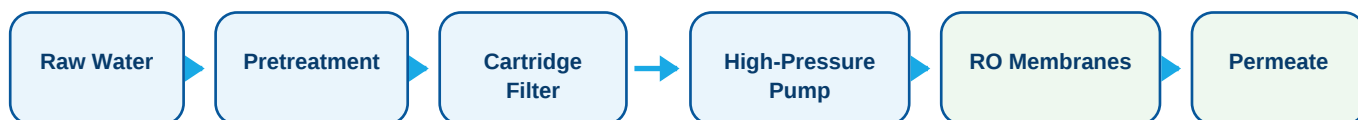


INDUSTRIAL RO PLANT

Design • Problems • Solutions • Long-Service-Life Engineering • Uninterrupted Operation



Typical industrial RO flow path — exact configuration is finalized from site water analysis and required product-water quality.

AQUA CHEM LABS

Professional water-treatment solutions for industrial RO systems

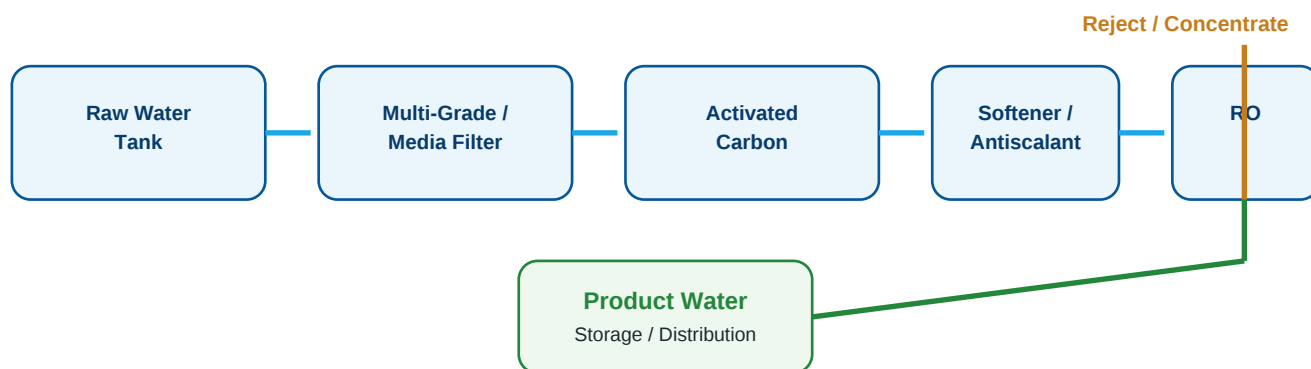
Engineered around actual feed-water chemistry, required product-water quality, operating load and maintainability.

1. Aqua Chem Labs — Industrial RO Plant Profile

Aqua Chem Labs provides industrial water-treatment plant design, engineering support, chemical programs, commissioning, operation and maintenance services. For RO applications, our design philosophy is to protect the membrane system by controlling the conditions that cause scaling, fouling, corrosion and premature component deterioration.

Our RO plant design philosophy

- **Design from water analysis:** raw-water chemistry and variability are considered before selecting pretreatment and RO operating conditions.
- **Protection before production:** pretreatment is designed to reduce the load reaching the RO membranes rather than relying on membrane cleaning alone.
- **Maintainability:** access, isolation, filtration, chemical dosing, instrumentation and cleaning provisions are considered so maintenance can be performed systematically.
- **Stable operation:** operating limits, alarms, interlocks and monitoring points are planned to reduce avoidable interruptions.
- **Long-service-life focus:** compatible materials, correct pretreatment, controlled recovery, appropriate chemical dosing and preventive maintenance help extend component life. Actual service life depends on water quality, operation and maintenance.



Typical project scope

- Site survey, raw-water and process-water assessment.
- RO capacity and recovery selection based on required production and feed conditions.
- Pretreatment, dosing and filtration selection.
- RO skid, membrane array, high-pressure pumping and instrumentation planning.
- Commissioning, performance testing, operator training and preventive-maintenance planning.
- Supply of RO antiscalants, cleaners, filters, resins and other treatment consumables as applicable.

