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Number 17**

EMISSION SCENARIO DOCUMENT ON RECOVERED PAPER MILLS

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OECD Environment Health and Safety Publications

Series on Emission Scenario Documents No. 17

**EMISSION SCENARIO DOCUMENT ON
RECOVERED PAPER MILLS**

**Environment Directorate
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT**

Paris, 2006

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EXPLANATORY NOTES

Purpose and background

This OECD Emission Scenario Document (ESD) is intended to provide information on the sources, use patterns and release pathways of chemicals used at recovered paper mills, to assist in the estimation of releases of chemicals into the environment.

This ESD should be seen as a 'living' document, which provides the most updated information available. As such, an ESD can be updated to take account of changes and new information, including those from the industry area in countries other than the lead (Canada). Users of the document are encouraged to submit comments, corrections, updates and new information to the OECD Environment, Health and Safety Division (env.riskassessment@oecd.org). The comments received will be forwarded to the OECD Task Force on Environmental Exposure Assessment, which will review the comments every two years so that the lead country can update the document. The comments will also be made available to users within the OECD web-site (www.oecd.org/env/riskassessment).

How to use this document

The user of this ESD needs to consider how the information contained in the document covers the situation for which they wish to estimate releases of chemicals. The document could be used as a framework to identify the information needed, or the approaches in the document could be used together with the suggested default values to provide estimates. Where specific information is available it should be used in preference to the defaults. At all times, the values inputted and the results should be critically reviewed to assure their validity and appropriateness.

Coverage

This ESD provides information on chemicals used at recovered paper mills. This ESD was developed along with two sister documents, an ESD on Kraft Pulp Mills, and an ESD on Non-integrated Paper Mills. Although they were designed as stand alone documents, by their nature they represent different phases of the life cycle of paper products. The ESD on Kraft Pulp Mills represents the production stage when pulp is first produced. The ESD on Non-integrated Paper Mills is representative of the industrial phase of the life cycle, when the pulp is converted to paper and/or board products. This ESD on Recovered Paper Mills is illustrative of the recovery stage, when paper products are recovered, reworked and recycled back into the community. To cover the entire life cycle of each of these pulp and paper mill types would be quite lengthy and impractical.

Other ESDs relating to the Pulp and Paper Industry have previously been developed in Europe. These include the EU document, "IC-12, Pulp Paper and Board Industry – Assessment of the Environmental Release of Chemicals Used in the Pulp, Paper and Board Industry." Other related documents are specific to the use of biocides in the Pulp and Paper Industry. These include the European Commission "Harmonization of Environmental Emission Scenarios for Slimicides" (Product Type 12; 2003) and "Emission Scenario Document for Biocides Used in Paper Coating and Finishing" by Tissier and Migné (Product Type 6, 7, and 9; 2001). The first-mentioned document covers additives used in printing and

writing papers, tissue paper, newsprint, as well as cardboard, carton, packaging and wrapping paper. There is thus some overlapping with the ESDs developed for Non-integrated Mills and Recycle Mills, in terms of material covered. However, none of the European ESDs deal with Kraft pulping, due to the nature of the pulp and paper industry in Europe. Kraft pulping is much more prevalent in North and South America and the Scandinavian countries than in continental Europe.

How this document was developed

This document was produced by Environment Canada and overseen by the OECD Task Force on Environmental Exposure Assessment, along with two sister documents aforementioned. The general information about the processes and chemicals used is derived from literature data and several reports from the European Union and the United States. The emission estimation methods given in this ESD are based on those developed by the OECD with parameter defaults reflecting Canadian operations.

The first draft was circulated to the Task Force in March 2003 and developed through the meetings of the Task Force in 2003 and 2004. The revised draft was circulated to the OECD member countries and posted on the OECD web-site in December 2004, with requests for comments and information by May 2005. Comments were received from the United States, Sweden and Finland. The comments received suggested further improvement of the ESD by recommending additional sections (e.g., sample calculations and data gaps), additional/updated information (e.g., function of each type of listed chemical agents and sources of wastewater), specific industry information (e.g., relationship between different types of mills and wastewater treatment practices adopted by the Canadian industry), editorial changes and points of clarification (e.g., cross-reference to other ESDs; addition to glossary; basis for tonnage values used). All these comments were addressed in this document.

This document is published on the responsibility of the Joint Meeting of the Chemicals Group and Management Committee of the Special Programme on the Control of Chemicals of the OECD.

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1 – INTRODUCTION

1. The purpose of this emission scenario document (ESD) is to provide a realistic worst-case emission scenario for chemicals used at recovered paper mills. The general information about the processes and chemicals used is derived from literature data and several reports from the European Union and the United States. The emission estimation methods given in this ESD are based on those developed by the Organization for Economic Cooperation and Development with parameter defaults reflecting Canadian operations.

2. This ESD on Recovered Paper Mills was developed in 2004 along with two sister documents, an ESD on Kraft Pulp Mills, and an ESD on Non-integrated Paper Mills. Although they were designed as stand alone documents, by their nature they represent different phases of the life cycle of paper products. The ESD on Kraft Pulp Mills represents the production stage when pulp is first produced. The ESD on Non-integrated Paper Mills is representative of the industrial phase of the life cycle, when the pulp is converted to paper and/or board products. This ESD on Recovered Paper Mills is illustrative of the recovery stage, when paper products are recovered, reworked and recycled back into the community. To cover the entire life cycle of each of these pulp and paper mill types would be quite lengthy and impractical.

3. Other ESDs relating to the Pulp and Paper Industry have previously been developed in Europe. These include the EU document, “IC-12, Pulp Paper and Board Industry – Assessment of the Environmental Release of Chemicals Used in the Pulp, Paper and Board Industry.” Other related documents are specific to the use of biocides in the Pulp and Paper Industry. These include the European Commission “Harmonization of Environmental Emission Scenarios for Slimicides” (Product Type 12; 2003) and “Emission Scenario Document for Biocides Used in Paper Coating and Finishing” by Tissier and Migné (Product Type 6, 7, and 9; 2001). The first-mentioned document covers additives used in printing and writing papers, tissue paper, newsprint, as well as cardboard, carton, packaging and wrapping paper. There is thus some overlapping with the Canadian ESDs developed for Non-integrated Mills and Recycle Mills, in terms of material covered. However, none of the European ESDs deal with Kraft pulping, due to the nature of the pulp and paper industry in Europe. Kraft pulping is much more prevalent in North and South America and the Scandinavian countries than in continental Europe.

2 – CANADIAN RECOVERED PAPER SECTOR

4. The pulp and paper industry produces commodity grades of wood pulp, primary paper products, and paperboard products. Most pulp is produced for the purpose of subsequent manufacture of paper and board products (European Commission, 1999, p.10). Some is destined for other uses such as thick fibreboard or products manufactured from dissolved cellulose.

5. Recovered paper mills refer to deinking plants that produce a variety of grades from recycled paper. They may produce newsprint from recycled newspapers and magazines, packaging paper and board

from recycled corrugated board, graphic paper from recycled household paper, and tissue paper from recycled office paper (European Commission, 1999, p.219-222).

6. As a reference, the quantities of various paper and board grades produced in Canada are provided in Table 1 (Lockwood-Post Directory, 2002). These quantities include products derived from both recycled and virgin fibres, but the breakdown between the two types of fibres is not known. Newsprint and fine paper (printing and writing) were the two major paper products produced in Canada over the years of 1999-2001, accounting for 55% and 37% of the total paper production, respectively. The total board production was about one quarter of the total paper production.

