KYZEN

Product Supplement

Aquanox® A4639

Electronic Assembly Aqueous Solution

Kyzen specializes in precision cleaning chemistries for electronics, advanced packaging, metal finishing and aerospace applications. Our industry expertise and dedicated customer support provide integrated cleaning process solutions that meet any cleaning challenge. Founded in 1990, Kyzen is the leading provider of environmentally responsible, RoHS compliant cleaning chemistries to industries worldwide.

Kyzen is an ISO 9001:2008 certified company.

CE ISO Certified 9001:2008

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PRODUCT DESCRIPTION

Aquanox® A4639 is a dispersive and moderately reactive aqueous cleaning agent engineered to remove lead-free and eutectic tin-lead no-clean, rosin and organic acid flux residues. Aquanox® A4639 removes all flux types by balancing dispersive, polarity and hydrogen bonding forces within the formulation design. Aquanox® A4639 is best suited for use in batch and/or spray-in-air cleaning tools.

Aquanox® A4639 solvency make-up is engineered with a mixture of oxygenated and polar organic reactive solvents. Functional additives are added to lower surface tension, reduce the foaming tendencies and to passivate (reduce interaction with) metallic surfaces. The combined features engineered into Aquanox® A4639 make for a highly effective cleaning agent for use in both batch and spray-in-air cleaning tools. When longer wash times are required to remove flux residues under bottom termination components, Aquanox® A4639 functions well and reduces the tendency to grey or blue solder joints.

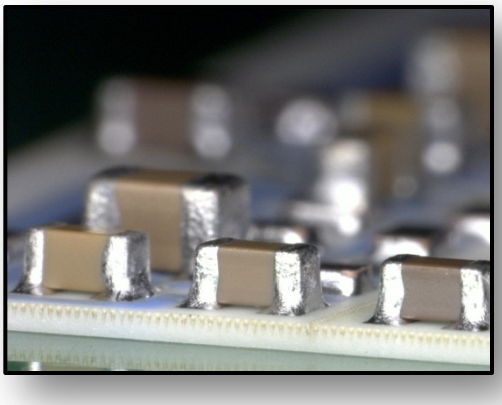
The polar solvents used within the formulation provide strong Van der Waals forces of attraction for water soluble and rosin flux residues. As such, Aquanox® A4639 is highly effective at removing lead-free water soluble flux residues. For water soluble flux residues, a concentration of 5-10% is recommended. The balance of solvating agents used within Aquanox® A4639 also makes for a highly effective cleaning agent on both rosin and no-clean flux residues. For rosin and no-clean flux residues, a concentration range of 10-15% is recommended.

The polar organic reactive solvents elevate the pH toward the alkaline range. To prevent oxidation onto solder alloys, copper, aluminum, silver and gold, the product contains corrosion inhibitors that protect against oxidation. This feature is highly beneficial in that higher reactivity improves the dissolution rate on hard to clean flux residues and allows for longer wash times when needed to remove flux residues under bottom termination components.

Aquanox® A4639 concentration is controlled with the use of refractive index. The recommended process temperature range is 55-65°C. The product is stable and holds soils without losing cleaning effectiveness. Losses of the wash bath to evaporation are nominal. The cost of operation is typically less than or comparable with other aqueous cleaning agents.

Electronic Assembly Aqueous Solution

- **Easy to control**
- **Protects Solder Joints from Chemical Attack**
- **Use at Low Concentrations**
- **Effective on B-Side Misprints**
- **No Sump–Side Additives Needed**



CHEMICAL AND PHYSICAL PROPERTIES

This Kyzen product is environmentally responsible and operator safe, when handled in accordance with good industrial hygiene and safety practices. *Table 1* summarizes important chemical and physical properties of this product.

