environmental
properties management, LLC

January 18, 2019

Mr. Ken Kalman
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852-2738

Mr. Paul Davis
Oklahoma Department of Environmental Quality
707 North Robinson
Oklahoma City, OK 73101

Mr. Robert Evans
U.S. Nuclear Regulatory Commission
1600 East Lamar Blvd; Suite 400
Arlington, TX 76011-4511

Re: Docket No. 70-925; License No. SNM-928
Need for Treatability Testing of Ion Exchange Resin in 2019

Dear Mr. Kalman:

Environmental Properties Management LLC (EPM) submitted a proposed budget for calendar year 2019 on November 11, 2018. Included in the scope of work for that proposed budget was a treatability test to evaluate the performance of an ion exchange resin in removing uranium from groundwater recovered at the Cimarron Remediation Site. During a January 10, 2019 telephone call, NRC questioned the need for a treatability test, because treatability tests conducted in 2015 resulted in the selection of DOWEX™ 1 ion exchange resin (herein referred to as DOWEX 1). Conducting another treatability test to evaluate the compatibility and performance of different ion exchange resins appeared to be an unnecessary expense since DOWEX 1 had already been selected for groundwater treatment. After explaining the rationale for conducting an additional treatability test in 2019 (i.e., DOWEX 1 resin is no longer commercially available) NRC requested that EPM submit a letter explaining the sequence of events that led to the potential need for additional treatability testing.

Several weeks before *Facility Decommissioning Plan – Rev 1* was submitted, EPM requested verification that the cost of the ion exchange resin had not changed significantly since the estimate was prepared for the 2015 *Facility Decommissioning Plan*. Upon contacting the Dow Chemical Company (Dow), we learned that Dow had ceased production of DOWEX 1. Dow personnel recommended the use of Ambersep™ 21K XLT (formerly labeled DOWEX 21K and referred to hereinafter as DOWEX 21) in place of DOWEX 1.

In 2013, Clean Harbors conducted two treatability column tests using DOWEX 1 resin. Prior to performing these tests, Clean Harbors conducted a literature review which revealed that DOWEX 21 had been successfully used at the Department of Energy (DOE) Rocky Flats site to remove uranium from groundwater extracted from weathered claystone and sandstone. The groundwater at the Rocky Flats site contained a higher concentration of total dissolved solids and higher pH than the groundwater at the Cimarron site. Clean Harbors also determined that DOWEX 1 resin was very similar to DOWEX 21, both being chloride-form styrene beads with an exchange capacity of 1.4 equivalents per liter. The only differences were that DOWEX 21 contained a very consistent bead size, whereas the DOWEX 1 was more well graded, and that DOWEX 21 is significantly more expensive than DOWEX 1. Based on this information DOWEX 1 was selected for the initial treatability column tests.

During the 2013 treatability test, groundwater obtained from the site was passed through columns filled with DOWEX 1. The initial test was terminated early because mineral scale filled the pore space voids in the resin, causing excessive pressure in the system and causing the cap of one test column to crack. During a second column test, the groundwater was pretreated with a cation exchange resin to reduce hardness; however, it was later determined that pretreating groundwater with cation resin at the full-scale would be cost prohibitive.

In 2014, EPM reviewed information related to the Rocky Flats site, and learned that uranium had been removed from groundwater at the site using DOWEX 21 resin without pretreatment and without encountering plugging issues related to scaling. It was also confirmed that Rocky Flats groundwater contained a higher concentration of total dissolved solids and higher pH than Cimarron groundwater. Based on this information, EPM requested that Clean Harbors further investigate and compare the properties of DOWEX 21 to DOWEX 1. In September 2014, Clean Harbors provided EPM a technical memorandum comparing DOWEX 1 and DOWEX 21 (Attachment 1). The memorandum concluded that if a sufficient flow rate was maintained during treatment, the two resins would perform similarly; however, DOWEX 2 remained significantly more expensive than DOWEX 1.

In 2015, EPM retained Kurion, Inc. (Kurion) to conduct additional ion exchange treatability tests. The first phase of the treatability test consisted of batch testing six different treatment media to evaluate their exchange capacity using site groundwater and “down select” the most promising media for subsequent dynamic treatability testing (i.e., column tests). DOWEX 1, DOWEX 21, and a third resin (designated UCR-5) were selected for column testing.

