REPORT

of

INDUSTRIAL WASTE AND STREAM POLLUTION SURVEY

DRYDEN PAPER CO., LIMITED

and the

WABIGOON RIVER

SEPTEMBER 7, 8, 9, 1958

ONTARIO WATER RESOURCES COMMISSION

CONTENTS

A survey of the disposal of pulp and paper mill wastes from the Dryden Paper Co., Limited, at Dryden, Ontario, was made on September 7, 8, and 9, 1958 to evaluate the sources and nature of wastes being discharged to the Wabigoon River, and to determine the degree of pollution existing in the river and downstream waters.

PERSONNEL

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DESCRIPTION OF THE AREA

The Dryden Paper Co., Limited, is located on the west bank of the Wabigoon River in the town of Dryden, approximately 230 miles northwest of Port Arthur. The Wabigoon River flows north from Wabigoon Lake at Dryden, then westerly and northerly approximately 50 miles to Clay Lake and thence to Ball Lake in

DESCRIPTION OF THE AREA cont'd

the English River system, approximately 90 miles (by water) from Dryden. The upper drainage area, in the Dryden vicinity, is mainly clay, and flows through farmland in the twenty or thirty miles below Dryden, and then beyond that through mainly undeveloped, forested land.

PREVIOUS STUDIES

The severity of pollution that existed prior to this current survey was indicated by studies which were made in August, 1952, and September, 1954. A programme of mill renovation had been begun by 1954, and measures were being taken to minimize pollution by improving plant operation and installing new equipment for recovery of usable materials within the mill. Production had increased during that time from 160 tons of unbleached paper per day to 250 - 260 tons per day. The 1954 survey indicated that the increased level of production, and hence waste disposal, more than off-set improvements in the mill, as river conditions deteriorated with the expansion.

ALTERATIONS AND EXPANSION SINCE 1954

A large-scale programme of expansion was undertaken by the company, following acquisition of control of the plant by Anglo Canadian Pulp and Paper Mills, Limited, of Quebec City.

ALTERATIONS AND EXPANSION SINCE 1954 cont'd

Briefly, the major units that were either completely renovated or added to existing facilities were as follows:

1. Wood room - completely rebuilt on a new site south of the mill (upstream). Screens remove bark for discharge to a disposal area west of the mill.

2. Four new digesters, with production capacity approximately equal to that of the eight existing digesters.

3. Blow tank - for receiving pulp from the four new digesters, and two of the old digesters when required.

4. Brown stock washers - to remove black liquor from the pulp from the blow tank.

5. Cowan Screens and Centricleaners for screening and cleaning pulp from Brown Stock washers.

6. Bleach Plant (including Chlorine Dioxide generator)

7. Pulp machine - replacing one of the paper machines formerly in use.

8. Increased chemical recovery capacity, including a second multiple effect evaporator and a second recovery furnace.

Improvement has been made in handling black liquor for recovery, and in recovering the volatile by-products of cooking. Condensed digester vent gases, containing turpentines, are fed to the washers, where they are removed with the recovered black liquor. A resin acid soap skimming tank has been installed for recovery of soap for burning and/or sale. Salt cake losses, both to the sewers and to the atmosphere, are under current study.

ALTERATIONS AND EXPANSION SINCE 1954 cont'd

In general, the increase of production to 500 tons of pulp per day has been effected by the addition of completely new pulp mill equipment, in parallel with the old part of the mill.

DESCRIPTION OF PROCESS

Both bleached and unbleached Kraft pulp and unbleached Kraft paper are produced in the conventional Kraft or Sulphate process, in which cooking of the wood is done in a solution of Sodium Hydroxide and Sodium Sulphide. The economy of the process is based on the recovery and re-use of cooking chemicals, and the use of heat obtained in the recovery furnaces.

Briefly, the process at Dryden is as follows:

Wood Room:- Logs are received at the mill in 4-foot or 8-foot lengths, the 8-foot lengths are reduced to 4-foot bolts in the slasher mill, and then all the wood carried by conveyor to five wet-drum barkers, operating in parallel. The barked logs are carried by conveyor to either block storage in the yard, or directly to the chipper. Chips are conveyed to ground-level storage bins for future delivery to the digesters.

The bark that is removed from the logs is sluiced to a ravine west of the mill where it is retained. Drainage from the bark disposal area, consisting of all the water used in the wood room, returns to the Wabigoon River by way of a creek about half a mile below the mill.

