



CLEANING UP:

TAKING MERCURY-FREE CHLORINE
PRODUCTION TO THE BANK

[**STOP**
SEAFOOD
CONTAMINATION]



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EXECUTIVE SUMMARY

“Chlorine production is currently among the major industrial sources of mercury releases to the environment.”

Of the serious environmental challenges posed by the industrial age, few lend themselves to clear, achievable solutions quite the way that mercury pollution in the chlorine industry does. In 1894, the industry discovered the unique qualities of mercury for creating an electrolytic cell to split salt molecules, revolutionizing the production of chlorine around the same time internal combustion engines were first invented. As revolutionary as it may have been, it is not revolutionary anymore. Depending on mercury to make chlorine is like depending on the Model-T for modern commerce. Inefficient, to say the least.

Because of this archaic technology, chlorine production is currently among the major industrial sources of mercury releases to the environment. Two other approaches that do not use mercury have been widely adopted. Yet many companies still rely on this 110-year-old process, even though it creates numerous tons of mercury wastes with associated disposal and cleanup problems, pumps up corporate electric bills unnecessarily, and in some cases turns neighboring communities against the companies. Today in the United States, five mercury-cell chlorine plants continue to rely upon this technology, releasing tons of mercury unnecessarily. We call them the “Filthy Five.”

Conversely, more than one hundred facilities just like these five mercury-cell chlorine plants waded through the industrial inertia and converted to better technologies. These plants began putting mercury and its associated challenges behind them as early as 1974. In doing so, they likely saved themselves millions of dollars in costs for fines, upgrades, cleanups, and other expenses that dogged their competitors.

In the seventies, technology using a diaphragm to create the electrolytic cell came into vogue, though it too had been invented in the previous century. Many plants switched to diaphragm-cell technology, while others did not. Around the same time, an even better method using membrane-cell electrolysis was being developed, increasing efficiency and still allowing the production of chlorine and caustic soda without the use or release of mercury. Many facilities soon began to shift to membrane-cell technology, as is shown in this report. In fact, some that had already undergone a shift to diaphragm technology saw the benefits of membranes and shifted a second time. Other facilities, however, sat out even this second revolution, sticking with mercury in spite of its associated costs.

Globally, the chlorine industry had largely moved to mercury-free technology by the turn of the 21st century. In the United States, the industry reported that by 2004, 90 percent of its chlorine was produced using mercury-free technology and no new mercury-cell plant has been built since 1970. Oceana’s Campaign to Stop Seafood Contamination targets the plants responsible for the remaining 10 percent.



This report details the successes of companies that have shifted and compares their successes to the lagging facilities in the United States that have remained in the 1894 technological rut. For each plant, Oceana looks at the likely costs of its mercury use and the financial benefits of moving away from mercury. We also tackle some of the prevailing arguments for not shifting – arguments that have been challenged by at least 115 similar facilities around the world. Compiling all of this history in one place clearly shows that the remaining mercury-cell plants are causing a major mercury problem with a clear, achievable solution that should be immediately implemented to benefit the environment and public health.



[KEY FINDINGS]

- If the Filthy Five eliminate mercury use in chlorine production, nearly 4,400 pounds of reported mercury releases would be eliminated every year. This does not include mercury that is “lost” and not monitored at the plants.
- At least 115 plants around the world have shifted or plan to shift to mercury-free technology since 1974. At least thirty-six of those plants shifted to diaphragm technology first and then upgraded to membrane-cell technology a short time later.
- Plants that have shifted to membrane-cell technology generally have achieved increases in energy efficiency between 25 and 37 percent per ton of chlorine produced. Since electricity can make up as much as half of total production costs, increasing efficiency can vastly improve a plant’s profitability.
- Assuming a 25 percent increase in energy efficiency, if each of the Filthy Five converted, their total savings from energy efficiency could amount to \$98.6 million over five years.
- Improved energy efficiency would also reduce greenhouse gas emissions. If the Filthy Five were to switch to mercury-free membrane-cell technology, the corresponding decrease in energy consumption would save enough electricity to power 40,200 average homes.
- Since membrane cells are smaller than mercury cells, allowing more cells to operate in a given space, many plants choose to increase their capacity when they shift. Increases on the order of 25 percent are common. If just four of the “Filthy Five” plants made such a change, their collective sales would increase by more than \$302 million over five years and they would save nearly another \$14.6 million due to the increased energy efficiency over five years. Expansion of the largest plant, Olin’s Tennessee plant, is not assumed in this estimate.
- There is no need to use mercury to create “mercury-grade,” also called “rayon-grade,” caustic soda, despite industry arguments. Rayon manufacturing at plants in India clearly shows that membrane-grade caustic can be used effectively. In addition, rayon textiles have not been manufactured in the United States for nearly a decade.
- Many household products made using chlorine or caustic soda contain traces of mercury. These include toothpaste, soap, shampoo, bleach and even soft drinks. When mercury is used to make caustic soda it is often found as a contaminant in the final product, and this may be the source of some of the residues.