Because the use of a cation resin to remove hardness prior treatment had already been deemed economically infeasible, an alternative pretreatment method, pH adjustment by acidification, was selected to address issues related to resin scaling. Column testing of DOWEX 1 was conducted using acidification to reduce the pH of the influent groundwater to 6.6 to 7.0 standard units. Since the DOWEX 21 has a more uniform bead size (525 to 625 micrometers (um) than

DOWEX 1 (<300 to >1,200 um), the DOWEX 21 was expected to be less subject to plugging should scaling occur. This comparative uniformity in bead size, combined with the DOE's success in using DOWEX 21 without pretreatment, the decision was made to conduct the DOWEX 21 column test without acidification. This was documented in Kurion's April 10, 2015 internal memorandum (Attachment 2). That memorandum also stated that the cost of DOWEX 21 was significantly higher in cost than DOWEX 1.

The results of the batch and column tests conducted by Kurion were reported in *Cimarron Environmental Response Trust, 2015 Groundwater Treatability Tests*, submitted to the NRC and the DEQ on November 3, 2015 (Attachment 3). According to the report, DOWEX 21 performed slightly better than DOWEX 1 in treating groundwater from Burial Area #1 during the batch tests. DOWEX 21 and DOWEX 1 yielded absorption capacities of 345 micrograms per gram (µg/g) and 314 µg/g, respectively. Using lower-concentration groundwater from the Western Alluvial Area, the DOWEX 21 performed significantly better than the DOWEX 1 during batch testing. DOWEX 21 and DOWEX 1yielded absorption capacities of 253 µg/g and 132 µg/g, respectively.

Dynamic column testing results were markedly different than batch testing results. During column tests conducted using groundwater from Burial Area #1, the DOWEX 21 absorption capacity was significantly lower than that of DOWEX 1, yielding 26.6 milligrams per gram (mg/g) versus 54.6 mg/g, respectively. Based on these results, Kurion recommended DOWEX 1 as the resin of choice for uranium treatment at the site. It is possible that the reduced performance of DOWEX 21 during column testing was caused by the formation of scale on the resin; however, since pressure was not recorded, this could not be determined from the test data. Based on the poorer performance of DOWEX 21 during the column tests combined with the significantly higher price of DOWEX 21, DOWEX 1 was selected for ion exchange treatment at the site.

Product information sheets for DOWEX 1 and DOWEX 21 (now labeled Ambersep 21) are provided as Attachments 4 and 5, respectively. As stated above, the product information sheets confirm that both resins are chlorine-form styrene beads, and both resins have a total exchange capacity of 1.4 equivalents per liter.

As stated above, it is possible that DOWEX 21 yielded a lower adsorption capacity than DOWEX 1 during column testing because some scaling did occur, impacting the ability of the resin to exchange chlorine ions for uranium. Therefore, it is also possible that DOWEX 21 would have yielded better performance, possibly equal to that of DOWEX 1, had the influent to the DOWEX 21 test columns been acidified. Consequently, the decommissioning cost estimate included in the 2018 *Facility Decommissioning Plan – Rev 1* assumed that the quantity of DOWEX 21 required for groundwater treatment would be the same as DOWEX 1; however, the unit cost of the resin was increased to reflect the higher cost of DOWEX 21.

The total cost of the treatability testing performed in 2015 was approximately $160,000. Because the unavailability of DOWEX 1 was not discovered until shortly before the submission of the proposed budget for 2019, the proposed 2019 budget included that amount for additional treatability testing. Additional testing would confirm or refute the premise that the performance of the DOWEX 21 resin is similar to that of DOWEX 1 when using acidification to pretreat the groundwater and prevent scaling. It is possible that the actual cost of this testing will be lower since the treatability test could be conducted with only one resin (DOWEX 21.

EPM could forego additional treatability testing and assume the DOWEX 21, with pretreatment, will perform as well as the DOWEX 1. Monitoring its performance during operation would provide for evaluation of this assumption in much the same way influent concentrations, U-235 enrichment values, and drawdown within the aquifers will be monitored and evaluated. Treatability testing was included in the proposed scope of work and budget to minimize uncertainties regarding the absorption capacity of DOWEX 21 when using pH adjustment as the only ion exchange pretreatment method.

Should the NRC and the DEQ consider the batch testing results and product information sufficient justification to eliminate additional treatability testing from the scope of work proposed for 2019, EPM will remove this from the next revision of the proposed budget for 2019.

Should you have any questions regarding this submittal, or desire clarification or additional information, please contact me at 405-642-5152 or at jlux@envpm.com.

