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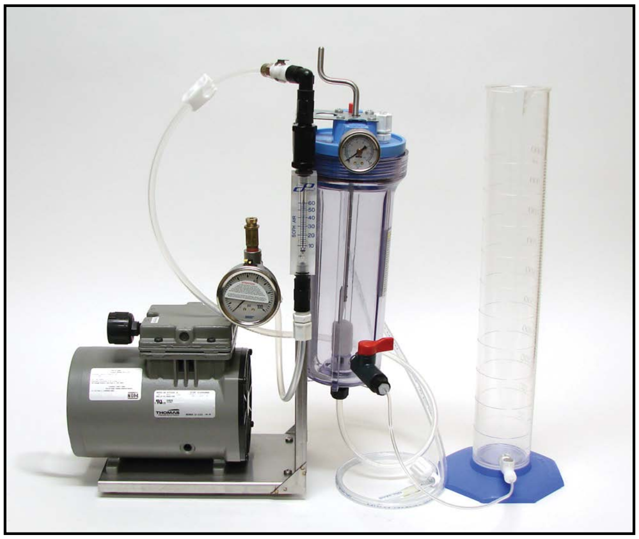

Diffused Air - Dissolved Air Flotation Test Apparatus (DADAFTA)

#298-00:115 Volt

#298-00-1: 230 Volt

Instruction Manual

Updated 10/28/2015

Ver. 3.0

OFI Testing Equipment, Inc.

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Intro

The performance of dissolved air flotation units can be enhanced by the addition of polymers. Polymers can increase solids recovery in the floated sludge from 85% to 99% and also reduce the suspended solids in the subnatant.

Bench testing utilizing the Poly Prep “N” Floc and Diffused Air Dissolved Air Flotation Test Apparatus (DADAFTA) are commonly used to evaluate the performance of a dissolved air flotation unit. Both test apparatus are effective for the purpose of selecting an appropriate polymer product and dosage.

Components

#135-04	External Retainer Ring
#141-22	Felt Filter
#143-01-1	200 PSI Gauge; ⅛" Back Connection
#153-09-2	1,000 mL Graduated Cylinder, PMP Nalgene
#171-90-04	¼" NPT Cross, 316 Stainless Steel
#171-90-12	¼" NPT Male Elbow, 316 Stainless Steel
#298-01	Stainless Steel Stand
#298-02	10" Clear Filter Housing with ⅜" Connection
#298-03	Barb Insert
#298-04	50 mm Flowmeter (0 - 30 SCFH)
#298-06	¼" Straight Coupling, Nylon
#298-07	Reducer Bushing, ¼" × ⅛"
#298-08	¼" Female/Male Elbow; Nylon
#298-09	8 mm Septum
#298-10	Liquidtight Straight Connector
#298-11	Reducer Bushing; ⅜" Male × ⅛" Female
#298-12	Dura Clamp
#298-13	Poly Pak Seal
#298-16	Quick Disconnect Coupling; Barbed Male; 1/16" × ⅛"
#298-17	Quick Disconnect Coupling; Threaded Male
#298-18	Quick Disconnect Coupling; Straight Comp Fit; ⅜" × 0.250"
#298-19	Plastic Pinch Valve
#298-20	Rubber Stopper
#298-21	Pressure Relief Valve; 100 PSI (689.5 kPa)
#298-22	Pump, 115 Volt
#298-22-1	Pump, 230 Volt
#298-23	Reducing Bushing; ⅜" × ¼"
#298-24	Male Pipe Straight Adapter; 5/16" × ¼"
#298-25	Male Pipe Adapter; Elbow; 5/16" × ¼"
#298-26	Acetal Check Valve; ¼" Female × ¼" Female
#298-27	Stopcock Valve; ¼" Male × Female
#298-28	Polyethylene Tubing; 3/16" ID × 5/16" OD; Qty: 5'
#298-29	Polyurethane Flexible Tubing
#298-30	In-Line Hose Barb; 1/16" ID
#298-31	Hose Adapter; 1/16" × ⅛"
#298-32	Stainless Steel Gauge; 100 PSI, 2½" Face; ¼" Back Connection; Glycerine Filled
#298-33	Air Diffuser; 1.5" L × 0.75" W, 3/16" OD; Barbed; 4 mm

