



HYDRACoRe

**CHLORINE TOLERANT
SPIRAL WOUND Nanofiltration
Color Removal Membrane Elements**

February 2002

**401 Jones Road, Oceanside, CA 92054
Phone: 760.901.2500 • Fax: 760.901.2578 • 1.800.CPA.Pure
www.membranes.com**

1. Introduction





HYDRACoRe membrane technology incorporates low-pressure flat sheet composite membrane with strongly negatively charged surface. The membrane barrier consists of sulfonated polyether sulfone polymer. Typically the thickness of the skin layer is about 0.3 μm . The membrane exhibits stable performance over a wide range of pH, from 2-11 (pH 12 is temperature dependent), and can be exposed to high concentrations of free chlorine. The membrane has high water permeability and high salt transport. There are three model types of HYDRACoRe membrane technologies available; HYDRACoRe 10, HYDRACoRe 50 and HYDRACoRe 70, with nominal NaCl rejection of 10%, 50% and 70% respectively. (Currently HYDRACoRe 10 and HYDRACoRe 70 are prototype membrane products and are available through our QualSep division for special separation applications).

The permaselectivity property of the HYDRACoRe is rather unique. The salt passage of divalent ions is higher than the passage of monovalent ions. Salt rejection of charged species decreases with increasing feed concentration. Salt rejection of neutral species remains stable over a wide range of concentration. Salt rejection of amphoteric electrolytes, such as amino acids, depends on pH and increases rapidly at pH higher than the isoelectric point. The rejection is high for negatively charged solutes such as ATP.

2. Product features

HYDRACoRe elements have the following features:

- 1) High permeate flux at low pressure.
- 2) Strong negatively charged membrane surface.
- 3) Superior chlorine tolerance. The performance of commercially available conventional RO/NF polyamide membranes decrease drastically due to chlorine exposure. The performance of the HYDRACoRe remains stable when the HYDRACoRe is used to treat feed water containing chlorine and/or membrane elements are cleaned using a chlorine solution.
- 4) Imperviousness to bacteria attack because the membrane consists of synthetic polymer thin film composite.
- 5) High reliability with element components selected for less elution and optimum element configuration.

HYDRACoRe membranes show superior performance in various water treatment processes. They are especially suitable for potable applications that require removal of dissolved organics and color reduction.

2-2 System Design Considerations



HYDRACoRe elements exhibit a high specific flux. Therefore, if several elements are connected in series in a single vessel, the lead elements could have very high flux rates, which may increase the fouling rate. RO/NF system configuration should be designed to maintain uniform flux distribution by maximizing flow efficiency through each pressure vessel. Specific design will be based on water application requirements.

2-3 Cleaning Chemicals

The type and composition of the applied cleaning formulation depends on the fouling material. The following cleaning chemicals are generally recommended. It is, however, recommended that the cleaning chemicals be selected only after identifying the fouling material and testing for effectiveness of foulant removal.

Example of Typical Cleaning Chemicals:

- 0.2 % Oxalic Acid solution
- 2% Citric acid + Ammonia solution (pH4)
- HCl solution (pH3-4)
- Phosphoric acid solution (pH3-4)
- NaOH solution (pH9-12)
- NaOCl solution (100ppm)
- Anion surfactant (0.1%)
- 1% Sodium hexametaphosphate solution

Note: The use of a cationic surfactant or a nonionic surfactant may result in a flux decrease. A cationic surfactant or a nonionic one should be used only after its compatibility with the membrane has been determined. The use of hydrogen peroxide solution may result in degradation of the membrane.

3. Membrane Performance



Table 3 –1: Separation performance of the rejection of inorganic compounds

HYDRACoRe 10

Anion			A ⁻	A ²⁻
			Cl	SO ₄
Cation		Molecular Weight	35	96
M ⁺	Na	23	10	15
M ²⁺	Mg	24	2	4
	Ca	40	1	-

HYDRACoRe 50

Anion			A ⁻	A ²⁻
			Cl	SO ₄
Cation		Molecular Weight	35	96
M ⁺	Na	23	50	90
M ²⁺	Mg	24	20	35
	Ca	40	12	-

HYDRACoRe 70

Anion			A ⁻	A ²⁻
			Cl	SO ₄
Cation		Molecular Weight	35	96
M ⁺	Na	23	70	95
M ²⁺	Mg	24	40	70
	Ca	40	30	-

Test Conditions:

Sample: Flat sheet membrane
 Pressure: 1.0 Mpa (143 psi)
 Feed Conc.: 0.20 by weight %
 Feed pH: 6.5
 Temperature: 25 C

