

HYDROAIR

— Membrane Separation Systems

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GMM
Pfaunder

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Hydro Air Research Italia was established in 1979 as a private enterprise specialized in design and manufacturing of membrane separation systems for industrial process applications.

Since 1979 the company has gained extensive expertise in process and waste water applications, becoming one of the leader in membrane separation technology, widening its portfolio to other advanced separation techniques in different fields of application.

Membrane solutions are usually designed in close cooperation with customers from pilot plant trials, design engineering, construction through start-up.

Hydroair also focuses its capabilities on research & development to drive the growth and continuous technological updating of its products and applications.

40+

Years experience

500+

Plants in operation

MEMBRANE SEPARATION SYSTEMS AND OTHER CAPABILITIES

Microfiltration (MF)

Ultrafiltration (UF)

**Nanofiltration (NF) &
Reverse Osmosis (RO)**

Pervaporation

Evaporation & Crystallization

**Chromatography &
Electrodialysis**





Capabilities

Hydroair provides test facilities and pilot plants for feasibility studies, bench tests, and semi-industrial tests.

We provide a complete support service for the preliminary feasibility of process tests to define:

- qualitative assessment of separation performance
- chemical compatibility
- operating parameters
- preliminary membrane choice
- useful data for scaling up industrial plants
- economic definition of industrial processes to determine the large-scale operation and capital costs required

Testing of the pilot plant at the customer site is recommended to generate data under real conditions in the field.



RESEARCH & DEVELOPMENT



R&D provide up-to-date answers to complex problems

PROCESS DESIGN & ENGINEERING



Project pre-study, design, cost estimation, engineering and project management

INSTALLATION & COMMISSIONING



Installation, start-up and commissioning of systems

AFTER SALES SERVICE



Keep your system operating at peak efficiency throughout its life

Industries & Sectors



Membrane Process Applications

By working through lab test, pilot scale test and industrial plants, Hydroair has gained extensive experience and own know-how on several process applications.

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

Recent success can be underlined in the field of bio-proteins, plant based proteins and in the production of bioplastics, important today in the view of sustainability and "green" processing.

Pharmaceutical & Biotechnology

Hydroair membrane systems are operating successfully in downstream processing for antibiotics and biological active principles extraction from fermentation broths

- Antibiotics concentration & purification
- APIs concentration & purification
- Fermentation Broth clarification and concentration
- Cell harvesting
- Sterilization of nutrient liquids
- Cell debris removal
- Enzymes / proteins concentration / purification

Bioproteins & bioplastics-Green Chemistry

Bio-proteins are molecules obtained by fermentation targeting the replacement of proteins available in nature.

Hydroair is partnering several players worldwide, supporting laboratory and pilot trials for the process development and manufacturing industrial production plants. Membrane plants are used in the downstream processing, mostly after the fermentation step, for clarification, purification and concentration of the target compound.

Other industrial process applications include applications upstream and downstream fermentation in bioethanol, biodiesel and biodegradable plastics production.

Bioplastic, biopolymers, biocosmetics are innovative production areas where membrane technology is now playing an important role.

- Bioprotein purification and concentration
- Plant based proteins
- Probiotics, Nutraceuticals
- Biopolymers fractionation and concentration
- Biomass concentration and separation



Chemical & Fine Chemicals

Applications include polymers concentration/recovery, brine purification, catalyst recovery, solvents clean-up and exchange, acids concentration/purification, glycerin purification, pesticides removal among the others.

Most of the attention is today towards recovery and reuse of acids, alkali and organic solvents, to reduce environmental impact and help sustainability.

- Chemicals purification and recovery
- Acids and alkali purification
- Brine, Oil / water, detergents, polymers purification/concentration
- Amine and glycol filtration
- Catalyst recovery
- Solvents clean-up
- Organic acids purification/concentration

Food & Beverage

Separation processes in fruit juice, sugar, starch, natural extracts, food additives, wine, beer, milk/milk whey, edible oils, waste water treatment and water reclamation.