Optional:

#291-00	Poly Prep "N" Floc Test Kit
#155-05	Electronic Clock / Timer
#154-22	Pocket Thermometer; 0° – 220°F (-17.7° – 104.4°C)
#147-16-1	Waterproof pH Test

Specifications

Maximum Pressure:	95 PSI (655 kPa)
Temperature Range:	40 – 100°F (4.4 – 37.7°C)
Fluid Capacity:	1,125 mL
Dimensions:	15" × 18" × 8" (38 × 46 × 20 cm)
Weight:	17 lb (7.7 kg)
Shipping Dimensions:	22" × 12.5" × 19" (55.6 × 31.8 × 48.3 cm)
Shipping Weight:	23 lb (10.4 kg)
Power Requirements:	115 Volt, 60 Hz or 230 Volt, 50 Hz

Typical Ranges:

Air to Solids Ratio (A/S):	0.004 – 0.080 mL (air) / mg (solids)
Rise Rate:	0.2 – 4.5 gal / min / ft^2 (9 – 170 L / m^2 / min.)
Recycle Gage Pressure:	40 – 80 PSI (275.8 – 551.6 kPa)
Recycle Rate:	20 – 100% of the influent

Required Reagents & Samples

- Water or wastewater sample that requires liquid/solid separation.
- Primary effluent from the treatment plant's clarifier, or existing DAF.
- Various types of polymers prepared in accordance with manufacturer's instructions.
- Recommended Polymer Preparation Procedure
- A total volume of 1 liter (1,000 mL).

Preparation

1. The DADAFTA procedure uses an effluent recycle method of aeration. Clean effluent is pressurized with air and released into a flotation cell containing fluids with <= 2.0% solids. Using dissolved air flotation at a water or wastewater treatment plant, the recycle rate is the percentage of the pressurized effluent that is to be applied to the influent.

   Example: If treatment plant recycle rate is known to be at 40%.

   1,000 mL × 0.40 = 400 mL

   Required Test Volumes: 600 mL of wastewater
   400 mL of clean effluent to be pressurized

   For evaluation purposes, use the same recycle rate as the treatment plant. If you use the same temperature, air pressure, and suspended solids levels as the plant, the air to solids ratio will also be the same.

2. Record the sample temperature, sample pH, operating pressure, recycle rate, and flotation detention time.

3. Determine the solids concentrations of the sample. Use the procedures in "Standard Methods for the Examination of Water and Wastewater" or refer to the "Formula" section on page 14. This will be used to determine the % solids recovery and to calculate the air to solids ratio (A/S).

4. If you will be using polymers to help reduce turbidity and serve as a flotation aid, run a jar test on the sample.

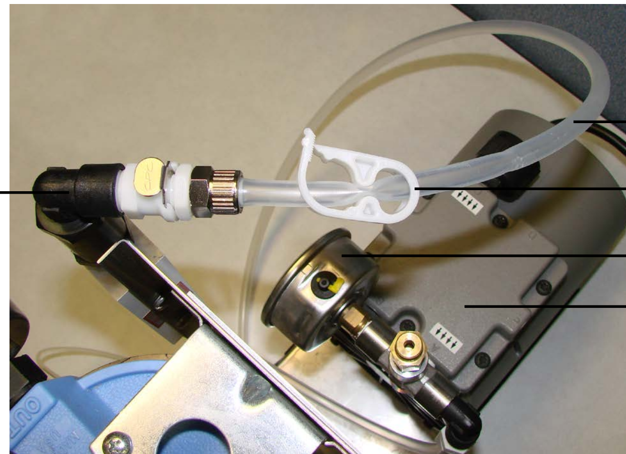
   a. Prepare the various types of polymers in accordance with the manufacturer's recommendations or OFITE Recommended Polymer Preparation Procedure.

   b. Add to each cylinder the amount of water or wastewater that was previously calculated in step 1.

   c. Retain at least the best 3 samples for comparative testing using the DADAFTA.