Table 1 – Paper and Board Production in Canada

Product		Annual Production (1000 tonne/yr)		
		1999	2000	2001
Paper	Newsprint	9,204	9,222	8,516
	Printing and writing	5,748	6,313	6,105
	Kraft packaging paper	534	531	519
	Tissue and specialty	664	652	688
	Total	16,150	16,718	15,828
Board	Linerboard	1,888	1,857	1,870
	Corrugating medium	1,137	1,105	1,110
	Boxboard	1,023	1,003	923
	Total	4,048	3,965	3,903

Source: Lockwood-Post Directory, 2002.

7. The provincial breakdown of the paper and board production is not available at the time of preparing this document, but it is believed that Quebec is the province with the highest paper and board production in Canada. This is reflected by the production statistics given in Table 2 (Quebec Forest Industry Council, www.cifq.qc.ca). Quebec was ranked first in terms of the total production and followed by British Columbia and Ontario. The other provinces accounted for about 20% of the total.

Table 2 – Production of Pulp, Paper and Paperboard in Canada

Province	Pulp, Paper and Paperboard (1000 tonne/year)		Newsprint (1000 tonne/year)	
	2000	2002	2000	2002
Quebec	10,206	10,032	3,848	3,726
British Columbia	8,424	7,393	1,428	1,171
Ontario	6,471	5,991	1,924	1,595
Other Provinces	7,098	6,702	2,022	1,973
Total	32,199	30,118	9,222	8,465

Source: Quebec Forest Industry Council, www.cifq.qc.ca

3 – RECOVERED PAPER PROCESS

3.1 – Process Description

8. Figure 1 shows a typical deinking process for recovered paper mills. It consists primarily of four sections: 1) pulping; 2) deinking; 3) bleaching; and 4) papermaking. Water and wastewater treatment and power boilers are commonly integral parts of a recovered paper mill. The code used in Figure 1 for chemicals added in various pulp and paper operations is given in Table 3. It should be noted that these chemicals are provided for the pulp and paper industry as a whole and not all of them are necessarily used by recovered paper mills.

9. Wastewater streams from the process are generally sent to an on-site wastewater treatment system before being discharged to a receiving water body. These streams are derived from flotation, washing and thickening operations.

10. As part of the Canadian Fisheries Act, the 1992 Pulp and Paper Effluent Regulations were enacted to set allowable limits on BOD, suspended solids and LC₅₀ toxicity values in mill effluents. Today almost all Kraft mills have primary and secondary treatment facilities to meet these targets, as do non-integrated and recycle mills, before discharging to a receiving body of water, be it river, lake, marine or estuary. Only one Kraft mill in Canada is releasing into a town's sewer system (after aerated lagoons). Many board mills (recycle mills) located in large urban centres release to the municipal sewer system following on-site primary treatment.

Table 3 – Pulp and Paper Chemicals

Code Used in Figure 1	Chemical	Function
1	Cooking aids/chip penetrants	Helps increase Kraft cooking yield.
2	Boilouts/cleaners	Removal of organic and inorganic deposition in chests and piping during major cleanups, in combination with an acid or caustic soda.
3	Scale control	Agent to prevent or delay inorganic scale formation.
4	Foam control	Prevention or control of foam in chests, washers and paper machines.
5	Washing/drainage aids	Improves throughput efficiency of brown stock washers.
6	Pitch/stickies control	Control and/or prevention of pitch and pitch-like substances from depositing out in system and/or causing quality problems in the finished pulp or sheet.
7	Clarification aids	An organic or inorganic substance to help in clarification of influent or effluent water.
8	Lime mud dewatering aids	Agent to increase lime mud solids prior to firing at lime kiln.
9	Tall oil separation and acidulation aids	Agent to increase separation yield of tall oil from black liquor at the skim tank in the evaporator train.
10	Turpentine separation aids	Agent to increase separation yield of turpentine from digester relief gases after the separation process.
11	Microbiological control	Substance to control microbiological organisms and the problems they cause (slime, off-odours, corrosion, quality defects).
12	Felt conditioners	Agent to clean felts or condition felt surface to prevent deposition. Applied continuously or in batch fashion.

Code Used in Figure 1	Chemical	Function
13	Retention/drainage aids	A flocculant and/or coagulant to aid in the separation of fibre from water at the paper or pulp machine, in save-all and clarifiers, etc.
14	Air pollution control	Agents added to help separation process in wet scrubbers.
15	Condensate treatment	Agents added to prevent return line corrosion in boiler systems.
16	Boiler water treatment	Agents added to prevent water side corrosion problems in boiler systems.
17	Corrosion inhibitors	Filming or sequestering agents to prevent corrosion in various parts of the pulp making process.
18	Settling aids	The use of flocculants in green and white liquor clarifiers.
19	Nutrients	Sources of nitrogen and phosphate to stimulate microbial action in effluent treatment.
20	Sludge conditioners	Flocculants, coagulants or combinations thereof to increase solids content of sludges in wastewater treatment systems.
21	Odour control	A substance added in wastewater treatment to control off odours caused by microorganisms.
22	Colour control	Usually, an agent added to remove/reduce colour in pulp or paper mill effluent.
23	Starch/sizes	Used to impart water repellency and stiffness to the paper product.
24	Wet strength agents	Agent added to improve wet strength of sheet of paper or board.
25	Dry strength agents	Agent added to impart dry strength of paper or board.
26	Dyes/dye fixatives/fluorescent whites	Agents added to give desired colour and reflectance to a sheet of paper.
27	Charge control	Agent added to help neutralize anionic trash in a paper machine system.
28	Fillers	Inorganic compounds added to paper machine stock to impart desired quality of opacity, printability and/or brightness to sheet.
29	Chelants/sequestrants	Agents used to control undesired metal ions.
30	Emulsifiers	Agent added to improve water solubility or miscibility of a particular component.
31	Antiskid agents	A substance, usually sprayed on at the dry end of a paper/board machine, added to promote stackability of board products, by increasing surface friction.
32	Save-all polymers	Coagulant or flocculant added to improve separation of fibre from white water at save-all.
33	Formation aids	Added at paper machine to improve sheet formation and uniformity.
34	Latex	Part of a specialty paper coating formulation surface treatment.
35	Surfactants/repulping aids	Agents added at the repulper to facilitate pulp slurry formation.
36	Dispersing agents	Agent added to improve water solubility of a hydrophobic constituent, to prevent agglomeration and deposition in a paper machine system.
37	Deinking aids	Agents added to help deinking of printed papers.
38	Soap/fatty acids	Agents used for deinking newsprint and magazines.
39	Barrier chemistry	Agents added at machine to make sheet of paper impervious to various liquids.
40	Bleaching chemicals	Any chemical added alone or in combination with others to improve sheet brightness via oxidative or reductive mechanism.

3.1.1 – Pulping

11. Cleaning may be required prior to pulping. Recovered paper is usually presorted before being delivered to a mill (USEPA, 1995, p.24). If not, it must be cleaned to remove contaminants. In some cases, contaminants of greater density than the desired secondary fibre are removed by centrifugal force, while lighter contaminants are removed by flotation.

12. Pulping is the first stage in papermaking using recovered paper. A typical pulper is a large vessel with a rotor filled with water which is sometimes heated (USEPA, 1995, p.24; European Commission, 1999, p.215). Ink is released from fibres and dispersed in the solution in the presence of surfactants. Pulping can be followed by deflaking which defibre tiny fibre bundles in a deflaker (Hamilton et al., 1987, p.161). Deinking in Europe is predominantly carried out by flotation while in North America mills still rely on the washing process or a combination of the two processes.

