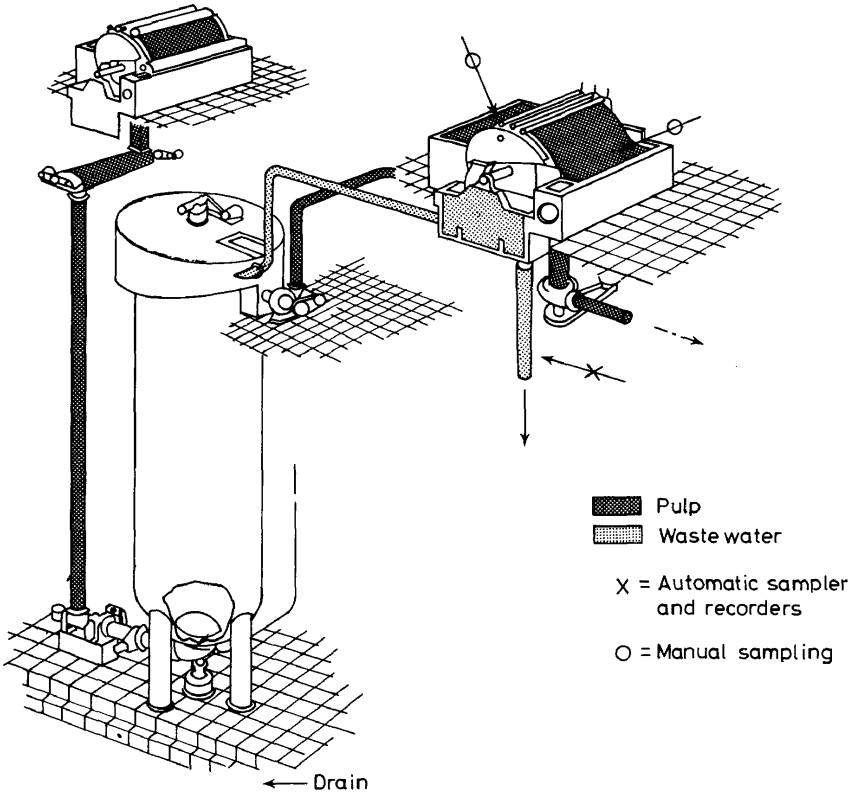

Figure 3. Scheme of part of the bleaching department in a pulp mill with proposed sampling points

MEASUREMENT

The investigation itself mostly runs fairly well if nothing special happens in the plant during the measuring period. All accidents, however, have to be reported to the leader of the investigation. The production during the day when measurements are done has naturally to be reported carefully while the final discharge of waste water is reported in kg/ton of product.

Sometimes during such internal investigations something happens in the

production that makes continuous sampling impossible or uninteresting, such as a strike by lightning or a break of electric current for a long time. The leader of the investigation has to decide if measurement can continue after such accidents or not. This is often an economical decision because investigations of this type must be rather expensive.

COST OF INVESTIGATION

It may probably be of some interest to say a few words just about the cost figures. It is impossible to give a fixed price for such an investigation because it depends so much on local conditions, type of industry, how many sewers there are and how old the plant is. For middle-sized plants in our country full plant investigation cannot be done cheaper than about 50 000 Sw.Cr. and for big plants such as steel and paper mills the cost will exceed 100 and in some few cases 200 000 Sw.Cr. We are aware of the very high cost but we also know the value for the plants to take such measures. When it comes to investments for measures against water pollution the cost for a good primary material for the decisions is a rather small but good investment in the total cost of waste treatment facilities.

ANALYSIS AND CALCULATION

Earlier we sent our laboratory staff out to the plants during plant investigations specially to take care of the BOD samples. We have found, however, by comparing this method with analysing everything in our laboratory at home that we get less errors with the second method. Therefore all samples today are sent home by air, train or car everyday during a plant investigation.

The analytical methods used are continuously revised by our research laboratory. As an example our BOD-test is done with an incubation of seven days instead of the usual five days. This means that we can incubate every day of our five-day week without necessity for analysing on Saturday or Sunday. It has also been shown that the BOD curve is more flat at seven than at five days, which means higher security in this very important test.

The water flow at the different sampling stations is recorded as a water level on charts. Dependent on the different methods used the flow is calculated from these primary values with use of different formulae and constants. We have made programmes for all the different measuring methods used so that the calculation can easily be done on a small computer. This naturally saves much time and also makes the calculation more exact.

