

## **Value Proposition CNSolution 3100**

### **Distillation Free Cyanide Methods**

OIA 1677 and OIA 1678 methods do not require distillation. Cyanide analysis without preliminary, time-consuming, labor intensive, distillations save time and money generating more revenue by increased throughput and decreased cost.

OIA 1677 is EPA approved for the analysis of cyanide in drinking water for SDWA compliance monitoring, and it is approved for the analysis of available cyanide (equivalent to CATC and WAD CN) for NPDES compliance monitoring. The same instrument that analyzes aquatic free cyanide can, with an optional UV irradiation module, analyze total cyanide by OIA 1678 or ASTM methods.

OIA 1678 provides a means to do low temperature (less hazardous) conversion of total cyanide to HCN without time consuming and potentially dangerous distillations and does not require the use of hazardous reagents. It is a safe, "green" chemistry that allows smaller samples to be shipped enabling total cyanide to be analyzed in triplicate with sample volumes as little as 1 milliliter.

OI Analytical pioneered the use of gas-diffusion in the separation of cyanide from an interfering matrix. Gas-diffusion can be used in place of distillation and is, in fact, the same principle as used in the Micro-Dist. However, OI Analytical employs gas-diffusion as an integral part of the instrumental method avoiding preliminary distillations.

Use the OI Analytical CNSolution™ 3100 for EPA compliance or process control. Meet requirements of the International Cyanide Code and exercise responsible management by analyzing cyanide with the only methods proven to accurately analyze cyanide in complex, interference-laden real world samples. Protect human health and the environment in a cost effective manner by rapidly measuring cyanide in a fraction of the time possible with any other method.

## Cost Comparison of Cyanide Distillations

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### Comparison of Distillation and Non-distillation for Cyanide Analysis

<b>Midi-Dist</b>	<b>Micro-Dist</b>	<b>CNSolution</b>
Fragile pieces to assemble and clean	Two disposable pieces	No distillation
Leaks can cause low recoveries	Rarely leaks	No distillation
Purge rate critical	No purge gas	No distillation
Irregular heating	Consistent heating	No distillation
20 samples per 8 hour on one 10 – place unit	168 samples per 8 hour on one 21 place unit	Up to <b>90 tests</b> per hour of unattended operation = <b>720 samples</b> in 8 hours
Reusable glassware	Disposable consumable	No Distillation
Operator dependent results	Operator dependent results	Consistent results
No unattended operation	No unattended operation	Unattended, overnight operation
Cost = glassware washing time + distillation time + analysis time + reagents	Cost = consumable + distillation time + analysis time + reagents	Cost = analysis time + reagents

## Cost Comparison of Cyanide Distillations

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Reagents = \$ 5 per distillation and \$ 0.2 – 2 per test.	Reagents + Consumables = \$ 7.5 per distillation and \$ 0.2 – 0.5 per test.	Reagents = \$ 0.10 – 0.50 per test.
Labor = Glassware washing, distillation, manual or automated analysis	Labor = Distillation, manual or automated analysis	Labor = automated analysis