3.1.2 – Deinking

13. Following the pulping and deflaking, cleaning and deinking are carried out. Contaminants such as stones, sand, grit and paper clips are removed by cleaning and screening (European Commission, 1999, p.217; European Commission, 1996, p.696). The cleaned pulp is then processed for ink removal by flotation or washing, or a combination of both. Besides ink particles, fillers and fines are also removed.

3.1.3 – Bleaching

14. The deinked pulp must be prepared prior to bleaching. Once again, cleaning and screening are carried out for further removal of contaminants (European Commission, 1999, p.218-219). The cleaned pulp is then thickened using sieve belt press, disc thickeners, and screw press. After these cleaning steps, small amounts of impurities such as ink particles and wax may still be present in the pulp and can be dispersed with a disperser.

15. Oxidative bleaching is performed in a bleach tower to remove colour matter from the pulp. Hydrogen peroxide is a common oxidative bleaching agent and used along with sodium hydroxide, sodium silicate and sometimes chelating agents (European Commission, 1999, p.218). After bleaching, the pulp is pumped to storage or mixing chests.

3.1.4 – Papermaking

16. The bleached pulp is converted into paper through a paper machine. This step is similar to that used in non-integrated paper mills. Through the paper machine, the pulp slurry is deposited onto a moving forming belt and water is removed by gravity, vacuum chambers, and vacuum rolls (USEPA, 1995, p.35). The continuous sheet is then pressed between a series of rollers to dry and compress fibres.

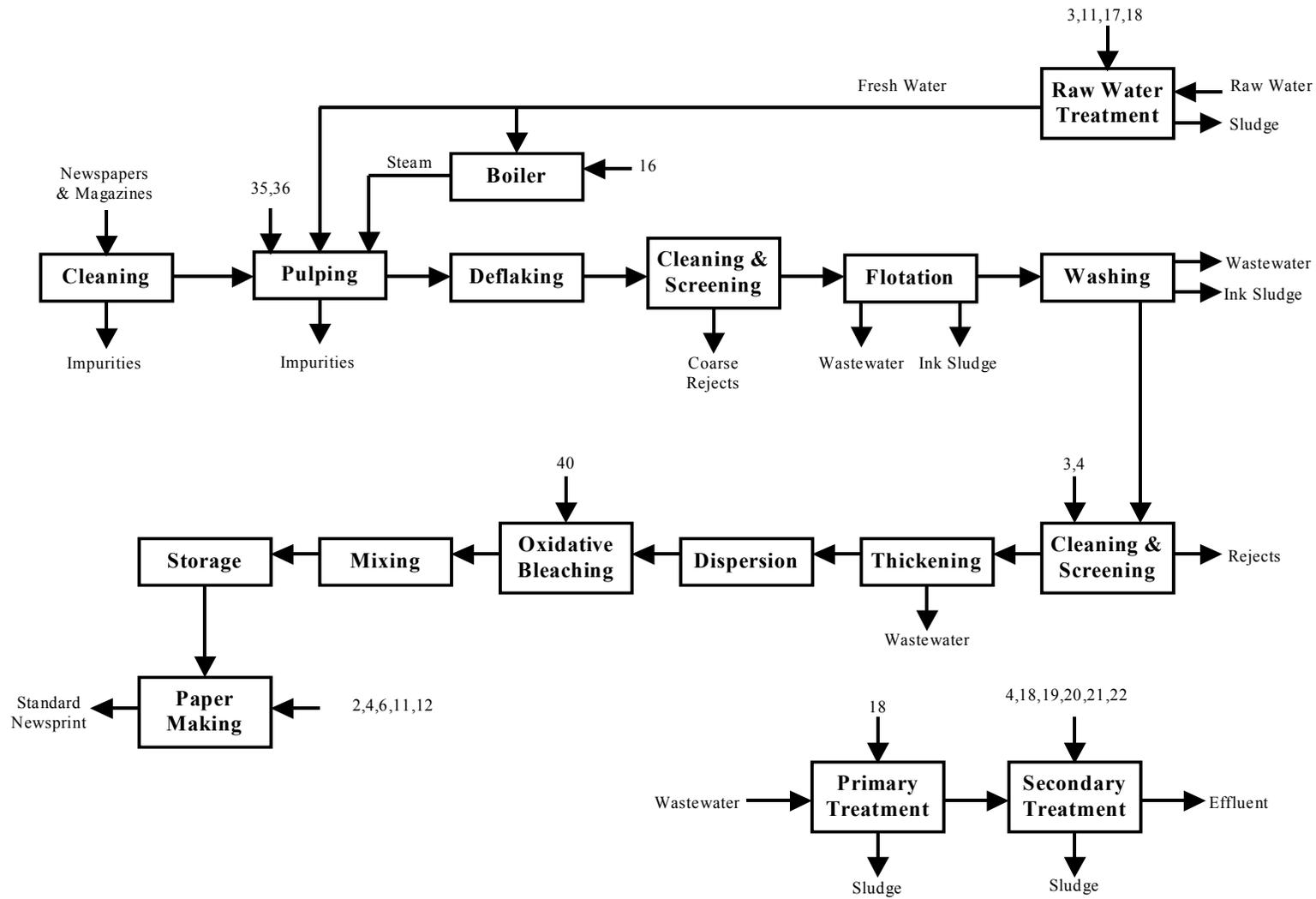


Figure 1 – Typical Process for Recovered Paper Mills with Deinking
 (Code for chemicals can be found in Table 3)

3.2 – Chemical Use

17. Chemical agents used at recovered paper mills are divided into product aids and process aids. Product aids optimize specific product properties, while process aids facilitate mill operations. Product and process aids commonly used in the European Union are summarized in Table 4 (European Commission, 1999, p.236-237).

18. Chemicals used for flotation deinking are dependent upon type of secondary fibres. For groundwood-containing secondary fibres such as newspapers and magazines, typical chemicals used include sodium hydroxide, sodium silicate, hydrogen peroxide, soaps or fatty acids, dispersing agents, and chelants (Hamilton et al., 1987, p.208-216). Soaps or fatty acids are primary deinking agents and are added to a pulper where they saponify in an alkaline pulp suspension. In addition, surfactants, preferably nonionic types, can also be used to intensify the deinking process. For wood-free secondary fibres, hydroxide peroxide is not required because alkali does not cause the fibres to turn yellow. This further eliminates the use of sodium silicate and chelants.