Table 1: Typical Chemical and Physical Properties

Parameter	100% Concentrate	5% Dilution	15% Dilution	Special Values
Clarity	Clear			
Color	Light straw			
Odor	Mild			
Flash Point, °C (TCC)	None to boiling			
Boiling Point, °F/C	214°F / 101°C			
Volatile Organic Compound (VOC) g/L EPA Method 24	615 g/L	31 g/L	92 g/L	150 [1]
Chemical Oxygen Demand, (COD), mg/L (ppm)	TBD			
pH	10.8 – 11.8	10.0 – 11.0		10.0 [2]
Specific Gravity	1.01 – 1.05			
Weight/gallon	8.57 lbs			
Refractive Index, ° BRIX	45 – 60 °Brix	2.9 °Brix	9.0 °Brix	
MEQ to pH 8.3	1.40 – 2.20			
MEQ to pH 4.0	1.80 – 2.60			
Alkalinity Ratio	1 : 1.2			
Non-volatile Residue (NVR) %	1.95%	0.10%	0.29%	

[1] A4639 has a VOC of 150 g/L at 24.2% to be in compliance with the *2011 OTC Model Rule for Solvent Degreasing*
[2] Measured at 10 g/L dilution.

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PRODUCT USE DIRECTIONS

In general, wash concentration, wash temperature, spray impingement energy, wash time and rinse are key elements of process optimization. Kyzen recommends the following process parameters for applications using this product:

1. **Wash Concentration:** For lead-free no-clean and rosin based flux residues, a concentration range from 10-15% is recommended. For organic acid flux residues, a concentration range of 5-10% is recommended. If the residues are badly charred, a higher concentration level may be needed.
2. **Wash Temperature**: For most lead-free no-clean and rosin flux residues, a wash temperature range of 60-65°C is recommended. For organic acid (water soluble) flux residues, an operating temperature range of 55-65°C is recommended. The defoaming properties of Aquanox® A4639 are best when operating at 55-65°C wash temperatures.
3. **Spray Impingement**: Spray energy is needed to move the cleaning agent to the soil under bottom termination components. Fluid dynamics improve cleaning and shorten cycle time. Spray pressures in the range of 50-100 psi using tight fan and coherent spray jets work well.
4. **Wash Time**: Determining the optimum wash time is a function of the residue properties, component density and geometry, Z-axis gap height and cleaning equipment. Planarized inline cleaning machine designs provide high fluid flow and energy. Conveyor belt speeds in the range of 0.5-2.0 FPM work well. Batch spray-in-air designs provide high flow at lower pressures. Wash time in the range of 10-15 minutes is adequate for most applications.
5. **Rinse**: Aquanox® A4639 is water soluble and rinses well with DI water. When processing in a batch spray-in-air tool, 3-6 rinse cycles are recommended. When processing in an inline spray-in-air tool, wet chemical isolation followed by course rinsing and a final polished rinse is recommended. A rinse temperature of 50-60°C is recommended.

Aquanox® A4639 works best when the cleaning agent is added to the wash tank using a dosing injection system. When the wash tank calls for water make-up, the dosing systems add Aquanox® A4639 at the desired concentration levels. Kyzen's PCS Type I (process control system) automatically controls the both cleaning agent and water make-up to the wash tank. Maintaining the concentration within the lower and upper set points reduces variability.

COMPATIBILITY INFORMATION- SUBSTRATES AND EQUIPMENT

All chemicals have the potential to adversely affect substrates and process equipment. As such, the effects of short-term exposure for substrates common to electronic assemblies and the effects of long-term exposure for materials of equipment construction must be considered. *Tables 2, 3 and 4* summarize known compatibility recommendations regarding the use of this product with specific substrates.

TABLE LEGEND		
R- Recommended	**NR-** Not Recommended	**T-** Test Before Use

Table 2: Plastics and Elastomers

Brand Name	Generic Description	A4639
Delrin™	Acetal	R
Acrylic	Acrylic	NR
Nylon	Synthetic Fiber	R
Lexan™	Polycarbonate resin	T
Polystyrene	Polystyrene	R
Polyurethane	Polyester/Polyether	R
PVC	Polyvinyl Co-polymer	R
Black Rubber	Black rubber	R
Pure Gum Rubber	Gum rubber	R
Neoprene	Polychloroprene	R
Phenolics	Phenol	R
Teflon™	Polytetrafluoroethylene	R
Kalrez	Perfluoro-Elastomer	R
Kynar™	Polyvinyl fluoride	R
Aflas	Tetrafluoroethylene and Propylene	T
Tefzel™	Ethylene/tetrafluoroethylene copolymer	R
Polypropylene	Polypropylene	R
Acculam™	Epoxy glass	R
XLPE™	Cross-linked polyethylene	R
Alathon™	High density polyethylene	R
Viton A or B	Fluoroelastomer	NR
Low density polyethylene	Polyethylene	R
Ultem™	Polyether imide	R
Silicone Rubber	Silicone Rubber	R
CPVC	Chlorinated Polyvinyl Chloride	R
Buna-S	Styrene Butadiene	NR
Buna-N	Styrene Nitrile Copolymer	NR
Ceramics	Composites	R
Glass	Glass	R

