

Pulp and Paper Industry Voluntarily Reduces Use of Nonylphenol Ethoxylates



Case Study

The Michigan pulp and paper industry is a \$5 billion industry with 34 mills located throughout Michigan. These mills manufacture different types of paper: specialty papers, corrugated cardboard, coated recycled paperboard, coated free sheet, lightweight paper, waxed goods, newsprint, coated book and publication paper.



The Michigan Pulp and Paper Environmental Council, MPPEC, is an industry trade association that represents 17 of the Michigan mills on environmental issues affecting the industry. The MPPEC and the Michigan Department of Environmental Quality (MDEQ) are partners in the Pulp and Paper Pollution Prevention Program (P5). P5 is a voluntary partnership that promotes pollution prevention (P2) and environmental stewardship through the implementation of annual P2 goals. The P5 partners have worked diligently over the last four years to reduce their impact to the environment through the implementation of source reduction, reuse, and recycling.

As one of several goals, MPPEC mills committed to reducing the use of nonylphenol ethoxylates (NPE) in the paper manufacturing process and to minimize its discharge. The use of NPE is a concern because it biodegrades to

nonylphenol (NP) a suspect endocrine disrupter (interferes with hormone development in living organisms). In 1998 MPPEC received a grant from the Office of the Great Lakes, Michigan Great Lakes Protection Fund, to conduct an NPE pollution prevention study that included wastewater sampling and identification of alternative materials to reduce NPE in their effluent.

NPE is a common component in additives used in the papermaking process. Paper manufacturing involves the conversion of pulp to paper. A pressurized headbox discharges a jet of papermaking stock onto a moving "fourdrinier" that forms the paper fibers into a continuous matted web while draining water from the



MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
ENVIRONMENTAL ASSISTANCE DIVISION
PO BOX 30457
LANSING MI 48909-7957
www.deq.state.mi.us



Environmental Assistance Center
1-800-662-9278

December 2000 • #9835



AUTHORITY: PA 451 OF 1994 TOTAL COPIES: 1500
TOTAL COST: \$298.30 COST PER COPY: \$.198
MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY



mixture. The sheet is conveyed through a series of presses to remove additional water. The dried calendared sheet enters a series of rolls to reduce thickness and smooth the surface to yield rolls of paper.¹ Additives containing NPE are introduced into the paper machine in the form of drainage aids, felt washing additives, anti-foaming agents, retention aids, latex coating emulsifiers, and deinking aids.²

MPPEC implemented a six-tier approach to reduce NPE use in paper mills.

1. *Perform baseline NPE wastewater effluent sampling for individual mills.*
2. *Identify products used in mills that contain NPE.*
3. *Pursue NPE-free alternatives from product suppliers.*
4. *Test the NPE-free alternative products in mill operations.*
5. *Implement the use of NPE-free replacements.*
6. *Sample NPE wastewater effluent to determine whether reductions to mill effluent occurred.*

¹Smook, G.A. Second Edition Handbook for Pulp and Paper Technologies. Anus Wilde Publication Inc., Vancouver B.C.

²NPE Pollution Prevention Study, Michigan Pulp and Paper Environmental Council, June 2000. Note that this case study is a summary of the aforementioned report. For more detailed information, refer to the original report.

Baseline Effluent Sampling

Wastewater sampling of mill effluent was performed in April 1999 to determine a baseline concentration and loading to Michigan waters for NP and NPE. Table 1 shows NP and NPE concentrations for individual mills. A mill code was used in an effort to protect the confidentiality of individual mills.

TABLE I
NP/NPE Baseline Effluent Sampling
April 1999 (ug/L)

<u>Mill Code</u>	<u>NP</u>	<u>NPE</u>
A	ND<0.03	0.24
B	ND<0.03	2.51
C ^a	3.2	0.26
C ^a	2.9	ND<0.2
C ^a	2.6	ND<0.2
D	2.3	ND<0.2
E	5.4	61.4
F	3.1	162
G	1.9	105
H	2.2	86.0
I	3.1	304
J	33.3	397
K	1.8	35.7
L	2.0	ND<0.2
M	10.4	168
N	15.2	2.1
O	3.4	83.2
P	1.1	14.6
Q	111	243

^aTriplicate samples

ND = non-detectable

Identifying NPE-Containing Products

The MPPEC spent considerable time creating a database of 780 process chemicals, supplied by over 100 vendors that potentially contained NPE. Each mill inventoried the major process chemicals used at their mills. These products were generally limited to process chemicals, such as drainage aids, felt washing additives, anti-foaming agents, retention aids, latex coating emulsifiers, and deinking aids that had the potential to impact wastewater discharge of NPE. Letters were sent to suppliers requesting that they identify those products containing NPE and provide its percent concentration. Of the 780 process chemicals used by the 17 participants:

- 604 products were NPE-free.
- 60 products were identified by the vendors as containing NPE.
- 31 products were no longer sold by vendors.
- 85 products were identified as having unknown NPE content.

Finding Alternatives

The goal was to have the supplier identify products containing NPE and to request that the supplier provide the mill with equivalent products not containing NPE or reformulate the product. Ideally, the drop-in replacement would not require significant modifications to a mill's paper manufacturing process, impact paper quality, or create an economic hardship. Of the 60 products containing NPE, vendors indicated that NPE concentrations varied from less than

one percent up to six percent. Efforts focused on finding NPE-free replacements. As a unified group, mills expressed to suppliers their reluctance to continue using NPE-containing products. As a result of this combined mill effort, MPPEC was able to provide the pressure needed to influence suppliers to reformulate products where there was no currently existing NPE-free alternative.