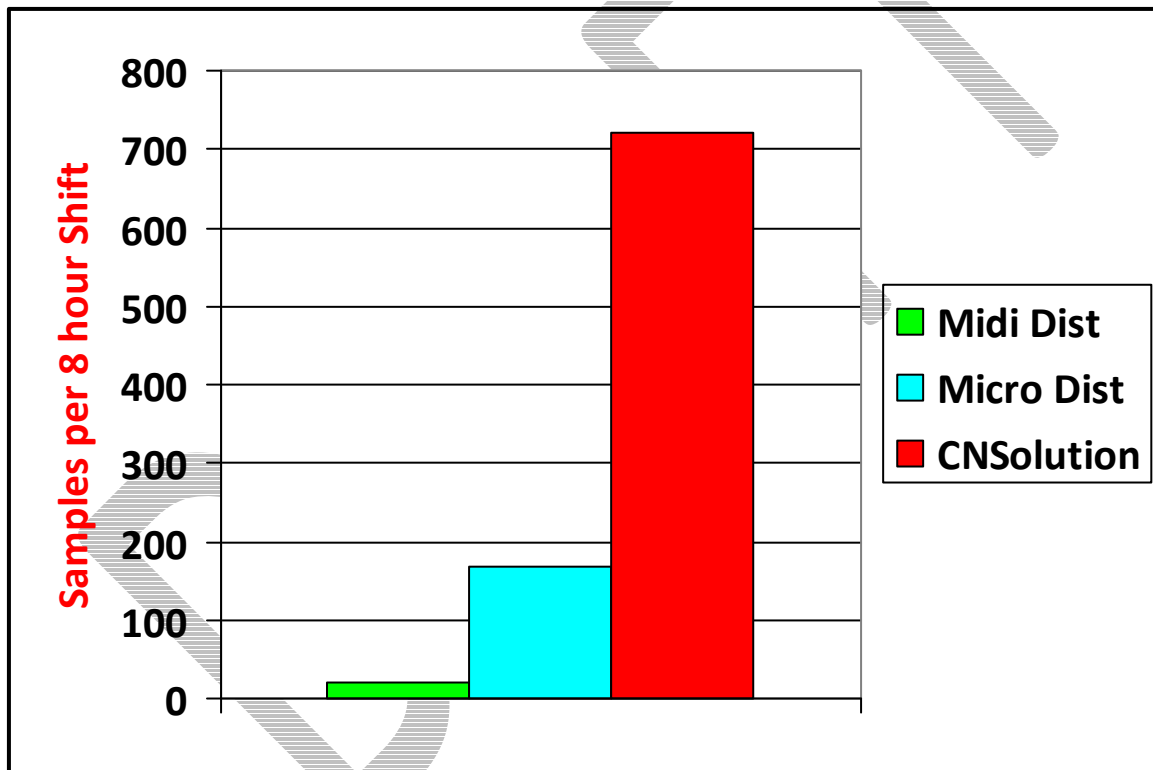
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## Cost Comparison of Cyanide Distillations

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### Increase Throughput and Laboratory Capacity Using Non- Distillation Cyanide Methods

The following chart illustrates the tremendous potential to increase laboratory throughput and capacity to analyze more samples by using non-distillation, automated cyanide methods. Since the analyzer is automated, overnight operation is possible doubling or even tripling potential sample analyses per day.



## Features, Advantages, and Benefits

### *CNSolution 3100*

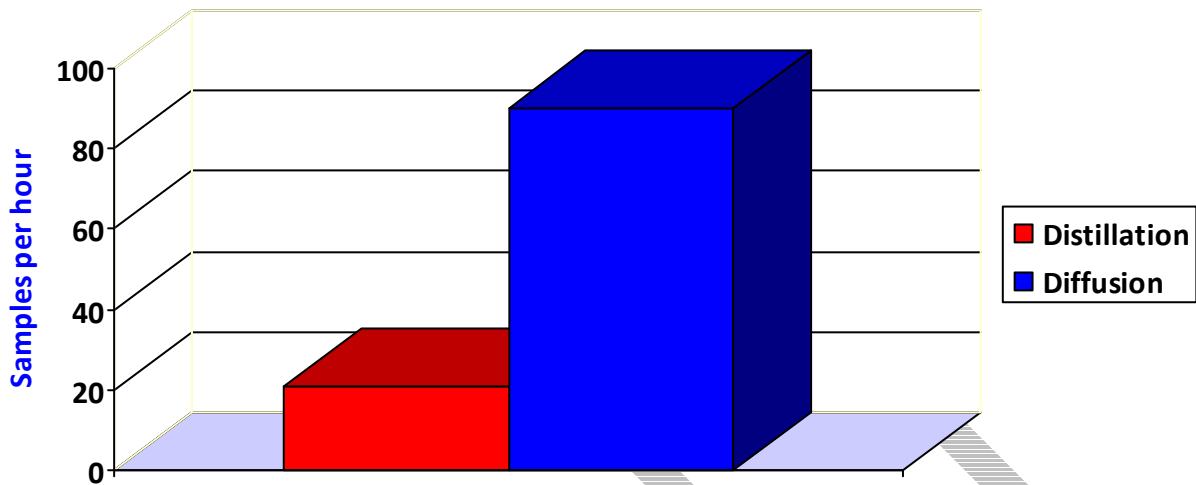
#### Feature: Gas Diffusion

**Advantage:** Eliminate the need for time-consuming cyanide distillations by separating simple cyanides from acid solutions using gas diffusion. Gas diffusion selectively separates hydrogen cyanide from an interfering matrix. Since gas diffusion occurs at room temperature, there are no interferences such as those caused by the high heat and strong acid concentration used in distillations.