Table 4 – Specialty Chemicals Commonly Used at Recovered Paper Mills

Category	Type	Code Used in Figure 1	Example	Function
Product aids	Fillers	28	Kaolin or clay, talc, lime, gypsum, titanium dioxide	- Improve printability, opacity, brightness, smoothness and gloss - Replace fibers
	Sizing agents	23	Modified starch, modified natural resins, wax emulsions, alkylketen dimers and maleic acid anhydride copolymers	- Improve surface quality - Make paper hydrophobic
	Fixing agents	26	Alum ($\text{Al}_2(\text{SO}_4)_3$)	- Improve adhesion/retention of additives to fibers
	Dry strength agents	25	Modified starch	- Improve strength under dry conditions
	Wet strength agents	24	Urea formaldehyde polymers, melamine-formaldehyde polymer, epichlorohydrin condensates	- Improve strength under wet conditions
	Dyes	26	Azo compounds, quarternary ammonium compounds	- Give paper a certain color and/or brightness
	Optical brighteners	26	Chemicals based on 4,4-diamino stilbene-2,2-disulfonic acid	- Give paper a white impression
Process aids	Coating chemicals	34	Pigments, binders, latex, coating clay, dispersion and lubrication agents, defoaming agents, slimicides	- Give paper certain surface properties
	Retention aids	13	Alum, sodium aluminate, polyaluminum chloride, starch products, gums, anionic polyacrylamides, nonionic polyacrylamides, cationic polymers	- Retain fibers, fines and fillers - Increase production by improving dewatering - Reduce emissions of pollutants
	Deinking and bleaching chemicals	37 and 40	NaOH, fatty acids, H_2O_2 , hydrosulfite, salts of fatty acids, complexing agents, sodium silicate, tensides (surfactants)	- Release ink from fibers - Bleach - Keep ink particles in dispersion
	Complexing (chelating) agents	29	DTPA or EDTA	- Remove metal ions by forming metallic complexes to prevent decomposition of bleaches
	Tensides (surfactants)	35	Acidic and alkaline surfactants	- Clean felts, wires and machinery - Clean water circuit system - Disperse substances
	Defoaming agents	4	Fatty acids, ethoxylates, poly-oxiethylene, fatty acid derivatives, alcohols, phosphoric acid esters, vegetable oil products	- Prevent and destroy foam
Process aids	Biocides (slimicides)	11	Organic bromine, sulfur or nitrogen compounds, quarternary ammonium compounds	- Prevent growth of microorganisms and slime formation

Source: European Commission, 1999, p.237

19. Provided in Table 5 are typical use levels of deinking chemicals found at recovered paper mills (Hamilton et al., 1987, p.185; European Commission, 1999, p.238).

Table 5 – Use Levels of Deinking Chemicals

Chemicals	Use Level (% on pulp)			
	Groundwood-Containing Secondary Fibre	Wood-Free Secondary Fibre	Deinking and Bleaching	Deinking Only
Sodium hydroxide	1.0-2.0%	2.0%	1.0-2.0%	0.6%
Sodium silicate	3.0%	not used	2.0-3.0%	1.0%
Hydrogen peroxide	0.8-1.2%	not used	0.5-2.5%	0.8%
Soap or fatty acid	0.4-1.0%	0.9-1.0%	0.5-0.8%	no data
Dispersing agent	0.1%	0.1%	no data	no data
Chelant	0.2%	not used	0.2-0.3%	0.2%
Sodium dithionite	not used	not used	0.6-1.0%	no data
Talc	not used	not used	1.0-1.5%	no data
Sulphuric acid	not used	not used	0.8-1.0%	no data
Reference	Hamilton et al., 1987, p.216	European Commission, 1999, p.238	Dingman & Perry, 1999	

4 – RELEASE ESTIMATION

4.1 – Wastewater

20. In European Union, the wastewater generated from recovered mills is generally discharged directly to surface water upon primary and biological treatment or to a municipal sewage treatment plant upon removal of solids by primary clarification (European Commission, 1999, p.242). It originates primarily from cleaning steps with the following sources:

- reject from screening and centrifugal separation;
- filtrates from washers, thickeners and sludge handling; and
- excess white water from papermaking.

21. Summarized in Table 6 is water consumption data for the pulp and paper industry in Canada, the U.S. and the European Union. In Canada, the water consumption was reportedly reduced from 73 m³/tonne in 1995 to 69 m³/tonne in 1999 for the industry as a whole (Forest Products Association of Canada, www.fpac.ca, 2004). The data for the province of Quebec in Canada was in the range of 57-62 m³/tonne in 1999 which was lower than the national average (Quebec Forest Industry Council, www.cifg.qc.ca, 2004). The sector of recovered paper mills (deinking plants) in Canada consumed much less water at 21 m³/tonne in 2002 (personal communications with Environment Canada, 2004).

Table 6 – Water Consumption by Pulp and Paper Industry

Region	Sector	Water Consumption (m ³ /tonne)	Reference
Canada	Pulp and paper industry as a whole	69-73	Forest Products Association of Canada, www.fpac.ca, 2004
Quebec, Canada	Pulp and paper industry as a whole	57-62	Quebec Forest Industry Council, www.cifq.qc.ca, 2004
Canada	Bleached Kraft mills	97.4	Personal communications with Environment Canada, 2004
Canada	Non-integrated mills	23.2	Personal communications with Environment Canada, 2004
Canada	Deinking mills	21.4	Personal communications with Environment Canada, 2004
USA	Pulp and paper industry as a whole	17-50	USEPA, 2002, p.36
USA	Bleached Kraft mills	15-45	Personal communications with U.S. Environmental Protection Agency, 2004
European Union	Pulp and paper industry as a whole	15-100	European Commission, 1999, p.32

22. Summarized in Table 7 is water consumption and wastewater generation data for recovered paper mills in European Union (European Commission, 1999, p.227-243). The difference between the water used and the wastewater generated was due to the loss via water evaporation.

Table 7 – Water Consumption and Wastewater Generation Data for Recovered Paper Mills

Parameter	Value (m ³ /tonne of pulp)
Water consumption	20
Wastewater generation	8-16

Source: European Commission, 1999, p.227-243

4.2 – Solid Waste

23. Recovered paper mills result in three types of solid waste: 1) rejects; 2) sludge; and 3) incineration ash (European Commission, 1999, p.245-246). They are generated from pulping, deinking, process water clarification, and wastewater treatment. Rejects can be divided between heavy/coarse rejects and light/fine rejects. Sludge can be classified into deinking sludge, flotation sludge and wastewater sludge. Their respective generation rates are summarized in Table 8 and the dry contents of some of these materials are provided in Table 9.

Table 8 – Solid Waste Generated from Recovered Paper Mills

Product	Graphic Paper	Tissue Paper	Market Pulp	Deinked office	Paper Board
Raw Material	Newspaper & magazines	Recovered office paper	Recovered paper	office	Shopping centre waste & recovered household paper
Heavy/coarse rejects	1-2%	1-2%	<1%		1-2%
Light/fine rejects	3-5%	3-5%	4-5%		3-6%
Deinking sludge	7-16%	8-13%	12-15%		-
Clarification sludge	1-5%	15-25%	15-25%		0-1%
Wastewater treatment sludge	1%	1%	1%		1%
Total	10-25%	28-40%	32-40%		4-9%

Source: European Commission, 1999, p.245-246

Table 9 – Dry Solids Content of Solids Waste from Recovered Paper Mills

Type of Solid Waste	Content of Dry Solids
Heavy/coarse rejects	50%-65%
Sludge	60%

Source: European Commission, 1999, p.245-246

24. The components that are contained in the solid waste and originate from recovered paper include impurities and paper residue. Impurities are lumps of fibres, staples, ring binders, sand, glass and plastics, and account for 6.5% of recovered paper (European Commission, 1999, p.246-247). Paper residue, consisting primarily of fibres and fillers, is present in water clarification sludge removed from white water circuits during fibre recovery as well as in wastewater treatment sludge.

4.3 – Air Emissions

25. Air emissions for recovered paper mills are a result of energy generation, on-site incineration of sludge and/or rejects, wastewater treatment (odour), and raw material handling (dust) (European Commission, 1999, p.248-250). Energy generation (steam and electricity) is the major source of air emissions and leads to releases of CO₂, NO_x, SO₂, dust and low concentrations of heavy metals.

