

Following Nature's Design

PANTREON
GMBH



ZELIX
MEMBRANE.KINETICS

THE FUTURE of membrane technology

Membrane separation becomes ever more a crucial process technique in

- Industrial production
- Energy production and distribution (e.g. renewables)
- Environmental technology

- Innovation in products, in their production, their quality and sustainability needs new standards of process fluids.
- Renewable and fossil energy sources, the efficiency in production and usage, the quality and reliability of distribution needs new standards of process fluids.
- The rising demand and reducing access to clean water needs new standards for water and wastewater treatment, its efficiency, its energy demand, reliability, availability.

BREAKING NEW GROUND in membrane technology

All these requirements lead to constant impulses for Pantreon in breaking new ground in membrane technology for new applications, high efficiency and sustainability with ->

- high viscous liquids
- high concentrations
- biologically and chemically sensible ingredients
- changing conditions in volume of feed and substances

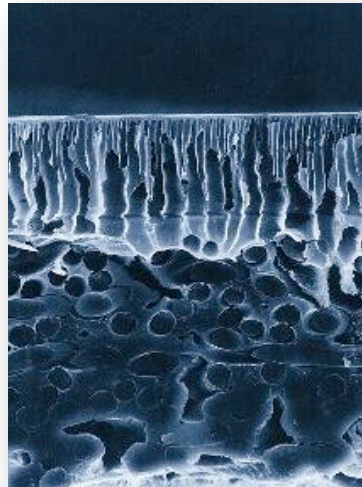
The PRINCIPLES of membrane filtration

Membrane filtration is the selective separation of substances by porous foils and layers

Surface

Membrane

Support



Consequence: The substances are concentrated at the membrane surface

In order to avoid surface layers through these concentrated substances membrane technology must provide:

-> **Shear forces** against adhesive reactions of substances with the membrane surface

-> **Exchange of concentrations** with liquids far from membrane surfaces

-> **Turbulent flow on the membrane surface**

The principle of TURBULENCE

There is no escape from the principles of physics.

As the *Reynolds* formula shows

- the velocity
- the geometry
- the viscosity

of fluids decide whether there is turbulent or laminar flow.



As in most fluids the viscosity is given fact, the **velocity** of flow, the methods to produce it, the geometry of space for such flow become main characteristics for membrane systems.

The focus of Pantreon on **geometry**, on calculation and design of flow spaces improves the dynamic effect of velocity and reduces mechanical stress and energy consumption.

With most conventional “cross-flow” and “dynamic” membrane systems leads insufficient turbulence to formation of layers with effects on retention, flux rate, mechanical stress, temperature, energy, membrane cleaning, etc.

The principle of ZELIX membrane system

Conventional systems

Turbulence through **only one linear flow direction** demands high energy and results in waning intensity.

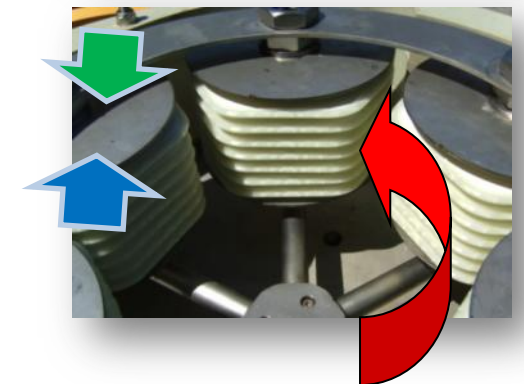
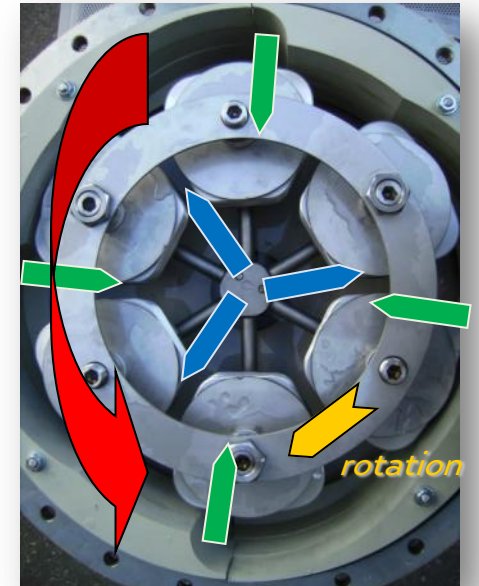


ZELIX membrane system

provides high shear forces, intensive and persistent turbulence on the entire membrane surface - through

3 FLOW DIRECTIONS

- Rotational flow**
- Radial flow outwards**
- Radial flow inwards**



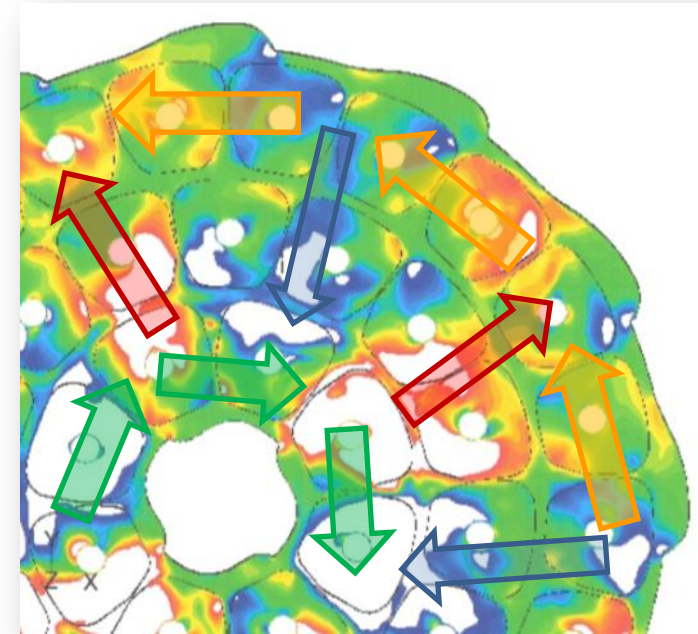
ZELIX membrane system developed with scientific CFD-models

ZELIX membrane system has been developed by using CFD-models* and achieves extremely dynamic flow on the entire surface -

through:

- NEW FILTER TECHNOLOGY
- NEW FLOW TECHNOLOGY
- NEW ROTATION TECHNOLOGY
- NEW HELIX4D FLOW CONCEPT

* *Computational Fluid Dynamics*



Example: calculation of turbulent flow through changing radial flow directions

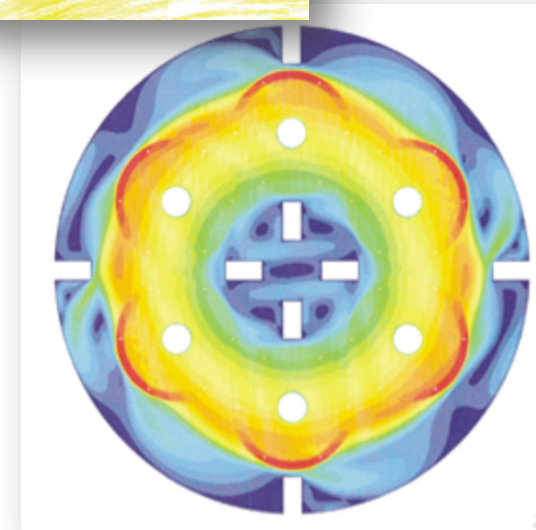
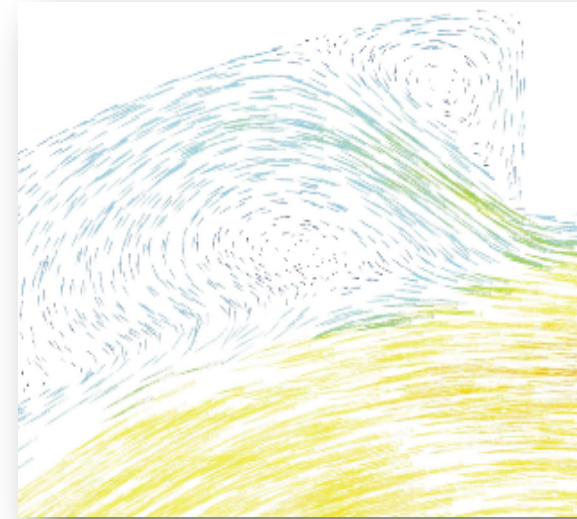
ZELIX membrane system developed with scientific CFD-models 2

