NEW YORK CITY
ENVIRONMENTAL PROTECTION
BUREAU OF WASTEWATER TREATMENT

DIVISON OF PROJECT COORDINATION
AND CONTRACT MANAGEMENT

BEDC COORDINATION AND
PROJECT DEVELOPMENT SECTION

PERFORMANCE EVALUATION REPORT OF STAMFORD SCIENTIFIC INCORPORATED (SSI) MEMBRANE DISC DIFFUSERS AT BOWERY BAY WWTP

June 2017

TABLE OF CONTENTS

TEST INFORMATION

Equipment: Stamford Scientific Incorporated (SSI) Fine Bubble Membrane Disc Diffusers

Location: Bowery Bay WWTP Aeration Tank #6, Pass C

Manufacturer: Stamford Scientific Aeration Incorporated
4 Tucker Drive
Poughkeepsie, NY 12603
Phone: (845) 454-8171
Fax: (845) 454-8094

Equipment: Polytetrafluoroethylene (PTFE) coated Ethylene Propylene Diene Monomer (EPDM) compression-molded ultra-fine 9-inch bubble disc membranes, model AFD270.

Witnesses: Charles Ofili - NYCDEP
Shanna Palmer, P.E. – NYCDEP
Yuklong Ma, P.E. - NYCDEP
Eric Klee, Plant Chief – NYCDEP / Bowery Bay (BB) WWTP
Yue Yue Guo, Process Engineer – NYCDEP / BB WWTP
Joseph Polomene, P.E., Sherwood Logan & Associates, Inc.
Tom Devine – SSI
Tom Frankel – SSI
Larry Brincat – L-C-M Enterprise

BACKGROUND

Activated sludge secondary treatment occurs in aeration tanks to remove pollutants from wastewater. Each aeration tank has multiple passes with aerobic and anaerobic zones separated by baffle walls. The anaerobic zones have mixers and/or coarse bubble diffusers to keep solids in suspension, while the aerobic zones have fine bubble diffusers to effectively transfer oxygen into solution. Alternating the aerobic/anaerobic zones and controlling oxygen transfer are process control mechanisms used to achieve treatment targets.

Air is supplied at the aerobic zones via fine bubble membrane or ceramic diffusers, which are connected to lateral air piping. These laterals are connected to drop leg pipes that are in turn connected to the plant air header. The oxygen from the air facilitates the selective growth of certain bacteria and other organisms that consume suspended and dissolved organic material in the wastewater.

Reliable and effective membrane diffusers are vital to the removal of organic material to meet regulatory requirements in an efficient manner. They have significant O&M impact since process blowers and aeration are the largest energy loads in a wastewater treatment plant. Also, the large quantity of diffusers in a plant represents a maintenance challenge.

About 1,400 fine bubble membrane diffusers supplied by Stamford Scientific Incorporated (SSI) were installed in Aeration Tank 6, Pass C of the Bowery Bay Wastewater Treatment Plant to replace existing membranes (Figure 1). The purpose of the equipment evaluation was to determine the ability of the new diffusers to provide consistent and efficient oxygen transfer, while maintaining their durability in the application environment.

Over a year of testing, the SSI fine bubble membrane diffusers provided effective oxygen transfer in the aeration tank. The diffusers were inspected and proved durable with minimal deterioration in material and performance characteristics. The SSI membrane diffusers are considered acceptable for use in BWT wastewater facilities.

Figure 1: SSI Membrane Diffusers installed in Pass C of Aeration Tank at Bowery Bay Wastewater Treatment Plant

EQUIPMENT SPECIFICATIONS

The SSI membrane disc diffusers are advertised as capable of high Oxygen Transfer Efficiency (OTE) by providing uniform fine bubble air diffusion, are easy to install, and have low head loss. The test membranes are made of EPDM with the exposed face coated with PTFE. PTFE is considered to have broad spectrum resistance to chemicals, solvents, fats, greases, etc. The catalog cuts are included in the Appendix. Material specifications of the PTFE coated EPDM membrane are stated in Table 1.