Based on these findings, two conclusions become apparent. First, it is clear that shifting to membrane-cell technology is both achievable and affordable, and second, that it is a necessary step to stop mercury releases and protect public health and the environment.

OLIN CORPORATION

Charleston, Tennessee

The Olin Corporation generates a considerable amount of mercury pollution from the two mercury-cell chlor-alkali plants it continues to operate. In 2005, Olin's Charleston, Tennessee plant reported emitting 1,250 pounds of mercury into the air, making it the number one mercury air polluter in the state.¹⁰¹

Additionally, this plant reported emitting nearly three times more mercury into the air than Tennessee's top mercury-emitting coal-fired power plant in 2005.¹⁰²

PROJECTED COST OF SWITCHING

With an estimated capacity of 270,000 tons of chlorine per year,¹⁰³ Olin's Tennessee facility is more than twice the size of its Georgia facility and is the largest plant considered in this report. To compare Olin's facility to one that has already switched, it is necessary to identify a larger-than-average plant that has switched to membrane-cell technology.

PPG Industries' chlor-alkali facility in Lake Charles, Louisiana, has a similar capacity to Olin's Tennessee plant and thus serves as the best example for comparison, as it has nearly finished converting from a mercury-cell process to membrane-cell technology. The Louisiana plant has a capacity of 275,000 tons of chlorine per year, making it just slightly larger than Olin's plant.¹⁰⁴ The upgrade to mercury-free membrane-cell technology should be completed by mid-2007 and was projected to cost \$90 million in 2005. It is reasonable to expect a conversion at Olin's Tennessee plant to fall in the same range. Adjusting for inflation puts the cost to convert Olin's Tennessee plant at about \$112 million in 2006 dollars.¹⁰⁵

To get another perspective, the EPA estimates that switching from mercury-cell to membrane-cell technology would cost between \$100,000 and \$200,000 per ton of chlorine produced per day.¹⁰⁶ Adjusting for inflation, the conversion of a facility of Olin's size would be expected to cost between \$117.8 million and \$235.7 million in 2006 dollars.¹⁰⁷ The estimate for converting based on the PPG experience suggests that the true cost would be near the low end of this range. The EPA formula is expected to be more accurate for an average sized plant than for an extremely large plant due to the economies of scale realized during a conversion. Combining the PPG experience and the EPA estimate, it appears that \$117.8 million is a reasonable cost estimate for Olin's Tennessee plant.





While \$117.8 million is no small amount, the costs of mercury use and the benefits of switching help to put it in perspective, as discussed below.

COSTS OF NOT SWITCHING

Using mercury has considerable downsides for companies. Here we look back at costs that Olin's Tennessee Plant has incurred in the past due to mercury use. If Olin had switched to mercury-free technology, these costs would have been avoided. Since these costs rival the cost of switching itself, they raise the question of whether sticking with mercury has been a good business decision for Olin. They also argue for switching now, since it is possible that additional costs along these lines could come into play in the future.

Penalties for Violations

Olin's mercury-cell chlor-alkali plant in Tennessee has certainly had its share of fines and required environmental

upgrades. In 1988, mercury was spilled at the plant while a pipe was being replaced, and in 1994, six years after the incident, the company paid a \$1 million fine to "avoid a lengthy and costly trial."¹⁰⁸ This amount is equal to about \$1.36 million in 2006 dollars.

Then in 2004, a worker used duct tape to seal a canister of hazardous waste: a violation of the Tennessee Hazardous Waste Management Act and one of Olin's eight violations of the Act since 2001. Additionally, the plant had two mercury-related violations in 2003 concerning its storm water discharges, forcing Olin to spend \$120,000 to upgrade its storm water system.¹⁰⁹ This amount is equal to about \$170,000 in 2006 dollars.

