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Purad High Purity

PVDF Piping

PART 1 GENERAL

1.1 Summary
Furnish a complete high purity PVDF piping system to include pipe, fittings, anchors, specialty fittings and valves.

1.2 References
The following standards apply to products used within this section.

ASTM D 1598	ASTM D 1599
ASTM D 2122	ASTM D 2657
ASTM D 2837-85	ASTM D 3222-81
DVS 2207-15	

The system design shall meet the requirements of ASME/ANSI B31.3 for design criteria where temperature and pressure fall within the limits of the code.

1.3 Definitions
Purad High Purity PVDF
Polyvinylidene Fluoride

1.4 System Description and Pressure Rating
System shall be a Purad PVDF system made of uniform pipe and fitting resin. System pressure ratings shall be based on continuous use of 50 years. Purad Pipe and Fittings shall be based on a Standard Dimensional Ratio (SDR) of 21, ½" through 9" (20-225mm) or 33, 3" through 12" (90-315mm). Pressure rating for pipe and fittings, unless otherwise noted, shall be 232 psi (16 bar) for SDR21 material and 150 psi (10 bar) for SDR33 material at 68ºF.

1.5 System Performance Requirements
System performance requirements shall handle the following:

Operating Pressure:	(TBD by Engineer/Project Owner)
Operating Temp:	(TBD by Engineer/Project Owner)
Test Pressure:	(TBD by Engineer/Project Owner)
Media:	Deionized Water

1.6 Submittals
Submit the Following:

A. Product data for the system specified; relative to materials, dimensions of individual components, profiles and finishes.

B. Product certificates signed by manufacturer of Purad PVDF piping product, stating compliance to stated requirements.

C. Welder certificates, certifying that welders comply with the installation procedures as outlined by ASTM D-2657 & DVS 2207-15. All required training should be scheduled and completed at to job start-up.

D. Qualification of firms supplying Purad PVDF: Firms must have a minimum of five years experience in HP design, installation and operation of thermoplastic high-purity piping systems.

1.7 Quality Assurance
Obtain components from a single source having responsibility and accountability to answer and resolve problems regarding proper installation, compatibility, performance, and acceptance.

1.8 Delivery, Storage and Handling
A. Deliver all Purad PVDF pipe to arrive on-site inside protected hard black PE tubes. Cardboard tubes are not allowed.

B. Deliver all Purad PVDF fittings to arrive on-site double bagged in boxes layered with bubble packing to prevent damage.

C. Store products on elevated platforms in a dry location with protection from the environment.

D. Lift, support and transport Purad PVDF piping per manufacturers' recommendations.

1.9 Warranty
Warranty period is one year after date of substantial completion.

1.10 Extra Material
Turn over to owner at end of construction necessary welding equipment as suggested by manufacturer for repair, additions and maintenance of Purad PVDF piping system.

PART 2 PRODUCTS

2.1 Manufacturers
Subject to compliance with requirements products which may be incorporated in the work include: The Purad PVDF System as supplied by Chemline Plastics Ltd. of Thornhill, Ontario, Canada 1-905-889-7890. Produced by Alois Gruber GmbH AGRU of Bad Hall, Austria.

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2.2 Material

Pipe, valves and fittings shall be made from HP resin produced by one supplier. The resin shall meet or exceed the requirements outlined for a Type II suspension grade homopolymer resin in ASTM D-3222. Resin is approved for contact with foodstuff as per the FDA CFR, Title 21 (2001) 177.1520.

Pipe shall be made of Solef 1010/0001 HP resin.

MFI = 4-7 g/10 min.

Fittings ½-2" shall be made of Solef 1009/0001 HP resin.

MFI = 12-16 g/10min.

Fittings 2½ -10" shall be made of Solef 1008/0001 HP resin.

MFI = 22-27 g/10 min.

All resins shall not introduce contaminations into the ultra high purity water. Specifically, all raw materials in product manufacturing shall be free of chemical additives, fillers, property enhancers and reinforcements, such as antioxidants, anti static agents, colorants, flame retardants, heat stabilizers lubricants, mold release agents, pigments, plasticizers, processing aids, ultraviolet stabilizers and viscosity depressants.