5. Make sure the air pump on the DADAFTA unit is off and that there is no pressure indicated on the gauges.

6. Disconnect the air inlet tube from the flowmeter at the quick-connect coupling. Close the labcock valve by turning it perpendicular to the direction of flow. Make sure the tube coming out of the labcock valve is disconnected from the graduated cylinder.



7. Remove the cap from the pressure cell.

8. Close the D-clamp on the air inlet tube to prevent the pressure cell from draining.

9. Fill the cell with clean, primary effluent. Use the volume calculated in step 1. Add an additional 120 mL to compensate for the dead space below the labcock valve.

10. Tighten the blue cap into the pressure housing. Make sure the o-ring is seated properly.

11. Open the D-clamp once the air inlet tube is reconnected to the flowmeter.

12. Re-connect the air inlet tube to the flowmeter by inserting the male end of the quick-connect coupling into the female end until the latch clicks.

13. Hang the pressure housing onto the metal frame using the support on the blue cap.

Quick Connect Coupling (Male)

Quick Connect Coupling (Female)

Test Procedure

1. Open the pinch valve at the end of the air outlet tube.

Pinch Valve

2. Turn on the air pump.

   Important

   Do not operate the pump near water or other potential fire hazards.

3. Gradually close the pinch valve until the pressure inside the cell reaches the desired level.

   To determine the appropriate pressure for the test, either use the pressure used at the treatment plant, or calculate it based on the Air to Solids ratio.

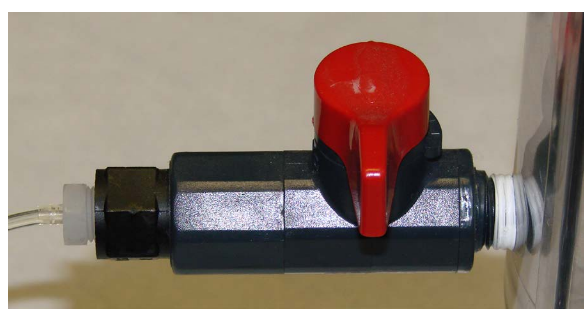
   Important

   Do not exceed 95 PSI in the pressure cell. The pressure relief valve on the pump is set to 100 PSI (689.5 kPa).

   For safety, keep hoses pointed away from people and equipment.

4. Maintain the test pressure for the appropriate retention time. The retention time should be either the recycle retention time at the treatment plant or 7 minutes.

5. Connect the labcock valve to the graduated cylinder with the quick-connect coupling.



Labcock Valve

6. Approximately 30 seconds before the retention time (refer to step 4 above) has elapsed, add to the graduated cylinder the amount of water or wastewater sample calculated in step 1 on page 5.

   Important

   Be careful not to break up any flocked solids in the sample.

7. Open the labcock valve to transfer the air charged recycle water into the graduated cylinder. Use the pinch valve to maintain the pressure in the pressure cell.

8. Close the labcock valve when the volume in the pressure cell approaches the labcock valve.

Important

Do not blow dry air into the graduated cylinder.

9. Turn off the pump and open the pinch valve to release the pressure in the cell.

10. A liquid-solid interface will form where the bottom boundary of the solids meets the top boundary of the dissolved air-fluid phase. Record the height of this interface as it becomes apparent. The position can be noted by using the appropriate graduate on the cylinder as a reference. Continue recording this height periodically for at least 10 minutes. The time being allowed is called the flotation detention time.

Tip

Use the graduates along the side of the graduated cylinder as quick reference points as the liquid-solid interface moves upward. The graduates will be converted to centimeters after the flotation time has elapsed.

If flotation is not complete after 10 minutes, make a note, then change one or more of the test parameters (air pressure, type/amount of flotation aid, recycle retention time, flotation detention time) and run the test again.

Make note of any settling of solids.

11. At the end of the flotation detention time, record the amount of float accumulation in centimeters.

12. Clean the pressure vessel after each use with soap and water. Do not use solvents.

Important

Organic solvents, such as those found in aerosol sprays for cleaning products and insecticides, may weaken the pressure cell, causing it to crack or craze. This can lead to failure or leakage. Store the pressure cell away from direct sunlight.