26. Deinking operations are a source of volatile organic hazardous air pollutants (HAPs) and volatile organic compounds (VOCs). A study of four recovered paper mills in the U.S. found that HAP emissions from deinking operations ranged from 0.022 to 0.31 lb per ton of pulp (NCPI, 1997, No.739). They consisted primarily of chloroform, methanol, biphenyl, toluene, and acetaldehyde. VOC emissions ranged from 0.032 to 0.87 lb per ton of pulp.

5 – EMISSION SCENARIOS

5.1 – Fate of Chemical Agents

27. Described in Figure 2 is the fate of a chemical agent used at a facility. The agent is shipped to the facility using one or more types of containers. It is then unloaded or unpackaged and transferred to the production process. The agent leaves the facility via the following routes:

- Container residue that remains in containers after unloading or unpackaging and ends up in wastewater or is disposed of by other means.
- Process residue that remains in process vessels and transfer pipelines and also ends up in wastewater or is disposed of by other means.
- Liquid loss that enters wastewater streams during normal applications.
- Air emission that occurs if the agent contains volatile components.
- Reaction loss that occurs if the agent undergoes chemical reactions during its use.
- Product retention that accounts for a portion of the agent fixed onto finished products.

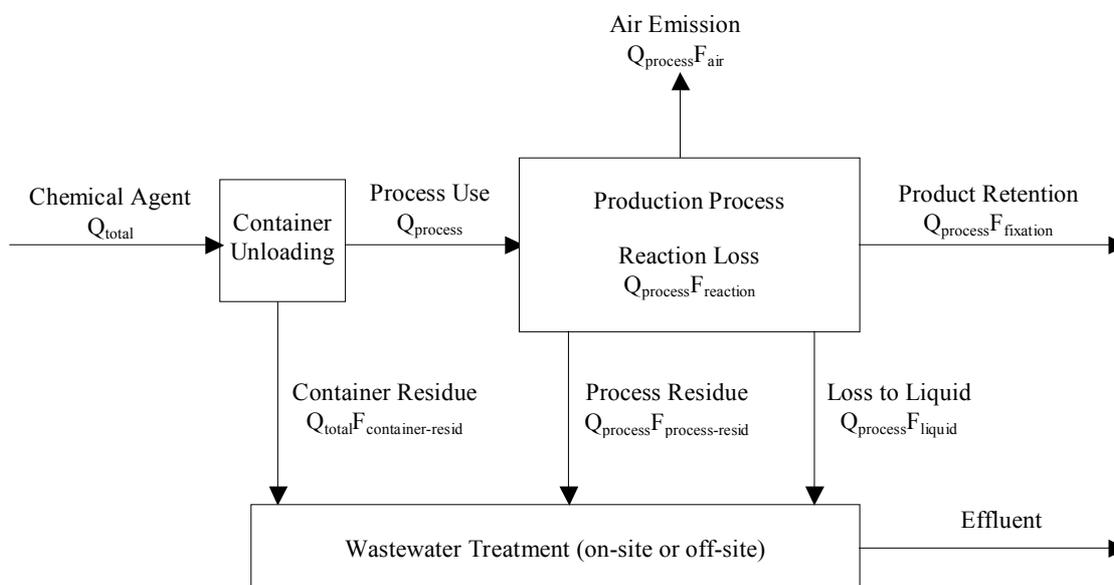


Figure 2 – Fate of a Chemical Agent Used at a Facility

5.2 – General Approach to Aqueous Emission Estimation

28. A general approach to aqueous emission estimation was recommended by the Organization for Economic Cooperation and Development in 2000 in a publication entitled "Guidance Document on Emission Scenario Documents" (OECD, 2000). The approach is based on the fixation of chemical agents

onto finished products and can be described by the following equation assuming no air emission and reaction loss:

$$E_{\text{water}} = \frac{Q_{\text{product}} Q_{\text{agent}} C_{\text{substance}} (1 - F_{\text{fixation}})}{T_{\text{operation}}}$$

29. The equation includes a set of input variables on the right and one output variable on the left. The definitions and value types of these variables are provided in Table 10.

Table 10 – Input and Output Variables of Aqueous Emission Estimation Equation

Variable	Symbol	Units	Value Type	
Output	Aqueous emission of a substance in chemical agent	E_{water}	kg/d	Calculated
Input	Annual production	Q_{product}	tonne/yr	User input without default available
	Chemical agent use rate	Q_{agent}	kg/tonne	
	Substance concentration in chemical agent	$C_{\text{substance}}$	%	Provided with default which can be modified by users
	Fixation rate (fraction of chemical agent retained by product)	F_{fixation}	%	
	Annual operation days	$T_{\text{operation}}$	d/yr	

Source: OECD, 2000.

5.3 – Emission Estimation Calculations

5.3.1 – Emission to Wastewater

30. The emission to wastewater from a recovered paper mill can be estimated according to a scheme described in Figure 2. The scheme is based on a spreadsheet formula used by the USEPA for exposure estimation. The emission consists of three portions: 1) liquid loss; 2) container residue; and 3) process residue. Liquid loss is incurred when a fraction of a chemical agent is not retained by finished products and enters wastewater, while container and process residues are common losses resulting from chemical handling and transferring. The following equation can be used for the aqueous emission estimation:

$$E_{\text{water}} = \text{liquid loss} + \text{container residue} + \text{process residue}$$

$$= \frac{Q_{\text{total}} C_{\text{substance}}}{T_{\text{operation}}} (1 - F_{\text{container-resid}} - F_{\text{process-resid}}) (1 - F_{\text{air}} - F_{\text{reaction}} - F_{\text{fixation}}) +$$

$$\frac{Q_{\text{total}} C_{\text{substance}}}{T_{\text{operation}}} F_{\text{container-resid}} + \frac{Q_{\text{total}} C_{\text{substance}}}{T_{\text{operation}}} F_{\text{process-resid}}$$

where

E_{water} : daily aqueous emission of a substance in chemical agent, kg/d
 Q_{total} : total chemical agent received by or shipped to a facility, kg/yr
 $C_{\text{substance}}$: substance concentration in chemical agent, %

$F_{\text{container-resid}}$:	container residue as percentage of total chemical agent received by or shipped to a facility, %
$F_{\text{process-resid}}$:	process residue as percentage of total chemical agent received by or shipped to a facility, %
F_{air} :	air emission as percentage of chemical agent used in production process, %
F_{reaction} :	reaction loss as percentage of chemical agent used in production process, %
F_{fixation} :	fixation rate, i.e., fraction of chemical agent retained by finished products, %
$T_{\text{operation}}$:	annual operation days, d/yr

5.3.2 – Total Chemical Agent

31. The total amount of a chemical agent received by or shipped to a facility can be estimated from the use rate of the agent if it is not provided directly. The use rate may be expressed on mass of finished products or volume of water or wastewater, depending upon the application of the agent. As a result, one of the equations given below may be used to determine the total amount of a chemical agent.