Table 3 -2. HYDRACoRe stability during exposure to various chemical compounds



Chemical Agent	Condition	Long Term Stability
Sulfuric acid	pH2	Stable
Hydrochloric acid	pH2	Stable
Nitric acid	pH2	Stable
Acetic acid	1%	Stable
Oxalic acid	2%	Stable
Citric acid	2%	Stable
Ethlenediamine tetra acetic acid disodium salt solution	2%	Stable
Sodium hydrogensulfate	2%	Stable
NaOH solution	pH13	Stable
Chlorine (Sodium hypochlorite)	100ppm	Stable
Hydrogen peroxide	1%	Unstable
Formalin	0.5%	Stable

Test conditions: 1 month soaking at room temperature

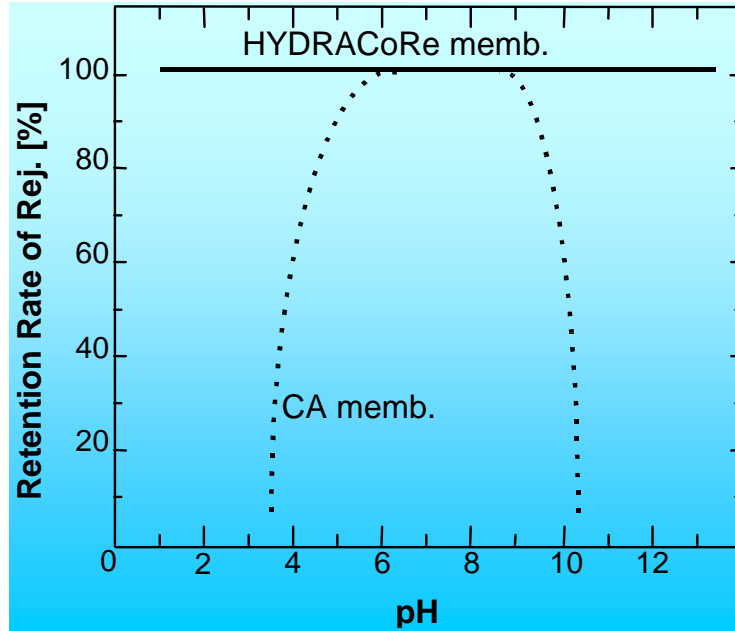


Fig. 3 -1 pH tolerance of HYDRACoRe membrane as compare with CA membrane.

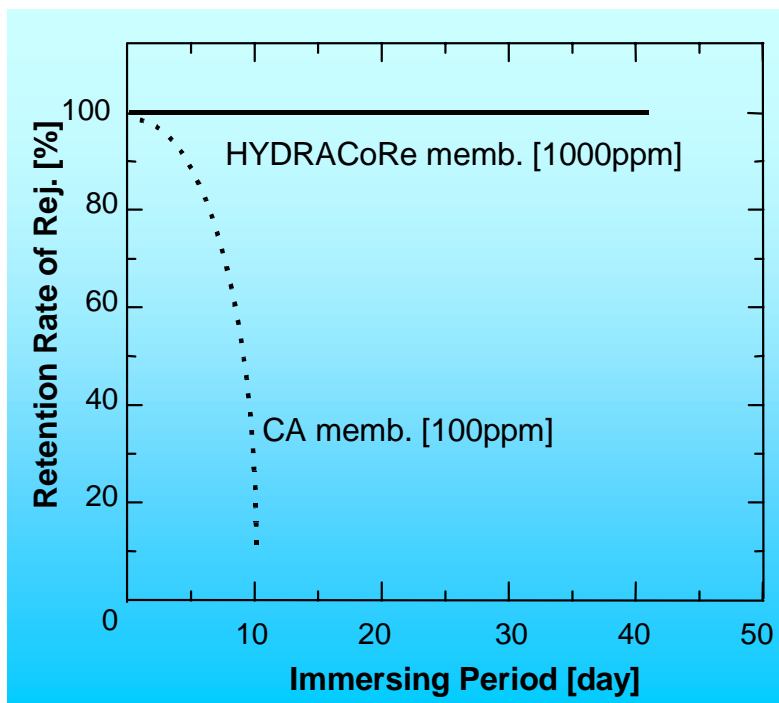


Fig. 3 -2 Chlorine tolerance of HYDRACoRe membrane as compare with CA membrane.