DESCRIPTION OF PROCESS cont'd

Pulp Mill:- Pulp is produced and processed in two separate "lines", approximately 150 tons per day of unbleached product in the old mill, and approximately 330 tons per day (most of which is bleached) in a new addition to the plant. The two "lines" operate separately, except for a cross-connection from two of the old digesters to the new process, (to augment the bleached production when required), and the use of knots and rejects from the new mill in the old plant.

(a) Cooking in the old mill is carried out in eight digesters which are charged with approximately 10.5 tons of chips and 450 cubic feet of white liquor, yielding approximately 6 tons of unbleached pulp per 3-1/2-hour cook. With the exception of the charge of two digesters, which may be discharged to the blow tank, and thence to the bleach process, the old digesters are discharged to diffusers, in which the separation of pulp from black liquor is made. Fourteen diffusers are in use, operating in pairs. The effluent from a partially washed charge serves to wash a freshly-cooked charge, with the wash from the latter returning to the recovery plant. The pulp is washed until the wash water from the fresh charge is reduced from about 12° Bé to 7° Bé. It then receives fresh water which then serves to wash a succeeding charge. This secondary washing continues to 0° Bé, and for an additional 30 minutes, before the wash is sewered. The washed pulp is then carried to the screen room, through the refining steps, and finally to one of three paper machines.

DESCRIPTION OF PROCESS cont'd

Pulp Mill:- cont'd

Two diffusers, in addition to the 14 used as above, are used to wash the rejects from the knotters at the head of the Brown Stock Washers, and send them on into the unbleached pulp and paper process.

(b) Cooking in the new part of the mill is carried out in four 4500 cubic feet digesters, each charged with 22 tons of chips and 900 cubic feet of white liquor, and yielding 12.5 tons of unbleached pulp per 3-1/2-hour cook. In both the old and new digesters, relief gases are passed through a condenser and the condensate sent to the 3rd Stage Brown Stock Washer for recovery with the black liquor. The cooked pulp from the new digesters is discharged to a blow tank (rather than to diffusers, as in the old plant) and thence to further processing. At the end of the cook, pressure in the digesters is reduced to about 100 psi, and the charge then blown to the blow tank. Blow gases are passed through a condenser (with relief gases) for recovery of volatiles. The pulp charge enters the blow tank through a cyclone separator, to trap fibre and black liquor entrained in the digester gases.

Separation of the pulp and black liquor from the blow tank is made in four-stage, countercurrent, rotary drum, Brown Stock Washers. The unwashed stock from the blow tank is first passed over 3 knotters, with the rejects going to two diffusers in the old plant (see above), then through the four-stage washing, in which fresh water is fed to the showers of the fourth stage

DESCRIPTION OF PROCESS cont'd

Pulp Mill:- (b) cont'd

washer, the effluent from that washer serving the third, and so on until the effluent from the first stage (fresh pulp) is sent to the Black Liquor recovery plant. Each washer is served by a wash water chest, or storage tank, located beneath the washer. Since there is normally no effluent to the sewers, any fibre in the liquor leaving the first stage is carried to the recovery plant for removal by screening there.

Foam is drawn from the washer chests to a foam tank equipped with mechanical foam breakers. Liquid from the foam tank is sent to the recovery plant. The hot exhaust of vapours from the foam tank is sent to the sewer along with a small flow of clean water. The resultant temperature of this flow (some 30 to 50 g.p.m.) is about 190° F.

Following washing, the pulp is passed through four primary Cowan screens, and one secondary screen, with the rejects going on through Bauer centricleaners. The rejects from the Centricleaners are sent through a secondary set of 60 cleaners, and the rejects from these to Vorject cleaners. In each case the accepted stock is returned to process. The rejects from the Vorject cleaners are sewered. (Measured by company at less than 0.6 tons of pulp per day.)

Following screening and cleaning, the pulp is sent to the bleach plant where it is bleached in a 5-stage process employing,

DESCRIPTION OF PROCESS cont'd

Pulp Mill:- (b) cont'd

in the following order: chlorination, caustic extraction, chlorine dioxide, caustic extraction and then a final chlorine dioxide treatment. The pH of the pulp is adjusted after the bleaching to a value between pH 6.0 and pH 6.5 with sulphur dioxide. Water washes are used after each stage in the bleaching process.

