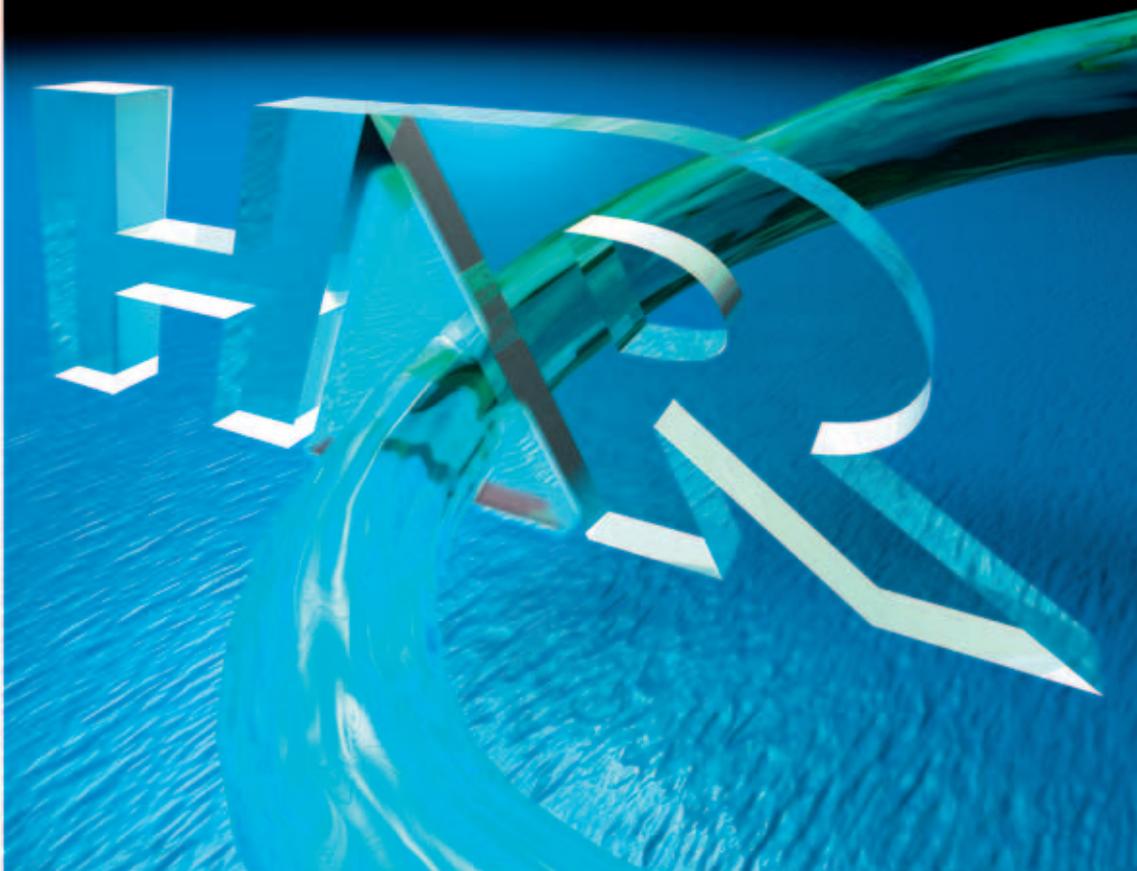


LEADER IN SEPARATION TECHNOLOGIES



HAR[®]
HYDRO AIR RESEARCH
MEMBRANE SEPARATION SYSTEM



E N V I R O N M E N T



Hydro Air Research Italia

Since 1979 HAR has gained extensive expertise in process and waste water applications, becoming a leader in membrane separation technology. Over 10% of HAR annual revenues are devoted to the company's research and development efforts. The result is an on-going technological upgrading of its products and applications, including separation technologies such as evaporation/crystallization, electrodialysis, chromatography and pervaporation.



Industrial process applications include biotechnology and pharmaceutical applications, where HAR developed its own know-how, as well as applications in food and dairy, fine chemicals, petrochemical and chemical field.

According to the increasingly stringent environmental legislation, HAR designs and supplies complete plants "Zero Discharge Water Recycling", an advanced process to treat effluents obtaining water suitable to reuse or to discharge according to the law restrictions. The goal is reached through the combination of different technologies, from bioHAR® Membrane Bioreactor through membrane processes, pervaporation and evaporation.

HAR has developed and realized patented systems for Landfill Leachate Treatment, plants with an economical process, effective and reliable.

HAR pursues ISO 9001 Quality Policy, to enable the maximum satisfaction of its customers by responding appropriately to their needs and requirements.



HAR approach to separation problems

The beginning of all HAR systems design is the evaluation of the customer's objectives and requirement. Test facilities and pilot plant are available for feasibility study and bench or semi-industrial trials.

Preliminary tests are carried out in HAR laboratories on small liquid samples providing separation performance and data useful for industrial plant scale-up as well as cost projections or economic models to determinate full-scale operation and required capital costs. Pilot plant verification at customer's site is recommended to generate data under actual field conditions.



Effluent Treatment

Disposal of spent/exhaust solutions or generally waste water is one of the biggest problems of industries.