COMPATIBILITY INFORMATION- SUBSTRATES AND EQUIPMENT

Table 3: Metals and Alloys	
Substrate	**A4639**
2024 Aluminum- Bare	T
2024 Aluminum- Alclad	T
2024 Aluminum- Anodized	T
Black Anodized Aluminum	T
3003, 6061 and 7075 Aluminum	T
7075 Aluminum- Alclad	T
Silver	R
Gold	R
Copper	R
1018 Steel	R
304 and 316 Stainless Steel	R
Titanium	T
Steel, Galvanized	R

Tin-based Alloy Compatibility

When used as directed, this product is compatible with Tin-Lead, Tin-Copper, Tin-Silver-Copper and Bismuth-Tin based alloys.

Application Note

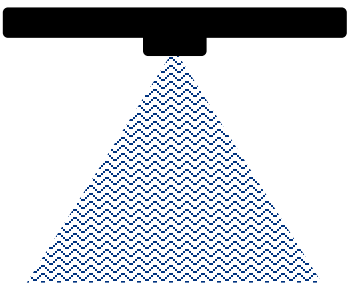
Metals, elastomers and plastics can varygreatly in quality. These compatibility recommendations are based on testing of commonly available materials. If your process uses materials that are of lesser quality than those tested by Kyzen, differences in compatibility may be noticed.

Table 4: Equipment	
When considering long-term exposure for materials of equipment construction, the following materials are generally compatible with chemistries used for inline and batch cleaning systems: ***(listed in order of resilience)***	
Type	**Compatibility**
EXHAUST	*Stainless Steel, Polypropylene, PVC or Galvanized Steel*
PUMP SEALS, O-RINGS, GASKETS	*Teflon™, Teflon™ encapsulated or EPDM (EPR)* *Note: Viton is not recommended.*
PLUMBING LINES	*Stainless steel or Polypropylene*
CURTAINS	*Polypropylene or Reinforced Silicone (red)*
WINDOW / DOOR SEALS	*EPDM or Silicone (red)*
RTV	*Dow Corning 732 or similar high grade*

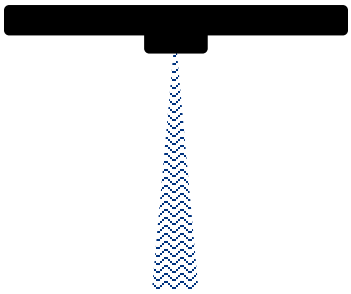
COMPATIBILITY INFORMATION- LABELS

Kyzen extensively studies label compatibility with key Kyzen products to assist customers in selecting an appropriate label stock for their application. Additionally, these studies allow Kyzen to determine the effects that certain process parameters can have on ink permanency and label adhesion in general. For example, applications using coherent spray nozzles for extended periods of time are more likely to abrade the label ink and/or shear the label off completely (*Figure 1*).

Figure 1: NOZZLE TYPES



In applications using **FAN NOZZLES**, the impingement energy is more evenly dispersed at the point of contact with the label.



In applications using **COHERENT NOZZLES**, the impingement energy is stronger and more direct at the point of contact with the label.

Label failures of ink permanency and label adhesion generally occur with increased ENERGY and extended EXPOSURE TIME.

In each label compatibility study, Kyzen uses standard evaluation parameters for wash concentration, temperature, belt speed and nozzle type. Each label is exposed to four wash passes though spray-in-air cleaning machines to determine ink permanency and label adhesion with reflow and non-reflow conditions. *Table 5* summarizes the scoring matrix used in all label compatibility studies.