2. Industrial RO Plant Design — From Water to Reliable Product Water

A good RO plant is not simply a membrane skid. The reliability of the complete system depends on the relationship between pretreatment, feed chemistry, hydraulics, membrane selection, recovery, instrumentation, chemical dosing and maintenance.

Major design stages

Stage	Design focus
1. Water characterization	Analyze pH, conductivity/TDS, hardness, alkalinity, silica, iron, manganese, turbidity, SDI and other relevant parameters.
2. Pretreatment design	Select clarification/filtration, activated carbon, softening, antiscalant, dechlorination and cartridge filtration as required.
3. RO projection	Determine membrane type, number of elements, stages, recovery, flux, feed pressure and concentrate flow.
4. Pumping & hydraulics	Size high-pressure pump, piping, valves and pressure-control components around the selected operating envelope.
5. Instrumentation	Provide monitoring of pressure, differential pressure, conductivity, flow, pH and other site-specific critical parameters.
6. Chemical system	Provide appropriate dosing, storage, calibration and injection arrangements with safe operating practices.
7. Commissioning	Verify flushing, pretreatment performance, membrane start-up, normalized performance and water quality.

Design principle

The target is not maximum recovery at any cost. The practical target is a balanced design that delivers the required permeate quantity and quality while keeping scaling risk, fouling tendency, energy use, chemical consumption and maintenance requirements within acceptable limits.

3. Pretreatment — The Foundation of RO Reliability

Most RO problems begin upstream of the membrane. Suspended solids, colloids, chlorine, hardness, iron, organics and biological growth can increase membrane fouling or damage membrane performance. Aqua Chem Labs focuses on controlling the feed condition before it reaches the RO.

Typical pretreatment elements

Stage	Purpose
Raw-water tank / equalization	Buffers variations in flow and water quality and provides stable feed to downstream treatment.
Media / multi-grade filtration	Reduces suspended solids and turbidity; protects downstream equipment and cartridge filters.
Activated carbon	Used where reduction of chlorine, organics or odor is required and compatible with the application.
Water softener	Reduces hardness loading where softening is appropriate for the RO design.
Antiscalant dosing	Controls precipitation of sparingly soluble salts when selected for the actual feed chemistry.
Dechlorination	Protects chlorine-sensitive RO membranes when free chlorine is present.
Cartridge filtration	Final particulate protection immediately upstream of the high-pressure RO section.

Pretreatment warning signs

- High cartridge-filter differential pressure or unusually short filter life.
- High SDI/turbidity after pretreatment.
- Free chlorine reaching the RO feed where chlorine-sensitive membranes are installed.
- Hardness or silica conditions inconsistent with the original RO projection.
- Biological growth, slime or organic fouling indicators.

4. Common Industrial RO Problems & Their Solutions

The same symptom can have multiple causes. Correct troubleshooting starts with trend data and water analysis rather than changing a chemical or membrane without diagnosis.

Problem / symptom	Likely technical causes	Aqua Chem Labs solution approach
Low permeate flow	Fouling, scaling, low feed temperature, inadequate pressure or membrane aging.	Check normalized permeate flow, pressure, temperature and differential pressure; identify fouling/scaling; optimize pretreatment and perform compatible cleaning when indicated.
High permeate conductivity	Membrane damage, high salt passage, poor pretreatment, pressure/recovery changes or O-ring/sealing issues.	Check conductivity trend, membrane integrity, operating pressure, recovery and sealing; inspect affected vessels and clean/replace components as required.
High differential pressure	Particulate/colloidal fouling, biofouling or excessive loading.	Inspect pretreatment and cartridge filtration, verify SDI/turbidity, identify foulant and apply an appropriate cleaning/pretreatment correction.
Frequent scaling	Hardness/silica/carbonate precipitation, unsuitable recovery or inadequate antiscalant program.	Recalculate scaling tendency from current feed analysis; optimize recovery, pretreatment and antiscalant dose.
Short cartridge life	High suspended solids, poor pretreatment or microbial/organic loading.	Review media-filter performance, backwash practice and raw-water changes; improve upstream removal and monitor differential pressure.
Foaming / biological growth	Organic contamination, biological activity or unsuitable storage conditions.	Review sanitation and pretreatment, assess biocide program where applicable, and correct the source rather than masking the symptom.
Pump pressure unstable	Hydraulic restriction, cavitation, air entry, valve/control issues or changing membrane condition.	Check suction conditions, filters, valves, pump health, air leaks and RO differential pressure; restore stable hydraulics.
Recovery not stable	Flow-control problem, scaling risk, instrumentation error or feed-water variation.	Verify flowmeters and control valves; review concentrate flow, feed chemistry and operating set points.

