CORROSION RESISTANCE OF SHEATH MATERIALS

24T: The following is a guideline to select an immersion heater sheath material for direct heating of corrosive materials. Based on known data and experience on the compatibility of standard materials and corrosive environments, the information should only be considered an initial step in the selection process. Other information can come from the manufacturer of the corrosive material and testing. The final selection comes from the end user's knowledge of the process. Variables to consider include:

- 1. Solution chemistry
- 2. Possible contamination of the solution from other processes
- 3. Process temperature
- 4. Flow rate (velocity) across elements
- Reducing heater watt density to keep element temperatures as low as possible
- Accumulating sludge can impede heat transfer from the elements to the process and can accelerate corrosion.
- The welding or other contact of dissimilar metals could generate galvanic corrosion
- 8. Provision should be made to periodically inspect the elements to

insure the continuation of the process

9. See warranty statement pertaining to corrosion

*NOTES

- This solution involves a mixture of various chemical compounds whose identity and proportions are unknown or subject to change without prior knowledge. Check supplier to confirm choice of sheath materials plus alternate sheath materials that may be used.
- 2. Caution Flammable material
- Chemical composition varies widely. Check supplier for specific recommendations.
- Direct immersion heaters not practical. Use clamp-on heaters on outside surface.
- 5. Element watt density should not exceed 20 watts/sq. in.
- For concentrations greater than 15%, element watt density should not exceed 20 watts/sq. in.
- 7. See suggested watt density chart.
- Remove crusts at liquid level.
- . Clean often.
- 10. Do not exceed 12 watts/sq. in.
- 11. Passivate stainless steel, Inconel and Incoloy.

	SHEATH MATERIAL													
OOLUTION		E LEEVE WAR	W KING K	SHINDING CO	.ds	, too	N'C.	و ده		E GO GO GO	ME COLO	in.	Λ.	
SOLUTION	140.	3	1 4	W. Co	RET W	Mi sol	,	S. Chi	STATE OF THE STATE	Silv Mc	JAN A	ANII OU	an'i Li	S.
Acetic Acid Acetone Alcohol Alcorite Alkaiine Cleaners Alkaline Soaking Cleaners	X X B	X X B	C B B	X A A	B A A	C B B	B B A	А В А	C A A	C A A	A A A	A A A	A X	Note 2 Note 1 Note 1 Note 1, Note 9 Note 1
Alodine Aluminum Bright Dip Aluminum Chloride Aluminum Cleaners Aluminum Sulphate Alum	X C X	X C X X	X X X	X X X	X A X	X A A X	A X A A X	X B A B	X A X X	X A X X	C B A X	A A X A	A	Note 1 Note 1 Note 1 Note 1 Note 1 Note 1
Ammonia Ammonium Bipluoride Ammonium Chloride Ammonium Hydroxide Ammonium Nitrate Ammonium Persulphate	X X X A A	X X X X X	çxxxcx	X X X X	X C X X	X C A A	X C A A B	X B C A A B	C X C A X C	B X C A X C	A A A X	A X A X A	A A	
Ammonium Sulphate Amyl Alcohol Aniline Anodizing ARP-28 ARP-80 Blackening Salt	X A B X	X B B X	X C B X	X A X X	B B X	C B A X	B B A X	B B A A	В В В Х	B B B X	A A A X	A A A A	A A	Note 2 Note 1 Note 1
Arsenic Acid Asphalt Barium Hydroxide Barium Sulphate Black Nickel Black Oxide	X A B B	X A B B	X X X B	X X X B	X X 8 B	C A B B	B A A B	B A A B	X A B B	X A B B	X A X A	A A A A	A	Note 2 Note 5 Note 5
Boric Acid Brass Cyanide Bright Copper-Acid Bright Copper-Cyanide Bright Nickel Bronze Plating	X A A	X	X	С	С	C A A	С	C	С	С	A	A A A	А	Note 1 Note 1 Note 1 Note 1, Note 5 Note 1
Butanol Cadmium Black Cadmium Plating Calcium Chlorate Calcium Chloride Carbon Dioxide-Dry Gas	A B B X	A B B X	B B A A	A C B A	A B B	A A B B	A B B	A B B	A B B	А В В А	A A X	A A A	A A X	Note 2 Note 1 Note 1
Carbon Dioxide-Wet Gas Carbonic Acid Carbon Tetrachloride Castor Oil Caustic Etch Chlorine Gas-Dry	X C X A A	X C X A A	A B X A X	X C A C X	A C A A C	A B A A C	A B A A C	A A A A B	A B A A C	A A A A B	X A A A B	A A A A X A	X A A	Note 6
Chlorine Gas-Wet Chloroacetic Acid Chromium Piating Chromic Acetate Chromic Acid Chromic Anodizing	X X X	X X X	X X X	X X X	X C X	X X X	X X X	X X X	X C X	X C X	Х А А	A A A A A	X A X	Note 1 Note 1

