

How to Select Permit Conditions That Ensure Maximum Operational Flexibility: A Case Study at a Cardboard Manufacturing Site

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ABSTRACT

The identification and acquisition of flexible permit conditions has been essential to the successful operation and compliance status of a cardboard manufacturing site in Los Angeles. In 1999, the owner was cited for exceeding the volatile organic compound (VOC) emission limits on two stationary sources by the California Air Quality Management District (CAQMD). A notice of violation (NOV) was issued and prompted a review and detailed evaluation of the old permit conditions. The original permits had extremely rigid permit conditions that allowed little operational flexibility. In addition, the owner's production rates, as well as the number of permitted sources, had slowly increased from 1996 to 1999. The previous permits and permit conditions were unable to accommodate this growth. The cardboard manufacturer needed broad operational flexibility on a daily basis for six manufacturing lines because of fluctuations in customer orders and the marketplace.

CH2M HILL developed emission estimates for toxics (such as formaldehyde) and VOCs and developed daily and annual emission limits in conjunction with CAQMD. CH2M HILL also suggested pollution prevention (P2) methods to the owner that included testing of ultra-low VOC adhesives and coatings. A successful P2 strategy was tracking emissions on a daily basis and altering production schedules if emissions approached any daily emission limit. As a result of these successful P2 measures, the cardboard manufacturer reduced its emissions from 5.9 tons per year (tpy) to 1.4 tpy and maintained compliance with their permit conditions for more than 3 years. Another benefit of these P2 strategies is remaining below the Title V threshold of 8 tpy and avoid this type of permit entirely.

INTRODUCTION

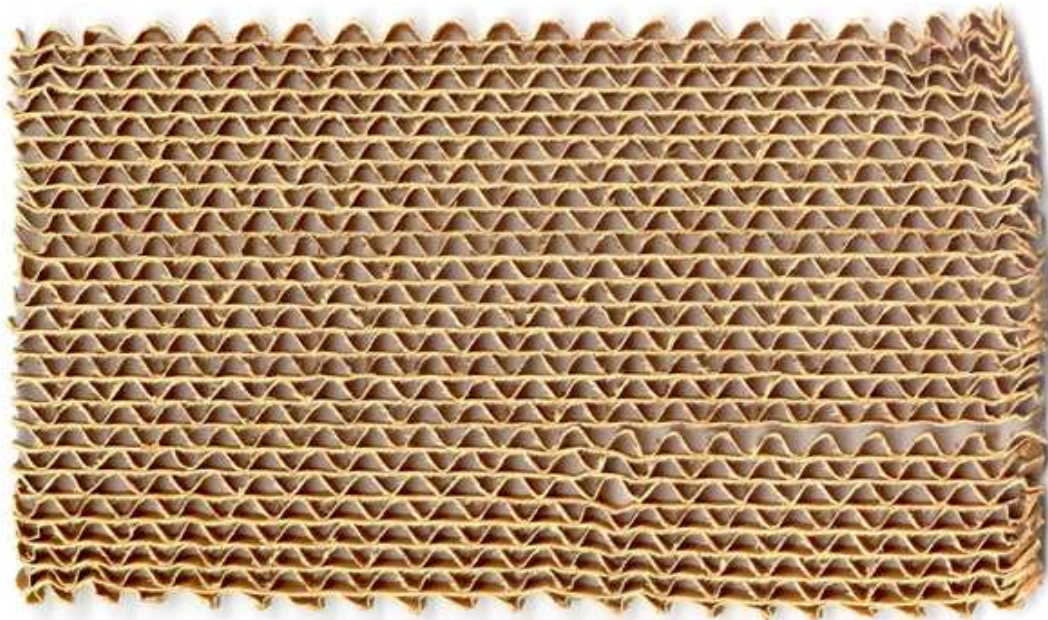
The cardboard manufacturer makes honeycomb core and honeycomb panels that are kraft paper-based products used for consumer product protection, structural applications, and original design packaging for a wide range of products and markets. Honeycomb core is produced by extruding glue in thin lines onto virgin kraft paper (see Photograph 1),

cutting the paper into cells, and pressing the cells together to form honeycomb or vertical (see Photograph 2). Honeycomb panels are produced when glue and kraft paper are applied to one or both faces of honeycomb core.

Photograph 1. Extrusion of Glue in Thin Lines onto Kraft Paper



Photograph 2. Vertical



This cardboard manufacturer uses large quantities of water-based adhesives, typically several hundred gallons per day on the continuous core machines, vertical machine, and panel lines. The adhesives that are currently used contain less than 10 grams per liter (g/L) of VOCs and are considered to be ultra-low VOC glues. In addition, the manufacturer has a process where impregnated core is baked and then formed into honeycomb. This process produces formaldehyde emissions from the heating of a phenolic resin.

