MEASURES AGAINST WATER POLLUTION IN MECHANICAL PULP AND PAPER MILLS

A. WICHMAN

Kvarnsvedens Pappersbruk, 78031 *Kvarnsveden, Sweden*

ABSTRACT

Large sums have been and are being invested in the forest industry for water preservation but the result of the investments has not been as efficient as hoped. The basic mechanism in flotation, flocculation and sedimentation is still partly unknown, despite the research carried out in the field. Research should be more systematically organized globally and carried out at an intense and escalated pace. Large amounts of money should not be invested on half-measures, without the necessary knowledge of the return in efficiency. The flow of information regarding the progress of research should be intensified.

Organized cooperation of all parties concerned should be established with the aim of achieving the most effective and economical use of the collective resources of the industry and the government.

The first questions to be asked are:

What is discharged with the effluent water from mechanical pulp and paper mills and what influence does this have on the recipient?

What problems occur in the treatment of waste water?

It should be pointed out that as far as waste water problems are concerned the mechanical pulp and paper mill is not one of the most troublesome within the forest industry.

Our main problem is to reduce effectively the discharge of fibre suspensions to an absolute minimum. These suspensions contain bark residue, fines of groundwood pulp, fibres of chemical pulps being used and in some cases a certain amount of clay. From a biological point of view the influence of these suspensions is relatively low but noticeable.

The waste water from a mechanical pulp and paper mill can have the following characteristics:

pH around 5.0–5.5

Dry substance before treatment of about 500–700 ppm

Dry substance after treatment of about 100–200 ppm, i.e. a cleaning effect of about 70 per cent.

BOD_7 (20°C) about 12 kg/ton daily.

All mechanical pulp and paper mills have been fighting with slime problems. Owing to the extended use of closed water systems, these problems have become more serious in the last few years and many mills are, therefore, using slimecides. Mercury compounds are—as you know—prohibited in Sweden. Chlorination of fresh water in combination with bromine products and in certain cases also with polychlorinated phenols is therefore being carried out. The influence of these products on the recipient has not been fully determined but is considered to be small.

A CURRENT EXAMPLE FROM KVARNSVEDEN PAPER MILL

The problems in common are many. *Figures 1* and *2* show the discharge of waste water from the Kvarnsveden Paper Mill with an average daily production of 1000 metric tons of newsprint on the machines 8, 9 and 10. The circles represent the average value per day during a period of 6 successive days. Very few disturbances occurred in the mill during this week. The investigation was carried out by The Swedish Water and Air Pollution Research Laboratory.

In *Figure 1* the lower right-hand circle shows the flow of water from different parts of the mill. The two upper circles show the evaporation residue (solids and soluble components) and suspended solids. It can be

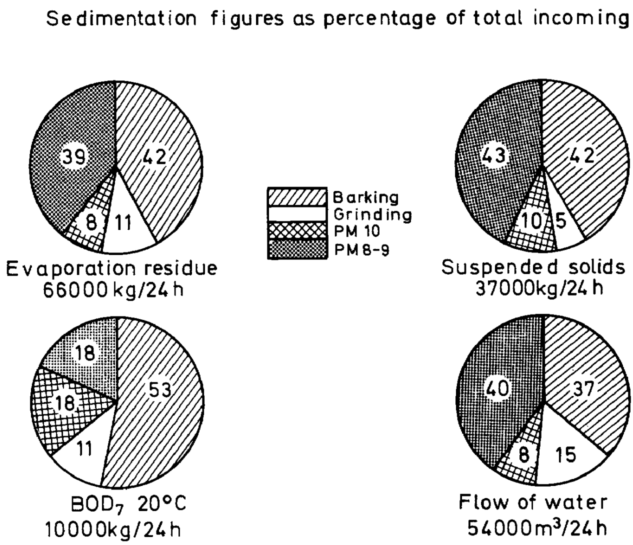

Figure 1.

seen from these circles that the influence of the different origins in the mill is roughly proportional to the corresponding flow of waste water as far as this analysis is concerned. The lower circle on the left shows the BOD_7. In this case, however, there is no proportionality to the flow of water from the different parts of the mill. The influence of the barking on BOD_7 is unexpectedly high.