In addition, manufacturer shall test all lots to ensure the melt flow index is within allowable range.

2.3 Pipe

A. Production

All pipe shall be produced on a dedicated extruder completely within a class 100 cleanroom and shall be packaged within a class 100 section of the cleanroom. Pipe shall be stress relieved on line as it is extruded. Post extrusion annealing is not allowed. Surface finish smoothness is as follows:

Size Inches	Size mm	Result
½" – 3"	20-90mm	Ra = 7.80µ" (0.20µm)
4"	110mm	Ra = 13.80µ" (0.35µm)
6" - 12"	160-315mm	Ra = 19.70µ" (0.50µm)

In addition manufacturer shall conduct continuous checking for micropores. The micropores shall not exceed a size of 1 micron.

B. Packaging

All pipes shall have ends sealed with PE bags and then capped. Pipe shall be sleeved in a PE encasement and heat-sealed. Pipe is then packed into a hard PE tube for shipping protection. Cardboard tubes are not acceptable. The following chart designates quantities of pipe per PE shipping tube:

Size inches	Size mm	Quantity Per Tube
1/2"	20	Five
3/4"	25	Four
1"	32	Three
1 1/4"	40	One
1 1/2"	50	One
2"	63	One
2 1/2"	75	One
3"	90	One
4"	110	One
6"	160	One
8"	200	One
9"	225	One
10"	250	One
12"	315	One

C. Pressure Rating

All pipe shall meet the requirements of Section 1.4.

2.4 Fittings

A. Production

All standard fittings through 12" (315mm) shall be injected molded. All fittings are to be molded with equipment in a class 100 cleanroom environment. After secondary machining all fittings shall be cleaned for a minimum of 1 hour in an automated 6-basin Hot DI rinse Stations. The DI Rinse water shall be 70°C with resistivity above 18MΩ and TOC ≥10PPB.

B. Packaging

All fittings are to be packaged in a class 100 cleanroom immediately after the cleaning process. Fittings are to be double bagged, purged with clean dry Class 100 air in PE/Nylon composite bags. Bags are to be silicone free and anti-static.

C. Specialty Fittings

Specialty fittings are to include restraint fittings, butt fusion instrumentation fittings, instrumentation donuts, etc. Specialty fittings shall be machined or molded of the same PVDF resin as the pipe and fittings.

D. Pressure Rating

All fittings, unless otherwise noted, shall meet the requirements of Section 1.4.

2.5 Valves

All valves shall be produced in the same manner as High Purity Fittings

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Type 342 Spigot Diaphragm Valves:
½"-4" (20mm –110mm) shall be the type 342 of the PURAD system. The Valves shall have a PVDF body (Solef Resin) and a PTFE diaphragm with EPDM backing. Valves will be spigot single body design. Top Works must include integral lockout device on the handle and position indicator.

Type 342 Flanged Diaphragm Valves:
½" – 2 ½" shall be type 342 with stub end and backing ring IR welded onto both sides. Top Works must include locking device on the handle and position indicator.

Flanged Diaphragm Valves:
3" - 4" shall be type 342 single PVDF body design with flanges molded as part of the body. Diaphragm shall be PTFE with EPDM backing. Top Works must include locking device on the handle and position indicator.

Flanged Diaphragm Valves:
6"-8" shall be type 15 or G single PVDF body with flanges molded as part of the body. Diaphragm shall be two piece style with PTFE and separate EPDM backing. Top works shall include a position indicator and travel stop.

Type 343 Reduced Dead Leg Valve:
½" x ½" through 4" x 2" (20mm x 20mm through 110mm x 63mm) reduced dead leg (zero dead leg) valves shall be Type 343 Style from the PURAD System. Valves shall be made of PVDF Solef resin. Valve bodies are to be unibody, molded design with a full 150 psi rating at 70ºF. All metal nuts and bolts must be capped or covered to reduce metal exposure. Top Works must include integral lockout device on the handle and position indicator.