- Vegetable/fruit juice clarification, concentration
- Beverage production and recovery
- Natural extracts
- Sugars clarification and concentration
- Gelatin concentration
- Food /Feed ingredients purification / concentration
- Starch (wheat, corn, potatoes) recovery and process water reuse
- Meat (Poultry, Rendering, Cured Meat) process water reuse



Industries & Sectors



Industrial Effluent Treatment

Hydroair 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. Recycling and reuse are central to a circular green economy approach and offer a strategy to improve water supply by better managing waste water, also on segregated streams more than traditional "end of pipe" treatment approach.

Hydroair develops and realizes systems for Landfill Leachate Treatment, plants with an economical process, effective and reliable.



Water reuse

One of the biggest problems of the industries is related to the disposal of spent/exhaust solutions or generally of the wastewater. Hydroair systems can handle wastewater characterized by very high level of contaminants. Hydroair is ready to face any separation problem on wastewater, to treat the water making it suitable for discharge according to the law or suitable for recycling for industrial uses.

Hydroair 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.

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

Zero Discharge and Water Recycling

Membrane separation (Microfiltration, Ultrafiltration, Nanofiltration and Reverse Osmosis) is the key technology of Hydroair 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.



Membrane Separation Solutions

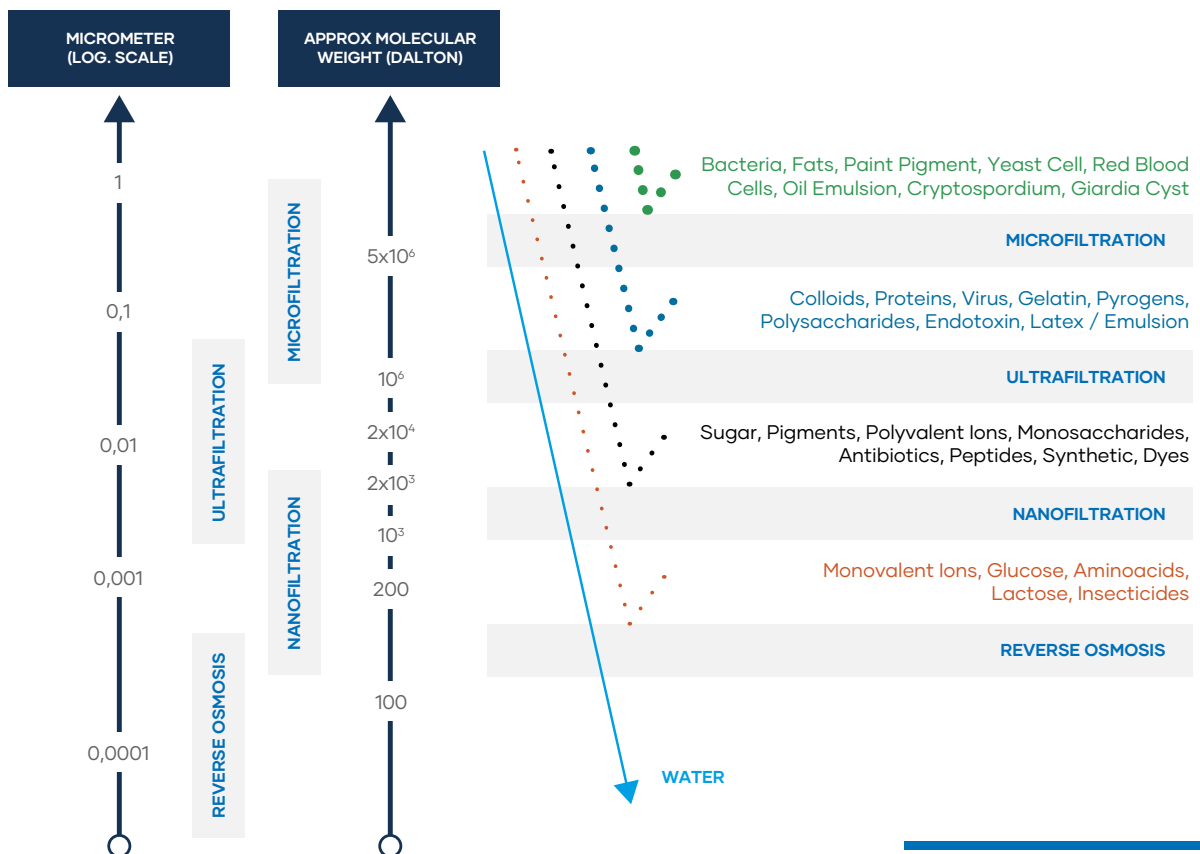
Membrane technology can be used in a wide range of separation processes. Hydroair expertise covers all the range of membrane processes, from Microfiltration and Ultrafiltration through Nanofiltration and Reverse Osmosis.