Table 1: Equipment Specification

Items	**PTFE coated membrane**
Manufacturer	SSI
Model	AFD270
Bubble Size(1mm slits)	1- 3mm
Chemical Resistance	PTFE offers better chemical resistance than EPDM
Resistance to Stick	Sludge stuck to PTFE is easier to remove thereby reducing fouling and scaling
Diameter (in)	9
Weight (lbs)	1.5
Friction Coefficient	0.09
Oil Content (%)	Compression Molded EPDM < 12
Hardness, Shore A Durometer Scale (ASTM D2240-95	61 +/- 5
Tensile Strength psi (ASTM D412-92)	> 2,000
Ultimate Elongation, % (ASTM-D412-92)	> 600
Tension Set @ 100% Elongation, % (ASTM D412-92)	> 1.7
Tear Strength (ASTMD624-91)	> 60
Design Flow (SCFM)	1.5 – 3.0
Flow Range (SCFM)	0 – 7
Active Surface Area (Sq. Ft)	0.4100
Perforation / Slit Quantity	>= 6,600

PERFORMANCE

As part of the testing protocol, the membranes were physically measured and inspected before and after use to determine durability. Prior to installation at BB WWTP, five (5) new SSI test diffuser disc membranes were provided to an independent test company, Redmon Engineering Company (REC), for pre-characterization. The retaining rings of the five (5) disc membranes were painted green (see Figure 2) to be able to identify them for post-test characterization. These five (5) membranes were randomly placed with the rest of the test membranes in Pass C of AT #6. Three (3) of the pre-characterized membranes were returned to REC for further study, after the end of the one year test. See Tables 2A and 2B for the laboratory results of the test conducted by REC.

DEFINITIONS:

Dynamic wet pressure (DWP): the pressure differential (or head loss) across the diffuser at various airflow rates while operating under water

Effective flux ratio (EFR): the ratio of effective air flux divided by the apparent flux.

Standard oxygen transfer efficiency (SOTE): fraction of oxygen in an input airflow dissolved under standard conditions of 68 deg. F, 1 atm pressure, zero salinity and zero dissolved oxygen in water.

Standard cubic feet of air per minute (SCFM): airflow rate at standard atmospheric pressure and temperature.

Table 2A: SSI Membrane Disc Diffusers at Bowery Bay WWTP. Performance Comparison of New, Used, and Cleaned Diffusers.

Diffuser No.	Description	DWP				EFR	Ratios of Flux			SOTE cw %
		@ 0.75 CFM	@ 1.0 CFM	@ 2.0 CFM	@ 3.0 CFM	@ 1.0 CFM	Center Overall	Intermed Overall	Outer Overall	@ 1.0 CFM
B38-21-1	New	12.00	12.30	14.30	17.00	1.070	0.91	1.10	0.53	20.65
	Used (as received)	15.15	15.85	18.25	20.15	1.085	1.02	1.02	0.84	22.00
	Scrubbed Clean*	14.85	15.55	17.45	19.45	1.121	1.03	1.01	0.90	21.60
B38-21-4	New	13.20	14.10	17.10	20.30	1.088	0.58	1.08	1.00	19.00
	Used (as received)	15.85	16.85	20.75	23.45	1.126	0.58	1.09	0.95	20.50
	Scrubbed Clean*	15.05	15.95	18.85	21.85	1.113	0.72	1.09	0.79	20.90
B38-21-5	New	12.8	13.10	15.60	18.20	1.056	0.81	1.09	0.67	19.85
	Used (as received)	14.75	15.75	18.75	22.65	1.100	0.80	1.02	1.09	20.35
	Scrubbed Clean*	13.65	14.45	17.45	20.15	1.077	0.90	1.08	0.65	20.35

*The Scrubbed Cleaned condition is not reasonably achievable in the field. It is included here for information use only

Based on the results listed in Table 2A, the following were observed:

1. The increase in DWP values between "Used" and "New" conditions in Table 2A suggests some fouling and scaling of the diffusers during the test period.
2. The EFR values of the "New" diffusers deviated 6 to 9% from 1.0. The EFR values of the "Used" deviated 9 to 13%. This again suggests minor fouling and scaling.

The laboratory data for both the DWP and EFT parameters indicate some fouling of the diffusers occurred after operating for more than a year, however it was not significant to impact the functionality of the diffusers.

Table 2B: SSI Membrane Disc Diffusers at Bowery Bay WWTP. Physical Characteristic Changes of New, Used, and Cleaned Diffusers.