Chlorine dioxide is produced by the reaction of a mixture of air and sulphur dioxide bubbling through a down-flow of sodium chlorate-sulphuric acid in a reaction tower. Sewered effluent is approximately 3 gpm.

Black Liquor Recovery:-

The black liquor recovered in the diffusers (20% solids) and from the brown stock washers (18% solids) is blended and sent to the recovery plant for regeneration of cooking chemicals, and make-up of chemical losses. The liquor is first screened to remove fibre, then thickened by evaporating, first in a 6-body, 5-effect evaporator and then in a cascade evaporator. (In the 6 stage evaporator, the first and second effects are used in parallel, and the third, fourth, fifth and sixth in series.) The resultant thick black liquor is sprayed by oscillating nozzles to two recovery furnaces, where the organic materials, which have been removed from the wood in the cooking process, are burned in reducing conditions. The resultant inorganic smelt drops to a dissolving tank, producing

DESCRIPTION OF PROCESS cont'd

Black Liquor Recovery:- cont'd

"green liquor", a solution of sodium carbonate and sodium sulphate.

The green liquor is clarified and pumped to a lime slaker, and then, with the lime, to a 4-compartment "white liquor" clarifier. Overflow from the clarifier is pumped to storage for re-use (as cooking chemical). The mud from the clarifier is pumped to a 2-stage mud washer of similar design. Weak liquor from here is pumped to storage for dilution in smelt dissolvers. Lime mud at 33% solids is repulped and fed to an Oliver vacuum filter and discharged at 55% solids to the sewer, pending installation of a kiln. The filtrate is used in the lime mud washer.

Machine Room:-

Three paper machines are in use, producing unbleached Kraft paper from the pulp stock that is produced in the old mill. All bleached stock from the new mill is finished in a pulp machine, which cuts the pulp sheet into four, 33" x 33" sheets as it leaves the machine. The sheets are baled and shipped for use elsewhere.

OPERATING DATA:

Production:- 150 tons per day unbleached Kraft paper

- 330 " " " bleached Kraft pulp

(A small part of the unbleached production is shipped as pulp at times)

Plant Operation:- New pulp plant, bleach plant, and pulp machine - 24 hours per day, 7 days per week

- Old pulp machine and paper machines (2, 3, and 4) - 24 hours per day, 6 days per week.

OPERATING DATA: cont'd

Number of Employees:- 760 (mill)

Water Consumption:- (Wabigoon Lake)

(a) Wood Room			- 2.4 MGD
(b) Bleach Plant			- 13.56 MGD
	(1) Caustic -	- 4.32 MGD	
	(2) Acid -	- 9.24 MGD	
(c) Pulp & Paper Mill			- 10.8 MGD
	(1) Pulp mill	- 6.6 MGD	
	(2) Paper mill #4 sewer	- 1.08 MGD	
	(3) " " #6 "	- 3.12 "	

Total water consumption - 26.76 MGD
Total pumping capacity - 32. MGD
(2 pumps @ 15,000 U.S. gpm each)

Water Treatment:- 6 North rotary filters, 100-mesh.

- no chemical treatment or chlorination.

Sanitary Water Supply:- from mill supply (not chlorinated)

Raw Materials: (daily consumption)

Wood	- 950 to 1,000 cords
Lime	- 85 tons
Salt cake (Sodium sulphate)	- 62.5 tons
(200 to 300 lbs. per ton pulp)	
Chlorine (liquid)	- 33 tons per day
Sodium chlorate	- 9 " " "
Sulphuric acid	- 7.5 " " "
Sulphur dioxide	- 3 " " "
Sodium hydroxide	- 20 " " "

PLANT SEWERS AND UNITS SERVED

Six sewers serve the pulp mill, bleach plant, and machine room as follows:

Sewer No. 1 - Liquor storage area - only small flow of surface drainage during this survey.