PROJECT DISCUSSION

Original Permits

CAQMD issued two permits for this facility for a honeycomb paper core manufacturing line and a paper-impregnating and curing system in 1990. These were the original permits from when the manufacturer first occupied the facility. The permit conditions contained the following strict provisions:

- *Total quantity of adhesives used in this equipment shall not exceed 50 gallons in any one day.*
- *The adhesives used in this equipment shall not contain more than 5 grams per liter by weight of volatile organic compounds (VOCs) and shall not contain any formaldehyde.*
- *The quantity of resin used in this equipment shall not exceed 110 gallons in any one day.*
- *The resin used in this equipment shall not contain more than 4.5% by weight of volatile organic compounds (VOC) and 1% by weight of formaldehyde.*

When manufacturing operations first began, these conditions were adequate. However, the company grew in size and revenues over time to where these permit conditions no longer were acceptable.

Changes in Production

The annual emissions inventory report that is submitted to CAQMD is an excellent source of historical data. Table 1 is a compilation of emissions data from 1996 to the present for the manufacturer:

Table 1. Glue and Phenolic Resin Usage Between 1996-2002.

Reporting Period	Actual Emissions (tons per year)	Glue Usage (gallons per year)	Average Daily Glue Usage (gallons per day)	Phenolic Resin Usage (gallons per year)	Average Daily Phenolic Resin Usage (gallons per day)
01/02	1.4	135,942	372	14,188	39
00/01	0.9	136,463	374	18,286	50
99/00	2.0	213,882	586	7,392	20
98/99	5.9	194,932	534	14,380	39
97/98	4.9	162,643	446	9,784	27
96/97	3.7	140,093	384	14,391	38
Daily Limit	-	-	50	-	110

In hindsight, it is clear that the daily glue usage limit (50 gallons/day) on the permits had become incompatible with the daily operational needs and production rates of the facility by 1996. The phenolic resin limit (110 gallons per day) was adequate. Production crept up slowly as market conditions changed and the manufacturer captured a larger portion of the marketshare.

The cardboard manufacturer began working with CH2M HILL in 1999 to develop new permit conditions that met the following criteria:

- Facilitywide limits were needed instead of a limit on each manufacturing line to interchange production schedules and customer orders as needed.
- The facility must be able to use different vendors and glue formulations to meet product performance and price requirements as its business and client needs change.
- Installing expensive control equipment was not feasible.
- The facility personnel were willing to track daily usage in more detail than required by CAQMD, if this would help with scheduling specific manufacturing activities.
- The facility agreed to reanalyze its resins and impregnated core using modern equipment and analytical methods to get more accurate VOC and formaldehyde contents in the event that the previous data and assumptions were poor.
- The cessation of the impregnated core operations was an option if formaldehyde emissions cause problems with the health risk assessment required under Rule 1401.¹

- CAQMD needed to recognize that the material safety data sheet (MSDS) provided by vendors contained VOC content information and that this is an acceptable source of data.

CH2M HILL worked within these criteria and constraints to suggest new permit conditions to CAQMD and obtain approval.

Agency File Search

The first thing that CH2M HILL did was to obtain the emission calculations and basis of the original permit conditions from the CAQMD's files. One of the important findings from this review was that the calculated facility emission rate was 55 pounds of VOC per day. This number was the new source review (NSR) balance for the facility and a critical starting point for negotiations with agency personnel.

Regarding the formaldehyde emissions in the impregnated core, the starting assumptions were 110 gallons per day usage of resin with a formaldehyde content of 1 percent for a total annual emission rate of 4,000 pounds per year of formaldehyde. It quickly became obvious that this was a rough order-of-magnitude (ROM) estimate of the formaldehyde content, and no quantitative data had been collected previously.

Analytical Testing

The cardboard manufacturer and CH2M HILL initiated a round of testing of its low-VOC glues, which is summarized in a previous work.² Overall, it was determined that EPA Method 24 was unsuitable to measure the VOC content of glues below 50 g/L. The results lacked both accuracy and precision and were unreliable. Based on this finding, CH2M HILL obtained an important concession from CAQMD – the VOC content from the manufacturer's MSDS was acceptable and would be used instead of unreliable laboratory data.