Data Analysis

Rise Rate

At the beginning of the DADAFTA test procedure, the liquid-solid interface is at the bottom of the graduated cylinder, or at 0 mL. As flotation progresses, the liquid-solid interface should move upward. The graduates should be recorded in mL every minute during the test.

Example :

Time (min.)	Position of Interface (mL)	Increase (mL)	
0	0	0	
1	70	70	
2	250	180	
3	450	**200**	← Highest Increase
4	650	200	
5	820	170	
6	920	100	
7	970	**50**	← Lowest Increase
8	970	0	
9	970	0	
10	970	0	

To calculate the average slope, add the highest and lowest increases and divide by two.

Average Slope = (200 + 50) / 2 = 125 mL/min.

The rise rate, or hydraulic loading rate, can be expressed in ft/minute or gallons per minute/ft^2 (GPM/ft^2).

Convert the average slope to rise rate in GPM/ft^2.

Rise Rate in GPM/ft^2 = (Average Slope / 3,785) / 0.06705

= (125 mL / 3,785) / 0.06705 = 0.49 GPM/ft^2

Data Analysis

Solids Content

After flotation is complete, use a 21-cm stainless steel chemical spoon to carefully withdraw a float solids sample from the graduated cylinder. Determine the total suspended solids using a 10-mL pipet. Be sure to place a finger over the pipet hole while going through the float solids layer. Purge the pipet with air using a pipet safety bulb prior to withdrawal.

Use the Total Solids of Float Solids and the Total Suspended Solids of Subnatant to determine % Recovery.

$$\%R = CK\,(CO - CF) \,/\, CO\,(CK - CF) \times 100$$

Where:

%R = Percent Solids Recovery
CK = Total Solids in Concentrated Sludge (Float, Floating Solids, or Cake)
CO = Total Solids in the Raw Sludge Influent (Sludge sample prior to using DADAFTA)
CF = Total Solids in Subnatant

Determine % recovery for each polymer dose used. Graph the results with polymer dose on the horizontal axis and % recovery on the vertical axis.

Data Analysis

Interpreting Results

The polymer dosage that will provide optimal flotation of the sludge at full scale is assumed to be at the dose giving the maximum rise rate, float solids concentration, and percent recovery. If it is difficult from the results to determine this dose, repeat the procedure using a second set of appropriate doses. The optimum dose can then be converted into a cost for use of this particular polymer, for comparison with other alternatives.

Another method for selecting a polymer is to designate a target Rise Rate or % Recovery. This target is obtained by testing the sludge from the current flotation process when operating at the desired efficiency. When testing other polymers, the **lowest** dose providing this target performance gives the predicted dose that will be required for this product. This required dose, multiplied by product cost, gives the unit cost for this polymer. Unit costs are then compared for all products under consideration.

Note

As with most small-scale tests, the flotation test should not be expected to accurately predict float or subnatant solids levels to be obtained full-scale. However, the procedure may be modified in a variety of ways to improve agreement for a given installation. The air-to-solids ratio, pressure, pressurization time, and flotation time may be fine-tuned to result in a procedure which gives similar results to full-scale. For purposes of predicting the full-scale performance of various polymers, the test conditions should be adjusted in particular so that the polymer in current use is found to have the optimum dose in the flotation test as is observed by varying the dose full-scale.

Alternate Procedure for Diffused Air

Diffused air flotation is used to determine the type and amount of cationic polymer required to improve oil recovery in produced water generated by wells or refineries. Negatively charged particles (oil droplets) will adhere to the bubbles, which are positively charged (cationic polymers) and rise to the surface to form an oil froth.

The produced water sample should contain no more than 4% oil and less than 2% total suspended solids (TSS).

1. Prepare the cationic polymers according to either the manufacturer's instructions or OFITE's recommended polymer preparation procedure as described in the "Poly Prep N Floc" (#291-00) Instructions.

2. Use an OFITE "Poly Prep N Floc" or Phipps and Bird Jar Tester to determine the grade and amount of cationic polymer required to obtain optimum water quality results (turbidity, oil, and grease).

3. Disconnect the air inlet tube from the flowmeter at the quick-connect coupling. Close the labcock valve by turning it perpendicular to the direction of flow. Make sure the tube coming out of the labcock valve is disconnected from the graduated cylinder.