5. Scaling & Fouling — Causes, Prevention and Cleaning

Scaling is the deposition of sparingly soluble salts on membrane surfaces. Fouling is the accumulation of particulate, colloidal, organic or biological material. Both reduce membrane productivity and can increase pressure requirements.

How Aqua Chem Labs approaches the problem

- **Analyze first:** compare current feed chemistry with the design basis and identify changes in hardness, alkalinity, silica, iron, turbidity or organics.
- **Protect upstream:** optimize filtration, softening, dechlorination and cartridge filtration as applicable.
- **Control precipitation:** select and dose an antiscalant appropriate to the actual water chemistry and recovery.
- **Trend normalized performance:** track permeate flow, salt passage and pressure differential rather than relying only on raw readings.
- **Clean based on evidence:** choose a membrane-compatible cleaning sequence based on the foulant type and membrane manufacturer requirements.
- **Prevent recurrence:** correct the feed-water or operating cause after cleaning; otherwise the same deterioration can return quickly.

Typical RO chemical support

- RO antiscalants
- Acidic/alkaline membrane-cleaning chemicals as appropriate
- Biocides where applicable and compatible with the membrane system
- pH adjustment chemicals
- Dechlorination chemicals for chlorine control

Important: chemical compatibility, concentration, temperature, contact time and cleaning procedure must follow the membrane/system manufacturer's requirements and site conditions.

6. Designing RO Plants for Longer Service Life

Aqua Chem Labs positions long service life as a design and maintenance objective rather than a single product claim. The useful life of membranes, pumps, valves, vessels and instruments depends on water quality, correct sizing, operating discipline and preventive maintenance.

Key engineering practices

Design/maintenance factor	Why it matters
Correct membrane loading	Avoid unnecessarily aggressive flux and recovery targets; size the array for the required duty and feed conditions.
Strong pretreatment	Reduce particulate, hardness, chlorine and biological loading before the RO stage.
Stable hydraulics	Use appropriate pumps, piping, valves and controls to minimize damaging pressure fluctuations and flow instability.
Correct chemical dosing	Use calibrated dosing systems and site-specific programs rather than fixed universal doses.
Instrumentation	Monitor the parameters that reveal deterioration early: pressure, differential pressure, flow, conductivity, pH and other relevant variables.
Cleanability	Provide isolation, flushing and cleaning provisions so the membrane system can be serviced without unnecessary disruption.
Spare strategy	Keep critical consumables and selected spares available according to plant criticality and lead times.
Preventive maintenance	Use scheduled inspection and trending instead of waiting for a sudden production failure.

Our objective

To engineer an RO system that is practical to operate, straightforward to maintain and protected against the dominant failure mechanisms identified from the site's water and operating conditions.

7. Services for Uninterrupted RO Plant Operation

Continuous production requires more than a correctly designed RO skid. Aqua Chem Labs supports the complete operating cycle through preventive checks, chemical management, troubleshooting, cleaning and spares planning.

Service	Scope
Preventive maintenance	Inspection of filters, pumps, dosing systems, valves, instruments, membrane performance and critical operating parameters.
Performance monitoring	Trend permeate flow, conductivity, recovery, pressure and differential pressure to identify deterioration early.
Chemical management	Antiscalant and cleaning-chemical selection, dosing review, stock planning and safe application guidance.
Membrane cleaning support	Diagnosis of fouling/scaling and selection of a compatible cleaning program.
Troubleshooting	Root-cause review of low flow, high conductivity, high pressure, scaling, fouling and unstable operation.
Spare & consumable support	Filters, membranes and compatible water-treatment consumables/spares as required.
AMC / technical support	Scheduled service and technical assistance designed around plant criticality and operating requirements.
Operator guidance	Routine checklists, parameter trending and practical operating guidance to reduce avoidable interruptions.