Flow Meters:
All Flowmeters shall be Vortex Style from the PURAD system. All Vortex Meters shall be made of PVDF and free of all seal materials. Supplier shall be capable of supplying all sizes ½" - 9" (20mm – 225mm).

All Vortex Meters shall be wet bench calibrated and supplied with Calibration Records from the manufacturer.

Check Valves:
All sizes class 150, ball type PVDF body with FPM seat and seals. 230 PSI at 73.4ºF for sizes ½" through 2½" nominal 150 PSI at 73.4ºF for sizes above 2½" nominal.

Pressure Rating--Valves
Pressure rating of valves shall be per manufacturer's recommendations based on materials, valve type and size.

2.6 Joining Equipment

Purad PVDF installation shall be performed by factory certified and trained installers in accordance with manufacturer's ISO procedures, ASTM D 2657 and DVS 2207-15. Date of certification or re-certification shall not exceed two years from the beginning of project. Available joining techniques are as follows:

A. Butt-Fusion
Proper equipment selection should be based on pipe size and site conditions. Butt fusion equipment should be designed and tested to provide reliable welds. All equipment should utilize electronically controlled heating elements for accurate welding temperatures. Tools should also incorporate planing units to face ends prior to heating. Butt-fusion equipment supplied shall weld joints based on force or pressure and not mechanical stops.

B. Socket Fusion
Proper equipment selection should be based on pipe size and site conditions. Socket fusion tools shall be available in two styles; one portable style capable of welding 1/2"- 2" (20mm – 63mm) and a bench style capable of welding 3/4"- 4" (25mm – 110mm). Heating elements are to be

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electronically controlled for accurate welding temperatures. Tools should also incorporate male and female heater inserts with Teflon coating.

C. Non-Contact Butt-Fusion

Proper equipment selection should be based on installation requirements and line sizes. Tool shall be either semi automatic (UF2000 style) or fully automatic (SP series).

UF2000 Style:
Tool shall be made available in ½"- 2" (20mm – 63mm) and 2 ½" – 10" (75mm – 250mm) size ranges. Tools shall possess electronic planer and non-contact heating element. To avoid improper welded joints, tools will utilize and measure the welding pressures to join material and not mechanical stops. All IR fusion equipment shall possess a minimum of the following capabilities:

1. Computer Control of the welding process.
2. Ability to store welding data internally on computer memory - up to 1000 welds.
3. Full alignment capabilities (vertical and horizontal)
4. All metal components coated to prevent any particle generation from metals.
5. Ability to download all data to a personal computer.

IR equipment shall also have the capability of following options incorporated into the tool for special demands:
1. Protective hood over welding area up to 2" (63mm)
2. Nitrogen Purge of the welding area.
3. Automatic Nitrogen purge of the pipeline.
4. Security Card Entry
5. Printer Labels for each weld automatically.

SP Series:
Tool shall be made available in ½" – 4" (20mm – 110mm) and 2½" – 10" (75mm – 250mm) size ranges. Tools shall possess electronic planar and infra heating element. Tools will utilize and measure the welding pressures to join material and not mechanical stops. To avoid improper welded joints, tool shall automatically operate clamps and control joining force. Tools shall possess the following features:

1. Computer control and automatic fusion.
2. Touch screen for tool operation and parameter selection.
3. Restricted access through use of PCMCIA cards.
4. Automatic label printouts after each weld.
5. Ability to display and graph weld processes weld is proceeding.
6. Memory storage of welds
7. Magnetic clamps to reduce change out time from one size to another.
8. Vertical and Horizontal Adjustment for pipe alignment.

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D. Beadless Fusion
High Performance Fusion (HPF) equipment should be designed to weld all PVDF pipe valves and fittings 1/2-2" (20mm – 62mm). Equipment shall incorporate a bar code scanner to set all weld parameters. An internal balloon shall be used to eliminate a bead formation. Where usage of the balloon is not possible, weld will be conducted without balloon. Each weld will be done utilizing a HPF coupling.