4. Remove the cap from the pressure cell.

5. Close the D-clamp on the air inlet tube to prevent the pressure cell from draining.

6. Add between 500 - 700 mL of produced water.

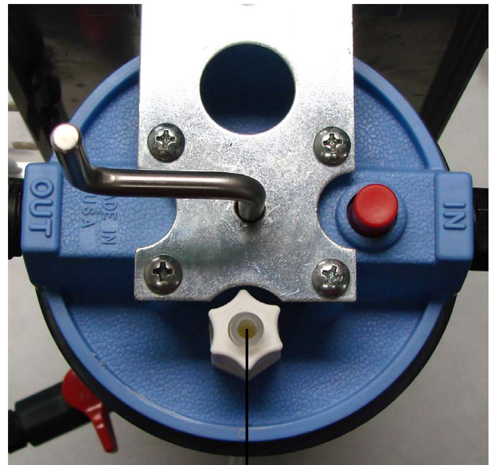
7. Tighten the blue cap into the pressure cell. Make sure the o-ring is seated properly.

8. Re-connect the air inlet tube to the flowmeter by inserting the male end of the quick-connect coupling into the female end until the latch clicks.

9. Open the D-clamp once the air inlet tube is reconnected to the flowmeter.

10. Hang the pressure housing onto the metal frame using the support on the blue cap.

11. Fill a 5 mL disposable syringe with the amount of cationic polymer that developed the best water quality results from the jar testing. Inject the cationic polymer through the septum while the air pump is off.



Septum

12. Open the pinch valve on the vent line.

13. Turn the air pump ON and rotate the stainless steel crank at a rate of approximately 75 to 100 RPM for 2 minutes.

14. Turn the air pump off after 4 minutes.

15. Open the labcock valve to obtain a water sample to conduct water analysis.

16. Clean the pressure vessel after each use with soap and water. Do not use solvents.

Organic solvents, such as those found in aerosol sprays for cleaning products and insecticides, may weaken the pressure cell, causing it to crack or craze. This can lead to failure or leakage. Store the pressure cell away from direct sunlight.

Formulas

Total Solids

Required Apparatus:

Analytical Balance (0.0001g readability)	1 each
50-mL Cylinder	1 each
Desiccant; Indicating Drierite	1 pound
Desiccator without Stopcock	1 each
Aluminum Dish; 57 mm	100 each
25-mL Pipet	2 each
Stainless Steel Crucible Tongs; 9"	1 each
Thermometer (0 – 200°C)	1 each
Gravity Convection Drying Oven - Max. Temp. 200°C 12" W × 10" H × 10" D	1 each

1. Preheat the oven to 300°F (150°C).

2. Label the aluminum dish and weigh it to the nearest 0.1 mg.

3. Mix the sample and add 50 mL to the pre-weighed aluminum dish.

4. Place the aluminum dish and sample inside the oven. Drying will take approximately 6 hours.

5. Remove the dish and sample and immediately place it inside the desiccator with the desiccant. Allow the sample to cool until it reaches room temperature.

6. Remove the dish and sample and weigh them to the nearest 0.1 mg using the analytical balance.

Calculation:

$$\text{Total Solids (mg/L)} = 1000\,(A - B)\,/\,\text{Sample Volume (mL)}$$

Where:

A = Weight (mg) of sample and aluminum dish
B = Weight (mg) of aluminum dish

Formulas

Total Suspended Solids

Required Apparatus:

Analytical Balance (0.0001g readability)	1 each
500-mL Wash Bottle	1 each
50-mL Cylinder	1 each
Watch Glass	3 each
Desiccant; Indicating Drierite	1 pound
Desiccator without Stopcock	1 each
Hand Operated Pump with Gauge and 2' of tubing	1 each
Polypropylene Filtering Flask with Tubulature; 1,000 mL	1 each
Glass Filter Holder for Vacuum Filtration; 47 mm	1 each
Glass Fiber Filter Disk; 47 mm; 1.5 µm	100 each
Stainless Steel Crucible Tongs; 9"	1 each
Stainless Steel Filter Forceps	1 each
Deionized Water	1 gallon
Thermometer (0 – 200°C)	1 each
Drying Oven, Gravity Convection Type - Max. Temp. 200°C 12" W × 10" H × 10" D	1 each

1. Preheat the oven to 300°F (150°C).

2. Place a 47 mm filter disk in the filter holder with the wrinkled surface upward.

   Note

   Always use tweezers to handle glass fiber disks. Fingers add moisture, which can lead to weighing errors.