Pollution Control Costs

Olin has had a troubled legacy with mercury pollution from chlor-alkali production, which continues to this day. The company testified in 1970 that it had spent more than

\$200,000 in six months to reduce mercury discharges into the Niagara River from its Niagara Falls, New York, mercury-cell chlor-alkali plant, and that the company planned on spending more than \$1.4 million over the remainder of the year to complete the job.¹¹⁰ Then in 1979, Olin was charged \$70,000 for falsifying documents pertaining to releasing mercury into the Niagara River from the same plant.¹¹¹ While these costs from the Niagara Falls plant are not included in our tally, costs may have been mounting from mercury use at Olin's Tennessee facility for decades. In 1990, Olin's Niagara Falls facility stopped using mercury in favor of mercury-free technology.

Despite previously installed mercury controls, the EPA issued a new rule in 2003 requiring a reduction of mercury air emissions by 2007.¹¹² According to the plant manager in Charleston, the company has already spent \$54 million over the past eight years on additional

technology for personnel and environmental safety programs.¹¹³ This included \$2.6 million in additional emissions control equipment. Even with the added upgrades, the company still expects to be emitting 1,084 pounds of mercury into the air annually in 2008.¹¹⁴ Olin will most likely retain its position as the number one mercury emitter in the state in spite of these and other investments.¹¹⁵

Even though some mercury air pollution will be prevented, carbon-based systems trap mercury in a filter, which then may be relocated into a landfill or recycled, at a greater cost to the company. While capturing mercury is better than allowing it to simply vent into the air, mercury may still escape from these filters by either evaporating after disposal in landfills or through spills which may allow mercury to leach into the environment. The mercury does not simply go away.

Hazardous Waste Treatment and Disposal

In 1992, EPA banned disposal of mercury-laden hazardous waste in regular landfills. Olin spent \$4.5 million (\$8 million in 2006 dollars) at its Charleston plant to build a mercury recovery unit to comply with the EPA ruling.¹¹⁶ In 2005, Olin's Tennessee reprocessing facility treated more than 31,000 pounds of mercury-laden waste, which included some waste from Olin's Augusta, Georgia mercury-cell chlor-alkali plant.¹¹⁷

Hydrogen Filtration

Although all plants treat and cool their hydrogen to remove as much mercury as possible, still nearly one percent of their total air mercury emissions come from the cleaned hydrogen that escapes. As a result, Olin plans to install additional filters to remove more mercury from hydrogen escaping the plant.¹¹⁸ Hydrogen filtration and the resulting mercury waste management costs can be completely avoided by switching to mercury-free technology. Plants in Europe have been known to spend nearly \$500,000¹¹⁹ on systems to treat hydrogen, as filters in these carbon-based systems need to be replaced every two to three years.¹²⁰

Summary of Costs

The continued use of mercury has required that Olin spend more than \$64.2 million (2006 dollars) in treatment systems, fines, and other mercury-related costs in Tennessee. This includes costs described above in 2006 dollars, including the fine (\$1.36 million), upgrades to manage mercury releases (\$54 million), the wastewater upgrade (\$170,000), hazardous material management (\$8 million), and hydrogen filtration (\$707,000).¹²¹ Other costs not included in this estimate include those related to legal and consulting fees, mercury permitting, and purchasing mercury. Despite having spent millions of dollars on control technology, the plant still reports emitting over 1,250 pounds of mercury pollution into the air annually and workers are tested weekly for high mercury levels. With each passing year, Olin will have to spend even more to control mercury pollution, while that \$64 million would have gone a long way toward paying for

the conversion to mercury-free technology. Switching would also provide substantial financial benefits to the company, not to mention to the environment and public health.

BENEFITS OF SWITCHING

Based on comparisons with the companies that have switched, Olin could achieve considerable financial



benefits at its Tennessee plant. These include increased energy efficiency, increased capacity, and decreased wastewater treatment costs.

[✓] Energy Savings

Electricity is considered a raw material in the chlor-alkali industry and in some cases represents up to half of a plant's total operating costs.¹²² For instance, given Olin's estimated size, the plant consumes the amount of

electricity¹²³ needed to power more than 66,100 average homes annually¹²⁴ – more homes than one will find in Clarksville, Tennessee.¹²⁵ Conversely, converting plants results in great gains in energy efficiency. For instance, PPG's Lake Charles, Louisiana facility expects to use 25 percent less electricity while producing the same

amount of chlorine and caustic soda.¹²⁶ If Olin were to reduce its electricity consumption by a similar percentage, it would save enough electricity to power 16,525 average homes. It could be estimated that such a decrease in electricity consumption would save the company nearly \$8 million annually or nearly \$40 million over five years.

