Molly Lee

General Mills

Solvent Recovery and Reuse

General Mills, Inc.

Molly Lee

Advisor: Jeff Becker

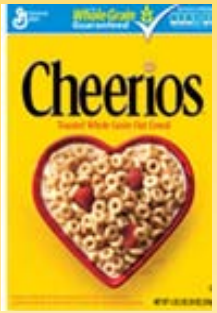
Minnesota Technical Assistance Program

UNIVERSITY OF MINNESOTA

Driven to Discover℠

General Mills, Inc.

- Sixth largest global food company



- Hazardous waste produced by analytical laboratories testing for food quality and safety

Nutrition Facts

Serving Size 1 cup (28g)
Children Under 4 - ¾ cup (21g)
Servings Per Container about 18
Children under 4 - about 24

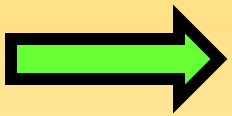
Amount Per Serving	Cheerios	with ½ cup skim milk	Cereal for Children Under 4
Calories	100	140	80
Calories from Fat	15	20	10
		% Daily Value**	
Total Fat 2g*	3%	3%	1.5g
Saturated Fat 0g	0%	3%	0g
Trans Fat 0g			0g
Polyunsaturated Fat 0.5g			0g
Monounsaturated Fat 0.5g			0g
Cholesterol 0mg	0%	1%	0mg
Sodium 190mg	8%	10%	140mg
Potassium 170mg	5%	11%	130mg
Total Carbohydrate 20g	7%	9%	15g
Dietary Fiber 3g	11%	11%	2g
Soluble Fiber 1g			0g
Sugars 1g			1g
Other Carbohydrate 16g			12g
Protein 3g			2g
			% Daily Value***
Protein	-	-	9%
Vitamin A	10%	15%	10%
Vitamin C	10%	10%	10%
Calcium	10%	25%	8%
Iron	45%	45%	50%
Vitamin D	10%	25%	6%
Thiamin	25%	30%	35%
Riboflavin	25%	35%	35%
Niacin	25%	25%	35%
Vitamin B_6	25%	25%	45%
Folic Acid	50%	50%	60%
Vitamin B_{12}	25%	35%	30%
Phosphorus	10%	25%	8%
Magnesium	10%	10%	10%
Zinc	25%	30%	30%

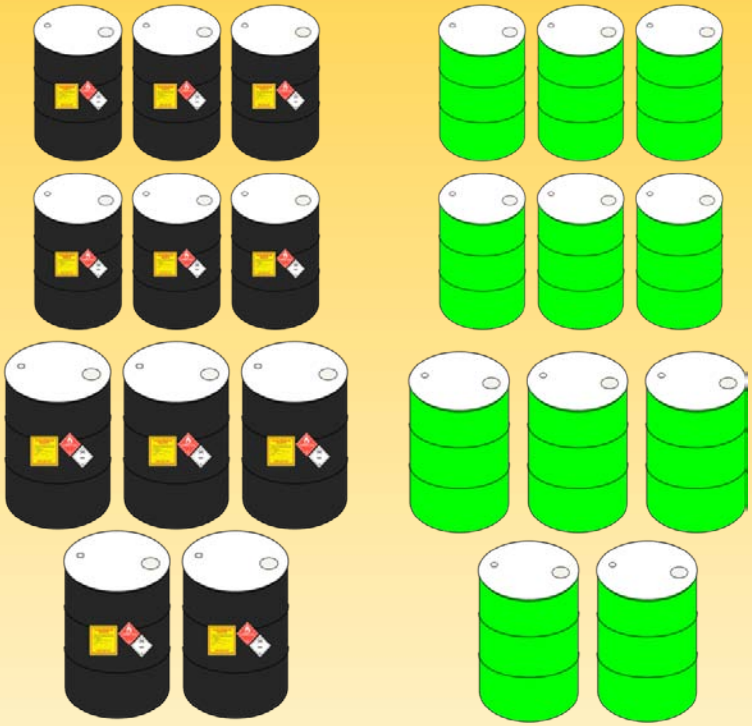
* Amount in cereal. A serving of cereal plus skim milk provides 2g total fat (0.5g saturated fat, 1g monounsaturated fat), less than 5mg cholesterol, 250mg sodium, 370mg potassium, 26g total carbohydrate (7g sugars) and 7g protein.

** Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Potassium		3,500mg	3,500mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g
Protein		50g	65g

Motivation for Change



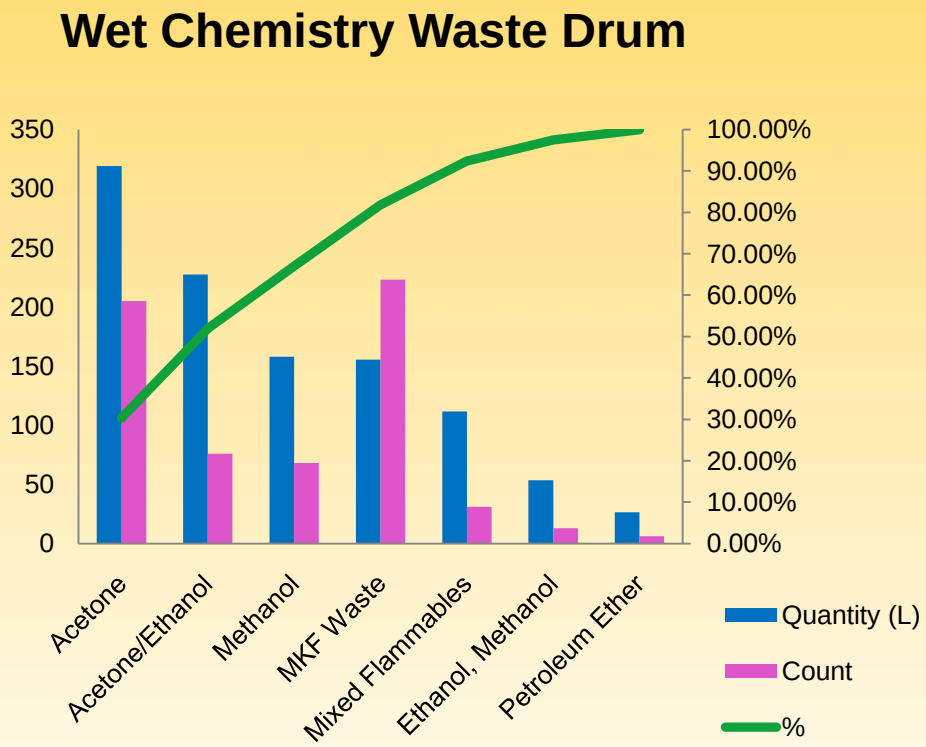


Reasons for MnTAP Assistance

- Process reduction
  - Hazardous waste generation
  - Virgin solvent use
  - Raw material and waste disposal costs
- Maintain small quantity generator size while enabling the lab to grow
- Increase safety and sustainability
- Strengthen relationship with the U of M
- Utilize technical support from MnTAP resources

Approach

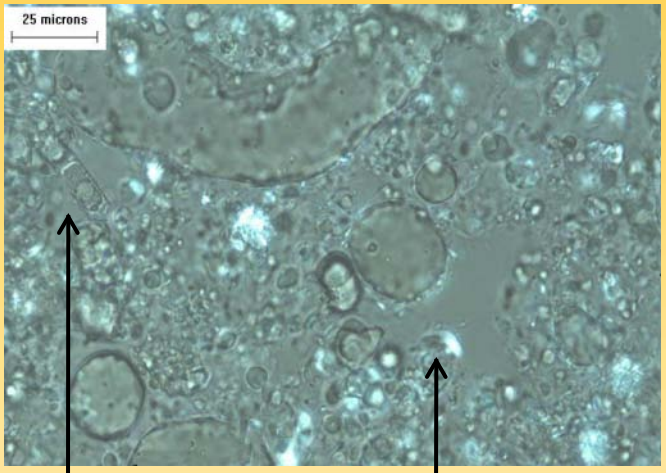
- Analyzed waste stream records from the past year

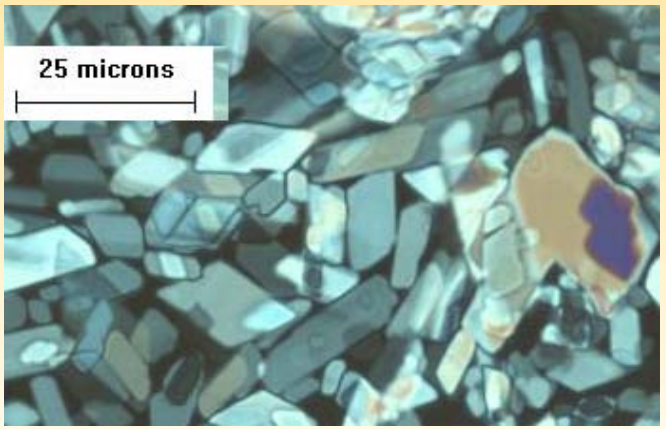


- Learned all processes contributing to waste drums by discussing solvent use with each of the lab analysts