4. Membrane Surface characteristics

The membrane surface characteristics of the HYDRACoRe has a strong negative charge. The surface Zeta potential of the HYDRACoRe membrane relative to other membrane types is shown in Fig 4-1. The strong negative charge of the membrane surface will result in the repulsion of negatively charged constituents in the feed water, which will reduce the fouling rate by anionic species. On the other hand, positively charged compounds will be attracted to the membrane surface resulting in a flux decline. This is especially important when processing streams containing cationic compounds, such as surfactants and flocculation polymers.

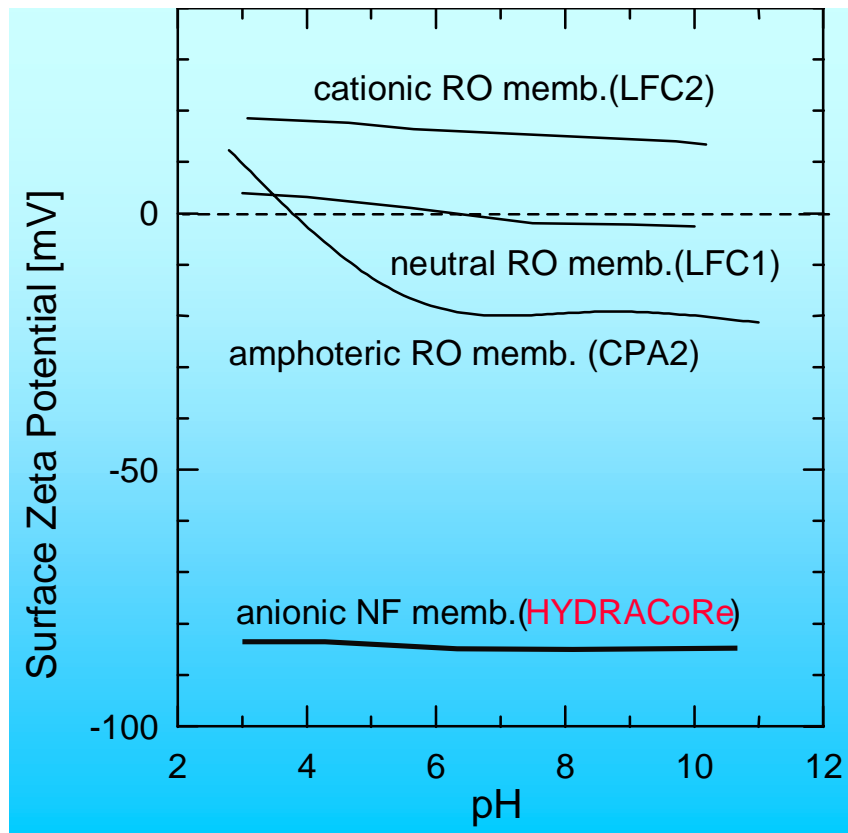


Fig. 4-1. Surface zeta potential of HYDRACoRe membrane as compared with other membranes.



5. Applications and References

Due to performance stability, in the presence of free chlorine, HYDRACoRe membranes were used initially to treat industrial wastewater, including highly colored streams from pulp and paper manufacturing (1). HYDRACoRe membranes are also being used in food applications for sugar fractionation and color removal from soy sauce.

Presently HYDRACoRe applications have been expanded to the treatment of low salinity, high color ground water. An extensive pilot study has been conducted (2 – 4), mainly using HYDRACoRe 50 membrane. One such study (4) has been conducted as a membrane screening program for a large (7.35 MGD, 27,800 m³/day) potable water treatment system at Irvine Ranch, California. The ground water is of low salinity, (about 250 ppm TDS), but contains high concentration of dissolved organics (10ppm TOC) and high color (200 CU). The objective is to reduce color and concentration of organics without significantly affecting the ion composition of the potable water produced. Out of eight different membrane types tested from various manufactures the HYDRACoRe 50 membrane was selected as the most suitable for this application. The project will utilize over 1300 8" HYDRACoRe 50 membrane elements and is scheduled to commence operation in early 2002. As a part of a product quality assurance procedure, during the manufacturing process, the performance of a representative number of randomly selected elements was tested on the actual ground water. The results are shown on Fig 5 –1. The data demonstrates very good reduction of color and high passage of dissolved inorganic constituents.

