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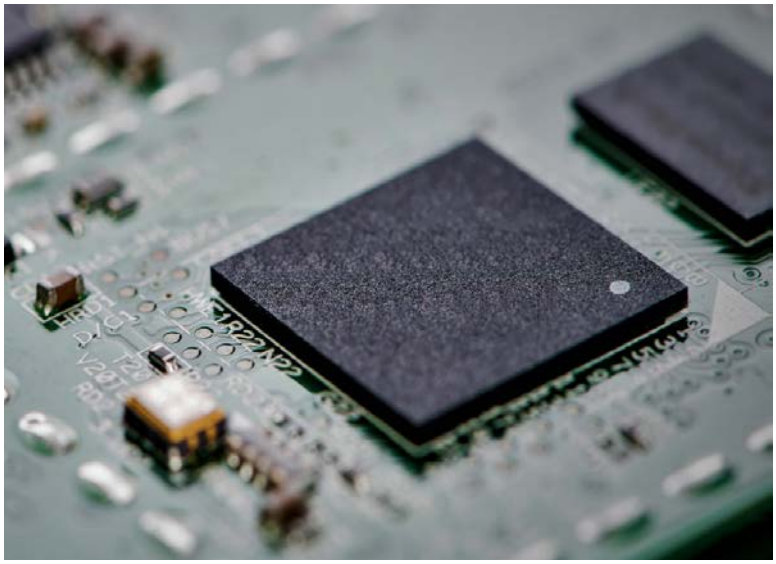
TECHNICAL SUPPLEMENT

AQUANOX® A4382

Organic Acid Residue Cleaning Agent

AQUANOX A4382 is an advanced cleaning agent targeted at organic acid fluxes. De-Ionized water alone results in insufficient or inconsistent cleaning, however, A4382 completely removes all water-soluble residues and other possible manufacturing contaminates. AQUANOX A4382 effectively cleans underneath low standoff or flush mount components.



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PRODUCT DESCRIPTION

AQUANOX A4382 is a near neutral range pH chemistry designed with superior cleaning efficacy with great material compatibility on surface mount assemblies. With smaller form factors (miniaturization) and high reflow processing conditions (lead-free soldering), water soluble flux residues may oxidize and char. When this occurs, highly active flux residues may no longer be easily soluble in hot DI water alone. A4382 most effectively cleans organic acid flux residues at lower concentrations. AQUANOX A4382 effectively cleans under highly dense surface mount components without reacting with exposed metals or damaging substrates.

A4382's intermolecular attractive forces for polar organic acid flux residues allow for rapid dissolution of the flux residue. The surfactant technology engineered into the cleaning agent lowers surface tension to allow the cleaning agent to penetrate the components' Z-axis. The low level of free alkalinity in combination with corrosion inhibition technology protects exposed metals from cleaning agent attack.

Oxidized organic acid flux residues generate an insoluble salt that A4382 dissolves. When comparing AQUANOX A4382 to other aqueous cleaning agents, this product performed exceptionally well. This is due to specifically selecting ingredients that match up to the residues left from organic acid fluxes.

AQUANOX A4382 is formulated as a concentrate. This product is designed to work in spray-in-air aqueous cleaning machines. The concentration needed is typically less than 10%. The product is low in odor and contains no hazardous materials. The product has a wide material compatibility window and is specifically designed for use on printed circuit board hardware.

The product is RoHs compliant and Halogen-free in accordance with RoHS Directive (EU) 2015/863 and EN 14582:2016

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	2% Dilution	6% Dilution
Clarity	Clear		
Color	Straw		
Odor	Mild		
Flash Point, °F/°C (TCC)	>210°F / >99°C		
Boiling Point, °F/C	266°F / 130°C		
Volatile Organic Compound (VOC) gm/L EPA Method 24	901		
Chemical Oxygen Demand, (COD), mg/L (ppm)	TBD		
pH	9.0 - 9.6	9.0 –10.0	
Specific Gravity	0.96		
Weight/gallon	8.0 lbs/gal		
Refractive Index, ° BRIX	54 – 60 °Brix	1.6 °Brix	4.9 °Brix
MEQ to pH 8.3	0.5 – 0.8		
MEQ to pH 4.0	1.05 – 1.15		
NVR	@3.25		

PRODUCT USE DIRECTIONS

AQUANOX A4382 is designed to be used in spray-in-air cleaning machines. Wash concentration, wash temperature, spray impingement energy and wash time are key factors to successful cleaning.

