Underway "clean" seawater system

Science needs: (Underway transects/ mapping)

- biogechemical cycling of bio-nutritive trace elements of bio-inhibitors
- sea/air interactions and atmospheric deposition
- pollutants
- organic biomarkers of surface ecosystem status

What is meant by clean??

- ability to accurately measure low levels ($\sim 10^{-8}$ per liter) of natural and pollutant elements (and their isotopes) and organic compounds in surface waters
- non-toxic seawater with ambient microbial concentrations to supply sensitive biological studies/experiments

UW System components:

- Pipe and fittings
- Pump
- Intake system

Science Requirement:

SYSTEM COMPONENTS DO NOT INTRODUCE CONTAMINANT METALS OR ORGANIC COMPOUNDS

(1) NO contact of wet-table surfaces with metallic parts

(2) Components do not leach elements or organics

Materials Comparison

MATERIALS	Chemical Compatibility/ Physical Properties	Price Comparison	
PVC (Polyvinylchoride)	 Iyvinylchoride) Ieaches plasticizers Ieaches organo-Sn, Cu, Zn, other stabilizers used in manufacturer Ieaches organics, etc. from joining solvents not "green" manufacture releases vinyl chloride, dioxin, pollutants releases HCI and dioxin when burned 		
PP (polypropylene) Standard grade	 better, leaches plasticizers, UV stabilizers or antioxidants joined using socket fusion or fitted connections low flammability materials available 	** (\$5-6/ft 1" Schedule 40)	
High Purity PP <u>www.ipex.com</u> www.orionfittings.com/highpurity.asp	 virgin material, no added plasticizers, UV stabilizers or antioxidants extremely low organic leachables metals generally below detection limit smooth walls reduce turbulence and impede microbial growth low flammability materials available 	*** (\$8-10)	
PVDF aka KYNAR (polyvinylidene fluoride)	 no detectable leachables (purity for aqueous comp. To Teflon) smooth walls reduce turbulence and impede microbial growth high density so more durable than PP, better for high impact appl. highly abrasion resistant 	***** (\$30-40)	
Lined Pipe (Teflon/PVDF/PP) http://www.resistoflex.com http://www.marspec.com (fabricator)	 highest purity and resistance to chlorinated flowstreams Teflon poor abrasion resistance, danger of surface tears PVDF best durability and abrasion resistance 	****	

Inappropriate pipe joining methods introduce contamination

	Purity Level	Joining Methods	Description
X	•	Threaded Metal Joints	Threaded metal components may cause leaching of contained metals, local stagnation of fluid flow and may produce potential sites for bacterial growth when used with high purity water.
X	• •	Soldered Metal Joints	Oxidation at welded, braised or soldered metal joints can cause contamination when exposed to the high purity water.
X	• • •	Solvent Welded Joints	Solvent welded plastic joints, unless carefully made and cured, can contribute contamination to high purity water.
• • •	••••	Socket Fusion	Socket fusion is a simple process of melting and fusing components together resulting in a clean homogeneous joint. As no compounds are used in the process, sources of material contamination are eliminated. For these types of applications, socket fusion is the joining method of choice.
• •	••••	threaded	(useful for elbows areas which need periodic cleaning)

Pump wetted surface must have no contact with metals

Centrifugal pumps of IHF model are designed on international standards. Pump body is of metal case with

PTFE Lined Chemical Process Pumps

PTFE lined chemical process pumps are not only extremely corrosion-resistant but also of very high quality and reliability. They are therefore used throughout industry for applications to pump dangerous, toxic and pungent media such as acids, alkalis and contaminated solvents containing solids.