Example 2 -

Calculating the previous rotation design shows high turbulent flow *off* the filter area, resulting in

-> superfluous mechanical stress + waste of energy

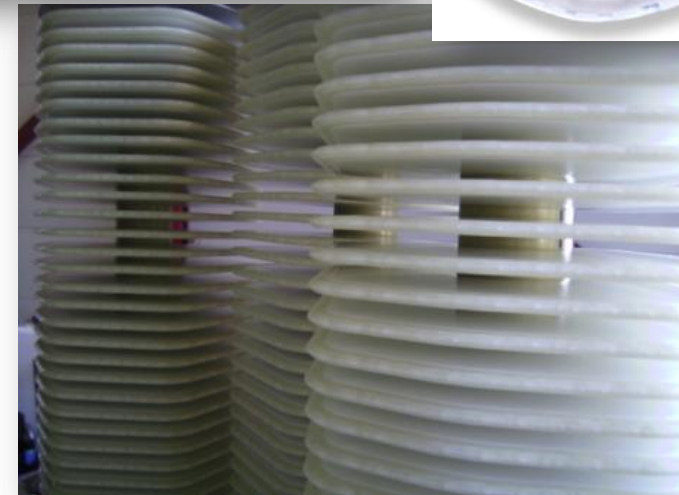
-> reduced effect + efficiency of turbulence on the membrane area



The new ZELIX FILTER TECHNOLOGY

The new ZELIX filter technology

- increases the **filter area** by 40 % through trapezoid disc design and increased # of discs
- increases the **performance** of membranes
- has optimized hydrodynamic design
- reduces the **mechanical stress**
- reduces the **energy consumption**



The new ZELIX FLOW TECHNOLOGY

The new ZELIX flow technology

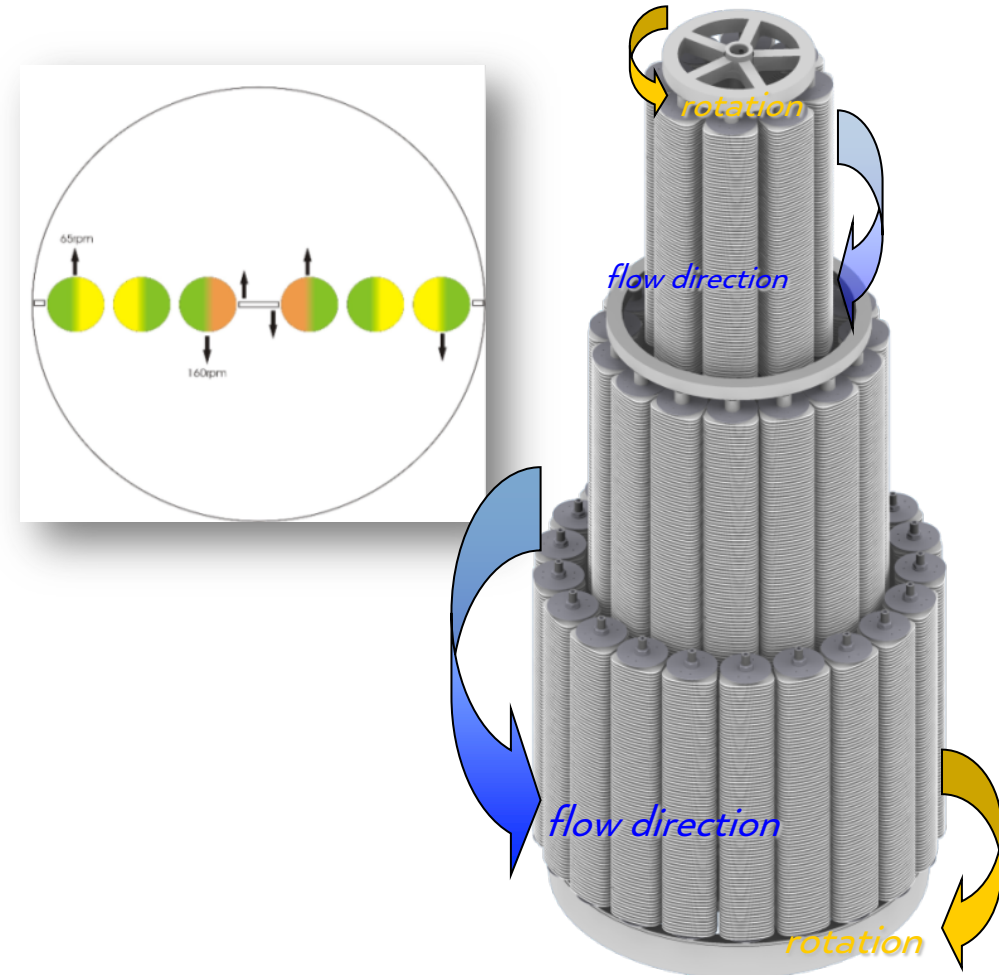
- increases the **dynamics** of turbulent flow on the membranes
- **directs + focuses** the turbulent flow to the filter modules and reduces dynamic loss off the membranes
- reduces the **energy** consumption and the **mechanical stress** on substances



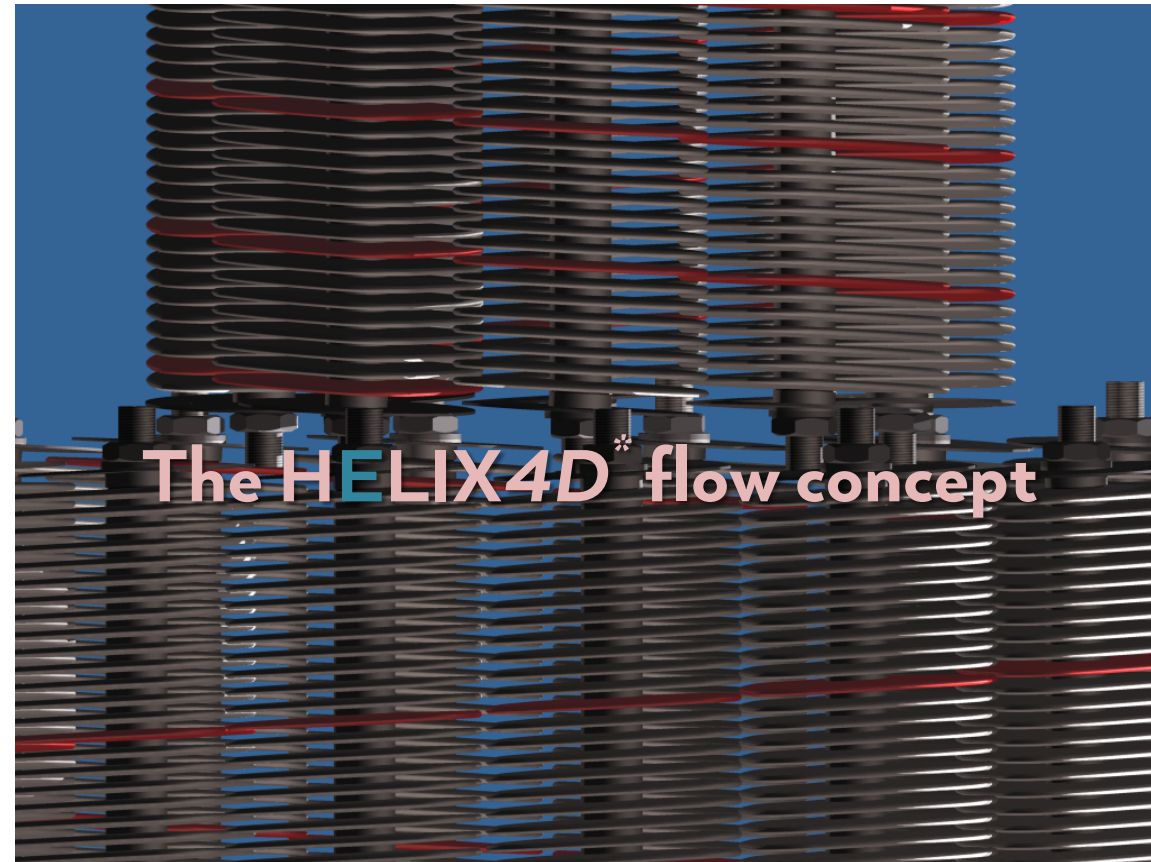
The new ZELIX ROTATION TECHNOLOGY

By **segmentation** of the filter area into smaller modules the rotation speeds and rotation directions can be adapted over the rotor radii in ZELIX membrane system.