1. **Wash Concentration:** For organic acid flux residues, a concentration range of 3-7% is recommended. If the residues are badly charred, a higher concentration level may be needed.

2. **Wash Temperature**: A wash temperature range of 60-65°C is recommended. The defoaming properties of AQUANOX A4382 are best when operating at 55-65°C wash temperatures.

3. **Spray Impingement**: Spray energy is needed to move the cleaning agent under the flip chip's Z-axis. 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 in-line cleaning machine designs provide high fluid flow and energy. Conveyor belt speeds in the range of 0.5-2.0 FPM work well.

AQUANOX A4382 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 system adds A4382 at the desired concentration levels. KYZEN's PCS Type I (process control system) automatically controls both cleaning agent and water make-up to the wash tank. Maintaining the concentration within the lower and upper set points reduces variability. KYZEN recommends that the wash concentration be monitored using refractive index (see section on monitoring wash concentration).

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 parts and 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. These compatibility recommendations are based on internet research of A4382's major formulation materials and internal KYZEN testing on the product as a whole of commonly available materials. Metals, elastomers and plastics can vary greatly in quality. For the most accurate results on long-term exposure of your materials, it is advised to perform additional testing.

Table 2: Plastics and Elastomers

Brand Name	Generic Description	A4382
Delrin™	Acetal	A
Acrylic	Acrylic	E
Nylon 6/6	Polyamide	B[1]
Lexan™	Polycarbonate resin	E
ABS Plastic	Acrylonitrile butadiene styrene	D
PEEK	Polyetherether Ketone	A
PVC	Polyvinyl Co-polymer	D
Natural Rubber	Black rubber	D
NORYL®	PPO™ resin and polystyrene	D
Neoprene	Polychloroprene	C
PPS (Ryton®)	Polyphenylene sulfide	A
PTFE (Teflon™)	Polytetrafluoroethylene	A
Kalrez® 4079	ASTM D395B: FFKM (FFPM)	A
Kynar™	Polyvinyl fluoride (PVDF)	A
Aflas®	Tetrafluoroethylene and Propylene (TFE,	B
Tefzel™	Ethylene/tetrafluoroethylene copolymer	E
Polypropylene	Polypropylene	A
Hypalon®	Chlorosulfonated Polyethylene (CSPE)	C
Chemraz®	Perfluoroelastomer (FFKM)	A
Alathon™	High density polyethylene	A
Viton A or B	Fluoroelastomer (FKM)	A
Low density polyethylene	Polyethylene	C
Ultem™	Polyether imide	E
Silicone Rubber	Silicone Rubber	C
CPVC	Chlorinated Polyvinyl Chloride	A
Tygon®	Trade Secret	D
Buna-S	Styrene Butadiene	D
Buna-N	Styrene Nitrile Copolymer	D
Kel-F® / Neoflon®	PolyChloroTriFluoEthylene (PCTFE)	A[1]
EPDM	Ethylene Propylene Diene Monomers	B

COMPATIBILITY INFORMATION - SUBSTRATES AND EQUIPMENT

Table 3: Metals and Alloys	
Substrate	**A4382**
2024 Aluminum- Bare	A[2]
2024 Aluminum- Alclad	A
2024 Aluminum- Anodized	A
Black Anodized Aluminum	A
3003, 6061 and 7075 Aluminum	A
7075 Aluminum- Alclad	A
Silver	A
Gold	A
Copper	A
Zinc	E
1018 Steel	E
304 and 316 Stainless Steel	A
Titanium	A
Hastelloy-C®	A
Tin-Lead Based Alloys	A[3]
Tin-Copper Based Alloys	A
Tin-Silver-Copper Based Alloys	A
Bismuth-Tin Based Alloys	A

