Mónashell Data Sheet

Product Overview

"Anua Clean Air International offer proven, patented clean air bio-technologies, which provide best-in-class process performance with the lowest utility and life cycle costs"

The Mónashell biofiltration system is a proven and cost-effective alternative to chemical scrubbing or carbon adsorption, designed like a Biotrickling system yet incorporating many benefits of traditional biofilters.

Figure 1 - Monashell OCU in Cavan WWTP, Ireland

The shell-based media is sustainable and renewable with the ability to maintain a neutral pH within the biofilter. This ensures optimal odour performance across a broad range of odour producing compounds, while simplifying operation and enhancing system reliability.

Control of odour-causing compounds emitted from wastewater and industrial treatment processes has become a growing area of concern.

As populations grow and housing encroaches on once-remote treatment facilities, the importance of effective, yet simple odour control technology will continue to increase. In addition, odourous compounds can be corrosive to equipment requiring ventilation to extend equipment life and reduce capital replacement expenditure.

Mónashell Biofiltration Benefits Over Other Biofilters:

- ✓ Treats high and variable concentrations of H_2S and a broader range of organic sulphides.
- ✓ Up to 67% footprint reduction compared to conventional biofilters due to higher efficiencies, reduced contact time, and deeper filter bed.
- ✓ No short circuiting or channelling through media.
- ✓ High porosity, low pressure drop, low energy requirement.
- ✓ Lower water consumption: water recirculation conserves H_2O.
- ✓ No nutrient addition

Over carbon and wet scrubbers:

- ✓ Low pressure drop, low energy costs.
- ✓ Lower media replacement costs.
- ✓ Eliminates need for chemicals.
- ✓ Sustainable process uses naturally occurring recovered media
- ✓ Effective on highly variable inlet conditions.
- ✓ Lower operating and maintenance costs.

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Mónashell Data Sheet

Treatment Details and Product Selection Considerations

Mónashell Single Stage Treatment and Product Selection Considerations		
Compound	**Concentration Range**	**Removal Efficiency**
Odour	1000 - 100,000 OU_E	98% +
H_2S	0-50ppm (100 ppm max)	98% +
VOC's	0 - 200 mgC/m^3	50% - 80%
Reduced Sulphur Compounds	0 -30 ppm	95%
Amines	0 - 5 ppm	95% +
Ammonia	0 -30 ppm	95%
Typical design contact times.	25 to 55 seconds	
Water Consumption per kg H_2S.	0.4 m^3	
Typical Media Life.	5 years	
Typical Pressure Drop per m^3.	50 pa	
Comments on Selection of Technology	In general for ideal airstreams with moderate levels of H2S, VOC, reduced sulphur, and ammonia.	
Comments on Life Cycle Cost	Low water consumption, low pressure drop and no requirement for carbon polishing gives very low life cycle cost	

Figure 2 - Mónashell Single Stage

Mónashell EBF Treatment and Product Selection Considerations		
Compound	**Concentration Range**	**Removal Efficiency**
Odour	1000 - 40,000,000 OU_E	99.9% +
H_2S	0 - 2000 ppm (4000 ppm max)	99.9% +
VOC's	0 - 1000 mgC/m^3	90 - 95%
Reduced Sulphur Compounds	0 - 500 ppm	99%
Amines	0 - 50 ppm	98% +
Ammonia	0 - 100 ppm	98%
Typical design contact times.	36 to 90 seconds	
Water Consumption per kg H_2S.	0.4 m^3	
Typical Media Life.	2 - 5 years	
Typical Pressure Drop per m^3.	250 pa	
Comments on Selection of Technology	This technology was developed for high high levels of H2S and VOC's generally used for industrial process emissions	
Comments on Life Cycle Cost	Low life cycle costs for high high VOC and H2S emissions when benchmarked against chemical scrubbers and Thermal oxidisers	

Figure 3 - Mónashell EBF

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Treatment Details and Product Selection Considerations

Mónashell Dual Pass Treatment and Product Selection Considerations		
Compound	**Concentration Range**	**Removal Efficiency**
Odour	1000 - 4,000,000 OU_E	99% +
H_2S	0 - 200 ppm (500 ppm max)	99.5% +
VOC's	0 - 400 mgC/m^3	85 - 95%
Reduced Sulphur Compounds	0 - 100 ppm	98%
Amines	0 - 20 ppm	98% +
Ammonia	0 - 50 ppm	98%

Typical design contact times.	18 to 36 seconds
Water Consumption per kg H_2S.	0.4 m^3
Typical Media Life.	5 years
Typical Pressure Drop per m^3.	100 pa
Comments on Selection of Technology	In general ideal for high strength airstreams where two stages of treatment required (no requirement for carbon polishing.
Comments on Life Cycle Cost	Dual pass negates the requirement for Carbon polishing so low running cost due to this and low water and power consumption for Monashell