The principle of *dynamic balance* makes possible **uniform flow conditions** over the entire filter surface.

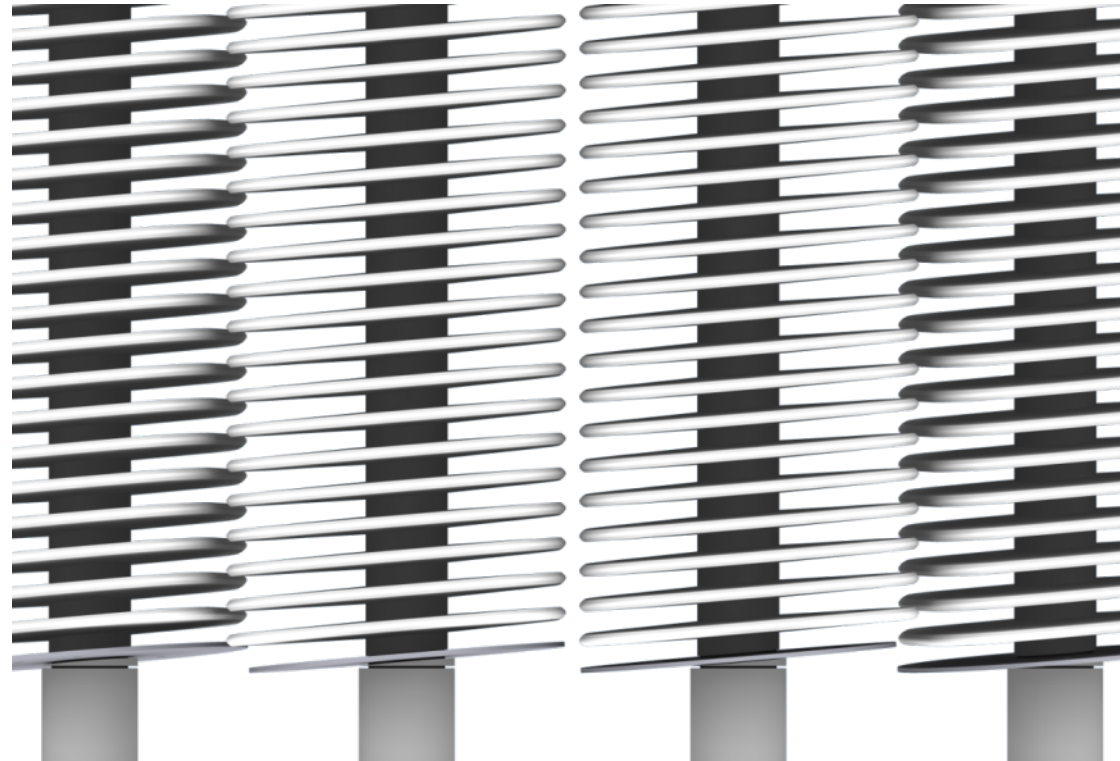


The NEW DIMENSION in membrane filtration

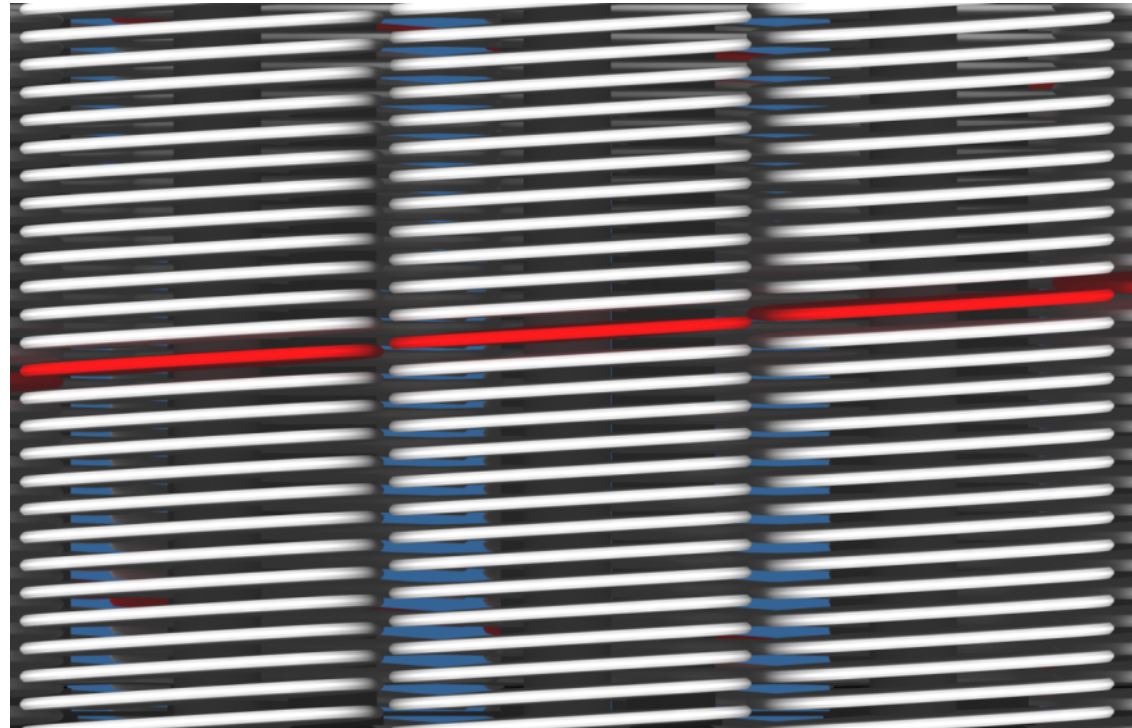


The HELIX4D flow concept

Selected INCLINATION of filter discs ...

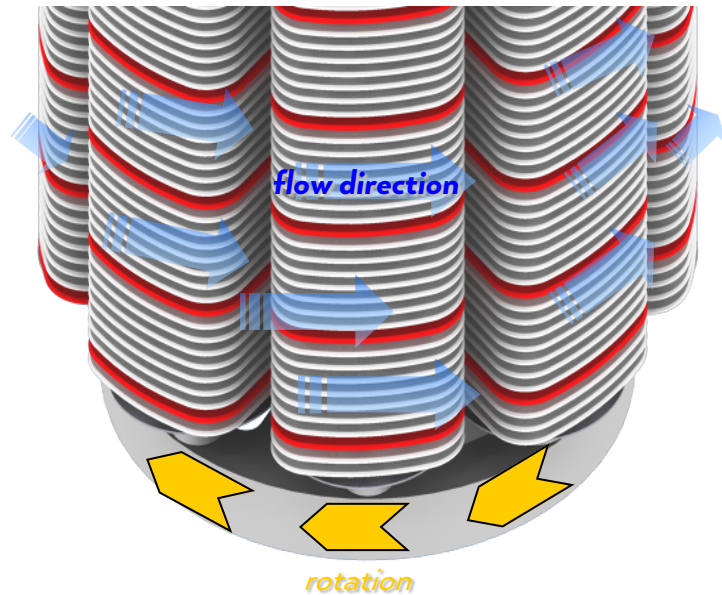


... results in consecutive UPWARD pointing tendency...