Diffuser No	**B38-21-1**	**B38-21-1**	**B38-21-4**	**B38-21-4**	**B38-21-5**	**B38-21-5**
Description	**Used**	**New**	**Used**	**New**	**Used**	**New**
Weight (grams)	150.00	148.80	153.75	153.90	149.40	149.70
Specific Gravity	1.099	1.098	1.098	1.098	1.099	1.098
Durometer	65.63	63.88	65.88	63.25	65.00	63.50
Thickness (in) Avg. x	0.075	0.076	0.083	0.084	0.075	0.077
Thickness s/x	0.081	0.082	0.121	0.125	0.082	0.09
Permanent Set (in)	3.524	3.525	3.522	3.516	3.488	3.481
Centermost Rows Measured	1st to last row	1st to last row	1st to last row	1st to last row	1st to last row	1st to last row
	Percent change from new		**Percent change from new**		**Percent change from new**	
	B38-21-1		**B38-21-4**		**B38-21-5**	
Weight (grams)	0.81%		-0.10%		-0.20%	
Specific Gravity	0.09%		0.00%		0.09%	
Durometer	2.74%		4.16%		2.36%	
Thickness (in) Avg.	-1.32%		-1.19%		2.60%	
Permanent Set (in)	-0.03%		0.17%		0.20%	

Based on the results listed in Table 2B above, the following were observed:

1. There was negligible change in membrane density, indicating a very slight absorption of substance from the mixed liquor.
2. Changes in Durometer hardness ranged from 2.36% to 4.16%, suggesting small leaching of oil or plasticizer from the membrane or absorption of substance.
3. The change in thickness percentage ranged from 1.19% to 2.60%, also suggesting minimal leaching of plasticizer of the membrane or absorption of substances.

The laboratory data showed minor changes in membrane density, hardness, and thickness and did not significant affect the performance of the diffusers.

The air dispersion patterns in the aeration tanks were also monitor for uniformity. Spots with large bubbling would have been an indication of a piping or diffuser blow-out. During the test period, the dispersion patterns were uniform. Subsequent dropping of the tank for inspection confirm that the diffusers did not suffer any blow-outs.

The SSI PTFE coated EPDM membranes performed adequately in the wastewater environment by providing a consistent supply of air for the treatment process and maintaining its durability over

the test period without failures. On the final inspection, the membranes in the aerobic zones were washed to remove sludge film (see Figure 4). It did not appear that the PTFE coating prevents the sludge from coating the membrane, but it may have made it easier to remove when it was hose washed. In the anaerobic zones, sludge was observed to have deposited on top the membranes (see Figure 5). The higher sludge deposits are expected because of reduced mixing in this zone compared to the aerated zones.

Visual inspection of the test membranes after they were washed and removed, did not show any appreciable signs of creep, slit / slit distortions, shrinkage, or loss in elasticity (see Figures 6 and 7). Subsequent laboratory measurement confirm that only minimal change in physical characteristics occurred.

Figure 3: Marked membrane removed from base in aerobic zones for inspection and after spray washing

Figure 4: Membranes being sprayed to remove sludge film in aerobic zones.

Figure 5: Settled sludge on membranes in anaerobic zones.

Figure 6: Close up of removed pre-marked tested PTFE face of membrane for inspection and after spray washing.

Figure 7: Close up of removed backside of pre-marked membrane for inspection and after spray washing.

CONCLUSIONS

The Stamford Scientific Incorporation membrane disc diffusers successfully completed their equipment performance evaluation in an Aeration Tank 6 at Bowery Bay WWTP. The diffusers supplied the appropriate level of air/oxygen for process treatment needs, while also maintaining its durability in activated sludge application environment. Therefore, the Stamford Scientific Incorporated membrane diffusers are considered acceptable for use in the BWT wastewater facilities.