Figure 4 - Mónashell Dual Pass

Mónashell Dual Pass/Dual Media Treatment and Product Selection Considerations		
Compound	**Concentration Range**	**Removal Efficiency**
Odour	1000 - 4,000,000 OU_E	99% +
H_2S	0 - 200 ppm (1000 ppm max)	99.5% +
VOC's	0 - 400 mgC/m^3	85 - 95%
Reduced Sulphur Compounds	0 - 100 ppm	98%
Amines	0 - 20 ppm	98% +
Ammonia	0 - 50 ppm	98%

Typical design contact times.	18 to 36 seconds
Water Consumption per kg H_2S.	0.4 m^3
Typical Media Life.	8 years
Typical Pressure Drop per m^3.	75 pa
Comments on Selection of Technology	Ideal for high strength H2S airstreams where two stages of treatment and a long media life is required (no requirement for carbon polishing)
Comments on Life Cycle Cost	Similar performance to dual pass but media life enhanced by use of denser shells in first stage so lower running cost due to less frequent media replacement

Figure 5 - Mónashell Dual Pass/Dual Media

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Treatment Details and Product Selection Considerations

Application	Odour		H_2S		VOC's		Reduced Sulphur		Amines		Ammonia	
ACAI Technology	Odour [Inlet Concentrations] [Ou_E]	Removal Efficiency [% $_{OuE}$]	H_2S [Inlet Concentrations] [ppm]	Removal Efficiency [% $_{H2S}$]	VOC's [Inlet Concentrations] [mgC/m^3]	Removal Efficiency [% $_{g.C/m3}$]	DMS [Inlet Concentrations] [ppm]	Removal Efficiency [% $_{H2S}$]	Amines [Inlet Concentrations] [ppm]	Removal Efficiency [% $_{ppm}$]	Ammonia [Inlet Concentrations] [ppm]	Removal Efficiency [% $_{ppm}$]
Mónafil	1000 - 50,000	95% +	0 - 30ppm (50 ppm max)	98% +	0 - 100	50%	0 -10	90%	0 - 10	99% +	0 - 20	98%
Mónashell [Single Stage]	1000 - 100,000	98% +	0 - 50 ppm (100 ppm max)	98% +	0 - 200	50 - 80%	0 - 30	95%	0 - 5	95% +	0 - 30	95%
Monashell EBF	1000 - 40,000,000	99.9% +	0 - 2000 ppm (4000 ppm max)	99.9% +	0 - 1000	90 - 95%	0 - 500	99%	0 - 50	98% +	0 - 100	98%
Monashell Dual Pass	1000 - 4,000,000	99% +	0 - 200 ppm (500 ppm max)	99.5%+	0 - 400	85 - 95%	0 - 100	98%	0 -20	98% +	0 - 50	98%
Monashell Dual Pass/Dual Media	1000 - 4,000,000	99% +	0 - 200ppm (1000 ppm max)	99.5%+	0 - 400	85 - 95%	0 - 100	98%	0 -20	98% +	0 - 50	98%
CrumRubber	1000 - 10,000,000	90% +	0 - 500 ppm (1000 ppm max)	95% +	0 - 100	50%	0 - 50	85%	0 -10	98% +	0 - 20	95%
Hybrid Multi-Media Multi-Stage [Crumb Rubber/Shell Media]	1000 - 20,000,000	99.9% +	0 - 1000 ppm (2000 ppm max)	99.9%+	N/A	50 - 80%	0 - 100	98%	0 -20	98% +	0 - 50	98%
CrumRubber [Biogas/Landfill Gas]	N/A	N/A	0 - 2000 ppm (4000 ppm max)	85-95%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lava	1000 - 50,000	95%	0 - 30ppm (100ppm max)	98%+	0 - 50	20 - 50%	0 - 10	90%	0 - 5	90%	0 - 20	80%
Woodchip	1000 - 20,000	85%	0 - 10ppm (30ppm max)	90%+	0 - 100	50%	0 - 5	80%	0 -5	90%	0 - 30	90%

Table 1 - Anua Clean Air Product/Treatment Matrix

Monashell Single Stage.

The original Monashell Single stage technology was developed around the use of Mussel shells which are a highly reactive shell and have excellent removal characteristics for Sulphur compounds. The process is configured as a Biotrickling filter with continuous recirculation of the irrigation water with a small purge to prevent excessive build-up of Salts in the water. The shells release calcium carbonate to neutralise sulphate and nitrate, these are acidic compounds produced from the biological oxidation of odourous inorganic compounds such as hydrogen sulphide and ammonia. Because of this the pH is maintained close to neutral and the system can simultaneous remove and treat organic sulphur compounds and VOC's in a single stage. This is critical for good odour removal. Because of the naturally affinity the media has for Sulphur we can treat significantly higher levels in smaller filters, this significantly reduces foot print and capital cost, in additions the media has very low pressure drops and the water consumption is only a fraction of conventional inert bio trickling filters. The media is consumed over its life span and the typical design media life is five years minimum.