SHEATH MATERIAL														
SOLUTION	IRON-STEEL	CAST IRON	ALUMINUM	СОРРЕЯ	MONEL-400	304,321,347,S.S.	316 S.S.	CARPENTER STAINLESS #20	INCOLOY 800	INCONEL 600	TITANIUM	QUARTZ	TEFLON	*NOTES
Chromylite Citric Acid Clear Chromate Cobalt Nickel Cobalt Plating Cod Liver 0il	Х	Х	Х	Х	В	B A A	A A	A	В	В	A	A A A A	А	Note 1 Note 1 Note 1, Note 6 Note 1
Copper Acid Copper Bright Copper Bright Acid Copper Chloride Copper Cyanide Copper Fluoborate	X A	X A	X X	X X	X C B	A X B B	X B B	X B B	X X B	X X B	A	A A A	А А А	Note 1 Note 1 Note 1
Copper Nitrate Copper Pyrophosphate Copper Strike Copper Sulphate Creosote Cresylic Acid	X A C	X A A C	X C X	X C B C	X X B C	8 A A B B	B B B	В А В В	C C B C	X X B C	A B	А А А	Α Λ	Note 1 Note 1 Note 2 Note 2
Deionized Water Deoxidizer (Etching) Deoxidizer (3AL-13) Dichromic Seal Diethylene Glycol Diversey-DS9333	X B	X A	В	В	В	A A	SEE V A A	VATER A A	A B	В	А	A A A	А	Note 1 Note 1. Non-Chromate Note 1
Diversey-511 Dur-Nu Electro Cleaner Electro Polishing Electroless Nickel Electroless Tin (Acid)	А					А					A A	A A A A		Note 1, Note 5 Note 1, Note 5 Note 1 Note 1 Note 1 Note 1
Flectroless Tin (Alkaline) Ether Enthone Acid-80 Ethyl Chloride Ethylene Glycol Fatty Acids	B A X	B B B	B B A	B A B X	B B B	B B B	А В А В	A A B A	8 8 8	B A B B	A A A A	A A A	А А А	Note 1 Note 2 Note 1 Note 2 Note 5
Ferric Chloride Ferric Nitrate Ferric Sulphate Fluoborate (high speed) Fluorine Gas, Dry Formaldehyde	X X X C	X X X	X X X X B	X X X	X X X A B	X B B	X B B	X A B C	X X C	X X C A B	A A A	A A A C A	A A	Note 1
Formic Acid Freon Fuel Oil-Normal Fuel Oil-Acid Gasolene-Refined Gasolene-Sour	X A A X A	X A A X A C	B A X A C	B A A X A C	B A B C B	A A C A B	X A A B A	A A A A	B A B C B	B A B C B	C A A	А А А		Note 2, Note 3, Note 7 Note 2, Note 3, Note 7 Note 2, Note 5 Note 2, Note 5
Glycerin, Glycerol Gold Acid Gold-Cyanide Grey Nickel Hot Seal Sodium Dichromate Hydrocarbons-Aliphatic	B A A	В	A A	B A	A A	A A A	A A A	A A	A A	A	A A	А А А	А	Note 1 Note 1 Note 1. Note 5 Note 1 Note 2
Hydrocarbons-Aromatic Hydrochloric Acid Hydrocyanic Acid Hydrofluoric Acid Hydrogen Peroxide Indium	А Х Х Х	A X X X	A X 8 X A	A X X X	A X B X B	A X B X B	A X B X B	A X B X B	A X B X B	A X B X B	X X A	A X A X A	А А А	Note 2 Note 5 Note 1
Iridite-#4-75, #4-73 #14, #14-2, #14-9, #18-P Iridite #1, #2, #3, #4 C, #4PC&S, #4P-4, #4-80, #4L-1, #4-2, #4-2A, #4-2P, #5P-1, #7, #7-P, #8, #8-P, #8-2, #12-P, #15, #17P, #18P							А					А		Note 1