Sewer No. 2 - 4600 Imp. g.p.m. (6.6 MGD)
- unbleached white water overflow
- bleached white water overflow
- main diffuser sewer
- old digester room
- diffuser room floor drains
- blow tank drain
- blowdown condenser condensate
- green liquor drags bottoms
- mud filter cake
- North filter rejects (raw water)

Sewer No. 3 - Approximately 40 Imp. g.p.m. (est. 30 to 50)
- mechanical foam breaker

Sewer No. 4 - 750 Imp. g.p.m. (1.08 MGD)
- No. 1 machine white water chest overflow
- No. 1 machine former pit
- No. 2 machine wire pit overflow
- No. 1 machine vacuum pumps

PLANT SEWERS AND UNITS SERVED cont'd

Sewer No. 5 - 6300 Imp. g.p.m. (13.56 MGD)

- bleach plant and chemical building
  - (a) acid - 3000 Imp.gpm (4.32 MGD)
  - (b) caustic - 6500 " " (9.24 ")
  - (c) chlorine dioxide generator - 3 gpm

Sewer No. 6 - 2180 Imp. g.p.m. (3.12 MGD)

- wet press
- knots and tailings
- drainer water
- No. 4 machine white water overflow
- diffuser agitator drain
- machine coloured white water
- screen room white water overflow
- No. 3 and No. 4 machines sewers
- No. 4 beater

SURVEY PROCEDURE

Samples were taken from 5 of the 6 mill sewers throughout the day, compositing hourly samples where possible, and collecting grab samples every two hours where it was impossible to take hourly composites. The main pulp sewer has been equipped with a Parshall flume for measuring flow and a sampler for compositing a sample from small portions taken at regular, short intervals. Three such composites were taken from this sampler, and one grab sample from the sewer at the flume. The sewer that was not sampled carried only a small flow of yard drainage, having formerly served to sewer the wood room which is now sewered to a bark storage area.

Grab samples were taken at seven locations in the Wabigoon River, with Dissolved Oxygen and temperature determinations made at the time of sampling.

All samples were returned to the laboratory in Toronto for analysis as follows: (see Result Sheets)

- BOD
- Total, Suspended & Dissolved Solids
- Ignited solids
- pH
- Alkalinity and/or acidity
- Phenols, or phenolic equivalents
- Hardness
- Calcium
- Resin Acid Soaps.

All analyses except pH reported in ppm unless otherwise indicated

INDUSTRIAL WASTE ANALYSIS

September 9, 1958

Sample No.	5-Day BOD	Solids Total	Solids Susp.	Solids Diss.	Lab. pH	Alkalinity Total	Alkalinity Phenol pH.	Acidity	Phenols ppb.	Hardness	Ignited Solids	Calc-ulated	Resin Acid Soaps
2A	192	6912	6114	798	10.0	5140	40	-	2000	-	578	40	-
2B	800	6062	5190	872	10.2	5000	60	-	2100	-	634	60	-
2C	152	6826	6258	568	9.9	5340	44	-	4800	-	696	100	-
2D	-	-	-	-	-	-	-	-	-	-	-	-	1.6
3	1236	482	248	234	8.9	136	-	-	2300	-	-	-	-
4	291	1336	130	1206	7.9	76	-	-	25	-	216	-	-
5A	202	1176	84	1092	2.8	-	-	400	32	121	192	-	-
5B	74	842	96	746	3.2	-	-	180	20	100	-	-	-
5C	78	878	74	804	3.1	-	-	200	25	72	-	-	-
6	180	794	304	4900	7.6	196	-	-	250	-	58	-	-

2A - Sewer #2 - Composite 7 AM - 9 AM)
2B - " #2 - " 11 AM - 12 AM) (From automatic sampler)
2C - " #2 - " 2PM - 4 PM)
2D - " #2 - Grab 4.30 PM
3 - " #3 - Composite 10 AM - 4 PM
4 - " #4 - " 10 AM - 4 PM
5A - " #5 - Grab 10.30 AM
5B - " #5 - " 12.00 AM
5C - " #5 - " 4.00 PM
6 - " #6 - Composite 10 AM - 4 PM

All analyses except pH reported in ppm unless otherwise indicated

RIVER SURVEY

September 6, 7, 1958

Sample Point No.	Lab. No.	5-Day BOD	Solids Total	Solids Susp.	Solids Diss.	D.O. ppm	Sample Temp. C	Total Alkalinity as $CaCO_3$	pH	Phenols	Ignited Solids	Resin Acids
1	R1417	4.2	88	18	70	9.1	16.5	50	7.5	1	34	-
2	R1418A	136	1428	572	856	0	24.0	296	7.0	175	748	1.6
3	R1419A	21	310	78	232	4.1	19.0	104	7.5	50	168	1.6
4	R1420A	34	274	36	238	0.5	18°	116	7.1	50	158	1.6
5	R1421A	19	324	44	280	0.5	17.5	112	7.0	60	132	1.6
6	R1422A	8.8	210	32	178	2.7	17.0	68	7.0	15	52	1.6
7	R1428	1.2	210	16	194	7.0	17.5	88	7.0	15	66	-