3. 3. Place the filter holder assembly in the filtering flask and add 100 mL of deionized water. Apply a vacuum to the flask until all the water is drawn through the filter.

4. Remove the filter disk from the filter holder and transfer it to a watch glass.

5. Place the filter disk and sample in a drying oven at 215°F (103°C) for one hour.

6. Remove the disk from the oven and place it in a desiccator. Allow it to cool to room temperature.

   Note

   Use metal tongs to transfer the watch glass and filter disk from the oven directly into the desiccator.

7. Remove the disk from the desiccator and weigh it to the nearest 0.1 mg using an analytical balance.

   Note

   Remove the watch glass and disk from the desiccator as a unit and place them beside the analytical balance. Use tweezers to transfer the disk to and from the weighing pan of the balance.

8. Place the disk in the filter holder/flask assembly with the wrinkled surface upward. Wet the disk with deionized water to make sure it adheres to the holder.

9. Shake or stir the sample well.

10. Filter 100 mL (or more if the solids content is low) by applying a vacuum to the flask. Follow with three separate 10 mL washings of deionized water.

11. Slowly release the vacuum from the filtering system and gently remove the filter disk from the holder. Place the disk on a watch glass. Inspect the filtrate (filtered water in flask) to make sure the solids were properly trapped on the disk.

12. Place the watch glass and filter in a drying oven at 215°F (103°C) for 1 hour.

13. Remove the watch glass from the oven and carefully place it in a desiccator. Allow it to cool to room temperature.

14. Carefully remove the disk from the desiccator and weigh it to the nearest 0.1 mg using an analytical balance.

Note

When removing the desiccator lid, be very careful not to disturb the dried suspended matter on the disk. Remove the watch glass and disk from the desiccator as a unit and place them beside the analytical balance. Use tweezers to transfer the disk to and from the weighing pan of the balance.

Total Solids (mg/L) = (A - B) / Sample Volume (Liters)

Where:

A = Weight (mg) of disk with residue
B = Weight (mg) of disk

Example:

A = 95.5 mg
B = 81.5 mg

(95.5 - 81.5) / 0.1 Liters = 140 mg/L Suspended Solids

Formulas

Air to Solids Ratio (A/S)

$$\text{Air to Solids Ratio (A/S)} = \frac{1.3 s_a (fP - 1) R}{S_a}$$

Where:

s_a = Air Solubility (mL/L)
f = Fraction of Air Dissolved at Pressure (P); usually 0.5
P = Pressure (atm)
= (Gauge Pressure + 14.7) / 14.7 (convert PSI to ATM)
= (Gauge Pressure + 101.35) / 101.35 (convert kPa to ATM)
S_a = Sludge Solids (mg/L)
R = Pressurized Recycle Rate (Million Gallons / Day)

Example:

Flotation thickener with pressurized recycle to thicken the solids in activated sludge mixed liquor from 0.3 to about 4.0%. Assume that the following conditions apply.

Optimum A/S Ratio	=	0.008 mL/mg
Temperature	=	68°F (20°C)
Air Solubility	=	18.7 mL/L
Recycle System Pressure	=	40 PSI (276 kPa)
Fraction of Saturation	=	0.5
Surface Loading Rate	=	0.2 GPM
Sludge Flowrate	=	0.1 Million gallon/Day

Step 1: Determine pressure in atmospheres.