When the primary data are listed the final work starts to produce a report. Every chance is taken during the preliminary work to control flow and waste streams in all possible combinations. It is naturally impossible to get the sum of all different streams in the plant to be equal with the flow in the main sewer. If the difference is less than 10 per cent there is no trouble, but now and then it is necessary to make some complementary measurements for confirming the results.

RESULT OF INVESTIGATION

Before the final version of the report is written the results are mostly

discussed with the plant technicians to avoid as far as possible mistakes entering the report. This presentation of the preliminary report to the technicians of the plant is not always too pleasant. We mostly get higher discharge figures than the industrial laboratories. Therefore many of our customers do not believe our results. We are naturally sometimes wrong, but mostly the high values can be confirmed by an overflow here, a pump breakdown there and eventually a sleeper somewhere. Even if our values from the first investigation are high they are constructive. We can show clearly that some peaks originate from leakages from a tank and that loss of product occurs frequently in a special part of the plant. Frequently the people responsible for the plant are aware of the "small streams of waste here and there" but they are shocked when we show them the loss of product which could be sold instead of causing pollution in the recipient.

The main part of the pollution load registered by our plant investigations are, however, dependent on factors involved in the processing. Each measure for reducing this pollution will mostly mean high investment cost.

The discussion after a plant investigation around different possibilities to reduce the pollution load and the water consumption in the plant has a tendency to give rise to technical solutions which can be used at once or may be an embryo for a research case. Such ideas are tested by our research laboratory and may be found useful. New methods adopted are frequently used by authorities as an argument in cases they have with other industries.

In this way the plant investigations step by step give the industry narrower margins, which may be looked upon as a bad thing from the industrial stand point. There are, however, always badly located industries who are interested in accepting every new idea if this can help them to continue the production or perhaps to produce more than today.

AN EXAMPLE

I will round up my paper with a really sunny case. A pulp and paper mill had a discharge of both BOD and suspended solids which could not be accepted by the authorities. The authorities proposed a new washing department which would mean a very high investment cost. This solution, however, seemed to be the only realistic one with respect to the high specific pollution load.

We were asked to carry out a plant investigation and did so during four days, the results being shown on the diagram. We confirmed the high pollution load but by measuring different points inside the factory we got an answer as to why the pollution load was fluctuating so much during the investigation. You can see from the diagram that some discharge points were fairly normal but others were high and really fluctuating. These figures, combined with observations made by our people during the test, gave us an indication that it might be possible to get a substantial reduction of the pollution load just by taking some measures inside the factory.

A technical analysis was made on the basis of our investigation and it was found that internal measures could be taken without too high an investment. The measures consisted mostly in the installation of some regulators and forming buffer capacity.

When these installations were finished we were asked to produce a new plant investigation and the result of this test is illustrated by the figures on 1–3 days at

the right on *Diagram 4*. As you can see the pollution this time was on quite another level, acceptable for discharge from an old pulp mill. Instead of asking for a new washing department the authorities agreed that the former heavy pollution load was dependent on irregular discharges which now are under control.

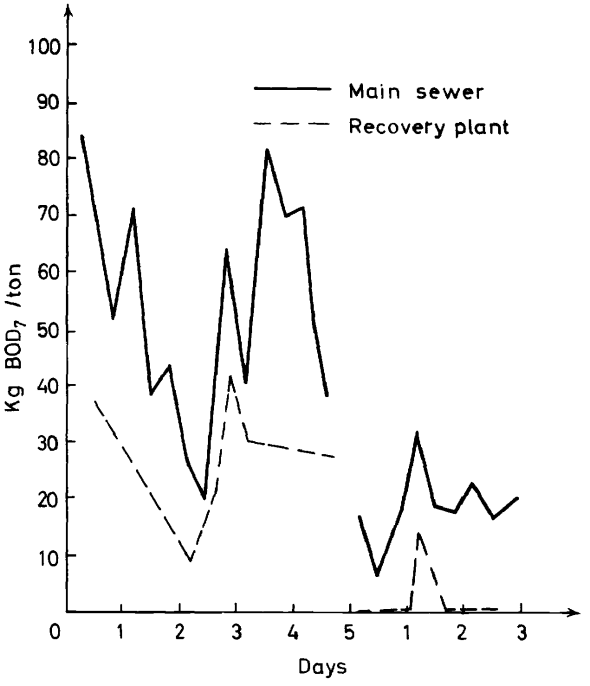

Figure 4. Diagram showing the result of two plant investigations. The second was done after some internal measures had been taken

ACKNOWLEDGEMENT

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