IHF Teflon-lined Centrifugal Pump

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Structure:

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1	Pump body:	Fluoroplastics lined
2	Impeller:	Fluoroplastics lined
3	Adjusting ring:	Fluororubber

Mechanical Seal: Polytetrafluoroethylene-aluminum oxide

Fallon-lined Anti-wear Pump



Type: Anti-wear Pump Wetted parts: PTFE lined Flow rate: 0.5~5.5 l/s Head: 16~25 m Rotation Speed: 2900 RPM

Magnatex® ME Series-PVDF Lined Pump

PVDF Lined-MESeries



- · Max Flow: 90 gpm
- Max Head: 140 Feet
- Temperature:32° F 195° F Working Pressure: 70 psig

More Info Quick Quote Pump Selection Tool

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Texel® ME Series are dependable, durable lined magnetic drive pumps. They are the solution for low to medium flow corrosive fluid applications.

Diaphragm Pumps



Diaphragm Pump Type: Operation: Pneumatic, Electric Wetted parts: PVDF, RPP, Stainless Steel, Al alloy Flow rate: 0.5 ~ 30 m3/h Head: 0~50 M

fluoroplastic liner inside. Its impeller and pump cover are made by pressing metal insert with fluoroplastic around it. Shaft seal is of the advanced outer-built type of mechanical sealing with corrugated pipe, stationary ring is of ceramic of 99.9% aluminum oxide; moving ring is of F4. they are strongly hard and good corrosion resistance, and can resist any density of strong acid, strong alkali, strong oxides agent and organic agent.

(Magnetically coupled PFVD-lined centrifugal pumps used on NOAA UW System on Explorer of the Seas)

Maintenance Requirements

- System must be designed to be cleanable
- Routine maintenance and cleaning to remove biofouling
- Periodic aggressive cleaning/dissasembly to leach any contaminants

Recommendations and lessons learned:

- PP, PVDF and Teflon (less so) nonporous and most resistant to biofouling
- isolate system in polluted or nearshore areas
- No elbows- sponge scrubber system can be
- Threaded parts where required for dissassembly
- Ability to rinse/isolate system or leach with deionized water (or weak acid, cleaning solutions (e.g ball-valves)

Safety and Compliance Issues

• Rich Findley mentioend ABS inspectors required no plastic under water line for SJ intake- lined pipe or double containment necessary to pass inspections????

• Flammability (toxicity)







ENPURE High Purity PP STATIC LEACH TEST

Table 1: Static Leach Test results comparing Enpure to Translucent Blue PVC and Type E-2 water requirements.

Element	Detection Limit (x10-8)	Type E-2 Water Req (x10-8)	Enpure x 10-8 @ 73°F	Blue PVC x10-8 @ 73°F
TOC	2	5	5	150
Fluoride	0.2	-	*	*
Chloride	0.02	0.1	*	0.74
Nitrate	0.05	0.1	0.09	*
Phosphate	0.05	0.1	*	*
Sulfate	0.05	0.1	*	0.69
Aluminum	0.005	-	*	*
Arsenic	0.02	-	*	*
Barium	0.001	-	*	0.009
Calcium	0.05	-	*	0.91
Chromium	0.003	-	*	*
Copper	0.005	0.1	*	*
Lead	0.005	-	*	*
Magnesium	0.002	-	*	0.029
Mercury	0.005	-	*	*
Nickel	0.005	0.1	*	*
Potassium	0.01	0.2	*	0.03
Selenium	0.7	-	*	*
Silver	0.003	-	*	*
Sodium	0.006	0.1	*	0.092
Tin	0.002	-	*	0.018
Zinc	0.006	0.1	*	*

* below detection limit

- not required by test method

- bold indicated noncompliance with the standard.

Typicals industrical applications for 18 ohm ultrapure water

Static Leach Analysis

This test represents a process shutdown scenario where the piping system would be offline for a given amount of time. Higher concentration levels of trace elements would leach out of the piping system due to the stagnant process water.

This test utilized 18.2 MegOhm-cm UPW and Enpure Schedule 80 - 1" diameter by 16" long pipe samples (approximately 47 square inches of wet surface contact area).

Riontite for High Purity Piping Systems

Riontite® Mechancial Joining System is our easiest to install high purity joining system.