Preventive operating checklist

- Daily: feed/permeate pressure, flow, conductivity, pH where relevant and cartridge-filter differential pressure.
- Routine: inspect chemical dosing, tank levels, leaks, pump sound/vibration and instrumentation.
- Weekly/monthly as applicable: review normalized RO performance, recovery, cleaning indicators and pretreatment performance.
- At defined intervals: calibration, membrane cleaning when performance criteria indicate it, filter replacement and preventive servicing.

8. RO Troubleshooting Matrix

Use operating trends to distinguish between hydraulic, chemical, membrane and pretreatment causes.

Symptom	First checks	Corrective direction
Permeate flow ↓	Feed pressure, temperature, DP, normalized flow	Identify scaling/fouling; correct pretreatment; clean if justified.
Permeate conductivity ↑	Feed conductivity, salt passage, pressure, sealing	Check membrane integrity and operating conditions; inspect/replace affected components.
Cartridge DP ↑	Pretreatment outlet turbidity/SDI	Improve upstream filtration/backwash; investigate feed-water change.
RO DP ↑	Stage-wise pressure drop	Identify foulant; inspect pretreatment and clean membrane system.
Antiscalant consumption ↑	Dosing pump calibration, feed flow, chemistry	Recalculate dose from current feed analysis; correct dosing/control.
Frequent cleaning	Cleaning frequency and foulant pattern	Find root cause: scaling, fouling, pretreatment failure or operating condition.
Reject flow unstable	Flowmeter, control valve, pressure	Restore hydraulic/control stability; verify instruments.

When to escalate

- A rapid change in permeate conductivity or pressure differential.
- Repeated cleaning without sustained recovery of performance.
- Unexpected membrane damage, severe leaks or abnormal vibration/noise.
- A major change in raw-water quality or production requirement.

9. Project Execution & Commissioning

Aqua Chem Labs can structure industrial RO projects from assessment through commissioning and ongoing service. The exact scope is adapted to plant capacity, feed water, product-water specification and site requirements.

Phase	Deliverable / focus
A. Site assessment	Collect water analysis, flow requirement, operating hours, existing equipment information and product-water target.
B. Engineering	Prepare process concept, pretreatment selection, RO projection, equipment sizing, piping/instrumentation philosophy and chemical dosing concept.
C. Supply & installation	Coordinate equipment, membranes, pumps, filtration, dosing, instruments and associated installation requirements.
D. Commissioning	Flush and verify pretreatment, commission dosing, start RO system, check pressures/flows and establish baseline product-water quality.
E. Performance baseline	Record operating parameters and normalized performance for future comparison.
F. Ongoing support	Preventive maintenance, chemical optimization, cleaning, troubleshooting, spares and AMC/technical support.

Information normally required for a detailed RO proposal

- Raw-water laboratory report and seasonal variation, if available.
- Required permeate production (m³/day or m³/hr) and operating hours.
- Required product-water conductivity/TDS and downstream application.
- Existing pretreatment details, membrane model, operating pressure and recovery if replacing/upgrading a system.
- Available electrical supply, installation space and site constraints.
- Historical problems such as scaling, fouling, frequent cleaning or high conductivity.

10. Aqua Chem Labs — Your RO Plant Support Partner

Our service philosophy is to combine plant design, water-treatment chemistry and maintenance support so that the RO system is treated as a complete process rather than as an isolated membrane package.

What we can support

- Industrial RO plant design and engineering
- Pretreatment and water-conditioning systems
- RO membrane systems and associated equipment
- Antiscalant and membrane-cleaning chemical programs
- Water analysis and troubleshooting
- Installation and commissioning support
- Operation & maintenance and AMC
- Preventive maintenance and performance monitoring
- Filters, resins, treatment chemicals and selected spares
- Plant optimization for reliable and maintainable operation

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LONGER LIFE • STABLE PERFORMANCE • PREVENTIVE CARE • TECHNICAL SUPPORT

Technical note: this brochure is a general industrial RO guide. Final equipment sizing, membrane selection, chemical dosing and operating limits should be established from actual site data and applicable equipment/membrane manufacturer requirements.