Typical applications:

- ✓ Pumping Stations
- ✓ Inlet Works Filter Press Rooms etc.
- ✓ Industrial Waste Water Applications with H_2S and low level VOC's.

Monashell Dual Pass.

Following the development of Monashell EBF where it was established that higher air face velocities can increase removal and elimination capacities, Dual pass Monashell filters were developed, essentially by incorporating a dividing wall in the existing housing to create two passes instead of one. At higher velocities we can increase elimination capacity and removal efficiency. This allows us either reduce the overall size of the filter or eliminate the requirement for secondary polishing. This offers significant further value to the End user.

The sweet spot for this technology is on waste water or Industrial applications with persistent VOC's. Typical concentrations for waste water would be 30 to 100ppm (200ppm max).

Typical applications:

- ✓ Sludge tanks
- ✓ Sludge dryers
- ✓ Sludge THP process's
- ✓ Centrifuges
- ✓ Transfer points on Anaerobic digesters
- ✓ ATAD reactors.

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Monashell EBF

The Monashell was developed between 1998 and 2002 following extensive in-house development work on the use of the Technology for treatment of medium to high levels of VOC. The first commercial application was installed in 2001 on a printing application treating circa 600 mgC/m^3. Two additional dynamics were employed to enhance the Monashell technology to effect enhanced capture and catabolic breakdown of VOC's. These are recirculation of air to enhance mass transfer and increased elimination capacity and Electromagnetic Stimulation of the water which regulates and controls the production of poly-saccharides by microbes and leads to higher catabolic breakdown of VOC's. Thermal Oxidisers are widely used for medium to high levels of VOC's for application above 1000 mgC/m^3 in general regenerative thermal oxidisers can self-sustain so the requirement for supplementary fuel is very low. For levels below this the requirement for supplementary fuel is high. Traditional biological filters had been used on VOC levels up to 100 mgC/m^3. By enhancing the Monashell technology we are comfortable able to treat levels up to and in excess of 600 mgC/m^3 at a much lower operating cost than conventional Thermal oxidisers with no requirement for supplementary fuel. This greatly reduces the cost of treating medium to moderately high levels of VOC.

The sweet spot for this technology is on printing and coating and pharmaceutical applications with VOC levels between 200 and 600 mgC/m^3. The technology has been proven on the more persistent difficult BTEX type compounds and on chlorinated solvents.

Monashell Dual Pass/Dual Media.

On H_2S and applications with inorganic compounds as the media release's calcium to neutralise acidic by products the media is consumed. There is a direct correlation between airbourne concentrations, media bulk density and media life. In 2010 an extensive study was undertaken to look at the performance of different shell media species. The outcome of this study was data which allows us utilise heavier denser shell species in multi stage units to enhance performance and greatly increase media life. Again, this allows us offer smaller units with higher performance and a longer media life.

The sweet spot for this technology is on waste water or Industrial applications with persistent VOC's. Typical concentrations for waste water would be 30 to 100ppm (200ppm max).

Typical applications:

- ✓ Sludge tanks
- ✓ Sludge dryers
- ✓ Sludge THP process's
- ✓ Centrifuges
- ✓ Transfer points on Anaerobic digesters
- ✓ ATAD reactors.

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Treatment Details and Product Selection Considerations