1 Wabigoon River above mill

2 " " just below mill at CPR bridge

3 " " at Hwy. #17 bridge - 2½ miles below Dryden

4 " " Eaton-Rugby Road - 14 miles below Dryden

5 " " north of Minnitaki-19 miles below Dryden

6 " " at Hwy. #105 - 38 miles below Dryden

7 " " at mouth of river at Clay Lake - 52 miles below Dryden

DRYDEN PAPER CO., LIMITED

(Summary of Sewer Data)

	Flow	B.O.D.		Solids			Phenols
				Total	Susp.		
	(M.G.D.)	lbs/day	pop.equiv.	lbs/day	lbs/day	pop.equiv.	lbs/day
Sewer #1	- No flow this date -						
Sewer #2	6.6	25,146	150,000	435,600	387,000	1,935,000	196
" #3	0.043	530	3,170	208	100	500	1
" #4	1.08	3,150	18,800	14,400	1,400	7,000	0.27
" #5	13.56	16,000	96,000	131,000	11,500	57,500	3.5
" #6	3.12	5,620	33,000	24,800	9,500	47,500	7.8
Wood Room	2.4	- Discharged to impoundment area -					
Totals	26.8	50,446	300,970	606,008	409,500	2,047,500	208.57

B. O. D. - 25.2 tons per day (total)

Suspended Solids - 205 tons per day (total)

River flow - Annual average (1945 - 1955) - 1552 cfs.
(Gauged at Quibell, approx. 45 miles downstream from Dryden).

CONCLUSIONS

The industrial waste and stream pollution survey which was made at the Dryden Paper Co., Limited, and on the Wabigoon River on September 7, 8, and 9, 1958, was intended to determine the total waste loading on the river, and to relate the wastes, generally, to the principal sources in the mill, and to their effects on the degree and extent of pollution in the river. Since mill operations were normal, and weather conditions consistently moderate, with little recent rainfall, it was felt that the analytical results, both of sewer and river samples, were fairly representative of conditions that existed at that time.

Expansion of production at the Dryden Paper Co., Limited, from approximately 250 tons per day of unbleached paper in 1954 to approximately 500 tons per day of unbleached paper and bleached pulp in 1958, has been carried out by a stepwise programme of modernization and enlargement of existing facilities, and the addition of new units at a total cost of about 15 million dollars. A lime kiln, the last major unit to be built in the recovery plant, is to be constructed and put into operation by late 1959. Burning of bark as fuel is being considered for the future.

Pollution of the Wabigoon River has been severe for many years, due mainly to the inherent inefficiencies of the equipment or methods used in the original mill. Steps have

<u>CONCLUSION</u> cont'd

been taken to minimize these losses, but any benefits that may have been obtained, so far as stream pollution is concerned, have been obscured by the additional loading that has been contributed by the increase in production. It has not been a case, then, of isolating the sources of wastes in the old mill, and applying corrective measures, (a major undertaking in itself), but also of bringing in new units and bringing their operation to an efficient level, while combining the old and new units into a single plant. Studies of sources of losses have been undertaken by the company, and it is expected will be broadened as part of normal plant operations on a continuing basis.

This present survey was not intended to consider the unit sources of waste in the mill, but rather to determine the total mill loading and its effect on the Wabigoon River. As with other Kraft mill studies, four waste components were considered:

(a) <u>Suspended Solids</u>:- There are two principal sources of suspended solids in the Dryden mill: lime mud (originating in the regeneration of caustic soda solution), and wood fibre. Bark has been a major problem in the past, but is now being impounded, with ultimate disposal to be considered by the Company in the future. Assuming all the daily consumption of lime (85 tons) to react with sodium carbonate in the recovery process to produce sodium hydroxide and calcium carbonate (lime mud), the amount of lime mud to be sewered is approximately 153 tons per day. This is discharged through sewer #2, and is shown in the summary on page 16 as contributing largely to the total suspended solids discharge. Re-use of

CONCLUSION

(a) Suspended Solids:- cont'd

lime, which will be made possible by burning in a lime kiln in late 1959, will greatly reduce the present discharge of suspended solids from this source. Fibre losses, even at a conservative estimate of 1 percent of production, would account for an additional 5 tons per day of suspended solids. However, no measurement of fibre loss was made in this survey, since it seemed of minor importance at this stage of the study of the mill, compared to the lime sludge. It is of major significance, of course, in the economy of pulp mill operation, and hence, will receive attention as a matter of good plant management. A fibre loss of between 1½ percent and 2.0 percent of production is considered representative of a modern, efficiently operated chemical pulp mill.