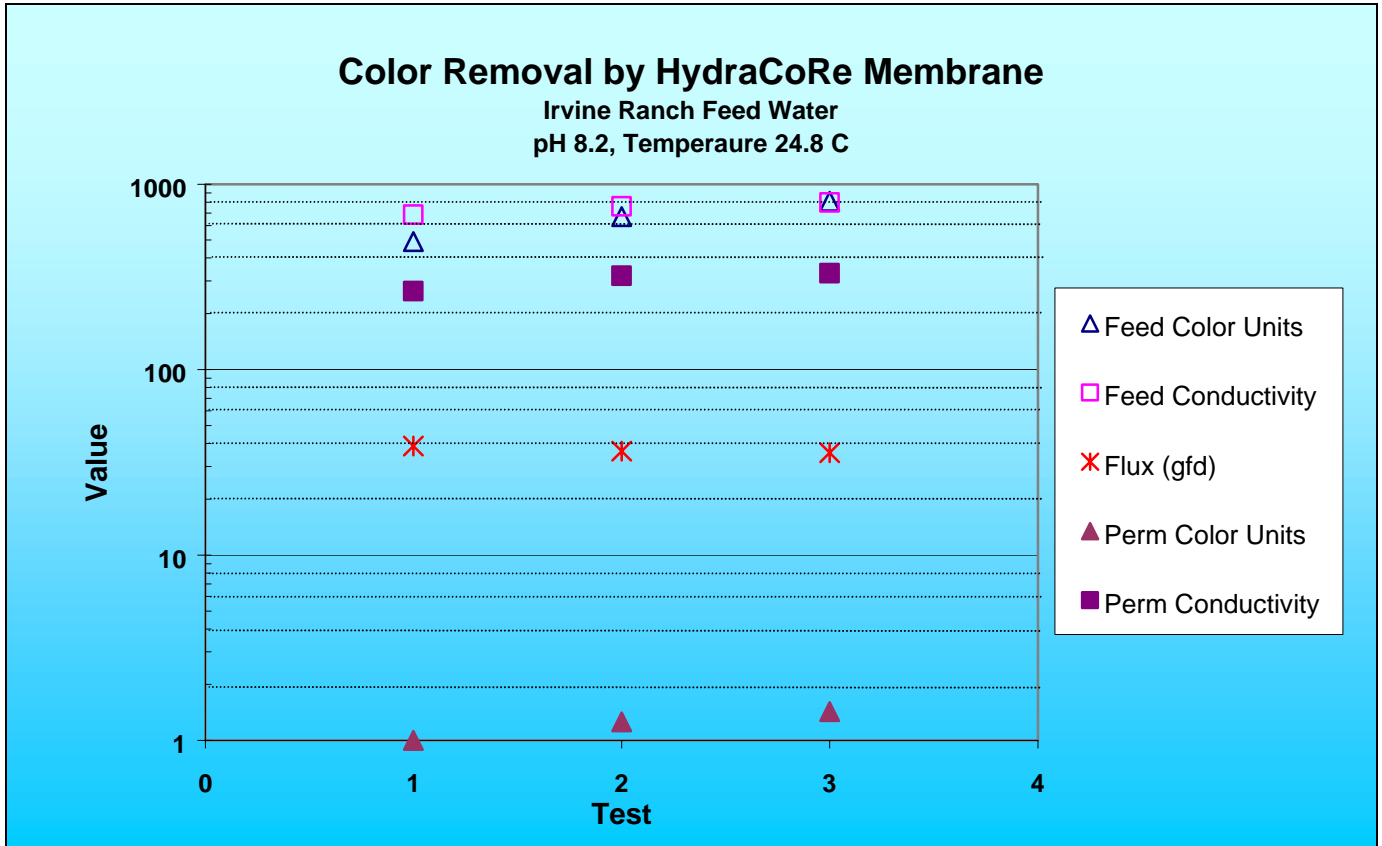


Fig 5 –1. Test results of HYDRACoRe elements for the Irvine Ranch Project



References

1. K. Ikeda, T. Nakano, H. Ito, T. Kubota and S. Yamamoto, New composite charged reverse osmosis membrane. *Desalination* 68 (1988) 109 – 119
2. S. Choi, Z. Yun, S. Hong and K. Ahn, The effect of co-existing ions and surface characteristic of membrane on removal of nitrate and fluoride. *Desalination* 133 (2001) 53 – 64
3. Y. Kiso, Y. Sugiura, T. Kiato and K. Nishimira, Effect of hydrophobicity and molecular size on rejection of aromatic pesticides with nanofiltration membranes. *Journal of Membrane Science* 192 (2001) 1 – 10
4. P. Fu, H. Ruiz, J. Lozier, K. Thompson and C. Spangenberg, A pilot study on ground water natural organics removal by low-pressure membranes. *Desalination* (1995) 47 - 56