GROSSTEK

Introduction to Ultressa[®] HX series membranes for Oil Wastewater, based on proven Bioinspired nanoceramic zNano[®] zUF

11/23/22



About zNano Technology

Focus is bioinspired material sciences to improve water treatment membranes. Technology has proven that surface grafting using bioinspired zNano technology can increase intrinsic permeability of ultrafiltration (UF) zMembranes – and can also protect against fouling from organics



Premium Bioinspired Nanoceramic Membranes



Why do we need another UF membrane?

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OIL FOULING REMAINS A MAJOR CHALLENGE FOR ULTRAFILTRATION

PROVEN CERAMIC ULTRAFILTRATION REMAINS EXPENSIVE FOUR DECADES ON

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ULTRESSA INCORPORATES THE KEY FEATURES THAT MAKES CERAMIC MEMBRANES RESIST **OIL FOULING:**

1. HYDROPHILICITY 2. CROSSFLOW **3. SURFACE CHARGE / ISOELECTRIC POINT 4. CLEANABILITY**



LET'S STUDY ULTRESSA VS CERAMIC

HYDROPHILICITY
 CROSSFLOW
 SURFACE CHARGE / ISOELECTRIC POINT
 CLEANABILITY



ULTRESSA HYDROPHILIC POLYMER PRODUCTS

Material	Hydrophilic Polymer				
	HX	HX ^{max}			
Format	Spiral small channel	Spiral large channel			
Flow path	Inside out, Crossflow	Inside out, Crossflow			
Pore size	0.025µm	0.025µm			
Key application	Low TSS, moderate Oil wastewater	Moderate TSS / Oil wastewater			
Concentrate limits	< 500mg/l TSS; < 50,000mg/l Oil	< 1,000mg/l TSS; < 100,000mg/l Oil			
Design temperature	50 to 140°F 10 to 60°C (FUTURE: 80°C)	50 to 140°F 10 to 60°C (FUTURE: 80°C)			



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SUPERIOR HYDROPHILICITY



What is Hydrophilicity? Why is it important?

- To transport water through a membrane, a membrane material with an affinity for water, i.e. hydrophilic material, reduces energy
- When combining water transmittance through, and oil/organics removal by the membrane, then hydrophilicity is vital to success, since material with an affinity for water (hydrophilic) also repels oil (oleophobic)
- Hydrophilicity is measured by contact angle (θ). Lower θ = more hydrophilic





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ULTRESSA CONTACT ANGLE - SUPERIOR

- Sessile drop method using 25 microliter water droplet and digital backlit filming of sample
- Three steps for data processing to measure contact angle:
- Contact angles: ceramic UF ~ 29°, <u>Ultressa ~ 20°</u>





CROSSFLOW - LESS ENERGY



CROSSFLOW – ULTRESSA USES LESS ENERGY

- **Crossflow rate depends on temperature and TSS + O&G in the concentrate**
- Maximum Temp is 60°C / 140°F (future 80°C) and maximum crossflow dP is 15psid / 1bar
- The graph below shows the extremes of pressure and crossflow rate allowed for the HX and HX^{MAX} modules
- Power 20°C: Ultressa HX ~100gpm/10psid ~0.043kW/m²; Compact ceramic: 333gpm/12psid ~0.20kW/m²



	dP,max,	GPM max	GPM max
Temp (oC)	psid	HX	HXmax
2	15	90	101
10	15	112	127
20	15	124	140
30	15	131	147
45	15	139	157
60	15	140	159



Utressd®

SURFACE CHARGE / ISOELECTRIC POINT LIKE CERAMIC UF



NEGATIVE CHARGE, LOW IEP - REDUCES FOULING

- Organics incl. oils typically have negative charge. Ultressa has negatively charged membranes to repel oil / organic fouling
- PH-charge relationship shows that at pH known as isoelectric point (IEP), membrane surface charge is zero. Above this pH the membrane shows negative charge and below this pH the membrane shows positive charge
- Ultressa has a pH-charge relationship similar to titania ceramic membranes giving it the same ability to be negatively charged with most wastewater pH (i.e. pH>5) while also retaining ability to reverse charge for cleaning at pH < 5







CLEANING - RELIABLE



TEMP, pH, OXIDANT & IEP OPTIONS AVAILABLE

pH Range: continuous // CIP	4 – 10 pHU ≤ 25°C,77°F; 4 – 9 pHU > 25°C,77°
Temperature: continuous and CIP	5 – 60°C, 41– 140°F
CIP Chlorine limits (pH 10.5 – 11)*	200,000 ppm.hrs (total); CIP Max concentrati

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F // 2 – 11 pHU

ion: 150 ppm





DESIGN AND PERFORMANCE



TYPES OF OIL ULTRESSA TREATS

Oil has the following main forms inside water phase:

- Floating oil coalesced, larger size, unstable droplets that floats, creams and/or breaks for skimming UF not needed, skim/float
- Mechanically emulsified oil medium size, semi-stable FROM kinetic energy, coalesces in quiet zone good for UF
- Chemically emulsified oil small size, stable due to surfactant, slow coalescence, UF preferred
- "Dissolved" oil or organics extremely fine droplets and sometimes reports as COD, removed to high degree with UF





3-PHASE EMULSION PRETREATMENT



Chemically emulsified oil "Dissolved" oil or organics

ULTRESSA FEED WATER

SOLID-LIQUID EMULSION PRETREATMENT

Feed: oil and suspended solids



Floating oil removed with oil skimmer

Mechanically and chemically emulsified oil as feed to Ultressa. **No flocculants chemicals** required in pre-treatment



Ultressa®



MARKETS AND APPLICATIONS

Applications and Market Segments:

Emulsion / Oil and Grease and TSS removal from wastewater in the food waste, oil and gas production, metalworking and automotive market segments

Advantage:

Simpler to operate, more reliable and improved effluent versus conventional processes Lower operating cost and footprint vs chemical approach (acid, coag/floc, neutralization)





ULTRESSA PERFORMANCE VS CERAMIC UF

- Side-by-side trial of Ultressa HX^{MAX} versus ceramic UF
- Ultressa and ceramic UF could concentrate emulsion from 1% V/V to 5% V/V
- Ultressa HX permeability followed expected logarithmic curve vs.
 concentration, showing expected TMP increase during constant flux experiment
- Both membranes showed permeate quality < 3 NTU
- Both membranes cleaned well with a detergent/alkaline CIP
- Ultressa is competitive with ceramic UF for oily wastewater in target markets









SUMMARY: ADVANTAGES OF ULTRESSA

Feature	Ultressa HX UF	Ceramic UF
Pore size for oil removal	25nm	10 – 100nm
Price of Solution	Low	High
Power required	Good	Very High
Temperature limit	60°C (future 80°C)	>90°C
Permeate quality	Excellent	Excellent
Size of System	Compact	Large/Mediun
Pretreatment Required	Medium	Low/Medium
Hydrophilicity	Very good	Low/Medium
Cleaning efficiency	Very good	Very good
Life cycle cost	Low	High





Ultressa HX Spiral System and Product

FRP, PVC XP system **1-tall membrane**



CONTACT US FOR

- Membrane elements we can support delivery of your systems as needed
- Oil and gas produced water treatment
- Bilgewater treatment to IMO / MARPOL standards
- Laundry water recovery
- Metal machining and rolling oil emulsions wastewater treatment
- Other oily wastewater and organic-loaded wastewaters



THANK YOU

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