***Benefit: No time lost doing distillations. Increase throughput from less than 20 samples per hour to 90 samples per hour. Increase sample capacity to over 700 samples per 8 hour shift.***

## Cost Comparison of Cyanide Distillations

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### Feature: Amperometric Detection

**Advantage:** Sensitive detection that uses non-toxic reagents. The OI amperometric detector uses a silver electrode that responds selectively to cyanide. Expanded Range detection is sensitive and has a large dynamic range. Replaces toxic pyridine based color reagents used in colorimetric methods with non-toxic, dilute sodium hydroxide.

**Benefit:** *No need for hazardous pyridine reagents. Eliminate costly waste disposal fees using a sensitive, cyanide specific detector with a calibration range from 2 ppb up to 5 ppm.*

### Feature: Runs all Gas-diffusion amperometric cyanide methods.

**Advantage:** A single instrument/platform is capable of running free cyanide, available cyanide, post distillation cyanide, and UV digested total cyanide. Combining gas diffusion, amperometry, and OI's Expanded Range detectors provides highly selective, highly sensitive, analysis for cyanide. Gas diffusion eliminates the need for time-consuming distillations.

**Benefit:** *Don't lose credibility analyzing CN with older, inaccurate technology. Get the right answers quickly. Besides being slow, distillation methods are not reliable below 15 – 20 ppb. Gas diffusion methods have DEMONSTRATED reliability at 2 ppb.*

## Cost Comparison of Cyanide Distillations

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Use the CNSolution for the following Methods:

Aquatic Free Cyanide                      ASTM D7237-06

Available Cyanide                            OIA 1677  
    ASTM D6888-04

Total Cyanide                                ASTM D7284-08  
    OIA 1678

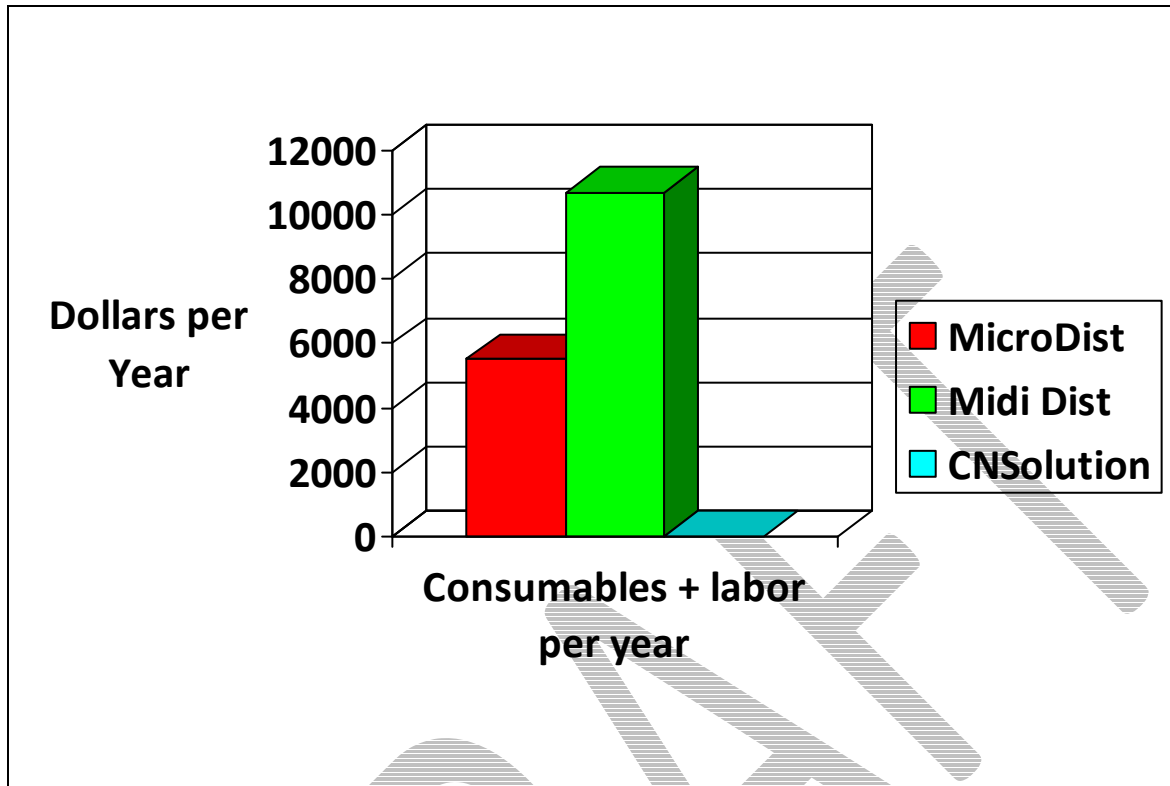
### **Feature: Optional UV digestion**

Advantage: Run total cyanide without the need for heat, or preliminary distillations. Digestion of total cyanides is accomplished at room temperature using UV irradiation. Since heat is not required, interferences are minimized. The simple cyanides formed after UV irradiation are separated by gas diffusion and determined by sensitive, cyanide specific, amperometric detection.

***Benefit: Stop losing thousands of dollars per year in labor and consumables by distilling total cyanide. UV digestion increases throughput and you save cash.***

## Cost Comparison of Cyanide Distillations

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### Feature: Compact, Expandable Design

Advantage: A modular design allows easy addition of colorimetric chemistries and occupies minimal bench space. Other methodologies can be analyzed on the same equipment. Perform cartridge changeovers from one method to another within 5 – 10 minutes. Keeps capital investment down.

***Benefit: Enjoy a rapid return on investment (ROI) by using a single analyzer for all automated chemistries. Use the same analyzer to run the following methods, or any other FS3100 method:***

EPA 335.4

Total Cyanide

## Cost Comparison of Cyanide Distillations

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EPA 420.4	Total Phenolics
EPA 350.1	Ammonia Nitrogen
EPA 353.2	Nitrate + Nitrite Nitrogen
EPA 365.1	Phosphorus, All Forms
EPA 351.2	TKN

### Feature: Overnight Operation

Advantage: Overnight operation is a common feature with automated equipment. Software slows, or stops pumps after runs are finished to minimize reagent usage. Overnight operation is essentially an extra shift without workers present.

***Benefit: Increase throughput and decrease labor costs. Let the instrument work while you sleep. An instrument running overnight is like a second shift, without labor costs. Overnight operation can increase capacity from over 700 samples per 8 hour shift to more than 1400 samples per day.***

### Feature: Run OIA 1677 and ASTM D6888-04 for CWA compliance

Advantage: The OI CNSolution 3100 is the only commercially available instrument capable of analyzing samples by OIA 1677 exactly as written. OIA1677 and ASTM D6888-04 analyze the same cyanide species as CATC and WAD cyanide methods and are EPA approved alternatives. These methods have been demonstrated to more accurately determine CATC and WAD cyanide in complex matrices.

## Cost Comparison of Cyanide Distillations

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***Benefit: Quit wasting time distilling drinking water samples. Run EPA approved, distillation free, alternatives to CATC and WAD cyanide and increase throughput, decrease costs, save time and money.***

### **Feature: Run OIA 1677-DW or ASTM D6888-04 for SDWA compliance**

Advantage: OIA 1677-DW and ASTM D6888-04 are approved for the analysis of cyanide in drinking water. The regulated cyanide in drinking water is “free” cyanide and gas-diffusion amperometry methods used without ligand exchange reagents are promulgated by EPA in the March 12, 2007 Method Update Rule.

***Benefit: Increase throughput and quality while decreasing cost by analyzing drinking water for SDWA compliance testing without time-consuming distillations.***

### **Feature: Analyze cyanide in samples containing interferences such as sulfide, sulfite, thiosulfate, and thiocyanate.**

Advantage: Only gas diffusion amperometry methods for cyanide can rapidly process samples with minimum or no interference from oxidized sulfur and thiocyanate. OI’s UV digestion gas diffusion-amperometry method accurately analyzes total cyanide in the presence of these interferences. ASTM recommends using gas diffusion-amperometry methods, even after distillation, if these compounds are present.