The Riontite® high purity mechanical joining system makes installation easy. Available in whiteline polypropylene and PVDF, the system incorporates fittings with male threads and a face seal for the end of the pipe. A nut is included which, when tightened on the end of the fitting, activates the sealing and locking features of the Riontite® system.

Features:

- · Easy to install even under the bench and in the air
- No displaced materials
- Bagged with instructions in each bag
- · Dissimilar material in nuts eliminates creep and cold flow
- Portability
- Bead and crevice free joint
- maximum system working pressure is 150 psi @ 73° F.



www.orionfittings.com/highpurity.asp

Polypropylene piping for high purity systems

Our Whiteline systems for high purity piping are manufactured from pure virgin unpigmented Type I homopolymer polypropylene. No anti-oxidants, pigments or other foreign substances are added to the resin in the manufacture process. This manufacturing process produces an system that can be relied on in your high purity situations.

Orion Standardline systems are manufactured from virgin Type II copolymer polypropylene.

Polypropylene demonstrates these advantages:

- Specific Gravity-polypropylene is the lightest of all plastics, weighing approximately two-thirds as much as PVC and one-eighth as much as steel.
- Tensile Strength-polypropylene is the strongest of the polyolefin resins. This strength is retained over a wide range of temperatures. At 200°F the tensile strength is 1700 psi.
- Flexural Strength-polypropylene is classed as a rigid plastic.
- Hardness-polypropylene indicates good abrasion resistance.
- Heat Distortion-the heat distortion temperature of polypropylene is the highest of all the low-cost plastics. Its maximum use temperature is higher than other polyolefins, PVC, and other low-cost plastics.
- Thermal Properties-polypropylene is one of the best plastic insulators.
- Electrical Properties-these are rated excellent.
- Impact Strength-polypropylene has an intermediate impact strength with respect to normal and impact PVC. Impact decreases with lower temperatures.
- Ultraviolet Stability-None. Orion high purity systems contain no ultraviolet inhibitor and therefore must be protected from direct sunlight or ultraviolet rays.
- Burn Characteristics-Polypropylene is classed as slow burning. It is stress-crack resistant unlike linear polyethylene.

Polyvinylidene Fluoride (PVDF)

Orion's Ultra high purity system is for those critical high purity liquid transportation situations when you absolutely, positively cannot tolerate extractables. It is manufactured from 100% pure, virgin, KYNAR® PVDF (Polyvinylidene fluoride) resin.

Features:

- Non-leaching-PVDF adds no detectable leachants or other contaminants to solutions.
- Smooth walls-The extra smooth walls PVDF produces help assure turbulent-free flow of liquids and prevent the collection and breeding of fungi, bacteria and other biological impurities.
- Chemical resistance-PVDF offers excellent chemical resistance to: weak acids, strong acids, oxidizing acids, mixed acids, organic solvents and many aggressive gases. Such resistance makes it an ideal choice for severe applications such as: chemical; cosmetic; pharmaceutical; educational; medical.
- Extended operating range-PVDF is able to maintain a high degree of its strength and chemical resistance within a temperature range of -40°F to 280°F.
- Durability-PVDF's high density (up to twice as dense as polypropylene) means it can take lots of abuse. That makes it an ideal choice in vibration-or impact-prone applications.
- Aging and stability-PVDF is designed to withstand direct sunlight-or be burled-while retaining its physical properties for a minimum of 20 years.
- Fungus resistance-PVDF will not support growth of fungi when tested by Method



Faucets

Laboratory Faucets for High Purity Piping Systems

Countertop and wall mounted faucets for High Purity Systems

Orion has a complete line of countertop and wall mounted Laboratory Faucets activated by a quick turn needle valve. Laboratory faucets are also available with integral vacuum breakers and recirculating faucets. High purity laboratory faucets are available in whiteline polypropylene and polyvinylidene fluoride PVDF materials.

Orion's faucets have been utilized in hundreds of hospitals and research laboratories since 1965 proof: that they represent your best investment in high purity transportation products.