PART 3 EXECUTION

3.1 Installation

A. Facilities
Subassembly and fabrication work should be conducted in a separate, temporary clean room located within the building. Cleanroom should be equipped with the following to provide a clean installation:

1. Provide Laminar flow Hepa filters in room ceiling to reach a level of class 10,000.
2. The quantity of filters should be determined by providing a minimum of 60 room air changes per hour.
3. Ideal set up is to place welding equipment directly under a filter. In addition nitrogen should be available for purging the pipelines with a positive pressure if the assemblies expand beyond the bounds of the room.

B. Tools
All fusion tools utilized are to be dedicated for clean build only, and should be kept separate. Special attention should be given to the fusion tools to prevent the possibility of contaminating a weld. The contractor shall lease or purchase all necessary welding equipment from the manufacturer. At the end of the installation, any necessary equipment needed on-site should be sold to the owner. Contractor is responsible for proper maintenance and care of the fusion tools during construction.

C. Certification
Installers shall be pre-qualified as per section 2.6. Manufacturer shall provide on-site training in the assembly and installation of the Purad PVDF piping system as needed.

3.2 Testing

A. Inspection
Prior to pressure testing, the system shall be examined for the following items:

1. Pipe shall be completed per drawing layout with all pipe and valve supports in place.
2. Pipe, valves, and equipment shall be supported as specified, without any concentrated loads on the system.
3. Pipe shall be in good conditions, void of any cracks, gouges or deformation.
4. Pipe flanges shall be properly aligned. All flange bolts should be checked for correct torques.
5. All diaphragm valve bonnet bolts shall be checked for correct torques.
6. All joints should be reviewed for appropriate welding technique:

Butt: To have two beads, 360° around the joint.

Socket: To have two beads on the end of the fitting and on the outside of the pipe in contact.

Non-Contact: Identity labels shall identify weld certification by the print "welding parameters OK". Joints should have two beads 360° around the joint.

Manufacturer to supply inspection procedures beyond the above recommendations. If any deficiencies appear, the quality control manager shall provide directions for repair.

B. Pressure Test
1. Test fluid should be deionized water, with quality level set by Quality Control Engineer. In all cases test must be done hydrostatically. Air test is not allowed

2. Filling the system--Open all valves and vents to purge the system of air. Slowly inject the water into the system, making sure that air does not become trapped in the system.

3. Begin pressurizing the system in increments of 10 PSI. Bring the system up to 100 PSI and hold. Allow system to hold pressure for a minimum of two hours and up to a recommended 12 hours. Check pressure gauge after one hour. Due to natural creep effects on plastic piping the pressure will have decreased. If drop is less than 10% pump the pressure back up. At this time the system may be fully pressurized to desired test pressure.

4. If after one hour the pressure has decreased more than 10%, test is consider a failure. Note the10% value may need to be greater for larger systems, or systems experiencing significant thermal changes.

5. Test is to be witnessed by Quality Control Engineer and certified by the contractor.

3.3 Cleaning of HP-PVDF Piping System

System shall be cleaned at completion of project according to requirements set by owner.

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Appendix A: Static Leach Out Data

In the international market different test methods for leach out behavior are being used. The different test methods provide different test results, which are not comparable. For better identification and qualification all Agru high purity systems have been tested according to valid international standards.

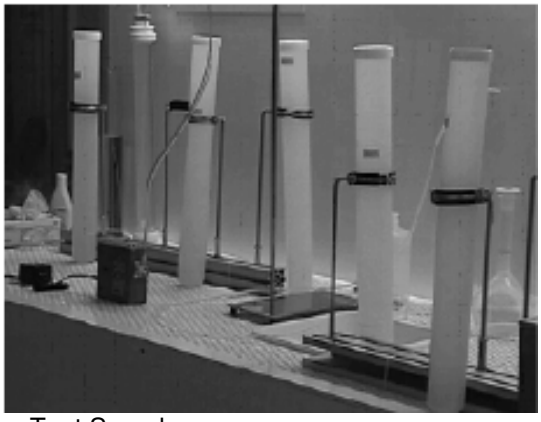
Static leach tests provide valuable information on a material's purity. Static tests provide a worst-case scenario since the test water is stagnant during the entire test. These tests are useful in comparing materials, but do not simulate an actual installation. When comparing this data to other materials, ensure the test methods and result units are identical. Results will vary based on the test method.