A second round of analytical testing then occurred on the impregnated core before and after baking in the oven. Two samples with a core thickness of 1-inch and 0.5-inch were analyzed according to EPA Method 8315:

Analyte	Concentration in 1-inch Core (mg/kg)	Concentration in 0.5-inch Core (mg/kg)
Formaldehyde	170	190
Phenol	2,000	1,300

These values were two orders of magnitude lower than the 1 percent (or 10,000 milligrams per kilogram [mg/kg]) concentration of formaldehyde used in the original permitting effort.

New Permit Conditions

Based on these new data and the operational requirements of the facility, CH2M HILL proposed the following permit conditions and was successful in gaining concurrence from CAQMD³:

- Daily VOC emission limit of 52 pounds per day for all six manufacturing lines
- Annual formaldehyde emission limit of 1,900 pounds per year
- Daily recordkeeping

CH2M HILL also was successful in determining with CAQMD that the ultra-low VOC adhesives being used were less than 55 g/L and, hence, qualified as best available control technology (BACT). The manufacturer was able to avoid installation of any afterburners as a result of this determination.

Daily Emissions Tracking Tool

CH2M HILL developed a Microsoft® Excel spreadsheet to track the usage of all materials at the site on a daily basis. This enabled the facility personnel to make real-time decisions about production runs and rates and the resulting emissions.

The first worksheet in the spreadsheet is the material information that includes the following data on 17 different materials:

- VOC content calculated from constituent information and density (grams/liter)
- VOC content (pounds/gallon)
- VOC content (percent by weight)
- VOC fraction
- Formaldehyde fraction
- Density (pounds per gallon)

The subsequent worksheets in the tool allow for input of daily usage of each material by facility personnel. Table 2 is an abbreviated version of the recordkeeping form from July 2002 that shows the data entry fields and the daily permit limit of 52 pounds per day.

Table 2. Daily Recordkeeping Form.

Material Name	Glue A	Glue B	Glue C	Glue D	Impregnated Core		
Day of Month	Quantity Used (Gal)	Quantity Used (lb)	Quantity Used (Gal)	Quantity Used (Gal)	Quantity Processed (lb)	Total Daily Emissions (lb)	Exceeds 52 lb/day?
1	0	0	0	0	0	0.0	NO
2	651	342	34	0	0	16.7	NO
3	589	193	9	0	4854	18.0	NO
...							
							...
30	558	0	14	0	0	6.9	NO
31	577	0	14	0	0	7.0	NO
TOTALS	10171	1876	320	0	9881	184	0

P2 Efforts

The cardboard manufacturer has tested a variety of glues over the last several years to identify the suppliers that meet all of their requirements. Glues are typically evaluated for the following:

- Cost
- VOC content (g/L)
- Drying time
- Tensile strength
- Durability
- Temperature performance

The facility has evaluated over 20 glues and coatings from three vendors since 1999. Annual emissions of VOCs have dropped from 5.9 to 1.4 tpy, while production levels remain fairly constant.

A comparison of VOC emissions versus annual production (paper usage) rates clearly shows this trend as shown in Table 3. VOC emissions have dropped by approximately two-thirds since 1999 even when production variations are taken into account. This

clearly demonstrates the success of the P2 program at the facility and how a concerted effort can produce measurable and quantifiable results.

Table 3. VOC Emissions as a Proportion of Paper Usage.

Year	Paper Usage (tons)	VOC Emissions (tons)	Ration of VOC Emission to Paper Used
1999	8,342	5.9	0.071%
2000	6,602	2.0	0.030%
2001	5,480	0.9	0.016%
2002	6,050	1.4	0.023%

CONCLUSIONS

The cardboard manufacturer has in place permit conditions with sufficient flexibility to allow for future growth of its operations and variation in their day-to-day manufacturing. The facility remains well below Title V thresholds and has successfully reduced its VOC emissions by successfully implementing various P2 strategies.

ACKNOWLEDGEMENTS

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REFERENCES

¹ South Coast Air Quality Management District. Rule 1401 - New Source Review of Toxic Air Contaminants. May 3, 2002.

² Schwerdtfeger, Christina J. and James McHenry. "The Permitting and Regulatory Nightmares of Using EPA Method 24 To Determine the VOC Content of Water-Based Coatings and Adhesives." *Proceedings of the 93rd Annual Conference and Exhibition of the Air & Waste Management Association*. June 2000.

³ Telephone conversations and correspondence with Mr. Ravi Bahtia at South Coast Air Quality Management District (SCAQMD) between June 1999 and January 2000.

Key Words:

Volatile Organic Compounds

Permitting

P2

Emission Reductions

Agency Negotiations