Depending on the purpose of the separation, different type of membranes can be used, characterized by different material of construction, configuration and selectivity.

Organic and inorganic membranes, spiral wound and hollow fiber, tubular and plate type can be selected depending on the application and on process requirements.

Hydroair technical specialists work with the end-user in order to satisfy the widest spectrum of requirements in terms of application, volume and rules, tailoring the system on the customer's needs.

MEMBRANE SPECTRUM



Membrane Separations Processes



Microfiltration & Ultrafiltration

Low pressure process for selective filtration of large molecules.



NARO®, Nanofiltration & Reverse Osmosis

Medium-High pressure separation processes and Hydroair trade mark system to improve solids concentration and permeate recovery.



Solvent stable Membranes

Membrane separation of molecules dissolved in organic solvents.



bioHAR® Membrane BioReactor (MBR)

Combination of activated sludge biological system and ultrafiltration system.

Other Separation Solutions



Pervaporation

Process for organic solvent drying and concentration, breaking azeotropes.



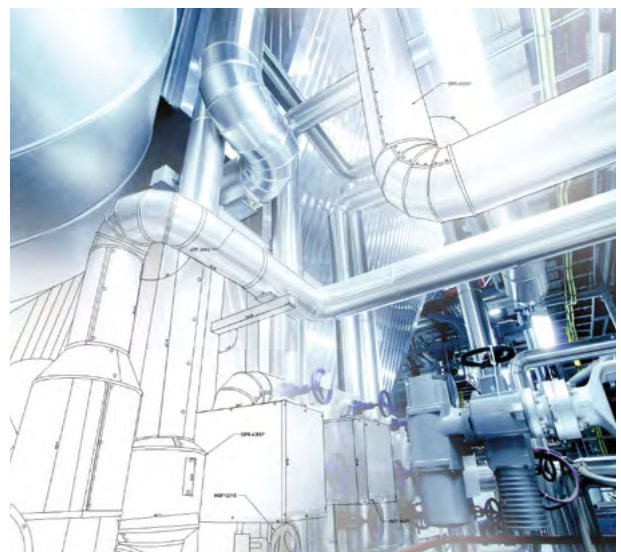
Evaporation & Crystallization

Concentration or separation of liquid solutions, suspensions and emulsions.



Chromatography & Electrodialysis

Selective separation by means of specific resins (chromatography) and charged membranes together with electrical potential difference (electrodialysis)



Microfiltration & Ultrafiltration



Microfiltration (MF) is the bigger pore size cross-flow filtration process. Typical application of this low pressure process is the removal of high molecular weight compounds such as bacteria, fats, yeasts and fungi, clarification of chemical, biological, pharmaceutical or food solutions, product purification, as well as waste water treatment.



Ultrafiltration (UF) is a low pressure process for selective filtration of molecules of specified size and weight. Material ranging in size from 1000 MW to 1.000.000 MW are retained by UF membrane while lower molecular weight compounds, salts and water are passing through. Typical applications of UF membrane are concentration and recovery of high molecular weight compounds separation/ removal of contaminants, clarification, fractionation of organics, removal of colloids and suspended solids, thus being also used as pretreatment for reverse osmosis units.