Several years ago HAR widened its portfolio of technologies, obtaining suitable and effective solutions to the "waste water problem".

HAR solutions are developed through feasibility studies and site tests, selecting the suitable technology according to the effluent characteristics and to the treated water quality requirement.



Discharge standards are becoming more and more stringent over the time and the result of this "tightening" would be Zero Discharge. Industries need water at various purity degrees for production processes or other internal uses. Combining the various technologies HAR is in position to provide for any specific solution to wastewater treatment meeting the standards for water discharge or reuse.

Treatment method selection criteria:

- ▶ Applicability of the process, relating to effluent characteristics
- ▶ Environmental factors, including weather and territorial aspects such as noise and odors
- ▶ Performance, in terms of quality of the treated effluent and legislation parameters in order to discharge or reuse the water
- ▶ Investment and running costs





BioHAR® Membrane Bioreactor

BioHAR® Membrane Bioreactor is a combination of an activated sludge biological system and an ultrafiltration system, for an optimal removal of organic contaminants in waste streams.

Two different bioHAR® configurations are available: sidestream and submerged.

In submerged configuration the membrane unit is installed inside the aeration tank and the driving force can be the static head or a suction from permeate side. In sidestream configuration the membrane module is an external unit. The activated sludge is continuously pumped from aeration tank through the membrane system and the biomass is recycled back to the tank.



In the oxidation tank biodegradable substances are eliminated and ammonia and nitrogen-based compounds can also be removed, while the membrane filtration system removes 100% of the suspended solids giving a fully sterilized treated water. One of the advantages of bioHAR® system is the stable filtration rate without membrane cleaning problems.

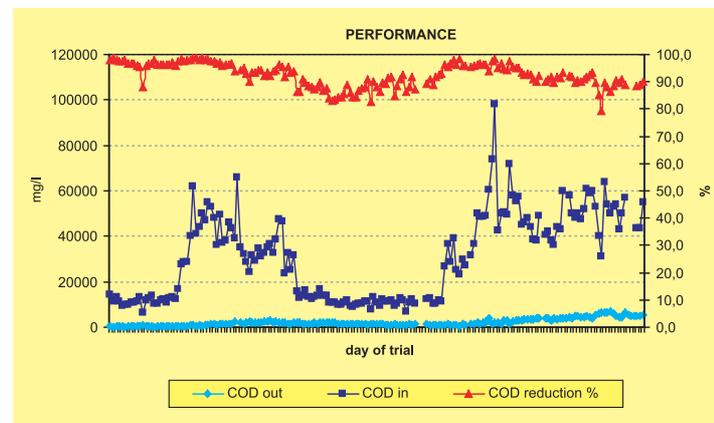
The membrane filtration system replaces the conventional phase of sedimentation by gravity and enables the retention of the biological sludge in the oxidation tank keeping a much higher concentration

than in a conventional biological system. The membrane, being an absolute barrier for the sludge, is also avoiding the entrainment of sludge in the treated effluent, trouble that often occurs in the traditional settling tanks because of bulking phenomena.

Advantages of bioHAR®

- ▶ Elimination of the settling tank and high quality of the treated effluent
- ▶ High efficiency for the removal of organic load due to high biomass concentration and retention of high molecular weight compounds
- ▶ Reduced production of sludge
- ▶ Increase of tolerance of normally toxic substances for a biological system, due to the high ratio biomass/toxic
- ▶ Small footprint
- ▶ Low operating costs
- ▶ Membranes high chemical resistance
- ▶ Stable membrane filtration rates
- ▶ Guaranteed membranes life

BioHAR® Membrane Bioreactor is a high efficiency step of "Zero Discharge Water Recycling" process and is the most suitable pre-treatment for a further processing through reverse osmosis.



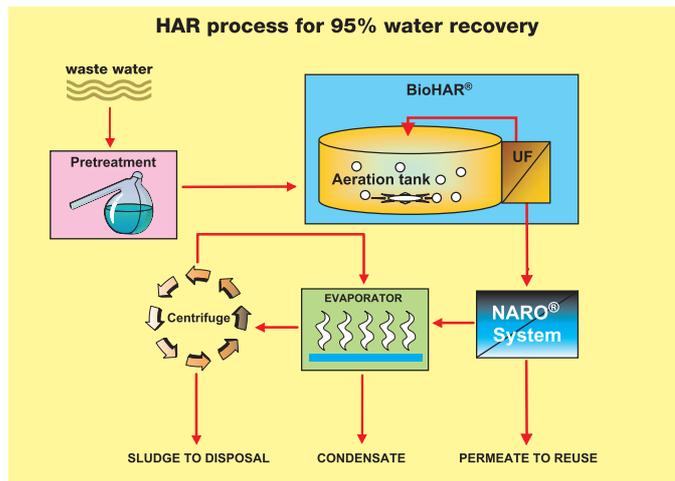
Zero Discharge and Water Recycling

HAR activity is focused on the design and supply of innovative processes for waste water treatment, with the goal to reuse water meeting high purity standards and to reduce the waste to a minimum volume with the lowest investment and operating costs.