***Benefit: Distillation/colorimetry methods cannot be trusted. Avoid reporting bad data. Obtain accurate, trustworthy, high quality results in complex matrices while saving time, money, and increasing throughput.***

# Cost Comparison of Cyanide Distillations

## Cost Comparison of Cyanide Distillation - 40 Samples per Month Distillation

Labor in Minutes	Microdist (21 samples)	Midi Dist (10 samples)	CNSolution *
Setup Time	15	30	0
Warm up time	15	30	0
Distillation time (per sample)	30	120	0
Cool down time	0	15	0
Clean up and Tear Down time	5	30	0
<b>Total Time in Minutes per batch</b>	<b>65</b>	<b>225</b>	<b>0</b>

## Labor Costs for Distillations - Monthly

Labor Costs - Monthly	Microdist	Midi Dist	CNSolution
# Samples per Month	40	40	0
# Samples per Batch	21	10	0
# Batches per Month	2	4	0
Time Spent per Month (hours)	2.17	15	0
Technician Salary (per hour)	15	15	15
Labor Cost per Batch (includes overhead)	\$81.25	\$562.50	\$0.00
<b>Total Labor Cost per Month</b>	<b>\$162.50</b>	<b>\$2,250.00</b>	<b>\$0.00</b>

## Labor Costs for Distillations - Yearly

Labor Costs - Yearly	Microdist	Midi Dist	CNSolution
# Batches per Year	24	48	0
Time spent per year (hours)	26	180	0
Technician Salary (per hour)	15	15	15
<b>Labor Cost per Year (includes overhead)</b>	<b>\$975.00</b>	<b>\$6,750.00</b>	<b>\$0.00</b>

## Total Consumables for Distillations - Yearly

Required Consumables	Microdist	Midi Dist	CNSolution
MicroDist tubes (each)	7	NA	0
# Batches per year	24	48	0

## Cost Comparison of Cyanide Distillations

# Tubes per Batch	21	0	0
# Tubes per Year	504	0	0
<b>Total Consumable Cost per year</b>	<b>\$3,528.00</b>	<b>NA</b>	<b>\$0.00</b>

### Total Reagent Cost for Distillations - Yearly

Required Reagents per year	Microdist	Midi Dist	CNSolution
Sulfuric Acid	\$10.00	\$100.00	\$0.00
Sulfamic Acid	\$23.20	\$232.00	\$0.00
Magnesium Chloride	\$37.20	\$372.00	\$0.00
Sodium Hydroxide	\$35.80	\$358.00	\$0.00
Reagent Labor	\$129.48	\$1,295.00	\$0.00
<b>Total Reagent Cost per year</b>	<b>\$235.68</b>	<b>\$2,357.00</b>	<b>\$0.00</b>

### Initial Equipment Cost for Distillations

Initial Investment	Microdist	Midi Dist	CNSolution
Microdist	\$4,000.00	NA	NA
Midi Apparatus + all glassware	NA	\$8,000.00	NA
UV Digester + all supplies	NA	NA	\$5,500.00
Total Initial Investment	\$4,000.00	\$8,000.00	\$5,500.00
<b>Total Amortized Investment (5 years)</b>	<b>\$800.00</b>	<b>\$1,600.00</b>	<b>\$1,100.00</b>

### Annual Analysis Cost - Cyanide Distillation vs Non - Distillation Methods (assumes ~ equal cost to determination step)

	MicroDist	Midi Dist	CNSolution
Labor (sample preparation)	\$975.00	\$6,750.00	\$0.00
Consumables (sample preparation)	\$3,528.00	\$0.00	\$0.00
Reagents (sample preparation)	\$235.68	\$2,357.00	\$0.00
Total Cost (labor, consumables, reagents)	\$4,738.68	\$9,107.00	\$0.00
Amortized Capital Equipment (sample preparation)	\$800.00	\$1,600.00	\$1,100.00
<b>Total Cost</b>	<b>\$5,538.68</b>	<b>\$10,707.00</b>	<b>\$1,100.00</b>

\* No distillations are required for CNSolution Cyanide methods. An optional UV digestion module is required for Total Cyanide without distillation. Since Microdist, Midi Dist, and CNSolution methods all require automated instrumentation, the costs

## Cost Comparison of Cyanide Distillations

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of the analytical step is not included. A CNSolution can also be used for the analytical step. If a CNSolution is used for the measurement, the cost of distillation by MicroDist or Midi Dist applies.