Ratings - Chemical Effect – 168 hours

***A** - Excellent*
***B** - Good: Minor Effect, slight corrosion, or discoloration.*
***C** - Fair: Moderate Effect, not recommended for continuous use. Softening or loss of strength, and swelling may occur.*
***D** - Severe Effect: Not recommended for any use.*
***E** – Test / Information not available.*

Explanation of Footnotes

1-Satisfactory to 72^{O}F (22^{O}C)

2-Satisfactory to 120^{O}F (48^{O}C)

3-Repeated wash exposure beyond a typical process cycle time can lead to discoloration or etching of the surface.
KYZEN Booster 20 is recommended to dose sump side to minimize any reaction.

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	*CPVC*
PUMP SEALS, O-RINGS, GASKETS	*Teflon, Kalrez® 4079, Viton*
PLUMBING LINES	*SST, PP, Kynar™ , Hastelloy-C®, or CPVC*
CURTAINS	*Viton, EPDM*
WINDOW / DOOR SEALS	*Viton, EPDM*
RTV	*Dow Corning 732 or similar high grade*

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. Expended process baths can be a significant and expensive waste stream for facilities. Numerous factors can degrade bath performance, including depletion or imbalance of bath chemistries and buildup of contaminants from drag-in or other sources. Process bath life can be extended through simple process control and contaminant reduction techniques, resulting in significant waste reductions and cost savings.

KYZEN recommends REFRACTIVE INDEX to monitor bath concentration.

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

There are two NVR methods available; The legacy, oven dry testing method as shown in the Application Note on Page 14 or the newest test method that uses the Mettler-Toledo HE53 Analyzer described on Page 15. Contact KYZEN Technical Support if you have any questions on wash bath monitoring or bath life testing.

NOTES AND COMMENTS:

- Recommended procedures for bath life maintenance and monitoring are appended to this supplement.
- **SPER® Scientific** and **Atago® Pocket Pal-1** brand refractometers, including full procedures for using these refractometers, are available for purchase through your KYZEN Representative.
    - Refractometer 0-20 Brix / PN# A1005
    - Refractometer 0-80 Brix (Dual Scale) / PN# A1002
    - Refractometer Digital Pocket Pal / PN# FF16018
- 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 / PN# F00206 can help determine NVR by analyzing wash bath samples collected over the life of a SUMP charge. Please contact your KYZEN Representative for more information.
- The Mettler-Toledo HE53 Moisture Balance Analyzer and its supporting items can be purchased directly from Mettler-Toledo or an authorized distributor.

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-life 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 25 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 5-50°C / 41-122°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 Safety Data Sheet (SDS) regarding safe handling practices with this product. It is always a good practice to wear nitrile gloves, 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 Safety Data Sheet (SDS) 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.
- Note: All information needed to properly classify a product for disposal, wastewater treatment or discharge into a wastewater stream can be found in the product SDS, specifically in Sections Three (3), Nine (9), Twelve (12) and Thirteen (13). *Therefore, KYZEN does not disclose proprietary, non-hazardous product constituents for this purpose.*

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 SDS, 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 Testing Procedures

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.

APPLICATION NOTE

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 – 10 °Brix or 0 – 80 °Brix (as appropriate)

REAGENTS AND MATERIALS

Bath Sample
Plastic Dropper

HAZARDS AND PRECAUTIONS

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

PROCEDURE

A. 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.
B. Hold refractometer up to a light source and read degrees Brix.
C. 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.