Sincerely,

Jeff Lux

Jeff Lux, P.E.
Project Manager

Attachments

cc: Ja-Kael Luey, Veolia Nuclear Solutions/Federal Services

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ATTACHMENT 1
SEPTEMBER 19, 2014 CLEAN HARBORS TECHNICAL MEMORANDUM

Anion Resin Technical Memorandum

Problem: Very high hardness in the groundwater to be treated for uranium and nitrate causes rapid and significant scale formation on the Ion Exchange (IX) beds used to remove the uranyl carbonate and nitrate anions. Water softening using a cation resin was successfully employed during the treatability study (TS) but preliminary cation bed design calculations determined water softening with cation resin was cost prohibitive.

Objective: Determine if other anion resins are available that will remove the contaminants of concern without developing the scale seen in Run 1 of the TS.

Findings: Preliminary research by Jeff Lux and others identified one DOE remediation project for uranium impacted groundwater that has been using Dowex 21K resin in Ion Exchange (IX) treatment systems without reporting issues due to scale forming on the resin even though the water was considered very hard.

Further research into this project determined that scale would form on the resin if the hydraulic loading rate fell below 8 gpm per square foot of resin bed.

Following is a comparison of Dowex 1 and Dowex 21K* resin:

	Dowex 1	**Dowex 21K***
Resin Type	Type I Strong Base Anion	Type I Strong Base Anion
Matrix	Styrene-DVB, gel	Styrene-DVB, gel
Functional Group	Quaternary Amine	Quaternary Amine
Form	Cl^-	Cl^-
Exchange Capacity	1.4 eq/l	1.4 eq/l 21K XLT 1.2 eq/l 21K 16/20
Bead Size	97% (1,200 to 300 µm)	21K XLT (525 to 625 µm) 21 K 16/20 90% (800 to 1,200 µm)
Contact Time	3.5 minutes	3.5 minutes
Hydraulic Loading Rate	2 – 15 gpm/ft^2	2 – 15 gpm/ft^2
Cost	\$118 / ft^3	\$697/ft3 (<80 ft^3) \$605/ft3 (80-195ft^3) \$526/ft3 (>195 ft^3)

21K XLT = Uniform Bead Size
21K 16/20 = Large Bead Size

Conclusions: The two resins would typically be considered equivalent for most applications. From a scaling standpoint there should be no difference unless the larger particle size allows a longer time before the flow path between beads is closed off. The cost for 21K resin is approximately 5 times more than Dowex 1.

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ATTACHMENT 2
APRIL 10, 2015 KURION TECHNICAL MEMORANDUM

KURION
Isolating Waste from the Environment

Internal Memorandum

Date:	April 10, 2015
To:	Ja-Kael Luey
From:	Zane Walton
Subject:	Final list of resins to be used in the Cimarron Column Test
Distribution:	Josh Mertz, Chris Harrington, Wes Bratton, Whitney Andrews, and Project Records

The purpose of this memo is to provide the final list of resins down-selected from the Cimarron Equilibrium Batch Tests for use in the Dynamic Column Tests. A meeting was held with Environmental Property Management (EPM) and Burns and McDonnell (BMcD) on April 6, 2015 (see ENVI01-001-MM-03) to discuss the results of the batch tests and the proposed list of down selected resin/media. The initial list of resin/media was based mainly on performance during the batch tests, i.e., the maximum uranium capacity observed in the test, or the maximum capacity (Q_{max}) as determined by the Langmuir isotherm curve. As part of the discussion, a request was made by EPM to include DOWEX™ 21K in the column tests under non-acidified conditions – without pH adjustment.

Based on the discussion with EPM and BMcD and the request to consider testing DOWEX™ 21K, the following resins are proposed for further column testing using Cimarron BA (approximate concentration = 600 ug/L) groundwater:

1. DOWEX™ 1 (UCR-1),
   Tested with pH adjusted Cimarron BA groundwater

   Rational:
   UCR-1 showed the second best performance (314 µg U/g). Although DOWEX™ 21K slightly out performed DOWEX™ 1, DOWEX™ 1 serves as a baseline comparison (previously tested in treatability studies) and is also familiar to the NRC.

   Cost and Availability:
   Cost for DOWEX™ 1 is expected to be $210 per ft^3, based on an annual demand of >1000 ft^3. Based on conversation with Dow, DOWEX™ 1 is expected to be available for the duration of the treatability system operation.