APPENDIX I: CATALOG CUTS

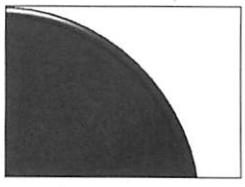
TECHNICAL DATA SHEET

SSI™ FINE BUBBLE DIFFUSERS

AFD270 9" DISC

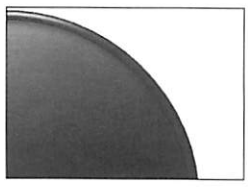
- Highest possible quality and technology means years of trouble-free efficient operation.
- Highest possible SOTE independently tested per ASCE, and lowest possible headloss.
- Industry Standard Size and Shape. Membranes are interchangeable with (3) other manufacturers.
- Experienced Engineering and Drafting staff with years of practice to assist you.
- Simple and quick installation with QC Saddle or Grommet.
- 212º F (100º C) temperature resistance and environmentally-friendly polypropylene body.
- Compression-molded membranes with individual thermocouples in each cavity = 100% quality control.
- Each membrane checked for even perforation depth to ensure uniform air release.
- Low membrane plasticizer content to reduce shrinkage and hardening, but enough to avoid creep.
- Multiple integral check valves keep your aeration piping system clean.
- 21st century-special materials, such as PTFE, fEPDM, as well as reinforced and coated ultra fine bubble membranes for outstanding chemical or fouling resistance, or for the highest oxygen transfer efficiency at a headloss you can live with.
- In stock on 3 continents in 4 locations.