Different configuration are available, the main are:

- Inorganic tubular (ceramic, sintered stainless steel)
- Inorganic plate (ceramic, Silicon carbide)
- Polymeric tubular
- Polymeric spiral wound
- Polymeric hollow fiber
- Polymeric flat sheet and cassettes
- Submerged polymeric (flat or fiber) and inorganic

- Bacteria
- Fats
- Yeasts
- Fungi
- Clarification of chemical
- Biological
- Pharmaceutical
- Food solutions
- Product purification
- Colloids
- Suspended solids
- Waste water treatment

NARO[®]

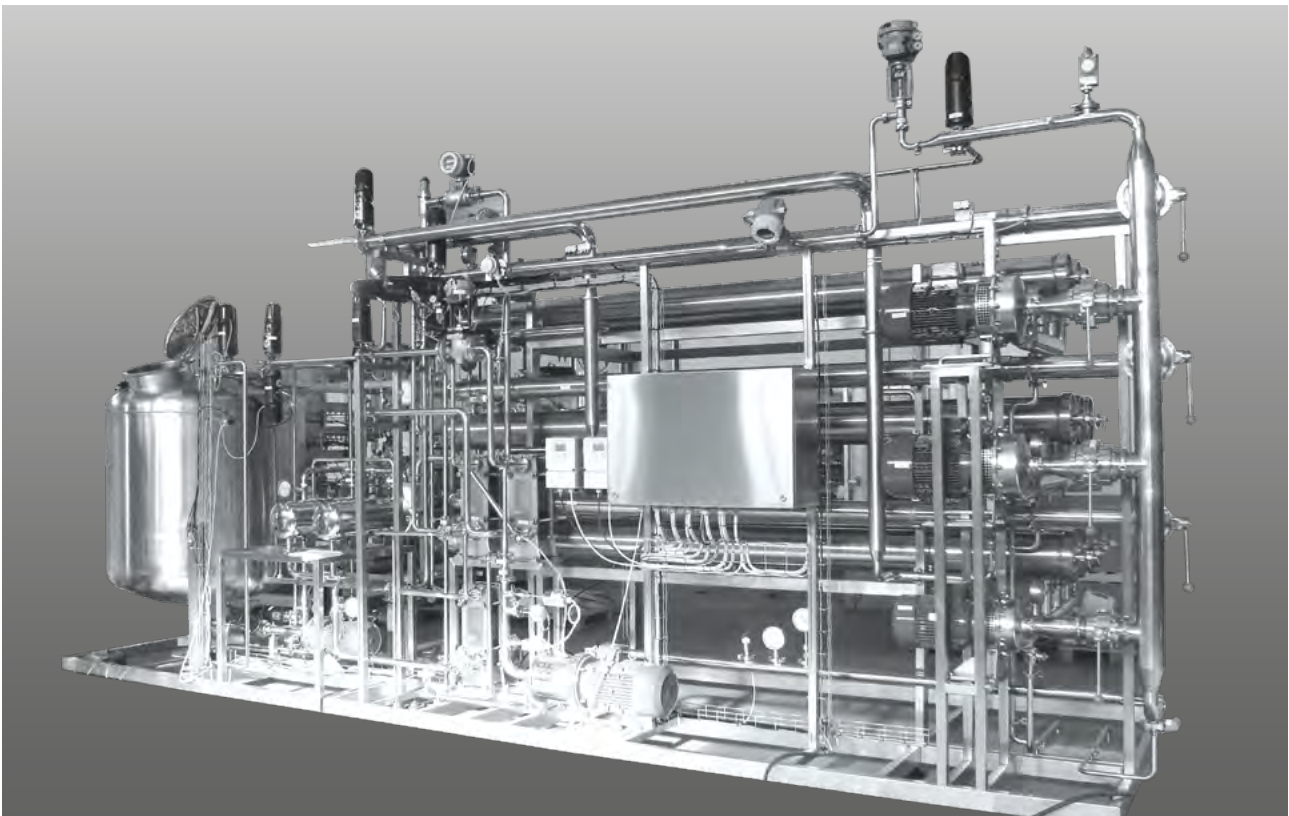
Nanofiltration Reverse Osmosis

Nanofiltration (NF) is a pressure driven process similar to Reverse Osmosis (RO) applied in the area between RO and UF. Monovalent ions and low molecular weight organics are passing through the membrane, while bigger compounds are rejected. MW cut off of a NF membrane is in the range 150-500 and typical applications are in pharmaceutical preparations, in food and chemical processes, removal of colour and hardness from water.

Hydroair has developed a reverse osmosis system able to concentrate the total dissolved solids to higher levels than the ones reachable with the traditional reverse osmosis systems, with better energy efficiency and optimal membranes performance. This system is called NARO[®] system.

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
- Investment and operating costs more competitive



Solvent Stable Membranes

Hydroair is able to design and manufacture complete systems for purification and/or concentration processes in presence of organic solvents, by means of different membranes, organic or inorganic. Hydroair can offer a range of nanofiltration membranes suitable for use in non-aqueous applications. Typical applications for these membranes in the pharmaceutical and fine chemical industries are solvent exchange, catalyst recycle, organics recovery and products purification.

Membrane separation of molecules dissolved in organic liquids has emerged as a new area of membrane science during the last decade, with huge potential for green applications across chemical-related industry sectors. Common purification processes, such as distillation,

extraction, chromatography, adsorption, and crystallization, can be energy or materials intensive, or suffer from problems of robustness. Solvent stable nanofiltration is a viable, energy saving, green alternative or complement to those.

Main applications:

- Removal of polymeric impurities
- Product purification
- Monomer/dimer separation
- Molecular fractionation
- Room temperature solvent exchange
- Catalyst recovery and recycle
- Decolouration
- Solvent recycling



bioHAR[®]

Membrane BioReactor