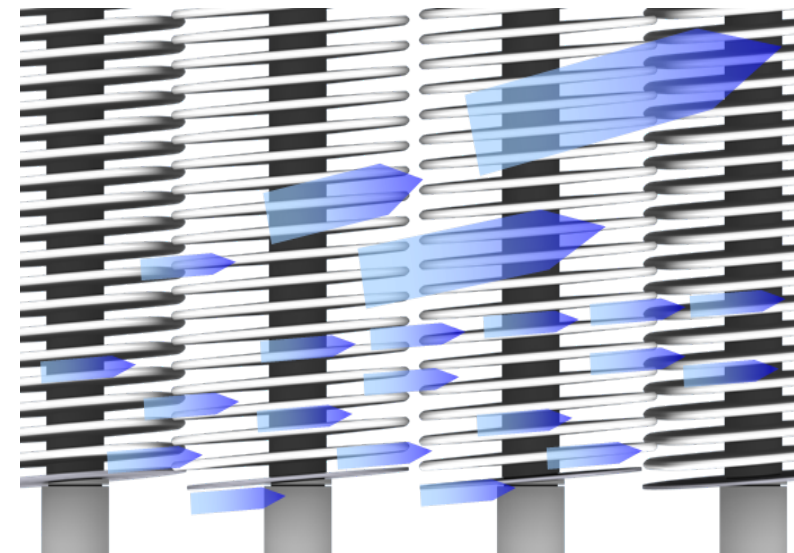
... through adjacent filter modules ...

The filter modules are fixed on rotating ring



... resulting in high-turbulent flow on the membranes of the filter discs.

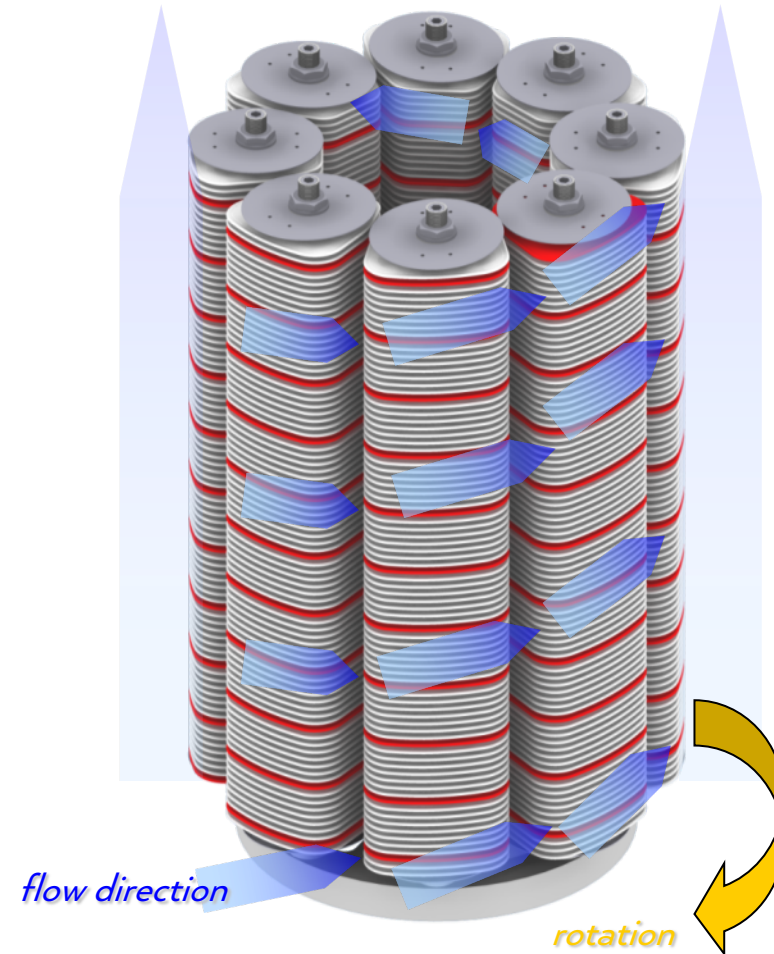
The selected inclination of the filter discs



... forces the high-turbulent flow into a strong upward direction.

HELIX4D – the unique VERTICAL flow direction

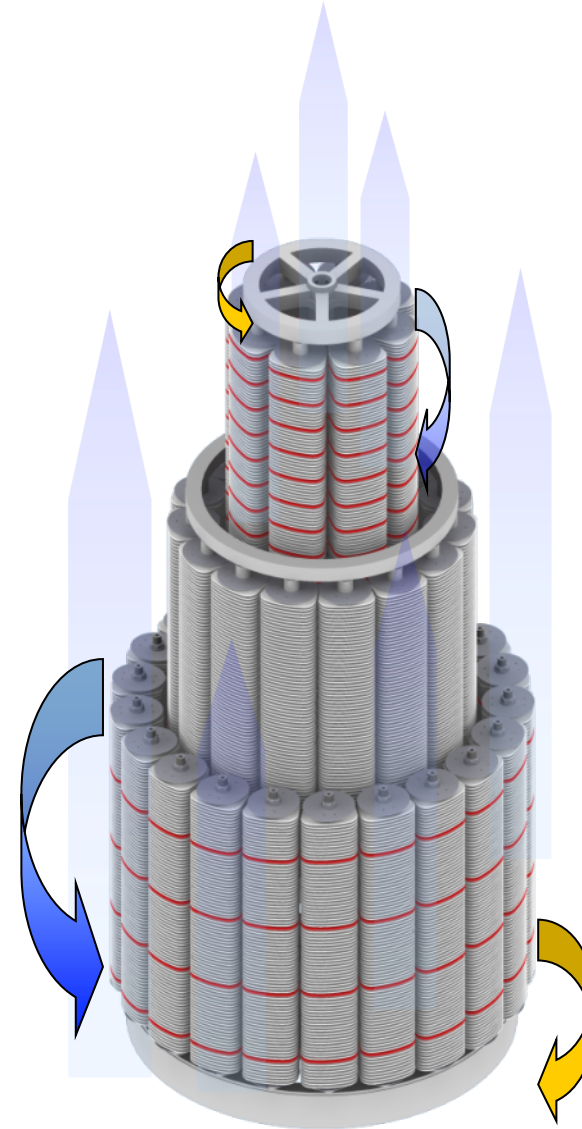
Through the ring of filter modules, the inclination of the filter discs results in a HELIX, which forces the turbulent flow in a strong vertical direction over the complete membrane filter installation.



HELIX4D – intensive EXCHANGE of CONCENTRATIONS

Even in installations with large filter area the innovative ZELIX design results in high turbulence through dynamic cross flow over the complete membrane surface.

The unique vertical flow direction of HELIX4D leads to intensive exchange of concentrations, even in high viscous fluids and substance content.



ADVANTAGES of ZELIX *membrane system*

Apart from the extraordinary performances in standard applications ZELIX has special advantages in

- higher viscous liquids
- higher concentrations
- biologically and chemically sensible ingredients
- changing conditions in volume of feed and substances

... which requires

- high shear forces for membrane performance
- high exchange of concentrations
- reduced physical and chemical stress
- adaptability and flexibility of the system

APPLICATIONS of ZELIX membrane system

Filtration of biomass

- Optimization of biogas process
- Separation of ammonia nitrogen
- Digestion residues concentration
- MBR applications
- Ethanol/biodiesel
- Separation in biochemical processes

Chemical / Petrochemical apps

- alkoxide filtration, acetic acid
- several others

Food / beverages

- milk, whey, brine
- wine, fruit juice, beer
- sugar syrup

Metal / Automobile

- aluminum
- Degreasing / rinsing water

Water / wastewater treatment

- UF/NF brackish/sea water
- Industr/municip wastewater

Pulp and Paper

- ground wood
- drainage + power water
- coating color
- lye in viscose process

Filtration of oils

- oils in food or metal industry
- transformer oils
- petrochemical processes

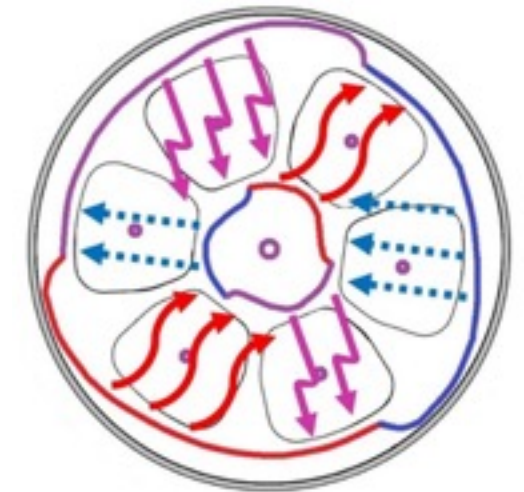
ZELIX - Following Nature's Design

MEMBRANES have a variety of functions in organic structures. They transport, select. They generate and transmit electrical signals. They activate messenger substances, etc.