Statistical evaluation of individual test parameters contributes to a final recommendation based on overall performance. In order to qualify for recommendation, labels must demonstrate appropriate ink permanency (score ≤3) and label adhesion (score ≤2) for a minimum of three wash passes.

Table 5: Label Study Scoring Matrix

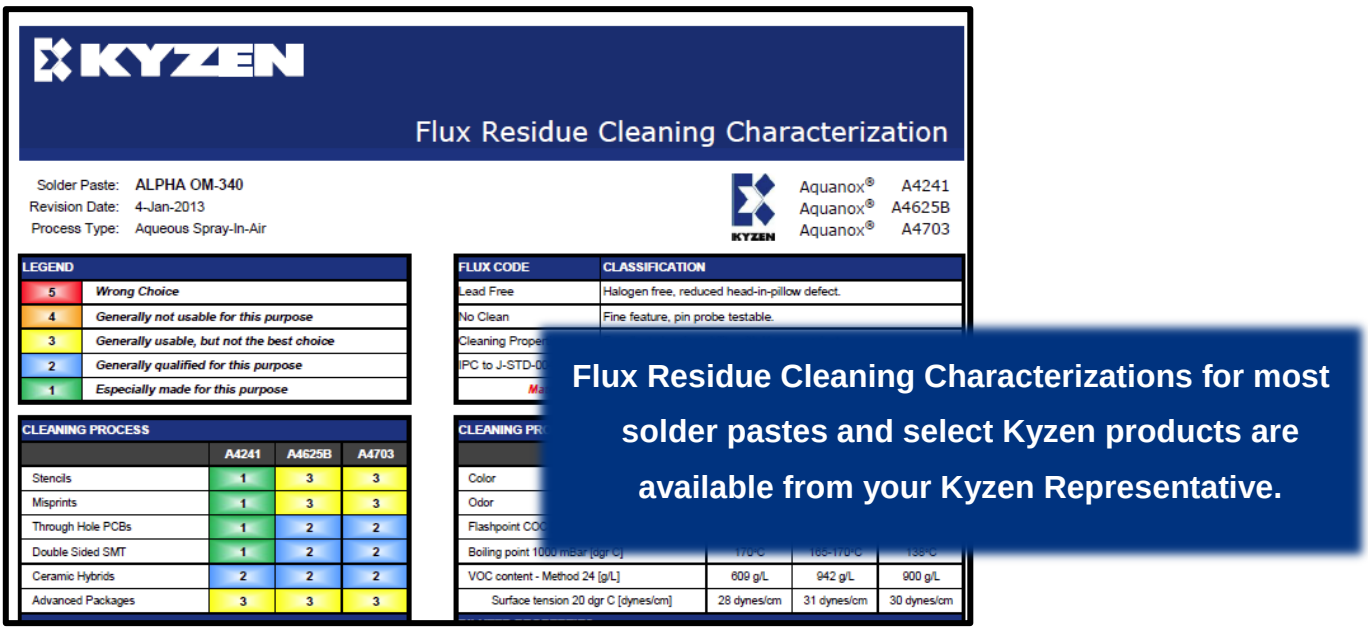
SCORE	INK ADHERENCE	LABEL ADHERENCE
1	No Effect to Ink	Full Adherence
2	Slight Dulling	Peeling at the edges
3	Moderate Dulling	>25% peeling
4	Heavy Dulling	>50% peeling
5	No Ink Remaining	>75% peeling
6	Not Observed	Not Observed (complete shearing)

Please reference the latest revision of the *Kyzen Label Compatibility Supplement* for a listing of labels which qualify for recommendation. Kyzen continues to test a large number of label types from all major label manufacturers and revises this publication on a regular basis. Additionally, your Kyzen Representative is available to assist you in selecting the most appropriate label stock for your particular application. To request a copy of the *Kyzen Label Compatibility Supplement*, please contact your Kyzen Representative.

SOILS REMOVED AND PROCESS LIMITS

An important data point when selecting a cleaning agent is its ability to match up and remove the soil in question. Miniaturization and lead-free soldering are two emerging trends in electronic assembly that have a significant impact on cleaning. Flux compositions must withstand higher soldering temperatures. As components decrease in size, less flux is available to remove oxides, to wet joining alloys and to improve solderability yields. To withstand higher reflow temperatures, flux compositions use higher molecular weight synthetic resins that form a harder resin shell, post soldering.