For use rate based on product mass:

$$Q_{\text{total}} = \frac{Q_{\text{product}} Q_{\text{agent}}}{(1 - F_{\text{container-resid}} - F_{\text{process-resid}})}$$

For use rate based on water volume (usually water treatment chemicals):

$$Q_{\text{total}} = \frac{Q_{\text{product}} Q_{\text{water}} X_{\text{agent}} \times 10^{-3}}{(1 - F_{\text{container-resid}} - F_{\text{process-resid}})}$$

For use rate based on wastewater volume (usually wastewater treatment chemicals):

$$Q_{\text{total}} = \frac{Q_{\text{product}} Q_{\text{wwater}} X_{\text{agent}} \times 10^{-3}}{(1 - F_{\text{container-resid}} - F_{\text{process-resid}})}$$

where

Q_{total} :	total chemical agent received by or shipped to a facility, kg/yr
$F_{\text{container-resid}}$:	container residue as percentage of total chemical agent received by or shipped to a facility, %
$F_{\text{process-resid}}$:	process residue as percentage of total chemical agent received by or shipped to a facility, %
Q_{product} :	annual paper production, tonne/yr
Q_{agent} :	chemical agent use rate based on product mass, kg/tonne
Q_{water} :	water consumption rate based on product mass, m ³ /tonne
Q_{wwater} :	wastewater generation rate based on product mass, m ³ /tonne
X_{agent} :	chemical agent use rate based on volume of water or wastewater, g/m ³ or ppm

5.3.3 – Air Emission

32. The fraction of a substance in a chemical agent emitted to the atmosphere refers to the release after a pollution control device and is defined as

$$F_{air} = \frac{E_{air}}{Q_{use}} \times 100\%$$

where

- F_{air} : fraction of a substance in a chemical agent released to air, %
 E_{air} : quantity of a substance in a chemical agent released to air, kg/d
 Q_{use} : quantity of a substance in a chemical agent used in production process, kg/d

33. The air emission of a target substance can be estimated from a reference substance based on vapour pressure if the two substances are involved in the same operations (USEPA, 2000).

$$F_{air} = F_{air-ref} \frac{P_{air}}{P_{air-ref}}$$

where

- F_{air} : fraction of a target substance released to air, %
 $F_{air-ref}$: fraction of a reference substance released to air, %
 P_{air} : vapour pressure of a target substance, Pa
 $P_{air-ref}$: vapour pressure of a reference substance, Pa

34. A reference substance should be volatile so that its air release reaches a sufficient quantity, while at the same time, it should be found in aqueous discharge to ensure reasonable partition between water and air. To simplify calculations it is necessary to assume that the reference substance is not retained by finished products and is released to air and water only. Under these conditions, the air emission of the reference substance can be estimated by the equation.

$$F_{air-ref} = \frac{E_{air-ref}}{E_{air-ref} + E_{water-ref}}$$

where

- $E_{air-ref}$: quantity of reference substance released to air, kg/d
 $E_{water-ref}$: quantity of reference substance released to water, kg/d

35. Errors may occur in applying the above equation when the volatilities of the target and reference substances are influenced to different extents by operating conditions such as pH (Stellan Fischer, 2005). Care should, therefore, be taken to select a reference substance that behaves as closely as possible to the target substance with respect to water solubility, partition, stability and ionization.

5.3.4 – Reaction Loss

36. The loss due to chemical reactions is substance specific. In general, it is assumed at zero, i.e., the substance in question does not undergo chemical transformation. Many substances, however, change chemically and need to be evaluated from the data available. For example, certain active ingredients in biocides have been found to hydrolyze and biodegrade within the water recycle loops of paper mills and these reactions need to be taken into account in the estimation of emissions to wastewater (European Commission, 2003).

5.4 – Parameter Defaults

5.4.1 – Container Residue

37. Container residue results from chemical unloading and its quantity depends primarily upon the type of containers used. Listed in Table 11 are container residue defaults used by the USEPA for exposure estimation. Semi-bulk and bulk are common container types used by the pulp and paper industry. It is recommended that a value of 3.0% instead of 4.0% be used to estimate liquid drum residue for Canadian facilities. Recent USEPA OPPT models further suggest 3% as a default for liquid drum residues and 1% for dry solids residues in transport containers.

Table 11 – Container Residue Defaults

Container Type	Residue as % of Total Quantity Received	
	Dry	Liquid
Bag	0.1	0.2
Keg	0.3	0.6
Drum	1.0	4.0
Semi-bulk	0.1	0.5
Bulk	0.1	0.2

Source: USEPA spreadsheet exposure estimation, 2004

5.4.2 – Process Residue

38. Process residue results from the use of process vessels and transfer pipelines. Listed in Table 12 are process residue defaults used by the USEPA for exposure estimation.

Table 12 – Process Residue Defaults

Process Hardware	Residue as % of Total Quantity Received	
	Dry	Liquid
General	0.1	1.0
Batch vessel	0.2	1.0
Transfer pipeline	0.1	1.0

Source: USEPA Spreadsheet Exposure Estimation, 2004

5.4.3 – Air Emission

39. The fraction of a substance in a chemical agent released to air depends upon its volatility. Its default is zero assuming the substance is a non-volatile compound. This default should be only used when releases to water, land or incineration are estimated. The value for a volatile substance may be estimated using emission factors or engineering calculations.

5.4.4 – Reaction Loss

40. The default for reaction loss is zero assuming no chemical reaction takes place as a chemical agent is used in production processes.

5.4.5 – Water Consumption Rate

41. It was estimated that Canadian recovered paper mills consumed 16-26 m³ of water per tonne of production with an average of 21 m³/tonne in 2002 (personal communications with Environment Canada, 2004).

5.4.6 – Wastewater Generation Rate

42. It was estimated that Canadian recovered paper mills generated 14-24 m³ of wastewater per tonne of production with an average of 19 m³/tonne in 2002 (personal communications with Environment Canada, 2004).

5.4.7 – Annual Paper Production

43. The annual paper production (Q_{product}) for Canadian recovered paper mills is in the range of 10,000-200,000 tonne/yr per mill with a typical figure at 85,000 tonne/yr. This figure was arrived at by totaling the rated capacity of each recycled paper mill (tonnes/yr) as listed in Pulp and Paper Canada (2004) and dividing by the total number of those mills to obtain the arithmetical average.

5.4.8 – Annual Operation Days

44. The default for annual operation days ($T_{\text{operation}}$) is 350 d/yr. It is based on the assumption that a two-week shutdown period is required for annual maintenance. The actual value may, however, vary from mill to mill.

5.4.9 – Use Rate, Active Substance Concentration and Fixation Rate

45. The use rate, active substance concentration, and fixation rate for chemicals used in various operations were evaluated in a previous study (Crechem Technologies, 2003). Their defaults are reviewed with some revisions in this study and presented in Tables 13-19.

46. It has been found that the aqueous releases of some chemical agents are too high when estimated from the use rates given in Tables 12-17. The reason for the overestimation is due to the fact that these chemical agents are only used on an intermittent basis or with variable dosages to treat intermittent problems or continuous problems of varying intensity, while the release calculations are based on continuous operations with conservative assumptions for chemical use. Coagulant polymers, felt wash agents, and chelants are examples of these chemicals.

47. With respect to chemicals that are considered to be totally water soluble in the tables below, a positive fixation rate was still indicated as a range. It is possible that although considered water soluble, a given substance may still be adsorbed onto fibre, and in the absence of specific data to the contrary, a range of 1-20% is used as the fixation rate.

