

Solvent Recovery and Recycling Case Study

ChemGenes Corporation, Wilmington, Massachusetts

Toxics Use Reduction Leader

ChemGenes has a long history with Toxics Use Reduction (TUR). Working with the Office of Technical Assistance (OTA) since 2005, the company has reduced its use of chloroform by 55 percent and hexane by 35 percent, resulting in a net savings of \$215,000. Then, in 2012, the Toxics Use Reduction Institute (TURI) at UMass Lowell awarded ChemGenes an incentive grant to help offset capital costs for a new solvent recovery and recycling system. The facility collected data, presented in this case study, from May through August 2013 of each batch run with the new system. In the long-term, ChemGenes expects to reduce the use of Hexane and Ethyl Acetate by 27,000 pounds, or 70 percent annually. Factoring in the TURI grant, ChemGenes estimates a return on investment in less than two years.

Challenge

ChemGenes Corporation is an ISO 9001:2008 certified company with 25 employees and a 20,000-square foot manufacturing facility located in Wilmington, MA. Geared towards small to mid-scale chemical manufacturing, ChemGenes supplies products for the biotechnology industry, specifically raw materials or building blocks for DNA/RNA manufacturing which are widely used in academic research, diagnostics and pharmaceutical companies worldwide. The core product line is nucleoside phosphoramidites, which must be produced to strict standards of purity so that the process of constructing a customized sequence of DNA or RNA is of the highest possible quality. The process is such that crystallization or precipitation of the final product is not possible and therefore column chromatography must be employed to meet the stringent purity requirements. Unfortunately, column chromatography utilizes significantly more solvent compared with crystallization or precipitation. Therefore, ChemGenes has focused its toxics use reduction efforts on reducing toxic solvent consumption.

Solution: Recovering and Recycling Solvents

Continuing on the success of past solvent reduction projects, ChemGenes next focused on solvent recycling. The first attempt involved the use of a 100L distillation plant designed to separate the solvent by-product to allow reuse of the solvent. However, the instrument operation was labor intensive, resulting in the determination that it was not cost effective. OTA recommended that ChemGenes consider a fully automated fractional distillation solvent recycling system manufactured by CBG Biotech (Columbus, OH).

The TechnoClean F-2500 was determined to be the right fit based on the current batch size for the mid to large scale manufacturing process. It has a 25-gallon auto fill tank and is a fully automated programmable system with easy drain capabilities. ChemGenes worked with CBG to qualify the instrument by testing solvent by-product collected from the process, and found the quality of solvent recovered to exceed required specifications for reuse in the process. However, the upfront capital cost of equipment and training was high enough that the project did not receive management approval to move forward. The original distillation plant required a fair amount of labor to operate. The costs were too high compared to buying fresh solvent.

ChemGenes needed a financial boost to help them justify investing the upfront capital of approximately \$26,000 to cover equipment costs associated with this solvent recovery project. The Toxic Use Reduction Institute (TURI) industry incentive grant of \$15,000 was a perfect opportunity to move the project forward, and in 2012, ChemGenes was awarded the grant.



TechnoClean F-2500 Solvent Recycler

Results: Reducing Toxics Use, Saving Money

Solvent Use Reduction

In the spring of 2013, the CBG fractional distillation system was installed. It has been in full operation since May of 2013 with no interruption in the processing line. As a result of implementing this process change, ChemGenes recycled 1340 liters of solvent (blend of hexane and ethyl acetate) between May and August 2013. This corresponds to a savings of approximately \$3,500 in avoided solvent purchases.

Hazardous Waste Reduction

ChemGenes was previously disposing of all solvent as hazardous waste after a single use. In the study time frame of four months, 1340 liters of solvent have been reused and therefore not been disposed of as liquid hazardous waste. This translates to approximately \$1000 in disposal cost savings including fees (as noted in the table on the next page).

Economics

Based on data collected in the study time frame of four months, the overall yield of the solvent recycling system is approximately 97%. The operational costs associated with the new process, including labor, quality control, equipment maintenance, utilities (electricity), and hazardous waste disposal, have been calculated to be approximately 50% of the total cost of the solvent that has been recycled. At this rate, ChemGenes expects the payback on the instrument to be approximately 1.8 years, factoring in the TURI grant offset. If ChemGenes covered the entire \$26,000 investment, the payback period would be about 3 years.

Parameters

Solvent X	\$3.20/L
Solvent Y	\$2.15/L
Labor rate – 1 hour at \$30/hr	\$30.00/batch
Inner liner bags – 10 uses/change	\$0.80/batch
Quality Control – GC-MS	\$45.00/sample
Maintenance \$1000/yr & 200runs/2yr	\$7.95/batch
Electricity Consumption	\$0.80/batch
Waste Disposal: 75 liners/25gal pail	\$5.00/batch

Hazardous waste cost (including transportation, disposal, regulatory fees, insurance costs)	\$149.50/200L
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Usage and Costs for Four Months	Quantity/Costs
Input solvent	1339 L
Output solvent	1308 L
% recovery	97.70%
Material and Waste Savings	
With 97.70% return, Solvent savings	\$3,475.76
Hazardous Waste Savings	\$1,000.90
Total Material and Waste Savings:	\$4,476.67
Labor and QC Costs	
Labor	\$810.00
QC	\$1215.00
Total Labor and QC Costs:	(\$2,025.00)
Operation and Maintenance Costs	
Maintenance	\$214.65
Tank Liners	\$21.60
Electricity	\$107.20
Waste Disposal	\$135.00
Total O&M Costs:	(\$478.45)
Total Savings:	\$1,973.22
	Over 27 batches or \$73.27 per batch

Summary

The toxics use reduction experience of ChemGenes illustrates the ability of small companies to improve their environmental footprint while significantly cutting costs. ChemGenes has benefited over the past decade from their relationship with OTA and TURI – reducing their use of solvents in processes as well as finding ways to reuse materials. ChemGenes is a growing company, and with the resources that the Commonwealth of Massachusetts offers, they are able to continue to grow stronger and compete in an extremely competitive global market.

ChemGenes' Toxics Use Reduction History

ChemGenes began working with the Office of Technical Assistance and Technology (OTA) in 2005 in connection with their use of volatile solvents. OTA provided several recommendations on more efficient use of solvents, making clear the benefits and the range of opportunities to examine, including a list of alternatives that have worked for other biotechnology companies. In 2006 ChemGenes assembled a team to focus on this idea in response to increasing solvent use and related costs, including rising prices for chloroform, and their goal of minimizing potential employee exposure to toxic solvents. The team included production chemists, the chief scientific officer, the quality control engineer, the safety officer, and the chief of operations/production manager along with support from consultants at Goldman Environmental. This process enabled the company to replace a significant percentage of their chloroform use with a less toxic blend of hexane and ethyl acetate. In addition, implementation of this process change freed up capital that ChemGenes was then able to invest in a new chromatography system that significantly improved the overall efficiency of their manufacturing process, reducing chemical purchase and disposal costs.

To learn more about ChemGenes or to discuss how your facility might be able to implement similar process modifications to reduce your use of solvents, contact Anuj Mohan, Chief Operations Officer, 978-694-4500, or amohan@chemgenes.com.

For more information about the Toxics Use Reduction Institute Industry Incentive Grants program, visit www.turi.org or contact info@turi.org, 978-934-3275.

For information about the on-site confidential technical assistance services provided by the Office of Technology and Technical Assistance (OTA), contact Rich Bizzozero, OTA Director, at (617) 626-1080 or Rich.Bizzozero@state.ma.us.