Figure 2 shows the reduction effect of sedimentation. During the measuring period we succeeded in reducing the evaporation residue, i.e. dry substance and soluble components, by about 35 per cent. The outlet contained only 65 per cent of the total in the inlet, 12 per cent being inorganic and 53 per cent organic components. The reduction in suspended solids was 67 per

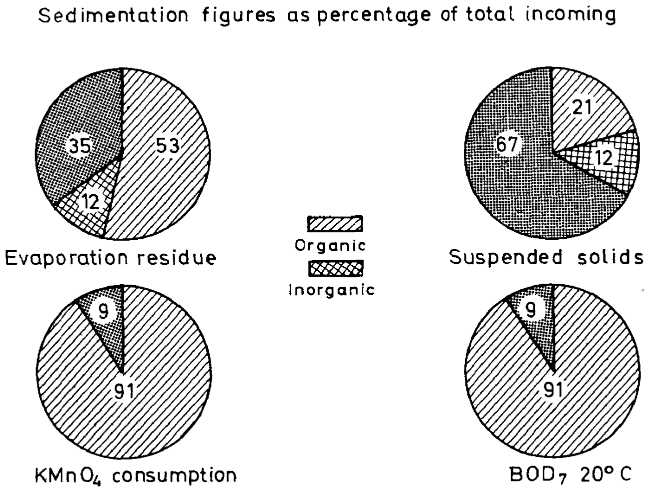

Figure 2.

cent and the 33 per cent in the outlet consisted of 12 per cent inorganic and 21 per cent organic components. The reduction of permanganate consumption and BOD_7 was about 9 per cent during sedimentation. I want to add that these figures comply with the requirements set by the authorities of water and waste water treatment.

When the problems in sedimentation or flotation are solved—which should be in the near future—this will, unfortunately, not be the end of our problems. Assuming that we have succeeded in purifying the waste water to an acceptable level we are then left with the remainder—the sludge —which also must be disposed of in an acceptable way. It seems to me that this problem would be the same in the mechanical as well as the chemical pulping industry. For several years many different methods have been tried out, more or less successfully, in an attempt to solve the sludge handling problem and its destruction in a rational way.

In my opinion, to dump the thickened sludge is out of the question in the long run. It has been proved, for example, that bark waste left in big piles can generate substances which are harmful to the environment. The use of bark waste as filling in road constructions has also proved to be a bad way of disposing of this type of waste for the same reason.

At our mill we recover the sludge from the sedimentation basins and dewater it up to around 20 per cent solids on a belt filter and subsequently press it in separate presses to bring the solids content up to 35–40 per cent. The sludge is then mixed with dry pressed bark and burned. This is one way of doing it, but perhaps not the best. The filtrate from each stage in the process of dewatering and pressing the sludge contains residues of the dewatered sludge which cause undesirable recirculation and accumulation problems.

It is unnecessary to make a worldwide survey of corresponding figures for other newsprint mills, since the existing literature on the subject tells us roughly the same as what I have related here. In other words, this should be a typical example of a newsprint mill where due attention has been given to water pollution problems.

IMPROVEMENTS AND RESEARCH

Let us now put the following question. Do we—in the newsprint industries as well as in the fibre industry in general—consider the related case to be satisfactory to our minds and do we feel that we have solved the problems of water pollution in an adequate and correct way and to everyone's satisfaction?

In the public debate, which is often very heated and quite non-objective, we are still judged as being great sinners as far as environmental control is concerned, although the authority, elected by us through parliament and the government, has appointed the limits with which we are doing our best to comply. In order to answer the question I will start with the declaration, in capital letters and underlined, that the industry is approaching the question with a positive determination to solve the waste water problem in the best possible way with the available resources. In the same breath, I want to underline that we do not feel satisfied with the results achieved. In spite of highly developed techniques in the different branches of industry, I have the definite feeling that, in our efforts to master the water pollution problems, we often fumble in darkness.

It is common and popular to report the contribution to control of air and water pollution in the amounts of money invested in 'fighting' equipment. These amounts reach figures of many millions. I do not want to give you the idea that this is only boasting or that the millions mentioned should serve as a kind of neutralizing screen between the industry and the public. This money has, of course, produced results but on the other hand I doubt that the interest—in other words the result—is proportional to the invested capital. It must be the aim of any industrial enterprise to secure a reasonable return.

When studying the water pollution problem in the mechanical pulp and paper industry, it is convenient to make comparisons with other branches of the fibre industry, for example sulphate pulp and paper. We shall start with the main raw material—wood.