Application ACAI Technology	Typical design contact times.	Water Consumption per kg H_2S.	Typical Media Life.	Typical Pressure Drop per m^3.	Comments on Selection of Technology	Comments on Life Cycle Cost
Mónafil	36 to 55 seconds	46 m^3	7 years ++	100	In general ideal for high volume airstreams with low levels of VOC, reduced sulphur, amines and ammonia.	Long media life and low pressure drop gives excellent life cycle cost on high air volume applicatons such as composting
Mónashell [Single Stage]	25 to 55 seconds	0.4 m^3	5 years	50 pa	In general for ideal airstreams with moderate levels of H2S, VOC, reduced sulphur, and ammonia.	Low water consumption, low pressure drop and no requirement for carbon polishing gives very low life cycle cost
Monashell EBF	36 to 90 seconds	0.4 m^3	2 - 5 years	250 pa	This technology was developed for high high levels of H2S and VOC's generally used for industrial process emissions	Low life cycle costs for high high VOC and H2S emissions when benchmarked against chemical scrubbers and Thermal oxidisers
Monashell Dual Pass	18 to 36 seconds	0.4 m^3	5 years	100 pa	In general ideal for high strength airstreams where two stages of treatment required (no requirement for carbon polishing.	Dual pass negates the requirement for Carbon polishing so low running cost due to this and low water and power consumption for Monashell
Monashell Dual Pass/Dual Media	18 to 36 seconds	0.4 m^3	8 years	75 pa	Ideal for high strength H2S airstreams where two stages of treatment and a long media life is required (no requirement for carbon polishing)	Similar performance to dual pass but media life enhanced by use of denser shells in first stage so lower running cost due to less frequent media replacement
CrumRubber	25 to 55 seconds	3 m^3	15 years +	100 pa	This technology was developed as a inert biotrickling filter for high H2S applicatons, particularily suited where water availability a high cost as media can with stand low pH	Inert media biotrickling filter with low running cost due to inert nature of media. Polishing required if high odour removal efficiencies are required
Hybrid Multi-Media Multi-Stage [Crumb Rubber/Shell Media]	25 to 55 seconds	2.4 m^3	10 years +	120 pa	This dual stage system offers the High H2S removal and long media life of CrumRubber coupled with excellent organic sulphur, VOC and odour removal of Monashell. Monashell media enhanced by factor of up to 5.	Hybrid with CrumRubber stage followed by Monashell this is ideal for very high H2S applications where very high odour removal and long media life is a requirement.
CrumRubber Biogas/Landfill Gas	50 to 100 + seconds	0.2 m^3	10 years +	75 pa	Inert media for H2S removal, also go0d removal for long chain volatile organic siloxanes	Ideal technology to complement activated carbon polishing and significantly reduce cost of landfill and biogas cleaning.
Lava	36 to 55 seconds	46 m^3	15 years +	100 pa	In general media is suitable when used with a carbon polishing filter for removal of low to moderate levels of H2S. Application limited by water availability and if no final effluent available running costs due to consumption of water, carbon and power is high	Lava is suitable for low to moderate H2S levels where high volumes of water are available to maintain pH very often carbon is used as a polisher which can leave life cycle costs high
Woodchip	50 to 90 seconds	46 m^3	2 years	250 pa	Wood chip media is low cost but requires long contact time, high water to work effectively and frequent change out.	Wood chip is a low performing media which requires very long contact times and has limited application. In general low media life and high pressure negate lower capital investment.

Table 2 - Product Selection Considerations

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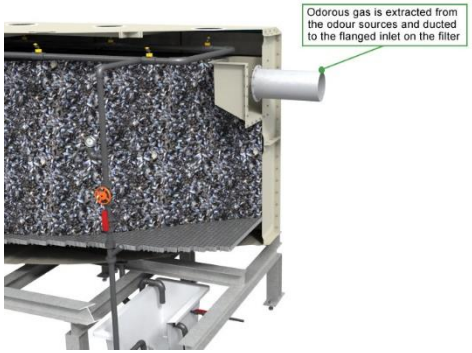
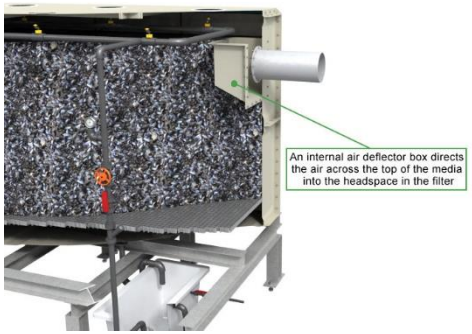
How the Mónashell System Works

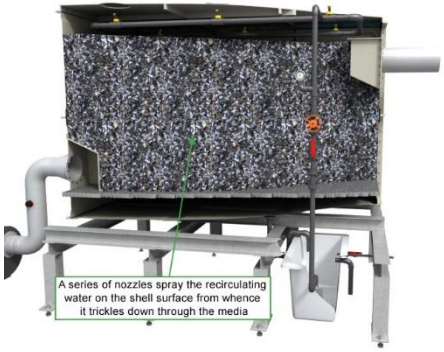


Step 1



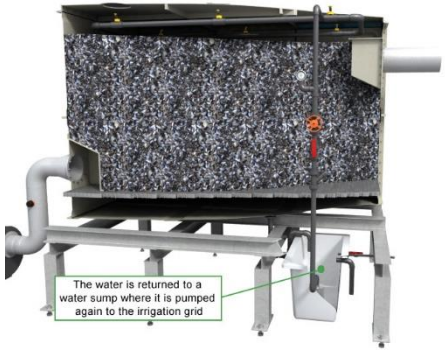
Step 2

Step 3



Step 4

Step 5



Step 6

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How the Mónashell System Works

Step 7

Step 8

Step 9

Figure 6 - Mónashell OCU installed in Becton WWTP, London

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