Most of the suspended solids settle in the 2½ mile reach of the river below the mill in a hydro impoundment, and do not seem to be excessive beyond that point.

(b) BOD:- The almost complete lack of dissolved oxygen in some 40 to 50 miles of the river below the mill indicates the degree to which the river is over-loaded. It can be shown that a river flow of 930 cfs or 348,000 gallons per minute, with a dissolved oxygen content of 10 ppm, would be necessary to provide the amount of oxygen necessary for the complete satisfaction of the BOD (50,446 lbs recorded in this survey). If the necessary amount of dissolved oxygen is not available, as is apparently the case here, the effect of BOD is carried downstream until

CONCLUSION

(b) BOD:- cont'd

the oxygen requirement is met. A flow of 1860 cfs with dissolved oxygen content of 10 ppm, would be required to ensure no more than 50 percent reduction in dissolved oxygen concentration. The annual average flow of the Wabigoon River, taken for 10 years (1945 to 1955) has been 1550 cfs indicating that the flow necessary to permit satisfaction of BOD is not present during the normal dry season periods, hence, the downstream extension of the effects of BOD as shown.

The population equivalent of the total mill waste, on the basis of 0.167 pounds of BOD per capita per day, is approximately 301,000, or equivalent in oxygen-consuming potential to the sanitary sewage from a city of that population. Sewer #2, serving the recovery plant, the old digesters and diffusers, and the new blow tank, contributes about 50 percent of the total BOD; and sewer #5, serving the bleach plant, contributes approximately 32 percent of the total. This latter is due, mainly, to the removal of the remaining non-cellulose material from the wood fibre by the bleaching chemicals and represents an 8 percent "shrinkage" in production of the bleach plant.

(c) Toxicity:- The production of toxic materials, as by-products of the cooking process, has always been of importance in Kraft mill waste studies. Crude sulphate turpentine is vented from the digesters wi with other volatiles, during the cooking period, and is condensed in a surface condenser, then separated by decantation from the condensate for burning in the recovery furnace, or for sale when market conditions are favourable. It is suspected that any abnormal losses of turpenes to the

CONCLUSION

(c) Toxicity:- cont'd

sewer would add greatly to the toxicity of the total mill waste. Resin acid soaps, also, by-products of cooking, remain in the black liquor and are removed, by skimming, prior to evaporation. They are similarly highly toxic, and require rigid control in their handling to minimize their adverse effects on the receiving waters. It is generally the practice in Kraft mills to skim off the soaps and feed them directly to the recovery furnace, and so avoid fouling the evaporators. Losses to the sewers have been due to improper handling and spills of the skimmed soap, or to direct losses of black liquor in the pulp mill or recovery plant. Resin acid soap determinations showed sub-lethal concentrations in the waste and in the river, although their low-level persistence throughout the river indicates a continuous, rather then intermittent, discharge.

(d) Tastes and Odours:- One of the most difficult aspects of the study of waste from Kraft mills has been the detection by analysis of waste components that produce tastes and odours in the receiving waters, where standard water analyses indicate recovery of the receiving waters to normal conditions. It is possible that certain organisms concentrate such substances in their metabolism, transmitting them to fish in the normal food cycle. This would explain why whitefish, for example, were reported as being tainted, while pickerel taken from the same waters, but which have different feeding habits, were not. If this assumption is correct, then extraction of such components from large volumes of water (by activated carbon filters, say) would permit their measurement

CONCLUSION

(d) Tastes and Odours:- cont'd

in the laboratory by the infra-red spectrophotometer.

Tastes and odours probably originate in relatively small volumes of wastes, including: (a) phenols, (in foam-control agents); (b) crude sulphate turpentine dissolved in the condensate and, hence, sewered from the turpentine decanter and; (c) sulphonated lignins in the black liquor. Control of phenols would be accomplished by the use of non-phenolic foam control materials. Although numerous proprietary compounds are used, some of them chloro-phenates, (e.g., Resinoid G), fuel oil is most commonly employed, especially in the paper machine head boxes, to prevent bubbles from being carried to the wire and producing defects in the paper sheet, and in the brown stock washers where the spent cooking liquor is separated from the fibre. In any case, it is likely that all phenolic compounds would be present in the river as chlorophenols in cases such as this, where the bleach effluent provides chlorine for the reaction with phenols.