The organic matter is structured in colloidal, extremely small particles. Their electrical charge determines the reaction with other colloids, with the surrounding liquid - and with membranes. The invention of artificial membranes was closely related to colloidal chemistry research.

Nature's Design Applied

The ZELIX flow technology, consistently developed for dynamics, opens up even more possibilities. Namely the integration of colloidal chemical membrane functions in ZELIX, such as kinetic activation.



A new standard in membrane technology

According to the **Einstein Relation**, mobility and permeation properties of **colloids** and interfaces are mainly determined by electrical charge and electrical mobility (as well as particle size and viscosity).

Strengthening this property with integrated electrokinetics creates a **new standard in membrane technology**.



The ZELIX flow technology, as electrodes for the construction of high-voltage fields with rotating filter modules as counter electrodes, creates a unique activation of interfaces –

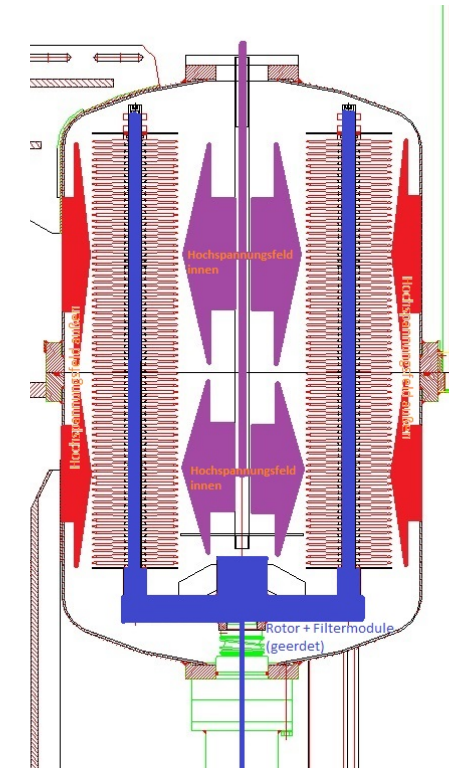
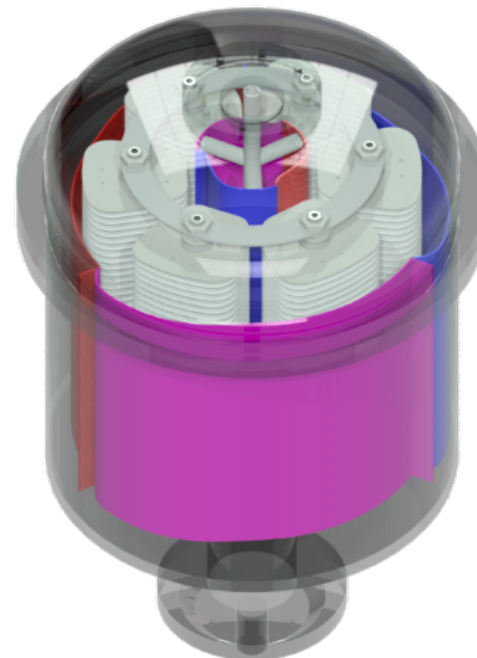
unique, innovative, especially together with the separation effects of the membranes directly at phase boundaries.

With strengthening effect of electrical charge on hydrophobic and colloidal properties, ZELIX shows increased performance even AFTER processes with (e.g. through oxidation) denatured molecules.

Integration instead of Combination

Considerations:

- Lower investment and operating costs.
- Longer residence time in the **high voltage field**
Performance depends on the electrodes' contact time
- *Smart dynamics* of ZELIX reinforce the effect of electrokinetics (and vv)
- Rotating filter modules as **counter electrodes**



Cooperation with INNOVUM GmbH

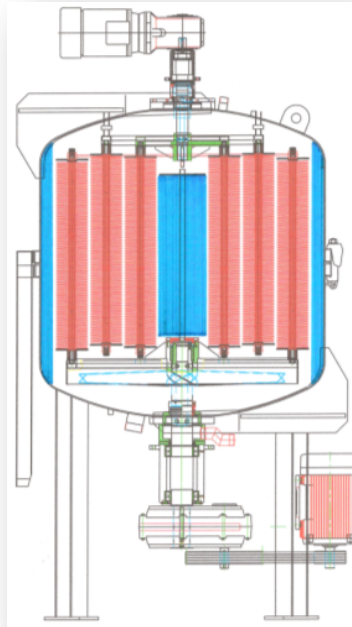
Experience from more than 4,500 electrokinetics projects worldwide.

ZELIX membrane system - TYPES

ZELIX 110/90 series

3 rotor rings

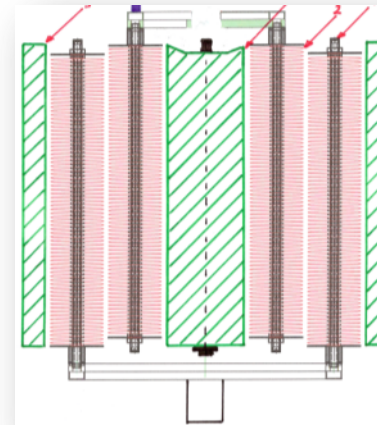
90-130m² filter area



ZELIX 90/50 series

2 rotor rings

33-70m² filter area

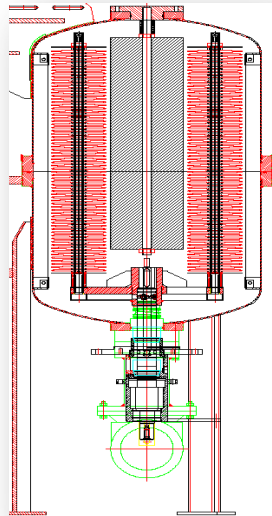
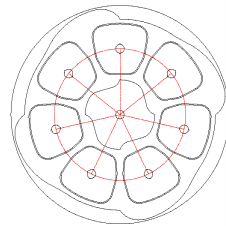


