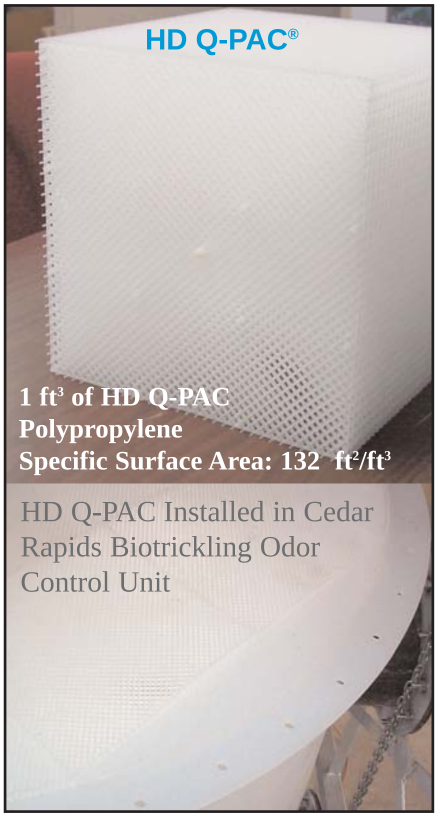
Biotrickling Filters for H_2S Odor Control Field test at Cedar Rapids, Iowa WWTP: HD Q-PAC Engineered Plastic Media vs. Lava Rock

Biological Odor Control at Cedar Rapids WWTP

This plant has two large biotrickling filters dedicated to H_2S odor control. The system was installed in 1998. The system consists of one large building. Each side of the building contains a biotrickling system that consists of a six foot deep bed of ¾" lava rock. The lava rock beds are intended to provide a large and suitable surface area for sulfur-consuming microbes (*Thiobacillus thiooxidans* is one example) to populate. These microbes convert sulfides to sulfates in their life processes. Their waste product is dilute sulfuric acid. Note the parameters of the lava rock biotrickling odor control system in the table below.



HD Q-PAC Installed in Cedar Rapids Biotrickling Odor Control Unit

The lava rock system has operated well over time at Cedar Rapids. Destruction efficiency of H_2S has remained satisfactory for the five years the system has been in operation. However, the pressure drop across the lava rock beds has essentially doubled over the life of the system. This increase in pressure drop has been accompanied by a 25% reduction in air volume being treated. New media developed by Lantec Products, HD Q-PAC, offers increased air handling capacity at much lower and constant pressure drop when used in biotrickling odor control units.

Cedar Rapids Lava Rock Odor Control System

Dimensions of Lava Rock Beds:	70 ft x 36 ft each
Bed Depth, ¾" (nominal) Lava Rock:	6 ft each
Air Flow	
New, Design:	40,000 cfm each
Summer 2003:	30,000 cfm each
Pressure Drop	
New, Design:	0.5 in WC
New, Actual:	1.5 in WC
Summer 2003	2.5 ~ 3.0 in WC
H_2S Destruction Efficiency:	**95% +**

The pressure drop increase across the lava rock beds has been caused by two possible events. It is also possible that these two events are both occuring simultaneously.

1. The formation of H_2SO_4 has chemically attacked the lava rock.
2. The bottom (entry) sections of the beds have become plugged.

Cedar Rapids WWTP Biotrickling Building - the single door seen to the left when opened yields the view of the lava rock bed presented on the right. This door provides the only access available to the lava rock bed. The other end of the building is a mirror image of the photos presented here.

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Samples taken from the top of the lava rock beds show no sign of chemical attack. Nor is there any visible settlement of the beds. Unfortunately there is no method available, other than to attempt to dig a trench down into the rock beds, to inspect the bottom (air entry) sections of the beds, which are in a concrete structure built to hold ***over 600 tons*** of lava rock.


Biotrickling odor control system containing HD Q-PAC tested at Cedar Rapids WWTP. Note that the other end of the building containing the lava rock, noted previously.

HD Q-PAC Biotrickling MediaSummer 2003 Testing at Cedar Rapids

HD Q-PAC has been used successfully in several H_2S odor control biotrickling units in the Saco, Maine sewer district. This success has also been repeated at the Thames River WWTP in East London, England. Based upon this experience, the Cedar Rapids WWTP agreed to a joint testing project in association with Lantec Products and Macrotek, Inc. (Markham, Ontario). This testing consisted of installation of a professionally constructed biotrickling system provided by Macrotek. The unit was based upon a process design

provided by Lantec Products and a mechanical design provided by Macrotek. HD Q-PAC in polypropylene is the media intended to support the biological mass that converts H_2S to H_2SO_4 in a slip stream of foul air coming from one of the lava rock systems' inlet.