	SHEATH MATERIAL													
SOLUTION	IRON-STEEL	CAST IRON	ALUMINUM	COPPER	MONEL-400	304,321,347,S.S.	316 S.S.	CARPENTER STAINLESS #20	INCOLOY 800	INCONEL 600	TITANIUM	OUARTZ	TEFLON	*NOTES
Iridite dyes-#12L-2, #40, #80 Irilac Iron Phosphate Isoprep Deoxidizer #187, #188 Isoprep Acid Aluminum Cleaner #186							A A					A	A A	Note 1 Note 1 Note 1 Note 1
Jeta. Kerosene Lacquer Solvent Lead Acetate Lead Acio Salts Lime Saturated Water	A A X B	A X B	A A X	A A X B	A B A B	A A A A B	А А Л	A A A B	A B A	А В А	A A	A A X		Note 1 Note 2 Note 2 Note 1
Linseed Oil Magnesium Chloride Magnesium Hydroxide Magnesium Nitrate Magnesium Sulfate McDermid #629	A X A B B	A X A B	8 X B B	B B A B	В В В А	A C A B B	А В А В	A A B B	В А В В	B A A X A	A B A	A A A A	А	Note 1
Mercuric Chloride Mercury Methy Alcohol Methanol Methyl Bromice Methyl Chloride Methylene Chloride	X A B C X	X A C C C	X X C X X C	Х В В А С	X B A B C C	X В А С С	X A B A C	X A B A A	X B B C C	X В В С В	A A A A A	A A A A		Note 2
Mineral Oil Muriato Naphtha Nicke' Acetate Sea' Nickel Chloride Nickel Plate-Bright	A A X	A B X	A A X	A A X	A C	A A X	A A C	A A B	A C	А Л В	A C A	A A A A	А Л А	Note 1 Note 2 Note 1 Note 1. Note 5 Note 1. Note 5
Nickel Plate-Duil Nickel Plate-Watts Sol. Nickel Sulphate Nickel Copper Strike (Cyanide Free) Nitric Acid	×	x	×	C	C	B A C	В	ВВ	c	c	A	A A A	A A A	Note 1. Nate 5 Note 1. Note 5 Note 1
Nitric Hydrochloric Acid Nitric 6% Phosphoric Acid Nitric Sodium Chromate Nitrobenzene Oakite #67 Oil	X A A	X B A	X B A	X B A	X B A	X B A A	X A A B	Х А А	X B A	X B A	X A A	A A A A	A A	Note 1 Note 1 Note 2 Note 1 Note 7
Oleic Acid Oxalic Acid Paint Stripper (High Alkaline Type) Paint Stripper (Sorvent Type) Paraffin Perchloroethylene	C X A A	C X A	C X A B	C B A B	В В В А	C X A	B X A A	В В А	B X	A B	B X	A A A	A A	Note 1 Note 1. Note 2 Note 2. Note 7
Petroleum-Crude Phenol Phosphate Phosphate Cleaner Phosphatizing Phosphoric Acid	B B	B B	A B	A	A B C	A C A	A B A A	A B	В	В	A	A A A	X X X A	Note 2, Note 3, Note 7 Note 1, Note 5, Note 9 Note 1, Note 5, Note 9 Note 1, Note 5, Note 9 Note 5, Note 9
Picric Acid Potassium Acid Sulphate Potassium Bichromate Potassium Chloride Potassium Cyanide Potassium Hydrochloric	X C X C	X C X X	X B X X	X C X	X B B C	B C B	8 B A B	B A B	C B C B	C C B	A A X	A A A A A	A A A A	Note 1
Potassium Hydroxide Potassium Nitrate Potassium Sulphate Reynolds Brightener Rhodium Hydroxide Rochelle Saft Cyanide	X B C	X B X	X A A	X B B	B B A	C B A	C B A	C B A	0 8 8	8 B B	C A	X A A A	A A A	Note 1 Note 1