ZELIX membrane system - TYPES

ZELIX 60 and ZELIX 50 series

1 rotor ring

1-25m² filter area



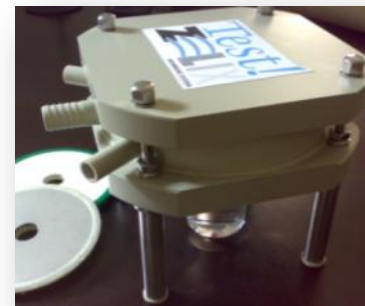
TEST!ZELIX series

for lab tests

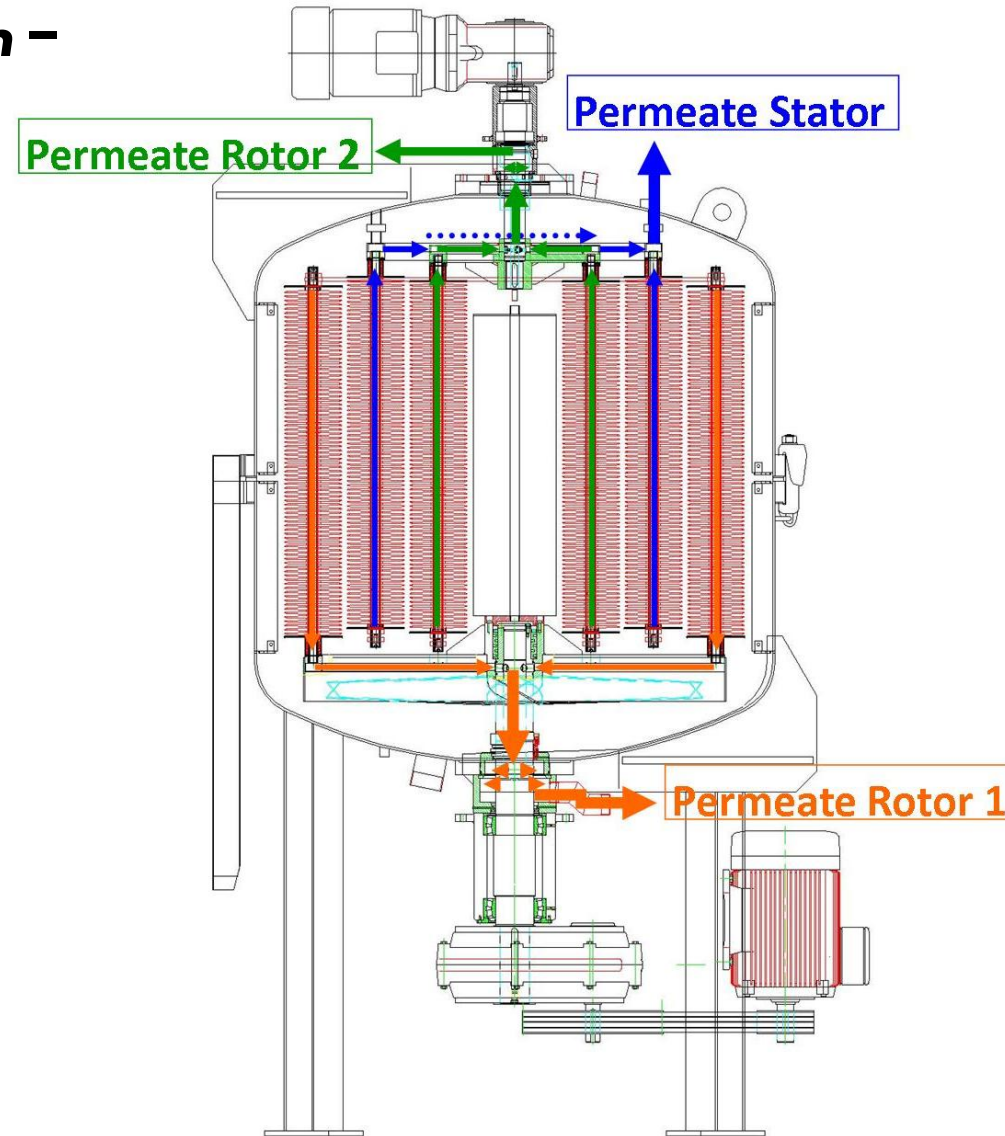
0,037m² filter area



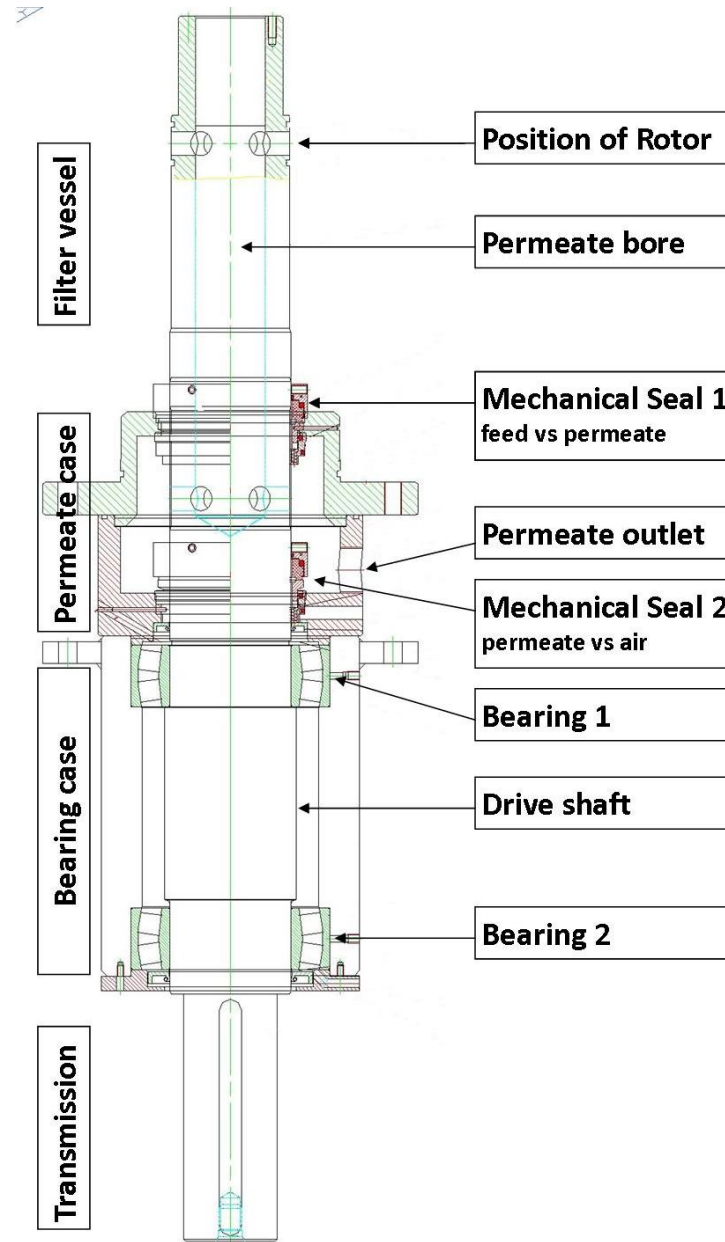
Simulation of ZELIX flow technology in lab scale!



ZELIX membrane system - Permeate Flow



ZELIX membrane system - Rotor drive



ZELIX membrane system - Rotor and Planetary shaft



ZELIX membrane system – Sizes

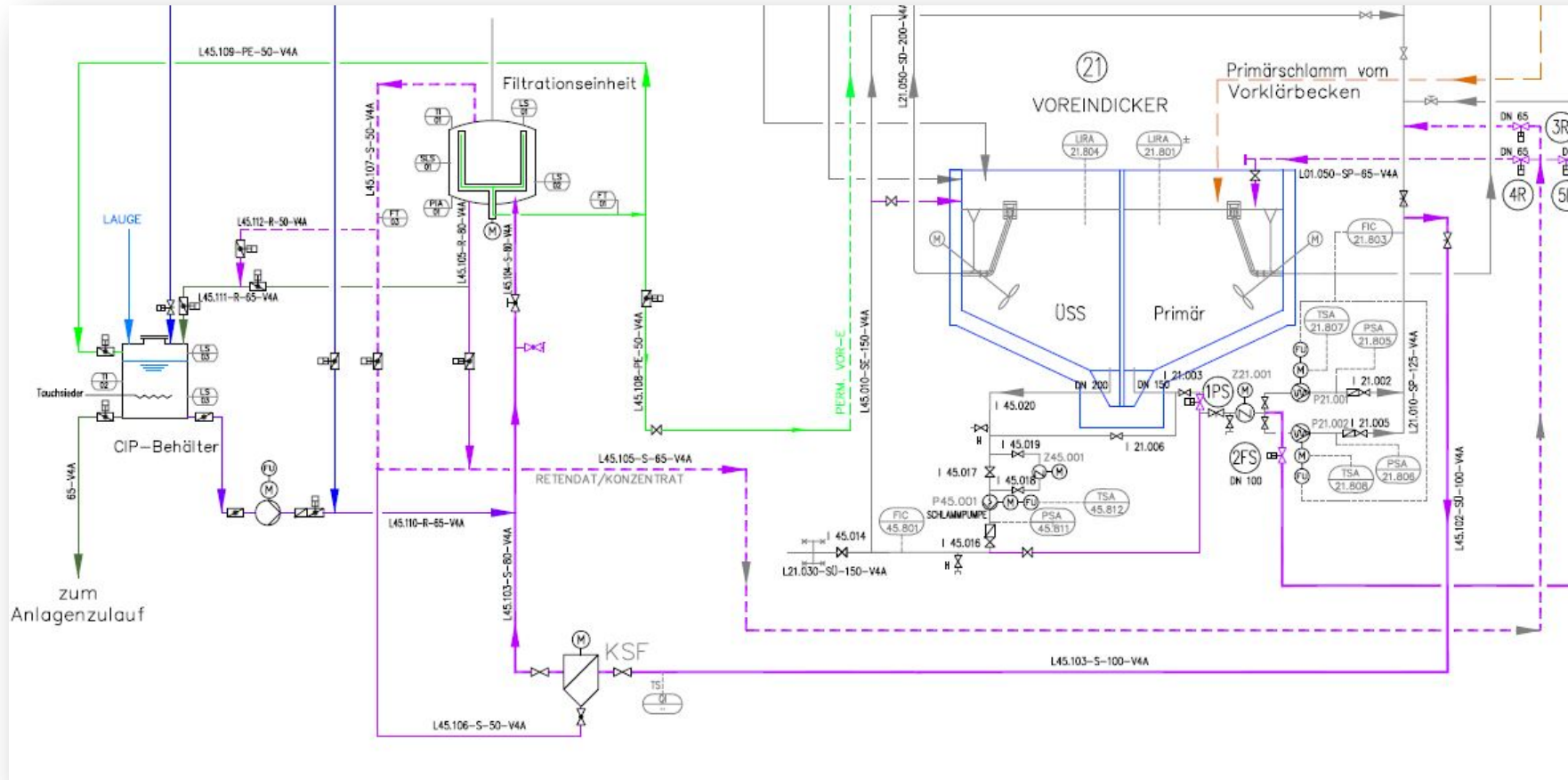
ZELIX Types	Drive 1	Drive 2	Rotor 1	Rotor 2	Stator	Planetary shafts	Standard* unit size
	Diameter of drive shaft	Diameter of drive shaft	Diam. rotor ring / No. planetary shafts	Diam. rotor ring / No. planetary shafts	Diam. stator ring / No. planetary shafts	Length / No. discs per p-s	No. discs (total) / Filter area
ZELIX 50-2	48 mm		335 mm / 6			220 mm / 9	54 / 2 m ²
ZELIX 50-5	48 mm		335 mm / 6			315 mm / 20	120 / 4.4 m ²
ZELIX 60-10	60 mm		350 mm / 6			765 mm / 50	300 / 11 m ²
ZELIX 60-15	60 mm		350 mm / 6			950 mm / 65	390 / 14.4 m ²
ZELIX 60-20	60 mm		440 mm / 8			950 mm / 65	520 / 19.1 m ²
ZELIX 60-25	60 mm		440 mm / 8			1140 mm / 80	640 / 23.6 m ²
ZELIX 90-35	90 mm		800 mm / 15			950 mm / 65	975 / 35.9 m ²
ZELIX 90-45	90 mm		800 mm / 15			1140 mm / 80	1200 / 44.2 m ²
ZELIX 90/50-55	90 mm	50 mm	800 mm / 15		440 mm / 8	950 mm / 65	1495 / 55 m ²
ZELIX 90/50-70	90 mm	50 mm	800 mm / 15		440 mm / 8	1140 mm / 80	1840 / 67.8 m ²
ZELIX 110/90-105	110 mm	90 mm	1160 mm / 21	440 mm / 8	800 mm / 15	950 mm / 65	2860 / 105.3 m ²
ZELIX 110/90-130	110 mm	90 mm	1160 mm / 21	440 mm / 8	800 mm / 15	1140 mm / 80	3520 / 129.6 m ²