Kyzen's solubility testing program partners with all major solder paste and flux companies to provide an accurate and predictive method for determining a cleaning agent's effectiveness on a subset of soils.



It is important to recognize that flux materials evaluated by Kyzen have been successfully cleaned only after being applied to the test substrate and reflowed using an appropriate temperature profile. Tests have shown that excessive heat exposure (peak temperature or extended soak / post-bake / multiple reflow cycle) can render an otherwise easy to remove residue, virtually uncleanable. Consideration should also be given to the reflow process parameters when establishing or optimizing your cleaning process. Fluid temperature, spray pressure, nozzle type and impingement angle also have a significant impact on the overall cleaning rate. Kyzen Technical Support can assist in evaluating your equipment so as to determine the optimal process parameters for your specific application.

BATH MAINTENANCE AND MONITORING

When a Kyzen bath solution is properly maintained, prolonged bath life can be expected. The results of a bath life study conducted with this product confirm the extended bath life experienced by many Kyzen users. Actual field results show that this chemistry, when properly maintained, may last indefinitely as most often the bath is changed out due to mechanical reasons, rather than chemical failure.

Kyzen recommends REFRACTIVE INDEX to monitor bath concentration.

Kyzen recommends NON-VOLATILE RESIDUE (NVR) to monitor bath life.

NOTES AND COMMENTS

- Recommended procedures for bath life maintenance and monitoring are appended to this supplement.
- **SPER® Scientific** and **Atago® Pocket Pal-1** refractometers, including full procedures for using these refractometers, are available for purchase through your Kyzen Representative.
- Flux and solder pastes can contribute to Refractive Index readings. Many years of field experience have validated the effectiveness of refractive index to control most Kyzen products. The wide operating window provided by Kyzen technology tends to minimize the induced error that soils create over time. As soil load increases, refractive index charts should be adjusted to reflect the predictable soil levels in your cleaning process. Kyzen's **Bath Profile Kit** can help determine if an adjustment is needed by analyzing wash bath samples collected over the life of a SUMP charge. Please contact your Kyzen Representative for more information.

SHELF-LIFE, PRODUCT COLOR, STORAGE AND HANDLING

SHELF-LIFE

Retain samples are taken from every product batch and kept for a minimum of five years. Additionally, randomly selected retain samples of key products are maintained indefinitely. Kyzen determined the shelf life of our aqueous and non-aqueous products by closely monitoring the quality of product samples stored in these retain samples over time. The results of this study provided valuable information on the stability of our products over time.

With few exceptions*, Kyzen products are acceptable for use up to FIVE (5) years, when packaged in sealed containers of five gallons or greater.

Conversely, it is more difficult to predict the long-term integrity of a product in containers holding less than five gallons, as well as unsealed containers of any size. Smaller product containers and unsealed containers are more susceptible to contamination and evaporation, which preclude extended expiration dates. Capping opened containers when not in use can minimize contamination and evaporation. Exceptions to shelf-live are clearly documented on product-specific Certificates of Compliance.

PRODUCT COLOR

For all Kyzen products, *color does not indicate product quality*; therefore, color is not used as a quality control parameter or specification for final product evaluation. Kyzen products are made from a blend of raw materials, some of which are organic solvents derived from agricultural materials. After 20 years of collecting data on Kyzen products containing these raw materials, studies have shown that these materials can contribute to color variances in concentrated and diluted product, as well as slight color variations over time. These same studies confirm that while *color changes may occur, product quality is unaffected*. To assure product quality, Kyzen evaluates each lot of these raw materials to verify integrity before blending.

STORAGE

Store this product in the original container at temperatures between 5-30°C / 41-86°F indoors, or out of direct sunlight. Most products have a freezing point much lower than water and a very high boiling point; therefore, most Kyzen products do not require any special handling to address temperature changes. Kyzen conducts freeze/thaw studies on all products to determine if product quality is affected by such factors and completes further testing if necessary. Following best practices always use the oldest inventory first and keep your stock rotating. *Exceptions to storage temperature requirements are clearly documented on product-specific Certificates of Compliance.*

HANDLING

This product is environmentally responsible and operator safe, when handled in accordance with good industrial hygiene and safety practices. Refer to the Material Safety Data Sheet (MSDS) regarding safe handling practices with this product. It is always a good practice to wear safety glasses or goggles whenever handling industrial chemicals.