It is probable that taste-and odour-producing substances are closely related to the toxic substances, so that control of wastes to reduce one effect will similarly reduce the other. However, the persistence of tastes and odours beyond the detectable limits of normal analyses, indicates the need for their complete removal and not merely their reduction. Determination of the actual substances in large volumes of river water, as suggested above, would perhaps indicate the sources of tastes and odours, and permit a study that might lead to their segregation at the source.

CONCLUSION

(d) Tastes and Odours:- cont'd

It should be noted that the water in Clay Lake probably has a trace of the typical Kraft mill odour, although the writer did not detect it at the time of this survey. The odour was quite noticeable at Highway 105, about 12 or 14 miles upstream, due, likely, to the aeration afforded by the rapids at that point. However, considering the persistence of the taste-and odour-producing substances in some 40 miles of the river, (i.e., at Highway 105), it is likely that they would continue, to some extent, at least, to Clay Lake, some 14 miles beyond.

Aside from the problem of industrial wastes disposal, it is noted that treated municipal water is not available on the west side of the Wabigoon River, so that the mill supply serves the drinking water requirements in the mill and offices, without chlorination or other preventive measures taken.

RECOMMENDATIONS

It has been shown in this survey that the Wabigoon River is severely polluted by Kraft mill wastes from the Dryden Paper Co., Limited, and that the recovery of the river by the normal process of natural purification does not take place for at least 40 or 50 miles below the mill. This prolonged effect of the wastes indicates not only over-loading, in the sense of de-oxygenation, for example, but also the characteristic persistence of tastes and odours that can usually be associated with Kraft mill wastes. Since these latter give rise to serious objection by persons using the downstream waters, beyond the point at which standard water analyses show pollution to exist, it appears obvious that a means of detecting tastes and odours, as well as means of identifying the causative agents, should be sought. Methods of controlling the loss of taste-and odour-producing substances in the mill and of determining the relationship to toxicity of the total wastes might then be indicated.

Following, or in conjunction with, a study of tastes and odours, and toxicity, consideration could be given to some of the standard methods of dealing with other waste components, particularly those contributing BOD and suspended solids. It is suggested, then, that the following be considered:

1. That the activated carbon filter technique for extracting organic substances from water be employed on a trial basis, to explore the feasibility of extracting measurable amounts of some of the more important components of Kraft mill waste. (Crude sulphate turpentine or turpenes, resin acid soap and sulphonated lignins or other organic

RECOMMENDATIONS cont'd

1. compounds. Identification in the laboratory might be made by infra-red spectrophotometry. Such a study might best be made as a special research project.
2. That a means of reducing BOD be sought by exploring the feasibility of lagooning or treating selected wastes, particularly those from the recovery plant and the digester, blow tank and diffuser areas, where black liquor losses are significant.
3. That a permanent method of bark disposal (and/or utilization) be employed. Continued use of a land area would seem difficult, since the quantity of bark to be disposed of is probably about 200 tons per day (estimated) or some 40,000 to 50,000 tons per year.
4. That the use of non-phenolic foam control agents and slimicides be investigated to minimize the discharge of taste-producing substances from this source.
5. That chemical and biological studies be continued by the company as a standard means of assessing the results of mill practices and alterations in terms of conditions in the river. The study of toxicity, as a part of these studies, could perhaps be related to item 1.
6. That drinking water supplies be chlorinated or otherwise disinfected.

In general, measurement of the volumes and nature of specific objectionable wastes can minimize the total undertaking of pollution control, by reducing the over-all problem to a number of problems, each of much lesser magnitude. Correction of unit waste discharges, on a priority basis, would then serve to first minimize or eliminate those waste components which give rise to the most serious objection, and

RECOMMENDATIONS cont'd

which would shorten the zone of pollution so that the distant downstream waters are not adversely affected. Every effort should be made to bring about an immediate, large-scale improvement in water quality. It is recognized that this is a major problem involving considerable study and investigation to obtain the most-effective measures. Close examination of all wastes for treatment separately or collectively will help in finding a solution. The Ontario Water Resources Commission is prepared to assist in any way possible in this program to obtain a clean stream with the minimum of delay.

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