Determining Inefficient Processes

- Identified and quantified contaminants in each of the individual waste streams
- Identified processes with least contaminants and easiest separations
- Received input from vendors, analysts, outside sources

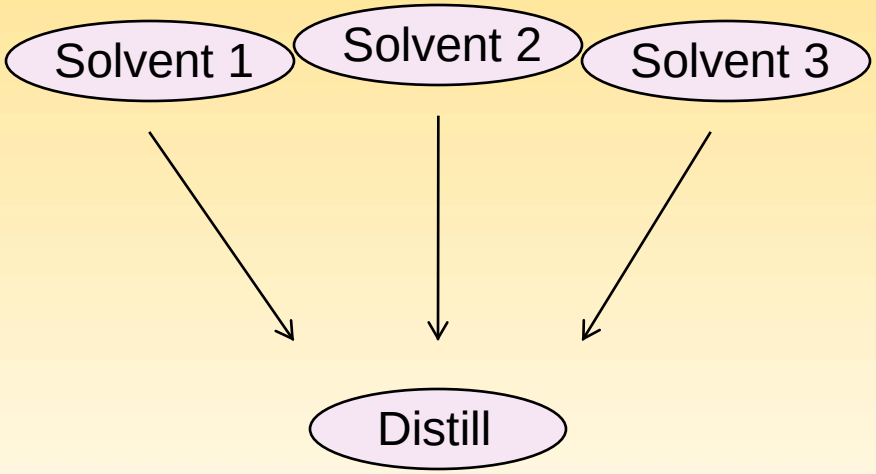




Solvent Recovery Overview

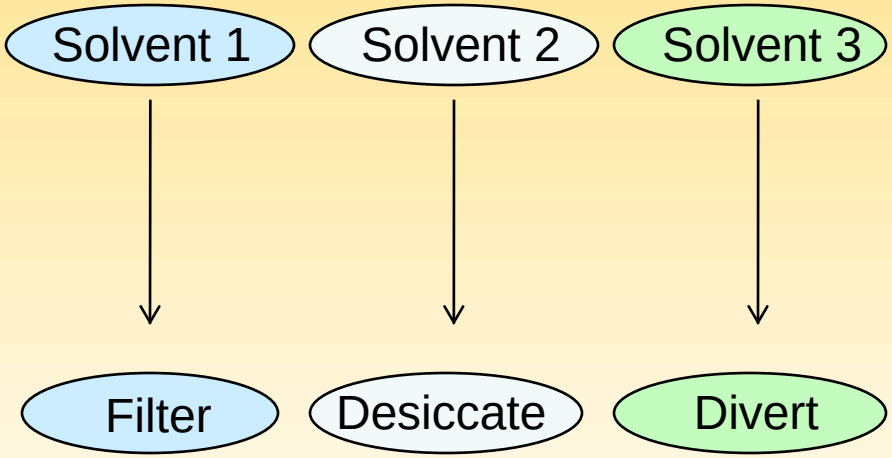
One Size Fits All

- The largest streams are all addressed by one single purification method



Customized

- Customized purification methods for each waste stream



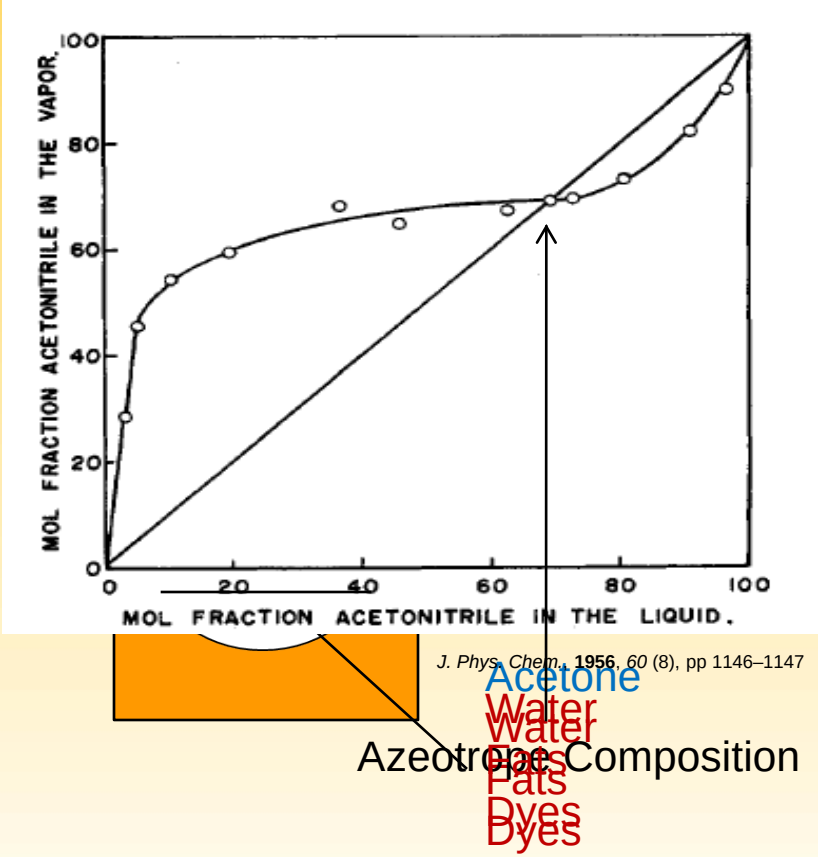
One Size Fits All: Distillation