ENVIRONMENTAL CONSIDERATIONS

Kyzen products are generally compatible with common primary and secondary waste treatment processes; however, the addition of soils removed during the cleaning process can significantly escalate environmental concerns. These environmental considerations vary widely depending on the cleaning machine and the operating parameters of your particular cleaning process. As such, the selection of the cleaning agent must incorporate the inherent impact on air emissions, water discharges and waste generation from your facility. Each of these three environmental mediums may require a permit depending on the usage rate and existence of other air emissions, water discharges and waste generation at your facility.

What are Kyzen's responsibilities for proper disposal?

- The *United States OSHA Hazard Communication Standard* requires suppliers to provide a Material Safety Data Sheet (MSDS) for all products.
- Kyzen is responsible for providing known information on toxicity testing, health hazards, waste disposal, safe work practices, protective equipment, material reactivity and flammability, etc.

What are the end user's responsibilities for proper disposal?

- It is the user's responsibility to seek guidance and rule interpretation from appropriate authorities before applying for any required permits. This is usually accomplished by providing a copy of the product MSDS, supplied by Kyzen, to local authorities. Because local regulations are often more stringent than federal regulations, it is imperative for the user to consult with local regulatory agencies before starting a waste water discharge, or introducing new chemicals or chemical processes to an existing permitted waste water discharge stream.
- The three regulatory agencies that a user must review are federal (national), state (regional), and local. Each company must meet the minimum federal standards. The state regulations may be the same or even more restrictive than the federal. Finally, the local community's regulations will be at least as restrictive as state regulations.
- The discharge of any wastewater stream, both by total flow and by chemical make-up must conform to national, regional and local regulations in all nations. Such regulations vary from very strict limits with little derogation to relatively flexible conditions. Many nations, particularly in Europe, have very strict legal requirements dictated on a national scale, covering many aspects of waste water quality. Other nations have less comprehensive regulations, covering only the more important considerations. Local authorities may offer derogations to national legislation if the local treatment plant is able to handle the otherwise out-of-tolerance waste.

The end user is ultimately responsible for compliance with all applicable regulations.

Kyzen is the industry leading provider of environmentally friendly cleaning chemistries and processes and contributes this knowledge and experience to a number of industry publications. For more detailed information on environmental considerations, please reference Section Nine (9) of the *IPC-CH-65B Guidelines for Cleaning of Printed Boards and Assemblies, July 2011.*

APPENDIX

Refractive Index Procedure, Reference Chart

NVR Procedure

Your Kyzen Representative is available to assist you throughout your cleaning process.

Kyzen Technical Support

1-800-845-5524

www.KYZEN.com

Materials furnished under all Kyzen orders are manufactured in accordance with Kyzen Corporation specifications. Kyzen maintains documentation of conformance to these specifications, which is available for review upon request. All raw materials used in Kyzen products are obtained from suppliers on Kyzen's Approved Vendor List (AVL), pursuant to ISO certified standard operating procedures for raw material quality control.

KYZEN

Refractive Index Concentration Chart

AQUANOX® A4639

°Brix	%Concentration
2.8	4.8
3.0	5.2
3.2	5.5
3.4	5.8
3.6	6.1
3.8	6.5
4.0	6.8
4.2	7.1
4.4	7.5
4.6	7.8
4.8	8.1
5.0	8.5
5.2	8.8
5.4	9.1
5.6	9.4
5.8	9.8
6.0	10.1
6.2	10.4
6.4	10.8
6.6	11.1
6.8	11.4
7.0	11.7
7.2	12.1
7.4	12.4
7.6	12.7
7.8	13.1
8.0	13.4
8.2	13.7
8.4	14.1
8.6	14.4
8.8	14.7

°Brix	%Concentration
9.0	15.0
9.2	15.4
9.4	15.7
9.6	16.0
9.8	16.4
10.0	16.7
10.2	17.0
10.4	17.3
10.6	17.7
10.8	18.0
11.0	18.3
11.2	18.7
11.4	19.0
11.6	19.3
11.8	19.7
12.0	20.0
12.2	20.3
12.4	20.6
12.6	21.0
12.8	21.3
13.0	21.6
13.2	22.0
13.4	22.3
13.6	22.6
13.8	22.9
14.0	23.3
14.2	23.6
14.4	23.9
14.6	24.3
14.8	24.6
15.0	24.9

REFRACTIVE INDEX PROCEDURE

This procedure provides an overview of the method used to measure the cleaner concentration based on refraction of light (refractive index).