### Cost Comparison of Cyanide Distillation - 100 Samples per Month

#### Distillation

Labor in Minutes	Microdist (21 samples)	Midi Dist (10 samples)	CNSolution
Setup Time	15	30	0
Warm up time	15	30	0
Distillation time (per sample)	30	120	0
Cool down time	0	15	0
Clean up and Tear Down time	5	30	0
<b>Total Time in Minutes per batch</b>	<b>65</b>	<b>225</b>	<b>0</b>

#### Labor Costs for Distillations - Monthly

Labor Costs - Monthly	Microdist	Midi Dist	CNSolution
# Samples per Month	100	100	0
# Samples per Batch	21	10	0
# Batches per Month	5	10	0
Time Spent per Month (hours)	5.16	37.5	0
Technician Salary (per hour)	15	15	15
Labor Cost per Batch (includes overhead)	\$193.45	\$1,406.25	\$0.00
<b>Total Labor Cost per Month</b>	<b>\$921.20</b>	<b>\$14,062.50</b>	<b>\$0.00</b>

#### Labor Costs for Distillations - Yearly

Labor Costs - Yearly	Microdist	Midi Dist	CNSolution
# Batches per Year	57.1	120	0
Time spent per year (hours)	61.9	450	0
Technician Salary (per hour)	15	15	15
<b>Labor Cost per Year (includes overhead)</b>	<b>\$2,321.43</b>	<b>\$16,875.00</b>	<b>\$0.00</b>

## Cost Comparison of Cyanide Distillations

### Total Consumables for Distillations - Yearly

Required Consumables	Microdist	Midi Dist	CNSolution
MicroDist tubes (each)	\$7.00	NA	0
# Batches per year	57	120	0
# Tubes per Batch	21	0	0
# Tubes per Year	1200	0	0
<b>Total Consumable Cost per year</b>	<b>\$8,400.00</b>	<b>NA</b>	<b>\$0.00</b>

### Total Reagent Cost for Distillations - Yearly

Required Reagents per year	Microdist	Midi Dist	CNSolution
Sulfuric Acid	\$25.00	\$250.00	\$0.00
Sulfamic Acid	\$58.00	\$580.00	\$0.00
Magnesium Chloride	\$93.00	\$930.00	\$0.00
Sodium Hydroxide	\$89.50	\$895.00	\$0.00
Reagent Labor	\$323.70	\$3,237.00	\$0.00
<b>Total Reagent Cost per year</b>	<b>\$589.20</b>	<b>\$5,892.00</b>	<b>\$0.00</b>

### Initial Equipment Cost for Distillations

Initial Investment	Microdist	Midi Dist	CNSolution
Microdist	\$4,000.00	NA	NA
Midi Apparatus + all glassware	NA	\$8,000.00	NA
UV Digestor + all supplies	NA	NA	\$5,500.00
<b>Total Initial Investment</b>	<b>\$4,000.00</b>	<b>\$8,000.00</b>	<b>\$5,500.00</b>
<b>Total Amortized Investment (5 years)</b>	<b>\$800.00</b>	<b>\$1,600.00</b>	<b>\$1,100.00</b>

### Annual Analysis Cost - Cyanide Distillation vs Non - Distillation Methods (assumes ~ equal cost to determination step)

	MicroDist	Midi Dist	CNSolution
Labor (sample preparation)	\$2,321.43	\$16,875.00	\$0.00
Consumables (sample preparation)	\$8,400.00	\$0.00	\$0.00
Reagents (sample preparation)	\$589.20	\$5,892.00	\$0.00
<b>Total Cost (labor, consumables, reagents)</b>	<b>\$11,310.63</b>	<b>\$22,767.00</b>	<b>\$0.00</b>

## Cost Comparison of Cyanide Distillations

Amortized Capital Equipment (sample preparation)	\$800.00	\$1,600.00	\$1,100.00
<b>Total Cost</b>	<b>\$12,110.63</b>	<b>\$24,367.00</b>	<b>\$1,100.00</b>