*) Vertical distance of filter discs: 5 mm

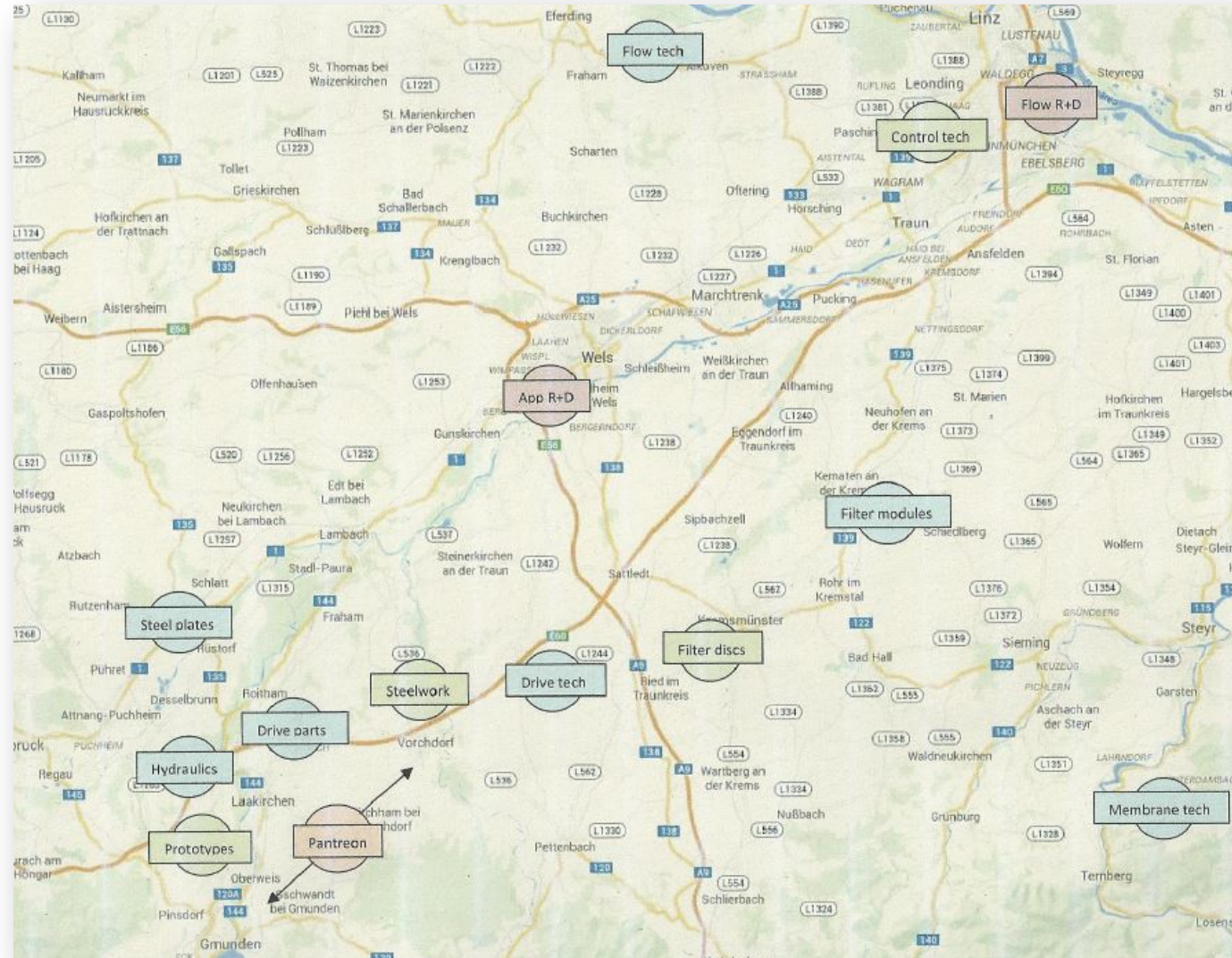
ZELIX membrane system – Design System

	ZELIX 50-2 / 5	ZELIX 60-10 / 15	ZELIX 60-20 / 25	ZELIX 90-35 / 45	ZELIX 90/50-55 / 70	ZELIX 110/90-105 / 130
Drive 2						
Stator						
Drive 1						