APPARATUS

Refractometer, Brix Scale, 0 – 15 °Brix

REAGENTS AND MATERIALS

Bath Sample

Plastic dropper

HAZARDS AND PRECAUTIONS

For specific safety information, reference the Material Safety Data Sheet for the product you are testing.

PROCEDURE

1. Taking care not to collect any floating soils, use a dropper to transfer a drop of the well-agitate bath fluid onto the refractometer lens.
2. Hold refractometer up to a light source and read degrees Brix.
3. Determine the concentration by using the chart included at the end of this supplement. Posting this chart in a conspicuous place can serve as quick and helpful reference for your operators.

NOTES AND COMMENTS

SPER® Scientific and **Atago® Pocket Pal-1** refractometers are available for purchase through Kyzen. Full procedures for using these refractometers are also available. Please contact your Kyzen Representative for more information.

NON-VOLATILE RESIDUE (NVR) PROCEDURE

Kyzen recommends Non-Volatile Residue (NVR) testing for soil contaminant as a tool for bath life monitoring of certain Kyzen products. A sample of a used wash bath is placed into an aluminum weighing dish and dried at 105°C / 221°F for a minimum of four hours. The residue that remains in the dish is allowed to cool in a desiccator and is re-weighed. The weight of the bath residue is then compared to the residue of a virgin sample of the cleaning product at the same concentration and dried in the same manner.

APPARATUS

Forced Air Oven set at 105°C / 221°F
Aluminum weighing dish
(See Tip Number 1 'Tips for Successful Use' at the end of the procedure)
Analytical Balance
Desiccator

REAGENTS AND MATERIALS

Transfer pipettes
Virgin sample of the product to be tested

HAZARDS AND PRECAUTIONS

For specific safety information, reference the Material Safety Data Sheet for the product you are testing.

STATISTICAL CONTROL

Samples should be analyzed in triplicate. The average of the three analyses is reported.

CALCULATIONS

%NVR = [(c-a)/b] x 100

a = Initial weight of the aluminum dish, b = Initial weight of the sample, c = Weight of weighing dish and residue after heating

% NVR resulting from soil contamination = %NVR of sample - % NVR of virgin sample

PREPARATION

A. Set the forced air oven to 105°C / 221°F for a minimum of two hours to allow the temperature to stabilize.
B. Place the aluminum weighing dishes to be used into the forced air oven at 105°C / 221°F for a minimum of one hour to dry.
C. Place the dried weighing dishes into a desiccator and allow to cool.

PROCEDURE

A. Place a cool weighing dish on the analytical balance. Record the weight (*this is weight 'a'*).
B. Tare the balance and add approximately 10 grams of sample to the weighing dish [2]. Record the weight of the sample to the nearest 0.0001g (*weight 'b'*).
C. Place the dish in the oven at 105°C / 221°F for a minimum of four hours [3]. Remove the dish to a desiccator and allow to cool.
D. Weigh the cooled dish on the analytical balance and record the weight to the nearest 0.0001g (*weight 'c'*).
E. Repeat Procedure steps A through D a total of three times for both the sample and the virgin product.

TIPS FOR SUCCESSFUL USE

1. A beaker or ceramic dish can be used in place of the aluminum pan; however, these must be compatible with the cleaning product and able to withstand the required oven temperatures.
2. The amount of sample used for testing is not critical, but must be weighed accurately.
3. A dirtier bath will require longer than 4 hours to completely dry. To ensure that your sample is completely dry, return the sample to the oven for 30 minutes after taking the first weight. Cool in the desiccator and reweigh. Continue this until there is less than 5% change in the weight