A—Good B—Fair

C—Depends upon conditions

X—Unsuitable

Blank—Data unavailable

	SHEATH MATERIAL													
SOLUTION	IRON-STEEL	CAST IRON	ALUMINUM	СОРРЕЯ	MONEL-400	304,321,347,S.S.	316 S.S.	CARPENTER STAINLESS #20	INCOLOY 800	INCONEL 600	TITANIUM	QUARTZ	TEFLON	*NOTES
Ruthenium Plating Silver Bromide Silver Cyanide Silver Lume Silver Nitrate Soap Solutions	X C X A	X C X A	X X X	X X	C B	X A A C A	X A C A	C A B	A C	С	A A	A A A	A A	Note 1 Note 1 Note 3
Sodium-Eiquid Metal Sodium Bisulphate Sodium Bromide Sodium Carbonate Sodium Chlorate Sodium Chloride	C X B C X	X X C X X	X C X X B	X B A A B	8 C B B A	A X X B X	Х В В В	B B B C	A B B B	А С В В А А	C A A C	X A C A A	A A A	
Sodium Citrate Sodium Cyaniae Sodium Dichromate (Sodium Bichromate) Sodium Hydroxide Sodium Hypochlorite	X X A C X	X B C X	X C X	X X X X	X C X	B A B X X	B A B C X	B A B C B	A B X	A B X	C C C A	A A A X A	A A A	Note 8. Note 6
Sodium Nitrate Sodium Peroxide Sodium Phosphate Sodium Salicylate Sodium Silicate Sodium Sulphate	B B B B B	B B C B X	X B X X	C X B B	B B B B B	A B B B B	A B B B B	А В В В	A B B B	A B B B	A A C	A A A A	A A A A	Note 5 Note 4
Sodium Sulphide Solder Bath Sodium Stannate Stanostar Stearic Acid Sugar Solution	X X C C	X B C C	X X B A	X X X A	B X B X A	X X B C A	C X B A A	C X B B	B X B B	C X B A A	C X A	C X A A A	A X A A	Note 1
Sulfamate Nickel Sulfurios Acid Sulfurous Acid Sulphamic Acid Sulphur Sulphur Chloride	X X X X	X X X X	X C X A X	X X X	X X B C	X X X A C	X X X A C	B A A C	X X A C	X X A B	A X A	A A A A A	A A A A	Note 1
Sulphur Dioxide Tannic Acid Tin (Molten) Tin-Nickel Plating Tin Plating-Alkaline Trichloroethane	C X A A	C X A	C C X	C X X	X C X	C B X A A	B B X	B B X	C C	C C X A	A A	A A A	X A	Note 4 Note 1 Note 1
Trichlorethylene Triethylene Glycol Trisodium Phosphate Trioxide (Pickle) Turco 4181 (Alk. Cleaner) Turco 4008 (Descaier)	A A A	A A A	A A X	B A C	B A C	A C	A C A A	A A C	A A	A A	A A	A A X A	X A	Note 1 Note 1 Note 1, Note 5
Turco 4338 (Oxidizer) Turco Ultrasonic Solution Ubec Udylite #66 Unichrome CR-110 Unichrome 5RHS							A				А	A A A	A A A	Nate 1, Note 7 Note 1 Note 1 Note 1, Note 5 Note 1 Note 1
Water Deionized Water Demineralized Water Pure Water Potable Water Sea Watt's Nickel Strike	X X X X	X X C X	X X C	X X B X	A A A A	A A C C	А А В С	A A A A	A A A B	A A A B	A A	А А А	A ^	Note 11 Note 11 Note 11
Whiskey Wood's Nickel Strike Yellow Dichromate Zinc (Moten) Zinc Chloride Zinc Plating Acid	х	Х	X X	A X X	X B	A X X	A A X X	A X B	X X	X B	X B	A A A	X A	Note 2 Note 1 Note 1 Note 1
Zinc Plating Cyanide Zinc Phosphate Zincate	A A					А А	А						X	Note 1 Note 1 Note 5 Note 1

A-Good

B—Fair

C—Depends upon conditions

X—Unsuitable

Blank—Data unavailable