2. DOWEX™ 21K (UCR-2)
   Tested with unaltered (i.e., no pH adjustment) Cimarron BA groundwater

   Rational:
   The UCR-2 showed the best performance in the batch test with a maximum measured capacity of 345 µg U/g. Because of the resin mesh size and resulting increased fluid flow properties, DOWEX™ 21K may be a good option to consider under non acidified conditions. DOWEX™ 21K has precedence for being used for uranium groundwater remediation on DOE sites, and is also familiar to the NRC.

Cost and Availability:
Cost for DOWEX™ 21K is expected to be \$300 per ft^3, based on an annual demand of >1000 ft^3. Based on conversation with Dow, DOWEX™ 21K is expected to be available for the duration of the treatability system operation.

3. Spherical Resin Bead #2 (UCR-5)
   Tested with pH adjusted Cimarron BA groundwater

   Rational:
   The UCR-5 showed the third best performance in the batch test with a maximum measured capacity of 259 µg U/g.

   Cost and Availability:
   Based on initial estimates, the cost of UCR-5 is expected to be comparable with DOWEX products based on the expected annual usage of >1000 ft^3. UCR-5 is expected to be available for the duration of the treatability system operation.

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ATTACHMENT 4
DOWEX 1 PRODUCT INFORMATION

DOWEX™ 1

High Capacity Strong Base Anion Exchange Resin for Regenerable and Non-Regenerable Applications

Features

- Selective removal of uranium, perchlorate, hexavalent chrome and iodine.
- Non-selective removal of common anions such as nitrate, sulfate and chloride.
- NSF/ANSI 61 approved for drinking water.

Product	Type	Matrix	Functional group
DOWEX™ 1	Type I strong base anion	Styrene-DVB, gel	Quaternary amine

Guaranteed Sales Specifications		Cl^- form
Total exchange capacity, min.	eq/L	1.4
	kgr/ft^3 as $CaCO_3$	30.6
Water content	%	43 - 48
Bead size distribution†		
> 1,200 μm, max. (16 mesh)	%	2
< 300 μm mm, max. (50 mesh)	%	1
Whole uncracked beads, min.	%	90
Crush strength		
Average, min.	g/bead	350

Typical Physical and Chemical Properties		Cl^- form
Particle density	g/mL	1.10
Shipping weight**	g/L	705
	lbs/ft^3	44

Recommended Operating Conditions

- Maximum operating temperature:
  - OH^- form: 60°C (140°F)
  - Cl^- form: 100°C (212°F)
- pH range: 0 - 14
- Bed depth, min.: 450 mm (1.5 ft)
- Service flow rate: 15 - 20 BV/hr
- Non-selective nitrate service regenerant:
  - Type: 7 - 10% NaCl
  - Temperature: Ambient or up to 50°C (122°F)

† For additional particle size information, please refer to Particle Size Distribution Cross Reference Chart (Form No. 177-01775)
**As per the backwashed and settled density of the resin, determined by ASTM D-2187

Typical Properties and Applications

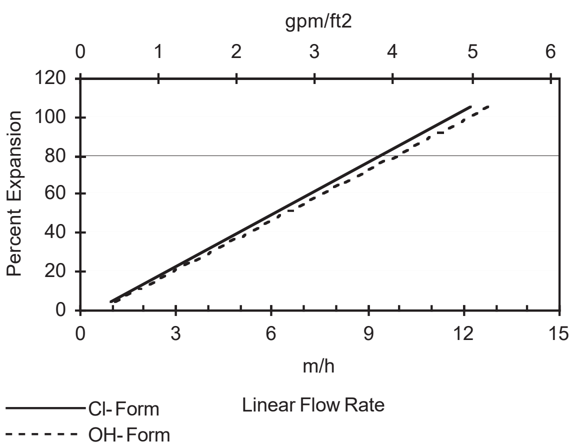
DOWEX™ 1 resin is a high quality anion resin with very good mechanical and chemical resistance. It meets NSF/ANSI Standard 61 for use in drinking water.

Uranium, perchlorate and hexavalent chrome bind very tightly to DOWEX 1, so regeneration results in significant volumes of waste. Dow recommends disposal of the resin once it is loaded.