### Comparison of Distillation Cost (40 samples / month) by Cyanide Species

Cyanide Species	Method	MicroDist (\$ per year)	MidiDist (\$ per year)	CNSolution (\$ per year)
Available Cyanides				
WAD Cyanide	ASTM D2036	\$5,538.68	\$10,707.00	\$0.00
CATC Cyanide (two distillations)	ASTM D2036	\$10,277.36	\$15,445.68	\$0.00
FIA - GD (reagents)	OIA 1677	NA	NA	\$221.57
Total Cyanides	EPA 335.4 OIA1678	\$5,538.68	\$10,707.00	\$1,100.00

### Comparison of Distillation Cost (100 samples / month) by Cyanide Species

Cyanide Species	Method	MicroDist (\$ per year)	MidiDist (\$ per year)	CNSolution (\$ per year)
Available Cyanides				
WAD Cyanide	ASTM D2036	\$12,110.63	\$24,367.00	\$0.00
CATC Cyanide (two distillations)	ASTM D2036	\$23,421.26	\$47,134.00	\$0.00
FIA - GD (reagents)	OIA 1677	NA	NA	\$553.92
Total Cyanides	EPA 335.4 OIA1678	\$12,110.63	\$24,367.00	\$1,100.00

# Cost Comparison of Cyanide Distillations

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## Available Cyanide cost analysis

	Price	Price per ml	mls per test	Price per Test
Base Reagent (liter)	\$60.00	\$0.06	\$0.56	\$0.03
Acid Reagent (liter)	\$25.00	\$0.03	\$0.56	\$0.01
Carrier Reagent (liter)	\$25.00	\$0.03	\$0.56	\$0.01
Ligand Reagent A (10 ml)	\$200.00	\$20.00	\$0.01	\$0.20
Ligand Reagent B (5 ml)	\$200.00	\$40.00	\$0.01	\$0.20
Reagent Cost per Test				
Total Cost per test				\$0.46

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## Cost Comparison of Cyanide Distillations

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### Comparison of Cost per Sample by Cyanide Species

Cyanide Species	Method	MicroDist (\$ per test)	MidiDist (\$ per test)	CNSolution (\$ per test)
Available Cyanides				
WAD Cyanide	ASTM D2036	\$11.54	\$22.31	\$0.00
CATC Cyanide (two distillations)	ASTM D2036	\$21.41	\$32.18	\$0.00
FIA - GD (reagents)	OIA 1677	NA	NA	\$0.46
Total Cyanides				
	EPA 335.4	\$11.54	\$22.31	
	OIA1678			\$2.29

### Profit per Sample by Method (\$40 Price per Test)

Cyanide Species	Method	MicroDist (\$ per test)	MidiDist (\$ per test)	CNSolution (\$ per test)
Available Cyanides				
WAD Cyanide	ASTM D2036	\$28.46	\$17.69	
CATC Cyanide (two distillations)	ASTM D2036	\$18.59	\$7.82	
FIA - GD (reagents)	OIA 1677			\$39.54
Total Cyanides				
	EPA 335.4	\$28.46	\$17.69	
	OIA1678			\$37.71

## Cost Comparison of Cyanide Distillations

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### Profit per Month (40 Samples per Month)

Cyanide Species Available Cyanides	Method	MicroDist (\$ per test)	MidiDist (\$ per test)	CNSolution (\$ per test)
WAD Cyanide	ASTM D2036	\$1,138.44	\$707.75	
CATC Cyanide (two distillations)	ASTM D2036	\$743.55	\$312.86	
FIA - GD (reagents)	OIA 1677			\$1,581.54
Total Cyanides	EPA 335.4 OIA1678	\$1,138.44	\$707.75	\$1,508.33

### Maximum Profit per 8 hour Shift based on Capacity

	Samples / hour	Samples per shift	Profit per Sample	Profit per Shift
Microdist*	21	168	\$28.46	\$4,781.28
Midi Dist*	2.67	21	\$17.69	\$377.39
CNSolution (available)+	90	720	\$39.54	<u>\$28,468.80</u>
CNSolution (total)+, **	30	240	\$37.71	<u>\$9,050.40</u>

\* Does not include analysis step

+ Analysis step is also included

\*\* Samples per hour based on 2 parts per billion detection limit. Higher throughput (up to 90) at higher detection limits is possible.

# Cost Comparison of Cyanide Distillations

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