[✓] Increased Capacity

Although newer technology allows increased capacity of chlor-alkali

products, Olin may opt not to increase capacity in this facility due to its large size. However, even increasing capacity at the Tennessee facility by a mere 10

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percent (when 25 to 30 percent increases in capacity are fairly regular) would provide quite a boost of chlor-alkali products in the market due to the plant's large size. Olin has been known to increase capacity by large quantities in the past, despite market conditions being less than favorable.¹²⁷ By

capitalizing on energy savings, and possibly opting to increase capacity, switching to membrane-cell technology could prove to be quite profitable. If Olin were to increase capacity by even 10 percent, the company could increase sales by nearly \$17 million annually (or \$85 million over five years.) Even better, because the manufacturing process would be more efficient, Olin would earn \$800,000 in extra profit each year (\$4 million over five years) due to saved electricity costs.

[✓] Eliminating Mercury Waste Management Costs

Olin spent \$4.5 million to build a waste treatment facility at its Tennessee plant where mercury-laden hazardous waste is reprocessed,¹²⁸ while switching to mercury-free technology could have reduced hazardous waste by 94.5 percent, as demonstrated by OxyChem's Mobile, Alabama plant which converted in 1991.¹²⁹ By eliminating future mercury waste, Olin could be saving many thousands of dollars in operation and maintenance costs related to the operation of its reprocessing facility.

[✓] Eliminating Mercury Monitoring and Maintenance

Despite Olin's best efforts to reduce mercury emissions, mercury still escapes from equipment and poses a threat not only to the environment, but also to the workers. While maintaining mercury cells properly can reduce releases, plants still need to monitor mercury levels in various media. This includes testing workers,¹³⁰ sometimes weekly.¹³¹ A European study estimates that a plant less than half the size of Olin's could be spending €300,000 annually in costs associated with mercury monitoring and maintenance.¹³² Because of the size of Olin's Tennessee plant, the European estimate should be increased by about 25 percent,¹³³ which would lead to the equivalent of spending about \$469,000¹³⁴ in 2006 dollars annually.¹³⁵

[✓] Eliminating Wastewater Treatment for Mercury

Besides emitting mercury into the air, mercury-cell chlorine plants generally also discharge the chemical into nearby waterways.¹³⁶ One of the Filthy Five, Ashta Chemicals, was required to invest in additional controls at a considerable cost. Ashta developed new technology to remove mercury from its wastewater in 1993 at a cost of \$10 million;¹³⁷ however, even this technology did not eliminate all of the mercury in the plant's wastewater, Ashta continued to discharge five pounds of mercury into Lake Erie in 1995 and 1996.¹³⁸ By 2004, the company had spent another \$6.9 million

to install additional wastewater treatment systems to eliminate its mercury releases.¹³⁹ If Olin had to completely eliminate mercury in its wastewater



discharge, it could expect a costly process similar to that of Ashta. This possible cost has not been included in the final tally.

Another way to estimate the costs of wastewater treatment is to use a European study. The study estimates that a plant could spend between €2 and €3 per metric ton of capacity per year for wastewater treatment associated with mercury contamination. For a plant of Olin's size, this would be the equivalent of spending between \$651,000 and \$977,000¹⁴⁰ annually on wastewater treatment in 2006 dollars. Over five years, this would add up to \$3.3 to \$4.9 million.

wastewater treatment costs. If the company chose to increase capacity along with the conversion, as many companies do, there would be an additional \$4 million in savings due to the increased energy efficiency and a projected increase of \$85 million in sales over five years based on just a 10 percent capacity increase. These benefits, when added to the prior costs of using mercury, nearly equal the cost to convert, without even considering the potential benefits of additional capacity. This suggests that conversion to membrane-cell technology would be good for this company, in addition to being good for the environment.

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FINAL TALLY

If Olin had converted its Tennessee facility to mercury-free technology in 1988, the company could have prevented over \$64 million in costs related to mercury according to the analysis above. Worse yet, many of these costs will continue to accrue. By keeping ahead of the regulations and switching to mercury-free technology, Olin could avoid costly endeavors that may never pay for themselves, while at the same time reducing energy consumption and possibly increasing capacity.

Over five years, shifting to the membrane-cell process could save the company about \$40 million in electricity costs, \$2.3 million from eliminating monitoring and maintenance costs associated with mercury use, and between \$3.3 million and \$4.9 million in estimated

	Cost to Switch:	\$117.8 million
	Costs of Using Mercury	\$64.2 million
	Benefits (Over 5 years)	
	Energy Savings	\$40 million
	Monitoring	\$2.3 million
	Wastewater Treatment	\$3.3 to 4.9 million
	Capacity Increase (Over 5 years)	
	Sales	\$84.9 million
	Energy Savings	\$4 million

Note: Capacity increase estimates for Olin, TN assume a 10 percent increase in capacity.

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