MEMBRANES



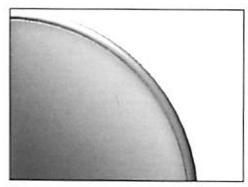
EPDM

- Excellent conventional material
- No encapsulation



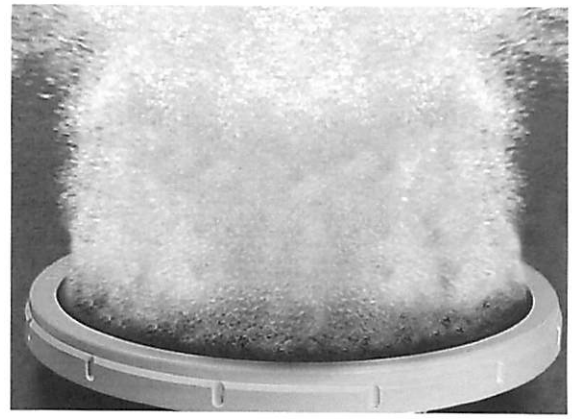
fEPDM

- Superior chemical resistance
- Complete surface and slit encapsulation



PTFE

- Best fouling resistance
- Non-stick coating
- Surface encapsulation



Please see reverse for additional technical data

STAMFORD SCIENTIFIC INTERNATIONAL
INCORPORATED

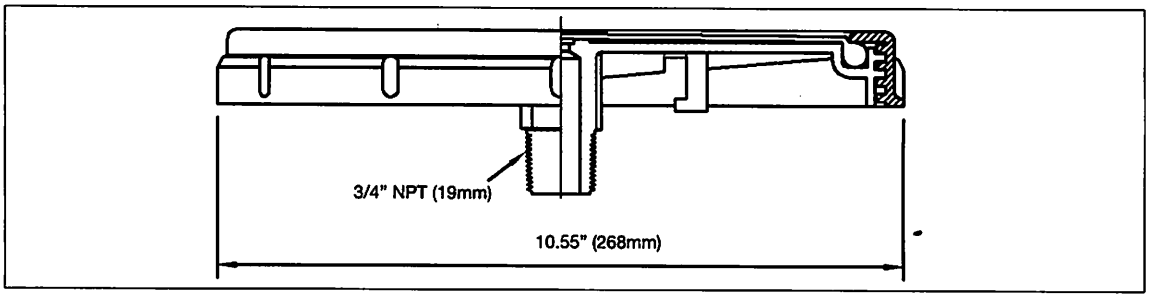
+1-845-454-8171 TEL
+1-845-454-8094 FAX

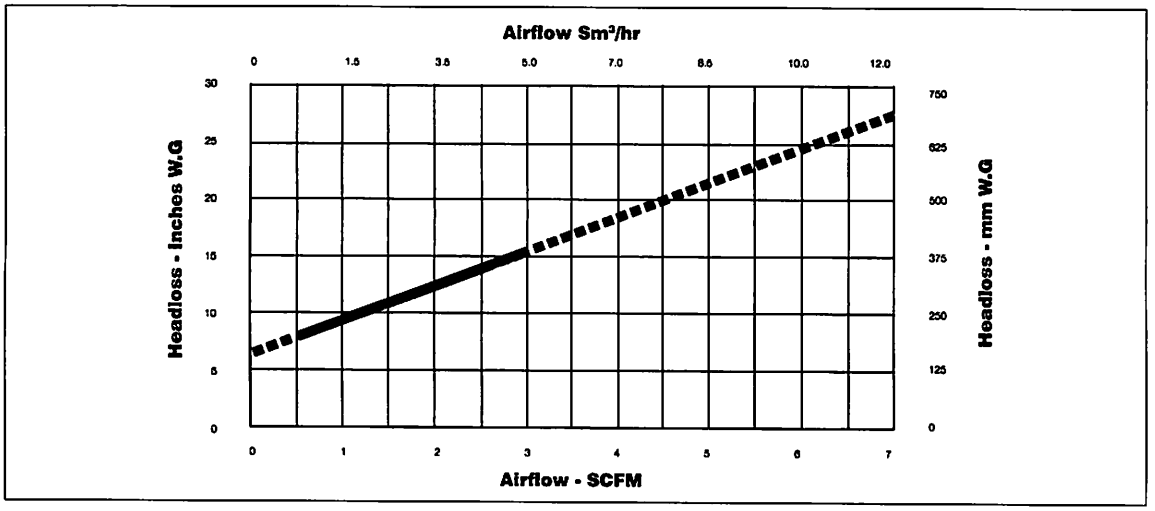
4 TUCKER DRIVE
POUGHKEEPSIE, NEW YORK 12603 USA
www.StamfordScientific.com
EMAIL: INFO@STAMFORDSCIENTIFIC.COM

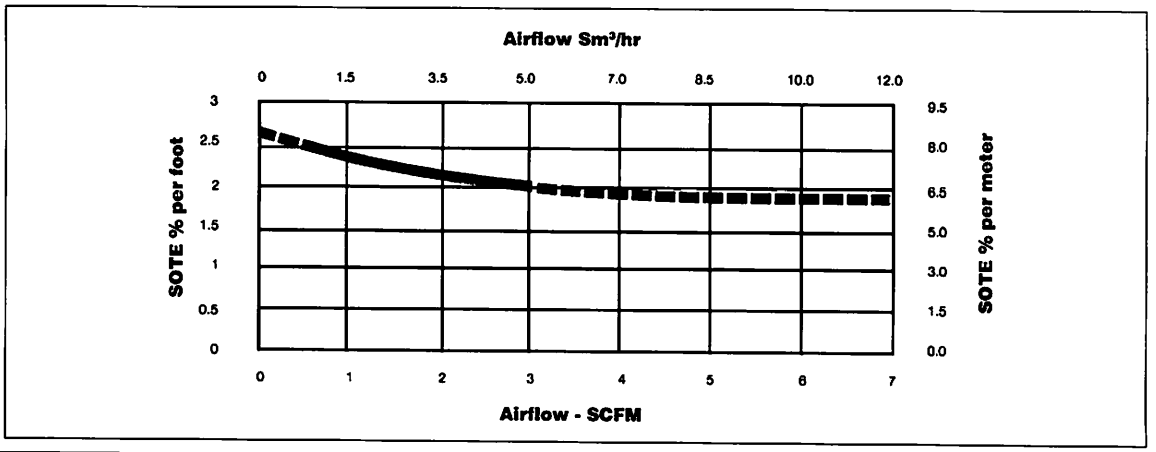
TECHNICAL DATA SHEET

SSI™ FINE BUBBLE DIFFUSERS *continued*

AFD270 9" DISC







DESIGN FLOW	FLOW RANGE	ACTIVE SURFACE AREA	SLIT QUANTITY	WEIGHT
1.5 - 3.0 SCFM (2.5 - 5.0 Sm^3/hr)	0 - 7 SCFM (0 - 12 Sm^3/hr)	0.4100 ft^2 (0.0375 m^2)	6,600	1.5 lbs (680.0 g)

STAMFORD SCIENTIFIC INTERNATIONAL
INCORPORATED

+1-845-454-8171 TEL
+1-845-454-8094 FAX

4 TUCKER DRIVE
POUGHKEEPSIE, NEW YORK 12603 USA
www.StamfordScientific.com
EMAIL: INFO@STAMFORDSCIENTIFIC.COM