- Largest streams could be collected separately and stored daily in each laboratory
- Separate materials based on volatility of components in mixture
- Challenges:

  -Azeotropes

  -Safety, Space

Vapor Liquid Equilibrium of Acetonitrile/Water Mixture



J. Phys. Chem., **1956**, *60* (8), pp 1146–1147

Recommended Process Change

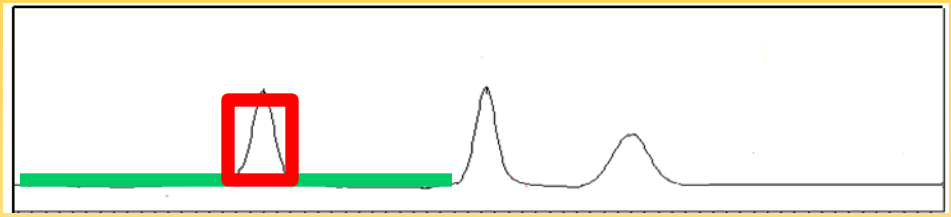
- Implement a distillation unit able to distill acetonitrile/water, acetone, heptanes, and methanol waste streams, distilling one per day

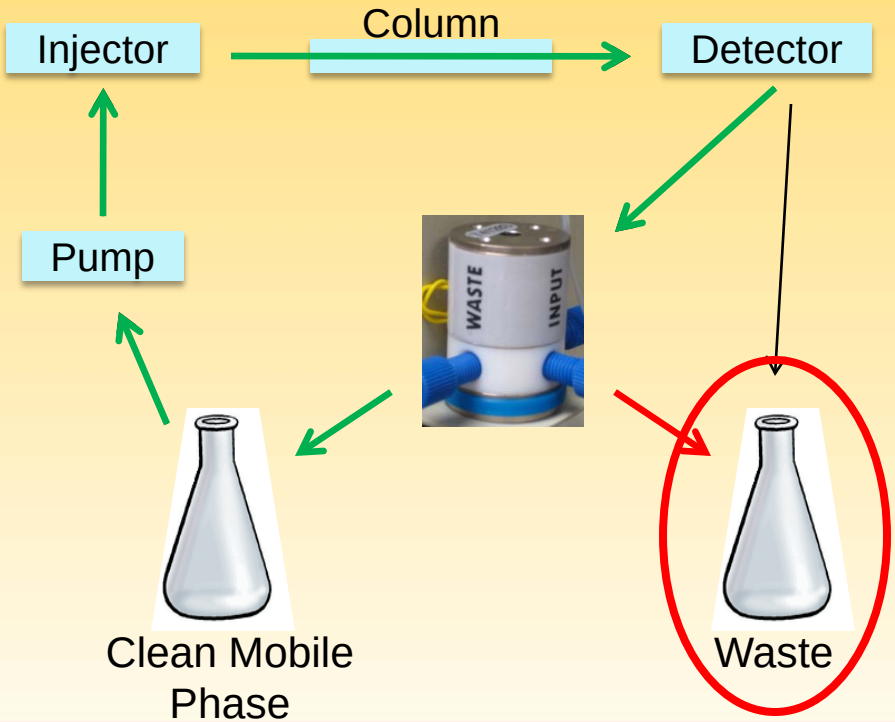
Total savings/year	$15,500
Total pounds/year saved	2,250
Percent of flammable waste	32%
Return on investment	1.25 years