Packaging

5 cubic foot fiber drums and 1,000 liter super sack

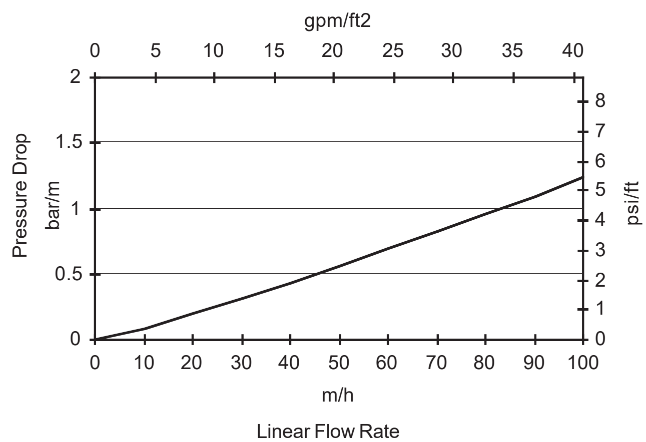
Figure 1. Backwash Expansion Data



For other temperatures use:

$F_T = F_{77°F}$ [1+ 0.008 ($T_{°F}$ -77)], where F ≡ gpm/ft^2
$F_T = F_{25°C}$ [1+ 0.008 (1.8$T_{°C}$ - 45)], where F ≡ m/h

Figure 2. Pressure Drop Data



For other temperatures use:

$P_T = P_{20°C}$ / (0.026 $T_{°C}$ + 0.48), where P ≡ bar/m
$P_T = P_{68°F}$ / (0.014 $T_{°F}$ + 0.05), where P ≡ psi/ft

DOWEX Ion Exchange Resins
For more information about DOWEX resins, call the Dow Liquid Separations business:
North America: 1-800-447-4369
Latin America: (+55) 11-5188-9222
Europe: (+32) 3-450-2240
Pacific: +60 3 7958 3392
Japan: +813 5460 2100
China: +86 21 2301 9000
http://www.dowex.com

Warning: Oxidizing agents such as nitric acid attack organic ion exchange resins under certain conditions. This could lead to anything from slight resin degradation to a violent exothermic reaction (explosion). Before using strong oxidizing agents, consult sources knowledgeable in handling such materials.

Form No. 177-01644-0906

ATTACHMENT 5
AMBERSEP 21K PRODUCT INFORMATION

Product Data Sheet

AMBERSEP™ 21K Ion Exchange Resins

Industrial-grade, Strong Base Anion Exchange Resins for Mineral Processing Applications

Description

AMBERSEP™ 21K Ion Exchange Resins are Type I strong base anion resins with excellent kinetics and regeneration efficiency, along with outstanding physical stability. Both are especially suited for mineral processing and groundwater remediation applications due to their enhanced-porosity gel bead matrix made by a special process giving fast equilibrium rates and improved resistance to organics.

AMBERSEP™ 21K 16–20 Ion Exchange Resin, with its screened particle size from 16 – 20 U.S. Mesh, is a high-efficiency, large-bead resin suitable for fluidized-bed and Resin-In-Pulp (RIP) applications.

AMBERSEP™ 21K XLT Ion Exchange Resin, with its high capacity and uniform particle size, represents the state-of-the-art solution for mineral processing, giving enhanced performance for packed bed systems.

Applications

- Mineral Processing (Zn, Mn, etc.)
- Precious metal recovery (Au, Ag, Pt, Pd, Rh)
- Uranium recovery

Typical Physical and Chemical Properties**

Matrix	Styrene-divinylbenzene, gel
Type	Strong base anion, Type I
Functional Group	Quaternary amine
Physical Form	Opaque, white to tan, hard, spherical beads
Ionic Form as Shipped	Cl^-

	AMBERSEP™ 21K XLT	**AMBERSEP™ 21K 16–20**
Total Exchange Capacity	≥ 1.4 eq/L	≥ 1.2 eq/L
Water Retention Capacity	50 – 60%	50 – 58%
Particle Size		
Particle Diameter §	575 ± 50 µm	800 – 1300 µm
Uniformity Coefficient	≤ 1.1	
< 840 µm		≤ 10%
< 710 µm		≤ 2%
Whole Uncracked Beads	≥ 95%	≥ 90%
Swelling	$Cl^- \rightarrow OH^-$: 18 – 20%	$Cl^- \rightarrow OH^-$: 20%
Particle Density	1.08 g/mL	1.08 g/mL
Bulk Density, as Shipped	670 g/L	690 g/L

§ For additional particle size information, please refer to the Particle Size Distribution Cross Reference Chart (Form No. 177-01775).