Table 13 – Use Rate, Active Substance Concentration and Fixation Rate for Chemicals Used in Pulping at Recovered Paper Mills

Chemical Agent	Use Rate (Q_{agent} , kg/tonne)		Concentration ($C_{\text{substance}}$, %)		Fixation Rate (F_{fixation} , %)	
	Default	Range	Default	Range	Default	Range
Surfactants/repulping aids	10	2-20	100	no data	10	1-20
Sodium silicate	30	20-40	100	no data	50 ¹	50 ¹
Dispersing agents	2.5	1-5	100	no data	10	1-20

Source: Crechem Technologies Inc., 2003

¹Estimates**Table 14 – Use Rate, Active Substance Concentration and Fixation Rate for Chemicals Used in Deinking at Recovered Paper Mills**

Chemical Agent	Use Rate (Q_{agent} , kg/tonne)		Concentration ($C_{\text{substance}}$, %)		Fixation Rate (F_{fixation} , %)	
	Default	Range	Default	Range	Default	Range
Deinking aids	5	1-10	100	no data	10	1-20
Soap/fatty acids	15	5-30	100	no data	10	1-20
Boilouts	no data	no data	100	no data	10	1-20
Settling aids (coagulants)	5.0	1-20	100	no data	10	1-20
Settling aids (flocculants)	0.5	0.02-1	100	no data	10	1-20

Source: Crechem Technologies Inc., 2003

Table 15 – Use Rate, Active Substance Concentration and Fixation Rate for Chemicals Used in Bleaching at Recovered Paper Mills

Chemical Agent	Use Rate (Q_{agent} , kg/tonne)		Concentration ($C_{\text{substance}}$, %)		Fixation Rate (F_{fixation} , %)	
	Default	Range	Default	Range	Default	Range
Peroxide	15	10-20	100	no data	10	1-20
Sodium hydroxide	40	30-50	100	no data	10	1-20
Sodium silicate	30	20-40	100	no data	50 ¹	50 ¹
Chelating agents/sequestrants	5	1-20	100	no data	10	1-20
Hydrosulfites	7.5	5-10	100	no data	10	1-20
Chlorine	10	5-30	100	no data	10	1-20

Source: Crechem Technologies Inc., 2003

¹Estimates

Table 16 – Use Rate, Active Substance Concentration and Fixation Rate for Chemicals Used in Papermaking at Recovered Paper Mills

Chemical Agent	Use Rate (Q_{agent} , kg/tonne)		Concentration ($C_{\text{substance}}$, %)		Fixation Rate (F_{fixation} , %)	
	Default	Range	Default	Range	Default	Range
Sizes	5	0.5-10	100	no data	0.2	0.1-0.3
Wet strength agents	10	2.5-20	100	no data	0.8	0.7-0.9
Dry strength agents	3.5	0.05-7.5	100	no data	50 ³	50 ³
Basic dyes	7.5	0.1-10	100	no data	73 ¹	50-95 ¹
Acid dyes	7.5	0.1-10	100	no data	65 ¹	40-90 ¹
Anionic direct dyes	7.5	0.1-10	100	no data	89 ¹	79-98 ¹
Cationic direct dyes	7.5	0.1-10	100	no data	95 ¹	90-99 ¹
Dye fixatives	7.5	0.1-10	100	no data	70	40-95
Fluorescent whites	7.5	0.1-10	100	no data	70	40-95
Corrosion inhibitors	2.0	0.5-5	100	no data	10	0-20
Retention/drainage aids (coagulants)	5.0	0.99-19.8	100	no data	35	70-90 ⁰
Retention/drainage aids (flocculants)	0.5	0.0198-0.99	100	no data	35	70-90
Retention/drainage aids (micro- particles)	0.3	0.099-0.396	100	no data	80	70-90
Barrier chemistry	no data	no data	100	no data	10	0-20
Formation aids	2.5	2-3	100	no data	50 ³	50 ³
Charge neutralization	5.0	1-20	100	no data	80	70-90
Chelants	0.12	0.08-0.16	100	no data	10	1-20
Antiskid agents	0.5	0.38-0.75	100	no data	10	1-20
Emulsifiers	1.00	0.5-2	100	no data	10	1-20
Foam control	0.25	0.125-0.5	100	no data	10	1-20
Pitch/stickies control (liquid)	1.0	0.25-2.5	100	no data	10	1-20
Pitch/stickies control (talc)	5.0	1-10	100	no data	25	25-50
Felt cleaning chemicals	1.0 ²	1.0 ²	100	100	10	1-20
Boilouts/ cleaners	no data	no data	100	no data	10	1-20
Microbiological control	no data	no data	100	no data	10	1-20
Latex	20	20-20	100	no data	50 ³	50 ³
Fillers	210	210-210	100	no data	95	95

Source: Crechem Technologies Inc., 2003

¹Data provided by European Commission (1996, p.700)²The use rate for felt cleaning rarely exceeds 1 kg/tonne for continuous applications.³Estimates

Table 17 – Use Rate, Active Substance Concentration and Fixation Rate for Chemicals Used in Recovery and Power Boilers at Recovered Paper Mills

Chemical Agent	Use Rate (Q_{agent} , kg/tonne)		Concentration ($C_{\text{substance}}$, %)		Fixation Rate (F_{fixation} , %)	
	Default	Range	Default	Range	Default	Range
Air pollution control	0.0027	0.0014-0.0027	100	no data	5	1-10
Condensate treatment	0.0062	0.0031-0.0062	100	no data	5	1-10
Boiler water treatment	0.015	0.00077-0.015	100	no data	5	1-10
Scale control	0.038	0.0077-0.077	100	no data	5	1-10
Corrosion inhibitors	0.0077	0.0015-0.0077	100	no data	5	1-10

Source: Crechem Technologies Inc., 2003

Table 18 – Use Rate and Active Substance Concentration for Chemicals Used in Water Treatment at Recovered Paper Mills

Chemical Agent	Use Rate (X_{agent} , ppm)		Concentration ($C_{\text{substance}}$, %)	
	Default	Range	Default	Range
Corrosion inhibitors	5.0	0.1-5	100	no data
Microbiological control	no data	no data	100	no data
Scale control	50	5-50	100	no data
Settling aids (coagulants)	50	5-100	35	no data
Settling aids (flocculants)	2.5	0.1-5	100	no data

Source: Crechem Technologies Inc., 2003

Table 19 – Use Rate and Active Substance Concentration for Chemicals Used in Wastewater Treatment at Recovered Paper Mills

Chemical Agent	Use Rate (X_{agent} , ppm)		Concentration ($C_{\text{substance}}$, %)	
	Default	Range	Default	Range
Settling aids (coagulants)	50	5-100	100	no data
Settling aids (flocculants)	2.5	0.1-5	100	no data
Foam control	25	2-25	100	no data
Nutrients	5	2-5	100	no data
Sludge conditioners (flocculants)	5	0.1-10	100	no data
Odour control	15	5-150	100	no data
Colour control (coagulants)	100	200	35	no data

Source: Crechem Technologies Inc., 2003

6 – EMISSION ESTIMATION EXAMPLE

6.1 – Scenario Description

48. A liquid surfactant is used to remove the ink in waste paper by flotation at a recovered paper mill. The surfactant is a long chain substance and is expected to have a low vapour pressure. It is added along with other agents to a pulping vessel where the waste paper is disintegrated in the presence of water and the ink contained in the paper is released and dispersed in the solution.

49. The surfactant enters mainly two waste streams as a result of the flotation process. The first stream is a filtration cake produced from the dewatering of the flotation ink sludge. The subsequent filtrate is discharged to an on-site wastewater treatment plant. The second stream is a wastewater stream as the sum of the filtrate and a reject that results from a clarification unit used to clarify the spent flotation liquid and is also discharged to the on-site wastewater treatment plant. The surfactant is distributed between the two streams at about 15% in the cake and 85% in the wastewater.

50. The surfactant is shipped in its pure form in 1,000 L tote bins to the mill. It is used at a rate of 2 kg/tonne and none of it is retained by the pulp after the flotation. The mill operates 350 days per year on a continuous basis and produces 50,000 tonnes of paper annually.