The results for the substitution efforts for the 60 products were:

- 28 products were reformulated to NPE-free products.
- 2 products did not have the potential for wastewater discharge so were not converted.
- 6 products were no longer sold by vendors.
- 24 products could not be reformulated.

Testing Alternative Products in Production

The 28 NPE-free alternatives were tested in the participating mills. Mills had individual criteria for accepting and testing the alternatives; however, general guidelines included the technical feasibility, economic evaluation, and effects on product quality. Mills also evaluated whether the product could be eliminated altogether. Mills ran product trials using scientific methods and statistics to assess substitution feasibility. All replacements that were tested were successful in maintaining paper quality. None of the substitutes had an adverse effect on the manufacturing process during testing.

Implementing Alternatives

Testing demonstrated that the 28 NPE-free alternatives could be implemented on a widespread basis. Mill experiments determined that the alternatives were drop-in replacements to their predecessors and did not significantly impact the papermaking process. Inventories of the remaining NPE-containing products were identified and removed from circulation.

There were 24 NPE-containing products suppliers did not substitute because testing showed that the products did not meet the material performance specifications. These products continue to be used in four mills and are applied primarily as coatings. These individual mills, however, are committed to working with their suppliers to find adequate NPE-free replacements.

TABLE 2

**Comparison of April 1999 and January 2000
Effluent Concentrations for NPE and NP (ug/L)**

MILL CODE	NP April 1999	NP January 2000	NPE April 1999	NPE January 2000
A	ND < 0.03	0.8	0.24	ND ^b 2.0
B	ND < 0.3	ND < 0.3	2.51	2.0
C ^a	3.2	1.3	0.26	ND ^b 2.0
C ^a	2.9	1.1	ND < 0.2	ND ^b 2.0
C ^a	2.6	0.71	ND < 0.2	ND ^b 2.0
D	2.3	1.5	ND < 0.2	ND ^b 2.0
E ^c	5.4	3.5	61.4	350
F ^c	3.1	1.4	162	230
G	1.9	1.4	105	15
H	2.2	3.7	86	38
I	3.1	2.1	304	210
J ^c	33.3	10	397	1200
K	1.8	2.3	35.7	24
L	2.0	0.8	ND < 0.2	ND ^b 2.0
M	10.4	8.5	168	15
N	15.2	4.8	2.1	ND ^b 2.0
O	3.4	13	83.2	19
P	1.1	1.0	14.6	ND ^b 2.0
Q ^c	111	76.8	243	360

^aTriplicate samples.

^bNote: Non-detectable (ND) changes from <0.2 ug/L in the April sampling to 2.0 ug/L in the January sampling due to an analytical process change to reduce column plugging resulting in a ten-fold loss of sensitivity.

^cMills that did not have successful product substitution trials by the January 2000 sampling date.

Performing Second Round of Effluent Sampling: NPE Reductions

Once substitutes were implemented where feasible, a second round of wastewater sampling was performed on the effluent of each mill. The results for NPE and NP wastewater effluent concentrations are shown in Table 2. Both the baseline samples and the samples collected after the substitutions are shown to aid in the comparison. All mills showed a decrease in NPE concentration in their effluent, with the exception of the four mills that were unable to find product substitutions. Three mills had small increases in NP concentrations. Mill concentration variation for NP and NPE is a function of NPE/NP material use, the volume of daily wastewater discharged, as well as the mill production volume. Dark shaded areas denote concentration increase(s).

Sampling Results

Thirteen of the seventeen mills demonstrated reductions or tested as non-detect for their NPE concentration. Loading of NPE into Michigan waters decreased from 11.7 lb NPE/day in April 1999 to 8.2 lb NPE/day in January 2000. Four mills were excluded in the loading calculation as their effluent was discharged from the mills' primary clarifiers to the local municipal treatment facilities for additional treatment and not directly to state waters. (These are not necessarily the same four mills that were unable to find adequate NPE alternatives.)

Statistical analysis between the loading trends was performed to determine the "levels of significance" for the decreases observed between the two sample dates. Levels of significance reported for test results indicate the probability that the reduction observed between the samples could have occurred by chance alone. In order for a change in concentration or loading to be considered statistically significant, a p-value must be less than 0.050.

NPE Reductions

Statistically significant reductions occurred in the NPE loading using data *from mills only where product substitutions were successfully implemented*; the p-value was 0.009. However, there was no statistical difference in NPE loading between the April 1999 and January 2000 samples collected *from all mills* (p-value was 0.139.) As a consequence, although reductions were seen at most mills, the decrease in NPE loading was not *statistically* relevant for the aggregate of all mills.

NP Reductions

Statistically significant reductions occurred in loading of NP between April 1999 and January 2000 *for all mills* participating in the study (p=0.036). However there was no statistical difference in NP loading for *all mills except the four that were not successful in finding alternative NPE-free products*; the p-value was 0.117.

Project Benefits

The MPPEC voluntary project to reduce NPE use in paper manufacturing processes was successful in demonstrating that a joint industry effort can result in source reduction; statistically significant NPE reductions were achieved by mills that made substitutions. The process of identifying and removing NPE from production and working with suppliers to find acceptable alternatives was effective. Chemical suppliers, at MPPEC's request, were able to provide existing

or reformulate 28 NPE-free products. Thirteen mills have ceased using NPE-containing additives and have pledged to discontinue purchasing materials containing NPE in the future. In cases where alternatives were not available, mills continue to work with their suppliers on an individual basis to encourage further reformulation of the remaining NPE-containing additives.



The Michigan Department of Environmental Quality (MDEQ) will not discriminate against any individual or group on the basis of race, sex, religion, age, national origin, color, marital status, disability, or political beliefs. Questions or concerns should be directed to the MDEQ Office of Personnel Services, PO Box 30473, Lansing, MI 48909.