Measurement Types:
Ion chromatography (IC) According to SEMI draft doc. 2840 (rev 05/14/98)
Total organic carbon Analyses (TOC) According to SEMI2840B STD (7d;850C)

Test Procedure:

- Sample preparation in class 10.000 environment
- Test was performed in class 1
- Precleaning of the sample with UPW according to SEMASPEC.
- Soak time 7 days
- Anion analyses by IC with suppressed conductivity and preconcentration unit (Release values are notified)
- Transition metals + Cation analyses by IC with suppressed conductivity and postcolumn derivation with PAR. (Release values are notified)
- TOC analyses by TAC-502P system

Analytical Equipment



Test Samples

Static Leach Out Test Results: Temperature 20ºC

	clean PVC		PPr		ECTFE		PVDF-HP		SEMI Spec.
	small	big	small	big	small	big	small	big	
	Ø 20 – 90	Ø 110 – 250	Ø 20 – 90	Ø 110 – 250	Ø 20 – 90	Ø 110 – 250	Ø 20 – 90	Ø 110 – 250	
Sulphate	2621.0	10545.0	< 7.5	< 27.0	49	11	112	98	300
Chloride	5687	21659	3.3	0.9	915.0	1292.0	751.0	709.0	3000
Nitrite	< 4.7	141.0	< 1.4	< 4.9	< 19.0	18.0	< 8.2	< 11.0	100
Bromide	< 5.0	< 8.2	< 4.5	< 16.0	< 15.0	10.0	< 8.2	< 12.0	100
Nitrate	< 12.0	66.0	< 4.5	< 16.0	69.0	35.0	< 8.2	< 11.0	100
Phosphate	12000.0	4180.0	< 3.7	< 13.0	220.0	95.0	239.0	174.0	300
Fluoride	< 5.0	< 8.2	< 1.5	< 5.3	5296.0	10707.0	53485.0	111359.0	60000
Oxalate	302.0	532.0	< 7.5	< 27.0	8.6	255.0	288.0	221.0	no spec.
Lithium	< 6.2	< 4.8	4.0	6.6	< 1.3	< 2.2	9.2	< 15.0	2
Sodium	78.0	36.0	13.0	30.0	< 1.1	31.0	< 3.1	37.0	15
Ammonium	82.0	223.0	1813	3213	119.0	102.0	< 4.1	< 14.0	1000
Potassium	< 41.0	50.0	56.8	91.0	< 1.5	8.4	7.6	< 21.0	15
Magnesium	50.0	116.0	31.0	61.0	4.3	< 2.2	< 4.1	< 15.0	5
Calcium	1661.0	1452.0	22.0	64.0	11.0	19.0	12.0	< 14.0	30
Iron	7.90	27.00	0.00	1.00	1.80	81.00	9.40	17.00	5
Copper	< 0.70	< 4.10	1.50	< 0.40	< 0.70	41.00	< 0.60	6.10	15
Nickel	12.00	43.00	0.10	0.50	0.20	50.00	< 0.30	< 0.84	1
Zinc	42.00	139.00	5.80	8.40	13.00	1174	< 1.70	< 0.85	10
Cobalt	< 0.60	< 4.10	< 0.10	< 0.30	< 0.20	< 0.20	< 0.20	< 0.56	no spec.
Manganese	< 2.50	< 8.20	< 0.30	< 1.10	< 0.20	< 0.20	< 0.80	< 1.64	5
TOC	53.096	198.815	34.762	117.342	55.136	55.822	27.872	73.336	60