Manufacturers of Precision Cleaners and P-80 Assembly Lubricants
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CONCENTRATION CONTROL METHODS

Concentration Control?

Concentration control methods are procedures that help users estimate the concentration of a cleaning solution.

- This information allows users to know when it's time to change the cleaning solution.

What Are Those Methods?

- There are four methods provided by International Products Corporation (IPC) to help estimate cleaner concentration:
  1. Refractive index
  2. Conductivity
  3. Total alkalinity and total acidity
  4. Foam height
- The methods can be used to test both the cleaning solution and the rinse water.

How Do They Work?

1. Refractive Index

Used for Micro-90®, Micro® Green Clean, LF2100®, Micro® A07, Surface-Cleanse/930®, Zymit® Low Foam, and Zymit® Pro

- *Refractive index* measures the bending of a ray of light when it passes from one medium into another[1]. It is measured using a refractometer, such as the *ATAGO handheld refractometer (see figure A)*.

- To use the refractometer, a few drops of cleaning solution should be placed on the refractometer's prism. Close the cover, point the refractometer towards light, and focus it. The refractive index can then be plugged into the equation that is specific to the cleaner.

- The refractive index of water should be zero, as seen in figure B. The following pictures show the refractive indexes of 2% and 10% Micro-90® as an example.

[1] The Editors of Encyclopedia Britannica. "Refractive index." Encyclopedia Britannica. Encyclopedia Britannica, Inc., 08 Jan. 2016. Web. 24 Apr. 2017.

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Figure A: ATAGO handheld refractometer

Concentration of cleaner (% V / V)	
Micro-90	% M90 = (refractive index) + 0.018 / 0.3611
Micro Green Clean	% MGC = (refractive index) + 0.0167 / 0.2842
LF2100	% LF2100 = (refractive index) + 0.0753 / 0.4416
Micro A07	% MA07 = (refractive index) + 0.0153 / 0.2885
Surface-Cleanse/930	% SC/930 = (refractive index) + 0.0147 / 0.3912
Zymit Low-Foam	% ZLF = (refractive index) + 0.0267 / 0.2919
Zymit Pro	% ZPro = (refractive index) - 0.0167 / 0.3103

Refractive index readings.

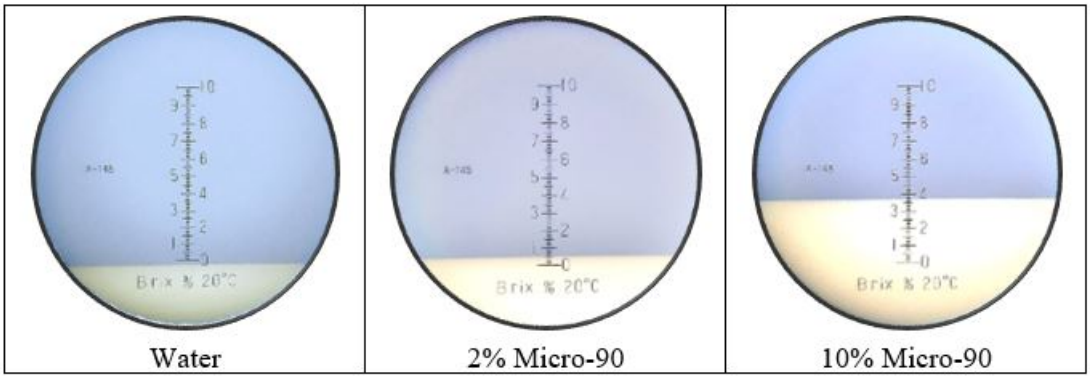

Figure B: Refractive index readings from water, 2% Micro-90 and 10% Micro-90.

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2. *Conductivity*

Used for Micro-90®, Micro® Green Clean, LF2100®, Micro® A07, Zymit® Low Foam, and Zymit® Pro

- *Conductivity* measures the ability of a substance to conduct electrical current.[2]
- Because cleaning solutions are more conductive than rinse water, conductivity is a feasible concentration control method[3].
- To measure conductivity, *Oakton Acorn Con 6 Conductivity Meter* can be used *(see figure C)*.
- To begin, ensure that the ATC factor is set to the default value of 2.1 and then calibrate using standard solutions (1413µS & 12.88mS).
- Ensure that the probe is clean and immerse it in the cleaning solution. The conductivity value is then recorded in micro Siemens (µS) and plugged into the appropriate formula for the cleaner.

Figure C: Oakton Acorn Con 6 Conductivity Meter.

% Concentration of cleaner (V / V)	
Micro-90	% M90 = (µS — 369) / 1255.5
Micro Green Clean	% MGC = (µS — 176.1) / 848.9
LF2100	% LF2100 = (µS — 536.3) / 1308.6
Micro A07	% MA07 = (µS — 347.8) / 691.7
Zymit Low-Foam	% ZLF = (µS — 18.3) / 70.2
Zymit Pro	% ZPRO = (µS — 109.3) / 378.0

Conductivity meter results.