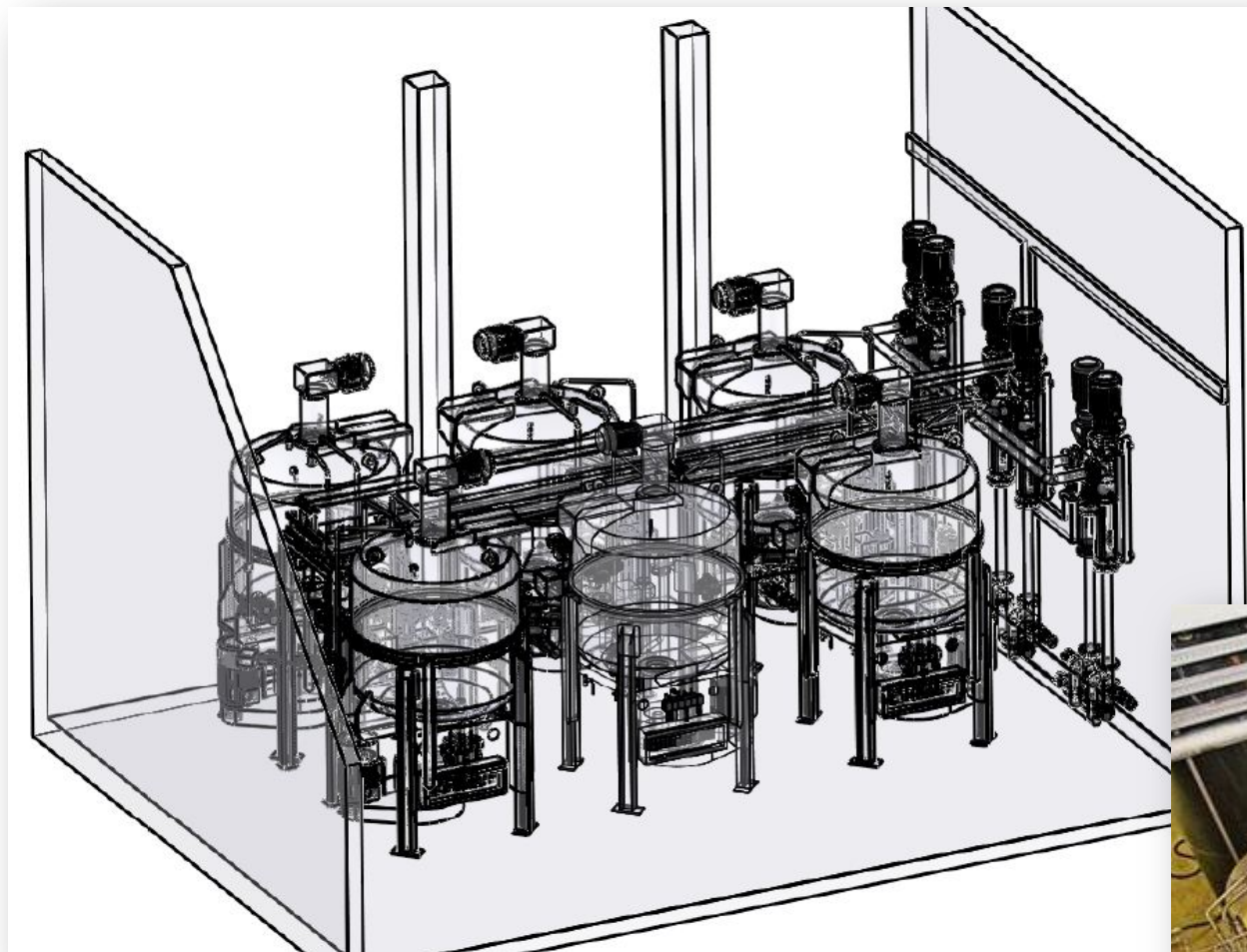
ZELIX membrane system - P + ID



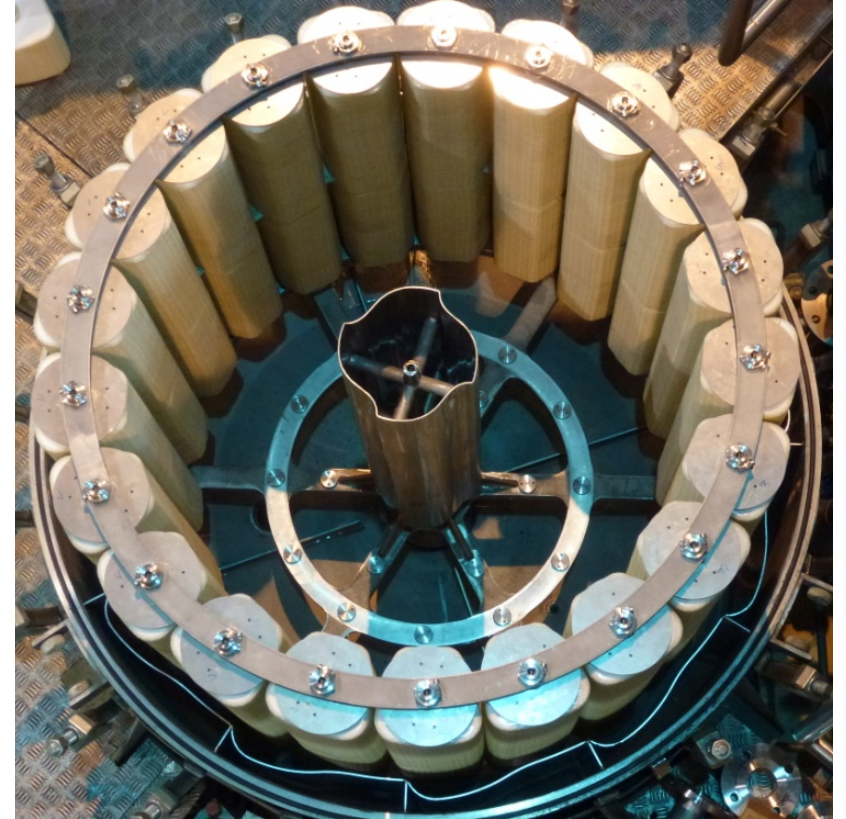
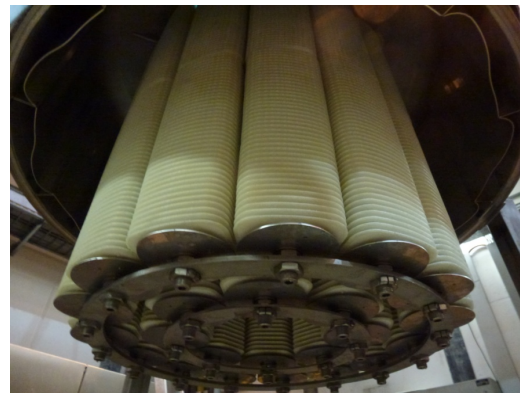
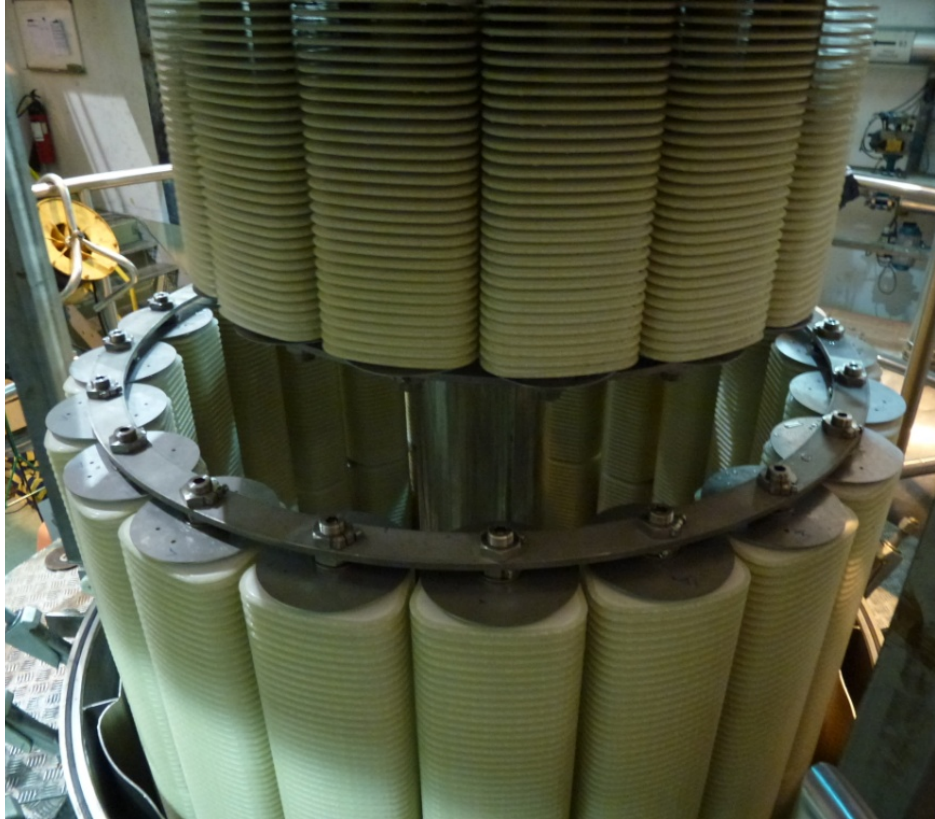
ZELIX membrane system - Cooperation in R+D and Production



ZELIX membrane system - Installation plan



ZELIX membrane system - TYPE ZELIX 110/90



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