Form No. 177-03691, Rev. 0
January 2018

Suggested Operating Conditions**

Maximum Operating Temperature		
Cl^- Form	100°C (212°F)	
OH^- Form	60°C (140°F)	
pH Range	0 – 14	
Bed Depth, min.	800 mm (2.6 ft)	
Organic Loading	≤ 3 g $KMnO_4$/L resin	

	AMBERSEP™ 21K XLT	**AMBERSEP™ 21K 16–20**
Flowrates		
Service	5 – 60 m/h (2 – 24 gpm/ft^2)	5 – 50 m/h (2 – 20 gpm/ft^2)
Backwash	See Figure 1	See Figure 1
Regeneration		
Chemical Injection		
Co-current	1 – 10 m/h (0.4 – 4 gpm/ft^2)	1 – 10 m/h (0.4 – 4 gpm/ft^2)
Counter-current	5 – 20 m/h (2 – 8 gpm/ft^2)	
Displacement Rinse		
Co-current	1 – 10 m/h (0.4 – 4 gpm/ft^2)	1 – 10 m/h (0.4 – 4 gpm/ft^2)
Counter-current	5 – 20 m/h (2 – 8 gpm/ft^2)	
Fast Rinse	5 – 60 m/h (2 – 24 gpm/ft^2)	5 – 50 m/h (2 – 20 gpm/ft^2)
Total Rinse Requirement	3 – 6 BV*	3 – 6 BV*
Regenerant	NaCl, Na_2CO_3, NaOH	
Temperature	Ambient or up to 50°C (122°F) for silica removal	

* 1 BV (Bed Volume) = 1 m^3 solution per m^3 resin or 7.5 gal per ft^3 resin

Hydraulic Characteristics

Bed expansion of AMBERSEP™ 21K XLT and AMBERSEP 21K 16–20 Ion Exchange Resins as a function of backwash flowrate at 25°C (77°F) is shown in Figure 1.

Pressure drop data for AMBERSEP 21K XLT and AMBERSEP 21K 16–20 as a function of service flowrate at 25°C (77°F) is shown in Figure 2. Pressure drop data are valid at the start of the service run with clean water.

Figure 1: Backwash Expansion

Temperature = 25°C (77°F)

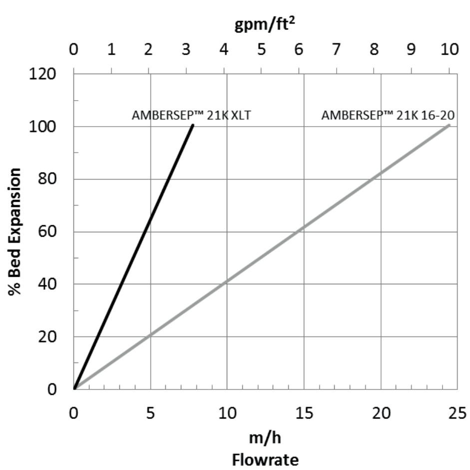
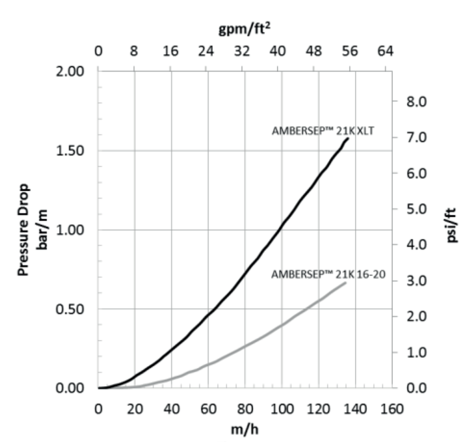


Figure 2: Pressure Drop

Temperature = 25°C (77°F)



Product Stewardship

Dow has a fundamental concern for all who make, distribute, and use its products, and for the environment in which we live. This concern is the basis for our product stewardship philosophy by which we assess the safety, health, and environmental information on our products and then take appropriate steps to protect employee and public health and our environment. The success of our product stewardship program rests with each and every individual involved with Dow products—from the initial concept and research, to manufacture, use, sale, disposal, and recycle of each product.

Customer Notice

Dow strongly encourages its customers to review both their manufacturing processes and their applications of Dow products from the standpoint of human health and environmental quality to ensure that Dow products are not used in ways for which they are not intended or tested. Dow personnel are available to answer your questions and to provide reasonable technical support. Dow product literature, including safety data sheets, should be consulted prior to use of Dow products. Current safety data sheets are available from Dow.

For more information, contact our Customer Information Group:

Asia Pacific	+86 21 3851 4988
Europe, Middle East, Africa	+31 115 672626
Latin America	+55 11 5184 8722
North America	1-800-447-4369

www.dowwaterandprocess.com

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January 2018