51. Estimate the quantity of the surfactant released daily to the on-site wastewater treatment plant.

6.2 – Solution

52. The calculation for this example will be limited to the estimation of the aqueous release of the surfactant to the on-site wastewater treatment plant to illustrate the use of the emission estimation methods described.

6.2.1 – Known Parameters

53. The known parameters given in the example are:

- Annual paper production $Q_{\text{product}} = 50,000$ tonne/yr
- Annual operation days $T_{\text{operation}} = 350$ d/yr
- Surfactant use rate $Q_{\text{agent}} = 2$ kg/tonne
- Substance fraction retained by pulp or fixation rate $F_{\text{fixation}} = 0\%$.
- Substance liquid loss $F_{\text{liquid}} = 85\%$

54. The parameters that can be readily estimated are as follows:

- No site-specific data is available for container residue. Considering the surfactant is a liquid and is shipped in 1,000 L totes (semi-bulk), on-site cleaning is assumed and the default for the fractional loss is $F_{\text{container-resid}} = 0.5\%$, as recommended by USEPA (2004).
- Concerning process residue, storage tanks and transfer pipelines are normally designated equipment for the surfactant and operate in a continuous mode. As a result, regular cleaning is not expected for this type of equipment and process residue can be reasonably assumed to be negligible, i.e., $F_{\text{process-resid}} = 0$.
- Since the surfactant is expected to have a low vapour pressure, the air emission can be assumed to be negligible, i.e., $F_{\text{air}} = 0$.
- Since the surfactant is supplied in its pure form, the active substance concentration is $C_{\text{substance}} = 100\%$.
- The surfactant is not expected to undergo chemical reactions, so the reaction loss $F_{\text{reaction}} = 0\%$.

6.2.2 – Total Chemical Agent

55. The total chemical agent refers to the total amount received in containers and is the same as the total surfactant received since the surfactant is supplied in its pure form rather than mixed with other

ingredients. This total is determined based on the paper production and the use rate of the surfactant and corrected for container and process residues.

$$Q_{total} = \frac{Q_{product} Q_{agent}}{(1 - F_{container-resid} - F_{process-resid})}$$

$$= \frac{50,000 \text{ tonne / yr} \times 2 \text{ kg / tonne}}{(1 - 0.5\% - 0)}$$

$$= 100,503 \text{ kg/yr}$$

Total amount received $Q_{total} = 100,503 \text{ kg/yr}$

6.2.3 – Container Residue

56. The daily loss from container residue to wastewater prior to on-site wastewater treatment is estimated as

$$\text{Container residue} = \frac{Q_{total} C_{substance}}{T_{operation}} F_{container-resid}$$

$$= \frac{100,503 \text{ kg / yr} \times 100\%}{350 \text{ d / yr}} \times 0.5\%$$

$$= 1.44 \text{ kg/d}$$

Container residue = 1.44 kg/d

6.2.4 – Process Residue

57. The daily loss from process residue to wastewater prior to on-site wastewater treatment is estimated as

$$\text{Process residue} = \frac{Q_{total} C_{substance}}{T_{operation}} F_{process-resid}$$

$$= \frac{100,503 \text{ kg / yr} \times 100\%}{350 \text{ d / yr}} \times 0\%$$

$$= 0 \text{ kg/d}$$

Process residue = 0 kg/d

6.2.5 – Liquid Loss

58. The liquid loss refers to the loss in the wastewater removed from the flotation cells and is estimated as

$$\begin{aligned}
 \text{Liquid loss} &= \frac{Q_{\text{total}} C_{\text{substance}}}{T_{\text{operation}}} (1 - F_{\text{container-resid}} - F_{\text{process-resid}}) F_{\text{liquid}} \\
 &= \frac{100,503 \text{ kg / yr} \times 100\%}{350 \text{ d / yr}} (1 - 0.5\% - 0\%) \times 85\% \\
 &= \frac{100,503 \text{ kg / yr} \times 100\%}{350 \text{ d / yr}} \times 99.5\% \times 85\% \\
 &= 242.86 \text{ kg/d}
 \end{aligned}$$

$$\text{Liquid loss} = 242.86 \text{ kg/d}$$

6.2.6 – Total Release

59. The total release to wastewater prior to on-site wastewater treatment is the sum of the aqueous releases from container residue, process residue and liquid loss.

$$\text{Total release to wastewater} = \text{Container residue} + \text{Process residue} + \text{Liquid loss}$$

$$= 1.44 \text{ kg/d} + 0 \text{ kg/d} + 242.86 \text{ kg/d}$$

$$= 244.30 \text{ kg/d}$$

$$\text{Total loss to wastewater} = 244.30 \text{ kg/d}$$

7 – DATA GAPS AND UNCERTAINTIES

60. Chemical use rate is considered the major area for data gaps and uncertainties. Although a range is provided for each class of chemicals, it is approximate and has not been reviewed by industry. Such a range needs to be confirmed or refined by industry (users and/or suppliers) in order to reflect typical mill operations.

61. The concentration of a substance in a chemical is generally lacking, but is not considered an issue. This is because in assessing the exposure of a given substance in a given scenario, the concentration is provided by the company that is involved with the use of the substance.

62. Data on air emissions originating from each class of chemicals is not readily available. The data depends upon not only the volatility of the ingredients in the chemicals, but also the operating conditions under which the chemicals are applied. Emission factors may be established to provide a realistic approach to the estimation of air emissions.

63. Reaction loss is important to the determination of environmental releases, but little information is available. Hydrolysis, neutralization and ionization are expected to be common to many chemicals such as biocides and the change in their chemical forms needs to be quantified.

64. Chemicals present in wasted paper (i.e., newspapers and magazines) represent a source of chemicals released to the environment in addition to those used at recovered paper mills. The content of these chemicals is dictated by both papermaking and subsequent printing. This information is not included in the current ESD and may be compiled when available.

GLOSSARY

Recovered Paper Mills – Paper mills having deinking facilities on site as the source or main source of fibre for their production.

Deflaking – In-line mechanical treatment of fibres to complete defiberizing and enhance dispersion of the fibres.

Saponification – The formation of soluble organic soaps under alkaline conditions.

Use Rate – An amount of a chemical agent used in pulp making operations per unit pulp production, usually expressed as kg/tonne of pulp.

Active Substance Concentration – Concentration of an active ingredient, usually a substance of concern, in a chemical agent, usually expressed as wt%.

Fixation Rate – Fraction of an active ingredient in a chemical agent, or a chemical agent, retained by pulp product, usually expressed as wt%.

Boil-out – Recirculation at high temperature over a period of time, usually several hours, of a caustic or acid based dispersant/surfactant solution in a specific part of a pulp or paper mill in order to dissolve or dislodge accumulations or deposits of fibre, fillers, pitch, scale, microbiological slime, or combinations thereof, which are causing throughput or quality problems in the finished product. Chelant boilouts can be performed if the deposition is mainly inorganic scale.

Digester Boil-out – Usually, a recirculation of dispersants and sequestrants to help remove calcium carbonate scale in a specific section of a digester, particularly in the upper cooking zone heat exchanger section of Kamyr digesters.

ABBREVIATIONS

CIFQ – Conseil Industriel Forestier du Québec

ESD – Emission scenario document

HAP – Hazardous air pollutants

USEPA – United States Environmental Protection Agency

OPPT – USEPA's Office of Pollution Prevention and Toxics

VOC – Volatile organic compounds

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