[2] "Conductivity". Dictionary.com Unabridged. Random House, Inc. 24 Apr. 2017. <Dictionary.com http://www.dictionary.com/browse/conductivity>.
[3] 16, 2007 Oct. "Conductivity Measurement: Critical for Clean-In-Place Systems." *Pharma Manufacturing*. N.p., n.d. Web. 01 May 2017. <http://www.pharmamanufacturing.com/articles/2007/159/?show=all>.

International Products CORPORATION

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3. *Total Alkalinity*

Used for Micro-90®, Micro® Green Clean, and LF2100®

- *Total alkalinity* measures the ability of a cleaner to neutralize acid. It assesses the cleaning solution's buffering capacity – its resistance to changes in pH caused by acid.
- Total alkalinity is tested by performing a *titration*, a technique where a solution of known concentration is used to determine the unknown concentration of another solution.
- 100mL of cleaner solution is slowly titrated with 0.1N HCI until the end point is reached.
  - To determine the end point, bromophenol blue, a color changing indicator, may be used to visually confirm the end point. This occurs when the solution turns yellow.
  - A pH meter may also be used to determine the end point. This occurs at pH 3.6.

	% Concentration of cleaner (V / V)
Micro-90	% M90 = $\frac{(\text{ml 0.1N HCl}) - 0.1367}{9.2223}$
Micro Green Clean	% MGC = $\frac{(\text{ml 0.1N HCl}) - 0.0627}{3.6005}$
LF2100	% LF2100 = $\frac{(\text{ml 0.1N HCl}) - 0.2187}{9.5987}$

Concentration results from titration.

Total Acidity

Used for Micro® A07

- Similar to total alkalinity, *total acidity* measures the ability of a cleaner to neutralize alkalinity.
- Total acidity is tested by performing a *titration* *(see figure D).* 100mL of cleaner solution is slowly titrated with 0.1N NaOH until the end point is reached.
  - To determine the end point, phenolphthalein, a color changing indicator, may be used to visually confirm the end point. This occurs when the solution turns pink.
  - A pH meter may also be used to determine the end point. This occurs at pH 8.2.

	% Concentration of cleaner (V / V)
Micro A07	% MA07 = $\frac{(\text{ml 0.1N NaOH added}) - 0.3293}{18.4720}$

Concentration results from titration method.

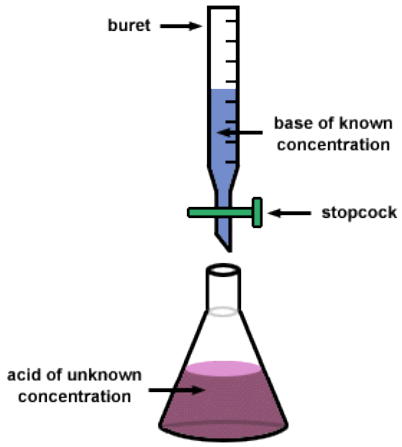

Figure D: Illustration of titration method.

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4. *Foam Height*

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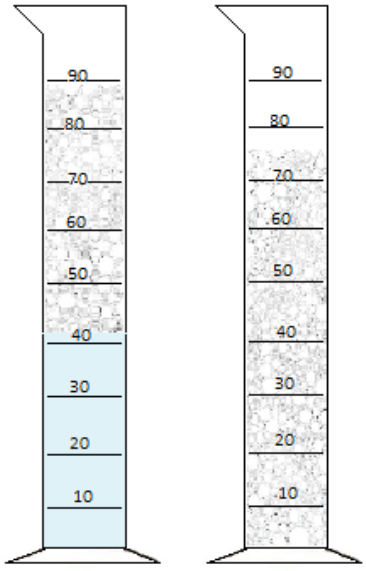
- Surfactants in cleaning solutions reduce surface tension, and, as a result, air may become entrapped. This leads to the formation of small bubbles known as *foam*.
- There are 2 methods for determining foam level; both ultimately involve measuring the total volume of solution in a graduated cylinder.
- **Blender**
  - 250mL of cleaning solution is poured in the blender. The blender is set to puree for 1 minute. After 1 minute of blending, the solution is poured into a graduated cylinder, where the total volume is recorded.
- **Graduated cylinder**
  - 100mL cleaning solution is poured into a 500mL graduated cylinder. The graduated cylinder is then shaken vigorously 10 times to create foam. The total volume of solution is then recorded.
- For both methods, a foam level curve should be made.
  - To do this, cleaners at various known concentrations should be used to generate foam.
  - A best fit equation can be created by plotting concentration vs total volume. The best fit equation can then be used to determine the concentration of future cleaning solutions whose concentration level is unknown.



The total volume in the graduated cylinder should be recorded. The graduated cylinder may contain both liquid and foam (left) or only foam (right).

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Where to find IPC's Concentration Control Methods

- Refractive Index
  http://www.ipcol.com/wp-content/uploads/Concentrated_Control_Methods-2.pdf

- Conductivity
  http://www.ipcol.com/wp-content/uploads/M90ConductivityConcentration.pdf

- Total Alkaline and Total Acidity
  http://www.ipcol.com/wp-content/uploads/Concentrated_Control_Methods-2.pdf

- Foam Height
  https://www.ipcol.com/wp-content/uploads/CleanersConcentrationsFoamHeight.pdf