B/R Instrument Corporation, 9600 Recycling System

Customized Approach 1: Recover Clean Mobile Phase

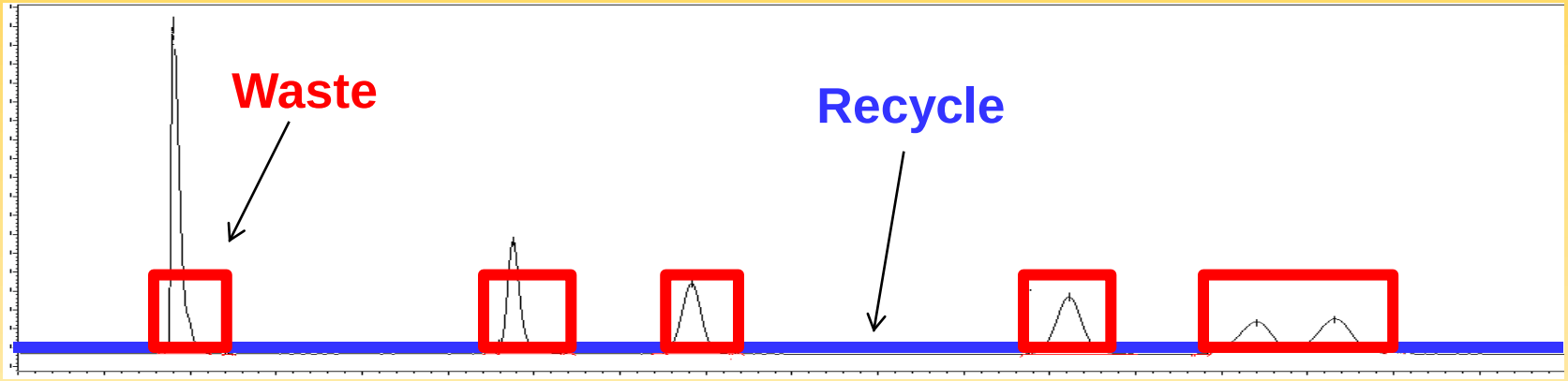
- 185 gallons/year of acetonitrile/water used as the mobile phase for one HPLC assay
- Utilizes separation from HPLC column
- Clean solvent is sent back to mobile phase
- Distill waste for reuse





Successful Process Change

- Installed a Solvent Trak clean solvent diverting unit for one of the HPLC systems

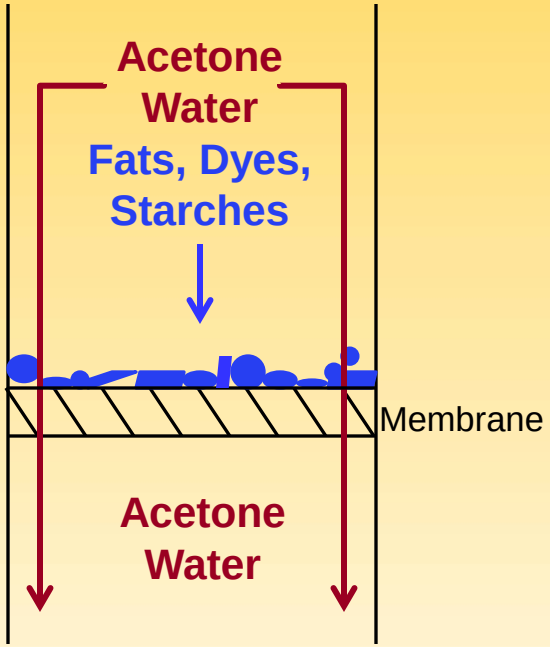


Total savings/year	$3,600
Total pounds/year saved	290
Percent of flammable waste	5%
Return on Investment	6 months

Could apply to 4 other HPLC systems at JFB and 5-10 sugars systems at manufacturing plants

Customized Approach 2: Acetone Recycle

- Wet chemistry analysis uses an estimated 85 gallons/year of acetone as a final rinse of one of the processes
- The waste stream contains small amounts of dyes, starches, fats, and water
- Use filtration to remove contaminants



Recommended Process Change

- Implement a nanofiltration system to purify the acetone waste stream through a ceramic membrane for reuse in the same process

Total savings/year	$2,800
Total pounds/year saved	660
Percent of flammable waste	10%
Return on Investment (est.)	6 months

Water in recycled stream

Solution: desiccate, distill, or reuse for limited time

Personal Benefits

- Project management experience
- Direct chemical engineering and chemistry concepts able to be applied and practiced
- Pollution, environmental impact, and safety models learned
- Networking
- Customer relation experience with analytical laboratory

Thank You

- All analysts at General Mills who provided information, answered questions, and collected separate waste streams
- Vendors and other outside sources
- **Special thanks to:**

  General Mills: Carolyn Sampson, Brett Post, Brooke Vetter, Paul Gould, Tim Peters

  MnTAP: Jeff Becker, Krysta Larson

  Vendors: ChromTech, NexGen Envirosystems, B/R Instruments Corporation