Results: HD Q-PAC Provides Superior Microbial Support vs. Lava Rock

HD Q-PAC offers a number of advantages as a microbial support:

1. Higher Superficial Design Velocity = Smaller Unit Size
2. Lower Pressure Drop = Lower Operating Expenses
3. Polypropylene Media = Not Degraded by Microbes or H_2SO_4
4. Low Specific Gravity = No Need to Build Massive Structures
5. Uniform Structure = Plugging Resistance
6. 100% Accessible Surface = Maintain Bacterial Colony in "Active Growth Phase"
7. Structured Media = Prevents "Wicking" or Channeling Common in Porous Media
8. Very High Surface Area, With Entire Surface Available for Microbe Colonization

Lava rock has a very porous structure. Although it offers an apparently high specific surface area, much of this surface is blinded by rock to rock contacts. Additionally, much of the pore structure of lava rock is inaccessible to water needed to transport nutrients to the bacteria as well as to carry away byproducts from the bacteria. And as the byproduct of sulfide scavengers is sulfuric acid, the poor mass transfer of lava rock will act to poison any bacteria that do manage to colonize deep pores.

The summer 2003 testing at Cedar Rapids yielded very interesting data:

Biotrickling Filter Media, Lava Rock vs. HD Q-PAC, Comparison Test Results

	Lava Rock	**HD Q-PAC**
Piece Size:	¾" Nominal	12"×12"×12"
Weight:	46 lb/ft^3	**7.5 lb/ft^3**
Air Flow:	30,000 cfm/bed	550 cfm
H_2S Inlet Concentration:	5 - 200 ppm_v	5 - 200 ppm_v
Air Superficial Velocity:	12 fpm	**35 fpm**
Air Residence Time:	30 sec	**10 sec**
Bed Pressure Drop:	~ 3 in WC	**0.25 in WC**
Efficiency:	95%+	95%+
H_2S Destruction Density*:	1x 10^{-3} lb/hr-ft^3	**3 x 10^{-3} lb/hr-ft^3**

* For an average of 100 ppm_v H_2S in an air stream at 80 °F, 96% conversion to H_2SO_4

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As noted in the table above, the amount of H_2S being destroyed in the bed of HD Q-PAC is ***three times greater***, per cubic foot, than the amount of H_2S being destroyed in a cubic foot of lava rock. This destruction is achieved in HD Q-PAC with a pressure drop that is a fraction of that of lava rock.

As an all rounded media, with many needles, the structure of HD Q-PAC offers a number of advantages when supporting a bacterial colony.

1. The effective surface area of the the microbial growth increases as the colony grows. On the other hand, lava rock is a very porous structure. Some pores will be blinded by rock to rock contact, other pores will be of limited value due to time dependent mass transport of nutrients into and waste products out of a given pore.

Therefore, the effective surface area of HD Q-PAC increases vs. its dry surface area as the biological colony grows. And by the same logic, the effective surface of lava rock must be some factor less than the actual dry surface area of the rock when the rock is populated by microbes.

2. As the microbial colony grows on HD Q-PAC, the rounded surfaces and many needles limit the total mass that accumulates on the media. At some point some microbes will 'slough off' the HD Q-PAC. This action provides a number of very beneficial effects:

A. The recirculating water is seeded with useful bacteria.
B. The HD Q-PAC is prevented from fouling due to this "self-cleaning" design.
C. The bacterial colony supported on the HD Q-PAC is maintained in "active growth phase".

Summation

HD Q-PAC has been proven to provide an excellent habitat for the development of sulfur consuming microbes. As the result of the favorable environment provided by HD Q-PAC, sufficient microbes were supported to accomplish a three fold increase in H_2S destruction per unit volume versus what is possible with lava rock.

Furthermore, the reduced pressure drop of HD Q-PAC means that this three fold increase in H_2S destruction capacity is being achieved with ***significantly reduced power cost*** versus lava rock. At the current pressure drop of the lava rock beds, approximately 16 extra horsepower is being consumed to drive the current 60,000 cfm through the two lava rock beds. If HD Q-PAC were in place, at a power cost of \$0.09 per kWh the yearly electric bill at the Cedar Rapids WWTP would be ***reduced by \$11,700***. (According to data published by the Electric Power Research Institute, Palo Alto, CA – assuming 80% efficient motors and 8000 hours operating time per year.)

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