A consequence of the modernized forestry is that most of the wood arriving at the mill is unbarked. Looking at the newsprint industry in general, it will be noticed that in northern Europe and North America the prevailing method is wet-barking, by which an acceptable cleanness of the mechanical pulp for the production of newsprint is achieved.

The waste water problems created in the woodrooms in these industries is therefore far greater than in the sulphate mills where the barking is less important. The sulphate mills use a relatively small amount of water or dry-bark. The latter is often the case in most sulphate mills in the US and it is also found in Europe. In sulphate mills running bleached pulp the result of the barking is still less important.

The water pollution created by secondary fibres is—according to known facts and my own experience—much more of a problem in a mechanical pulp and paper mill than in a sulphate mill. On the other hand, if we look at the pollution by chemicals, we find that the opposite is true.

Since the main problem of the mechanical pulp and paper industry is the recovery and destruction of secondary fibres, fines etc, I will now concentrate on these two factors.

Technical questions which arise in a production line are and ought to be solved in most cases. For example, the separation of process waters containing fibres and those without should today be completely solved. The internal recovery of fibres and the re-use of cleaned white water are also things that are controlled in modern mills. It is, however, not possible to close the loop completely, since the major part of the water taken into the process with the wood and from the recipient must be returned to the recipient.

In the process at a modern mechanical pulp and paper mill the part that lies between the woodroom, groundwood mill, the paper machines and the recipient is the waste water cleaning—either the sedimentation or the flotation method is used. This is where, in our opinion, the water pollution problems are solved. Yes, they are partly solved, but not completely.

Intensive research is carried out all over the world on the manufacture of pulp, paper, steel and numerous other items. We are sending rockets to the moon, sniffing at the atmospheres of Mars and Venus, but do we know all the secrets of sedimentation or flotation?

I am not reading this paper as a scientist but as a resident manager of a newsprint mill, responsible for the optimum running of the mill including the problems of water and air pollution. Waste water problems occupy much of our attention. In spite of that, I often feel desperate— there must be better ways of mastering the whole complex of waste water problems.

I have often asked the question and still do: Is the research in this field carried out in a sufficiently organized and effective way? Many will probably object when I say that the opposite is too often the case. I find in reading both older and quite recent literature that great uncertainty still prevails with regard to many aspects of waste water cleaning. In the first place, I am thinking of sedimentation which, after all, is the last 'policeman' before the waste water is returned to the recipient.

The theories of Kynch, Coe and Clevenenger[1] on sedimentation of sedimentation of substances are well known. These theories can be applied to fibre substances such as newsprint fines only with great caution because these scientists have based their research work on substances other than those we are faced with here. In the sedimentation of fibre suspensions, unexplainable variations in the effect occur. This I can personally confirm, based on case studies at my mill as well as on former experience.

The Literature Study, Series B No. 17[2], published by the Swedish Forest Products Research Laboratory, on flocculation of fibres and fines increases the uncertainty that the basic knowledge of the mechanism of sedimentation is insufficient.

As I mentioned earlier, it seems that sedimentation is much easier to control for sulphate pulp fibres compared with newsprint fines. There are many theories on the way in which the mechanism of sedimentation is affected by, for instance, the particle size of the waste water suspension. The above-mentioned scientists have presented many theories on the subject but none has been practically tested, which I wish to point out with wood fibre water suspensions. There are too many 'ifs' in the picture and I quote from the paper 69:2 published by the Royal Institute of Technology in Stockholm:

'In order to determine the area of a continuous thickener according to Coe's and Cleverenger's methods the initial sedimentation rate as a function of the initial concentration is measured. The same result is obtained with Kynch's and Coe's and Cleverenger's methods to determine the area of a continuous thickener:

if (1) rate of sedimentation is only a function of the local concentration and

if (2) all concentration levels are simultaneously formed at the bottom of the sedimentation vessel.'

Edde and Eckenfelder[3] have suggested an empirical formula for dimensioning the required area of sludge thickeners. The suspensions used in these studies are again different from those used by Kynch. The theories can, therefore, not be compared and continued research is necessary.

'There are no reliable quantitative measures published of the relative importance of hydrodynamic and physico-chemical effects on flocculation of fibres and fines at different hydrodynamic stresses and concentrations.'

The following quotation is taken from the Swedish Forest Research Laboratory's Information Series B No. 17.

'On the whole, it seems that basic, reliable and documented knowledge of the whole mechanism of flocculation and sedimentation of fibres and fines is lacking.'