P = (40 + 14.7) / 14.7 = 3.72 atm

Step 2: Determine the required recycle rate:

$$0.008 = \frac{(1.3)\ (18.7\ \text{mL/L})\ [(.5)\ (3.72) - 1]\ R}{(3{,}000\ \text{mg/L})\ (0.1\ \text{Million Gallons / Day})}$$

R = 0.115 Million Gallons / Day

Step 3: Determine the required surface area:

$$A = \frac{\text{Sludge Flow Rate} + R}{(\text{Surface Loading Rate})\ (60\ \text{min / hr})\ (24\ \text{hr / day})}$$

$$A = \frac{215{,}000\ \text{Gallons / Day}}{(0.2\ \text{Gallons / min. / ft}^2)\ (60\ \text{min / hr})\ (24\ \text{hr / day})} = 747\ \text{ft}^2$$

Air Solubility Table:

Temperature, °C (°F)	Air Solubility, mL/L
0.0 (34)	29.2
5.0 (41)	25.5
10.0 (50)	22.6
15.0 (59)	20.2
20.0 (68)	18.2
25.0 (77)	16.5
30.0 (86)	15.1
35.0 (95)	13.9
40.0 (104)	12.8

Warranty and Return Policy

Warranty:

OFI Testing Equipment, Inc. (OFITE) warrants that the products shall be free from liens and defects in title, and shall conform in all respects to the terms of the sales order and the specifications applicable to the products. All products shall be furnished subject to OFITE's standard manufacturing variations and practices. Unless the warranty period is otherwise extended in writing, the following warranty shall apply: if, at any time prior to twelve (12) months from the date of invoice, the products, or any part thereof, do not conform to these warranties or to the specifications applicable thereto, and OFITE is so notified in writing upon discovery, OFITE shall promptly repair or replace the defective products. Notwithstanding the foregoing, OFITE's warranty obligations shall not extend to any use by the buyer of the products in conditions more severe than OFITE's recommendations, nor to any defects which were visually observable by the buyer but which are not promptly brought to OFITE's attention.

In the event that the buyer has purchased installation and commissioning services on applicable products, the above warranty shall extend for an additional period of twelve (12) months from the date of the original warranty expiration for such products.

In the event that OFITE is requested to provide customized research and development for the buyer, OFITE shall use its best efforts but makes no guarantees to the buyer that any products will be provided.

OFITE makes no other warranties or guarantees to the buyer, either express or implied, and the warranties provided in this clause shall be exclusive of any other warranties including ANY IMPLIED OR STATUTORY WARRANTIES OF FITNESS FOR PURPOSE, MERCHANTABILITY, AND OTHER STATUTORY REMEDIES WHICH ARE WAIVED.

This limited warranty does not cover any losses or damages that occur as a result of:

- Improper installation or maintenance of the products
- Misuse
- Neglect
- Adjustment by non-authorized sources
- Improper environment
- Excessive or inadequate heating or air conditioning or electrical power failures, surges, or other irregularities
- Equipment, products, or material not manufactured by OFITE
- Firmware or hardware that have been modified or altered by a third party
- Consumable parts (bearings, accessories, etc.)

Returns and Repairs:

Items being returned must be carefully packaged to prevent damage in shipment and insured against possible damage or loss. OFITE will not be responsible for equipment damaged due to insufficient packaging.

Any non-defective items returned to OFITE within ninety (90) days of invoice are subject to a 15% restocking fee. Items returned must be received by OFITE in original condition for it to be accepted. Reagents and special order items will not be accepted for return or refund.

OFITE employs experienced personnel to service and repair equipment manufactured by us, as well as other companies. To help expedite the repair process, please include a repair form with all equipment sent to OFITE for repair. Be sure to include your name, company name, phone number, email address, detailed description of work to be done, purchase order number, and a shipping address for returning the equipment. All repairs performed as "repair as needed" are subject to the ninety (90) day limited warranty. All "Certified Repairs" are subject to the twelve (12) month limited warranty.

Returns and potential warranty repairs require a Return Material Authorization (RMA) number. An RMA form is available from your sales or service representative.

Please ship all equipment (with the RMA number for returns or warranty repairs) to the following address:

OFI Testing Equipment, Inc.
Attn: Repair Department
11302 Steeplecrest Dr.
Houston, TX 77065
USA

OFITE also offers competitive service contracts for repairing and/or maintaining your lab equipment, including equipment from other manufacturers. For more information about our technical support and repair services, please contact techservice@ofite.com.