Our Membrane Bioreactor (MBR) is a combination of an activated sludge biological system and an ultrafiltration system, for an optimal removal of organic contaminants in waste streams. Depending on the effluent characteristic and on the customer needs Hydroair is able to supply two different bioHAR[®] configurations: sidestream and submerged. In sidestream configuration the membrane module is a separate unit and the sludge is continuously recirculated in the reactor, in submerged configuration the membrane module is placed in the activated sludge in a dedicated tank and the driving force is a negative pressure on permeate side. In membrane bioreactor the biodegradable substances are eliminated and, if necessary, ammonia and nitrogen-based compounds can be removed. The ultrafiltration system replaces the conventional phase of sedimentation by gravity, enables the recirculation and retention of the biological sludge in the oxidation tank keeping a higher concentration than in the conventional biological systems. The Ultrafiltration membrane, being an absolute barrier for the sludge, is also avoiding the entrainment of sludge in the treated effluent, trouble that often occur in the traditional settling tanks because of bulking phenomena. bioHAR[®] membrane bioreactor is an high efficiency step of zero discharge water recycling system and it is important to make the effluent suitable for a further treatment through reverse osmosis process.

- 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, due to autolysis phenomena caused by the high concentration of the biomass
- Increase of tolerance of normally toxic substances for a biological system, due to the high ratio biomass/toxic
- Small footprint
- Low operating costs
- High chemical resistance



Pervaporation

Pervaporation is a membrane process for organic solvent drying and concentration. Pervaporation or vapour permeation (depending if the separation is performed starting from liquid phase or gas phase) is an optimal process to break azeotropes and to solve bottlenecking problems at competitive costs. It offers the possibility to separate miscible liquids of similar molar mass and it is an alternative method to distillation, overcoming the limitations of standard distillation in presence of azeotropes. Pervaporation technology can offer considerable savings both in terms of costs and performances

- The solvent can be concentrated down from any water level to very low water content
- Azeotropes are easily broken
- Membranes are highly selective and offer a continuous high flux operation
- Water produced is highly pure and can be reprocessed
- It is a low energy process

The membranes used in pervaporation processes are classified according to the nature of the separation being performed:

- Hydrophilic membranes are used to remove water from organic solutions.
- Organophilic membranes are used to remove organics from water solutions.