In the view to offering advantageous technical-economical solutions, HAR is cooperating with international research institutes and world leading companies of the field, allowing its team of experts to provide solutions and systems based on the combination of different technologies. Membrane separation (Microfiltration, Ultrafiltration, Nanofiltration and Reverse Osmosis) is the key technology of HAR process, a “clean” technology not using either chemicals or heat, not generating either air pollution or noise problems, allowing removal of contaminants, water recycling and byproducts recovery.



Depending on the quality of the effluent to be treated, the first step of “Zero Discharge Water Recycling” process is bioHAR® Membrane Bioreactor system, that is a high efficiency combination of biological activated sludge and membrane processes.



The *second step* is NARO® system, a registered mark for an advanced membrane process that can concentrate the residual contaminants coming from bioHAR® to very high dissolved solids content, achieving excellent energy efficiency and optimal membranes performance.

The NARO® concentrate, still liquid, can be further reduced in volume through the evaporation / crystallization step, while the NARO® permeate can be directly reused or discharged according to the local regulations.





NARO® System

NARO® system is a patented reverse osmosis system able to concentrate the total dissolved solids to higher levels than traditional reverse osmosis systems, with better energy efficiency and optimal membranes performance.

NARO® system is a multistage system with feed and bleed configuration, i.e. with continuous discharge of the concentrated phase, that with a variable distribution of the operating pressure in the loops gives the following advantages compared with the traditional systems:

- ▶ Lower energy consumption
- ▶ Best performance of the membranes, in terms of rejection and fluxes
- ▶ More competitive investment and operating costs

NARO® system is extremely flexible as regards operating parameters; the working pressure, driving the volumetric concentration factor as well as the permeate flux, is automatically controlled in a wide pressure range. In NARO® system the membrane area is



distributed in a series of independent loops (each one composed by recirculation pump, instrumentation, membranes) with series/parallel configuration of the membranes

depending on the characteristics of the fluid to be treated.

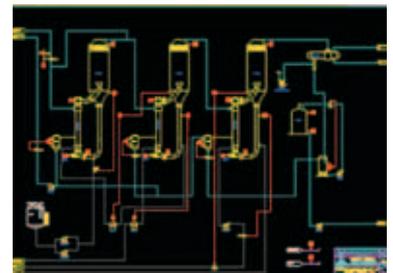
Evaporators & Crystallizers

HAR started to design evaporators and crystallizers as complementary equipment to membrane separation systems for liquid waste treatment. The particular requirements of the handled fluids led HAR to develop its own evaporation "state of the art" and to manufacture the equipments following the international quality standard according to the company mission.



The main features of HAR evaporators can be summarized as follows:

- ▶ Construction materials "custom tailored" to the special needs of every process stream.
- ▶ Possibility of handling fouling fluids and solids into the stream.
- ▶ Low energy consumptions through multi effects evaporation.
- ▶ Special design to reduce entrainment into the condensate.
- ▶ Possibility of designing the equipment as a crystallizer and discharging slurries up to 50% of solids by volume.
- ▶ Heating and condensing media selected case by case to increase the energy conservation of the production system.
- ▶ Full synergy with upstream and downstream plants.
- ▶ "Easy and safe" control and automation system.



HAR can offer a range of evaporators from 500 to over 10.000 kg/hour of condensate, in the main metal alloys and lined materials. Evaporation and crystallization tests can be performed at HAR laboratories, where pilot plants are available for bench and semi-industrial trials.

Landfill Leachate Treatment

Landfill leachate is heavily polluted with various mineral and organic materials.

HAR system for the treatment of such effluent is essentially based on membrane separation technology; however, depending either on the variability of the characteristics of the leachate and on the concentrate disposal problems, HAR can offer suitable process combinations.

The system is able to treat the leachate to make the effluent suitable to discharge according to the most severe law restrictions.



1st stage: ULTRAFILTRATION / bioHAR® Membrane Bioreactor

2nd stage: NARO® system

3rd stage: NARO® system



Process description

HAR process for leachate treatment is based on membrane processes.

Depending on the feed characteristics and on the required water quality for discharge, the leachate is treated through a continuous two/three-stages processing:

- ▶ Discharge according to law restriction
- ▶ Constant performance with variable feed characteristics
- ▶ High automation level
- ▶ Absence of gas emissions
- ▶ Small footprint
- ▶ Very competitive investment and operating cost
- ▶ Guaranteed operating costs



A further step of the treatment developed by HAR is the treatment of the final concentrate waste by evaporation or other technologies which can allow a easier disposal at the lowest cost.



Hydro Air Research Italia in the World

Italy (Head office):

Hydro Air Research Italia
Strada Provinciale 181, n° 11 - 26833 Merlinò (LO) - Italy
tel: +39 02 9066601 - fax: +39 02 90666030
www.hydair.com
e-mail - har@hydair.com

China

Hydro Air Research Beijing Representative Office
Room No.1601A, Air China Plaza, No. 36 XiaoYun Road
ChaoYang District, Beijing, China
tel: +86 10 84475581/582 - fax: +86 10 84475583
www.hydair.com.cn
e-mail - harchina@hydair.com