A newsprint mill—say with several paper machines—has an overall efficiency of let us say 90 per cent. The remaining 10 per cent includes downtime of different machines which cause disturbances in the water control system. Such disturbances have repercussions on the sedimentation, i.e. the result is not satisfactory.

The mill engineer responsible for waste water treatment would be happy to know or be able to obtain the prescription for avoiding and curing such bad results.

I would like, once again, to call your attention to the fact that it is the aim of any industrial enterprise to optimise its operation so that a reasonable profit is obtained for the continued existence of the enterprise. Based on personal experience, discussions with colleagues throughout the world and, not least, study of the literature on effluent cleaning I dare to say that the millions invested in environmental control have been half measures to a great extent. The criticism from the public has, however, very often been unfair, originating in the lack of knowledge of the whole complex problem

I feel there is every reason to suggest that either full-scale or pilot plants should be built with joint resources at a few typical industries for a close study of the whole mechanism of sedimentation. The corresponding investments will, of course, not be small, since such installations must be flexible constructively and technically over a wide range to enable fundamental and scientific research to be carried out.

I have a definite feeling that the manufacturers of sedimentation plants are fumbling in semi-darkness because of the lack of documented basic material. How are you, manufacturers of machinery for waste water and and sludge treatment, feeling about your responsibility for the solution of our problems? How close is your cooperation with the research institutions in this field?

I cannot imagine that we will reveal any secrets to the detriment of the competition between pulp and paper makers by working in close cooperation in the field of flocculation, sedimentation, flotation or destruction of sludge. This is a typical example of how we all could save money.

LOCATION OF INDUSTRY–RECIPIENT

In all these lines of thoughts—in connection with either mechanical or chemical pulp and paper industries—the question arises as to where this type of industry be located from the point of view of water preservation as well as economics. Should it be at the cost or at an appropriate recipient inland?

The best location from an economical point of view is doubtless inland—in the middle of the raw material supply area where the transport costs can be kept at the lowest possible level. This viewpoint has today become increasingly important. I maintain that this is relevant also from a water preservation point of view. The industry should be located in the interior of the country at a recipient which must of course, be sufficiently large in relation to the size of the mill.

As an example, our mill, the Kvarnsveden Paper Mill, is located about 120 kms from the Gulf of Bothnia. The normal rate of flow in the Dala River is about 250 m^3/second and the mill's maximum intake of fresh water is about 1.2 m^3/second. On its way to the Gulf of Bothnia, which receives the waste water from many industries, most of them located at the coast, the water passes over a number of waterfalls with a total vertical drop of a good 100 metres.

The waste water from our mill on its way to the inland sea, the Gulf of Bothnia, is subject to a vigorous agitation in the waterfalls and, consequently, to a continuous feed of oxygen. We make continuous measurements which show that the degree of oxygen saturation is already almost complete shortly below the mill, despire the fact that we have an integrated mill with our own chemical pulp production. Therefore, it can rightly be claimed that the water is almost perfect biochemically when it reaches the coast.

On the other hand, we cannot deny the fact that the recipient, the Dala River, just below the mill acts as a final sedimentation basin. In this connection, I can mention that we know by analysis of the Dala River water that the Kvarnsveden Paper Mill increases the sludge content in the river by about 0.5 mg/litre. At spring and autumn floods the normal sludge content at the water intake is about 3 mg/litre.

We are all aware of the risk which applies to an inland sea like the Gulf of Bothnia that the waste water can easily create stagnant inversion layers with no oxygen. Consequently, the waste water from an inland mill located at a sufficiently large recipient has in most cases a higher self-cleaning effect than the waste water let out from a mill at the coast. With this, I do not want to say that the inland mill, even if it is located at an appropriate recipient, is able to pay less attention to the problem of water pollution than the mill located at the coast. The responsibilities are equal.

REFERENCES

[1] B. Hultman. Sludge thickener. Part III. Kynch's. Coe's and Cleverenger's theories for sedimentation. Royal Institute of Technology, Publication 69:2, Stockholm, May (1969).

[2] S. Martin-Löfe. Literature study of the influence of chemical agents on flocculation of fibres and fines. *Swedish Forest Products Research Laboratory Information Series B.* No. 17, Stockholm (1970).

[3] B. Hultman, A. Carlsson. and H. Flodman. Investigation of Edde and Eckenfelder's dimensioning method of sludge thickener. Royal Institute of Technology. Stockholm (1968).