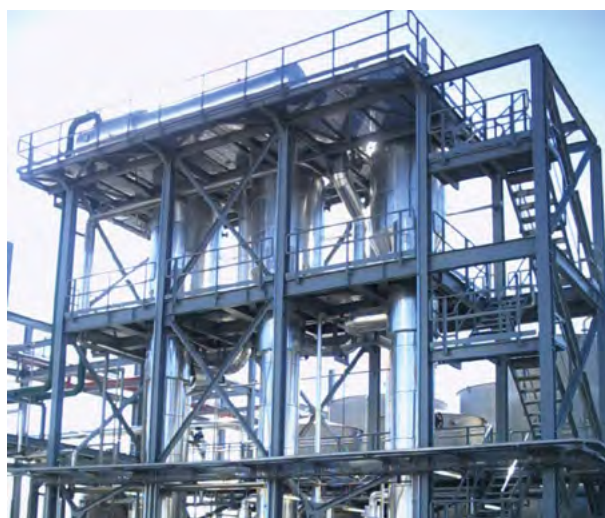


Evaporation & Crystallization

Hydroair designs and supplies single or multi-effects forced circulation evaporators, falling film, thin film with thermal compression or mechanical vapour recompression (MVR) evaporators and crystallizers.

Hydroair can offer wide range of evaporators in different materials of construction, from stainless steel to different metal alloys, duplex and super-duplex steel, hastelloy, titanium and lined materials.

Evaporation and crystallization tests can be performed during the process feasibility phase, to verify separation efficiency and allow preliminary cost evaluation before entering industrial design.



Chromatography & Electrodialysis

Hydroair, in collaborative effort with international institutes and adsorbent resin manufacturer, built an expertise in designing process for different industrial chromatographic separations for molecules from antibiotics, natural active ingredients of plant origin, synthetic peptides, synthetic APIs, to macromolecules like enzymes, antibodies and plasmid DNA, DNA and RNA .

Hydroair can design column hardware for both packed bed and expanded bed format of adsorption chromatography. Packed bed and expanded bed purification technologies have been developed for molecules from penicillin G, rifamycin, vitamin B12, and beta-carotene to proteins like lactoferrin, lactoperoxidase, lysozyme, insulin etc.

Hydroair is also proposing of a new variant of expanded bed adsorption that attempts to overcome all disadvantages of packed bed and expanded bed operations.

Electrodialysis is a membrane-based process, an electrically driven technology that relies on the transmembrane transport of ions. In ED an electric field is applied across a stack of ion-exchange membranes to drive ions toward the oppositely charged electrode.

As a feed solution enters the ED stack, cations and anions selectively pass through alternating cation and anion exchange membranes, respectively, forming ion-concentrated and weakened solution streams on each side of the membrane.

ED can be used for water desalination, but also in bioprocessing, pharmaceutical, and food industries.



Worldwide Presence



GMM Pfaudler is a global leader in corrosion-resistant technologies, systems, and services for the chemical, pharmaceutical, food and energy industry.

Our Branded Product Lines that include PFAUDLER, NORMAG, MAVAG, MIXION, INTERSEAL, EQUILLOY, EDLON and HYDROAIR showcase our strength as a group, our capabilities, and our pursuit for constant innovation. With an end-to-end solutions-oriented approach, a global footprint, and a perfectly integrated offering system we are able to meet complex industry demands worldwide.

GMM Pfaudler is driven by 1800+ individuals across 4 continents and 15 global manufacturing facilities around the world. The Group's targeted investments in strategic markets, innovation and competitiveness paves the way forward for GMM Pfaudler's continued legacy.

80+
Countries

1800+
Employees

04
Continents

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