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Refractive Index Chart

AQUANOX® A4382

°Brix	%Conc	°Brix	%Conc
0.2	0.2	6.4	7.8
0.4	0.5	6.6	8.0
0.6	0.7	6.8	8.3
0.8	1.0	7.0	8.5
1.0	1.2	7.2	8.8
1.2	1.5	7.4	9.0
1.4	1.7	7.6	9.2
1.6	1.9	7.8	9.5
1.8	2.2	8.0	9.7
2.0	2.4	8.2	10.0
2.2	2.7	8.4	10.2
2.4	2.9	8.6	10.5
2.6	3.2	8.8	10.7
2.8	3.4	9.0	10.9
3.0	3.6	9.2	11.2
3.2	3.9	9.4	11.4
3.4	4.1	9.6	11.7
3.6	4.4	9.8	11.9
3.8	4.6	10.0	12.2
4.0	4.9	10.2	12.4
4.2	5.1	10.4	12.6
4.4	5.4	10.6	12.9
4.6	5.6	10.8	13.1
4.8	5.8	11.0	13.4
5.0	6.1	11.2	13.6
5.2	6.3	11.4	13.9
5.4	6.6	11.6	14.1
5.6	6.8	11.8	14.3
5.8	7.1	12.0	14.6
6.0	7.3	12.2	14.8
6.2	7.5	12.4	15.1

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APPLICATION NOTE

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 160°C / 320°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 160°C / 320°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 160°C / 320°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 160°C / 320°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 160°C / 320°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

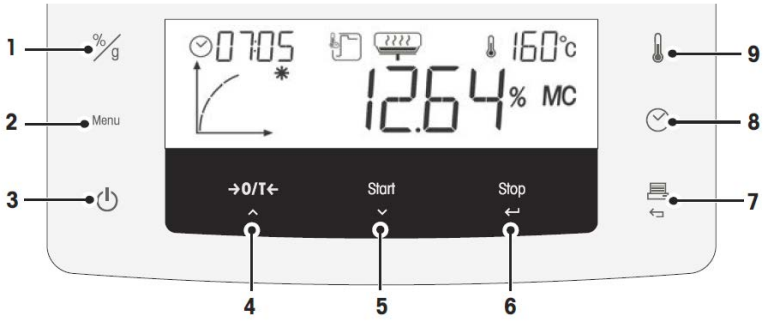
1. A beaker or ceramic dish can be used in place of the aluminum pan; however, these must be compatible with the cleaning product and able to withstand the required oven temperatures.
2. The amount of sample used for testing is not critical, but must be weighed accurately.
3. A dirtier bath will require 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.

APPLICATION NOTE

NVR Measurement by HE53 Moisture Analyzer Method
KYZEN® AQUEOUS PRODUCTS

This Application Note provides instructions on how to use the Mettler Toledo HE53 Moisture Analyzer to measure the Non-Volatile Residue (NVR) of KYZEN® Aqueous Products.

1. Follow instructions in Section 4 of the *HE53 Operating Instructions* to appropriately setup the moisture analyzer and prepare for measurement.
2. Program the moisture analyzer to the settings below to begin the measurement procedure.



   a. Press Menu [2]. Use the Up [4] and Down [5] arrows to select **PROG** and press Stop [6]. Again, using either of the arrows, select **RAPID** and press Stop [6]. This selects the RAPID DRYING MODE.
   b. Press Thermometer [9]. Adjust temperature, using arrows, to **120^{0}C** and press Stop [6].
   c. Press Clock [8]. Use arrows to select **TIMED** and press Stop [6]. Use arrows to adjust to **1 hour** then press Stop [6].
   d. Press %/g [1]. Use arrows to select **%DC** and press Stop [6]. The results will be displayed in % DRY CONTENT.
3. Place the empty sample pan in the sample pan handler and place the sample pan handler in the draft shield. Ensure that the tongue of the sample pan handler lies in the slot of the draft shield.
4. Place the provided Glass Fiber Pad in the sample pan. *Note: the pads are designed for single use and a new pad should be used for each test in ensure accuracy of the test.*
5. Close the heating module and press O/T [4] to tare.
6. Open the heating module cover and add approximately 2 grams of sample directly to the Glass Fiber Pad in the sample pan.
7. Close the heating module and press Start [5]. The **%NVR** results will display on the screen when finished.

Condensation may collect and pool in the chamber- this is normal. Follow instructions in Section 9.1 of the HE53 Operating Instructions to clean and thoroughly dry equipment between each use.