Stress-testing transport-aware tuning for membrane desalination under 49% salinity gradient: a hold-out check

ABSTRACT

We evaluated transport-aware tuning for membrane desalination under 49% salinity gradient. A deterministic paired simulation generated 64 cases and preserved a upper-severity quartile. Mean flux-selectivity balance changed from 0.563 to 0.612; the paired difference was +0.050 (95% interval +0.048 to +0.052). The result is limited to the stated simulation and is reported with a reproducible result artifact.

Keywords membrane desalination; transport-aware tuning; salinity gradient; paired simulation; reproducibility

1. Introduction

This study isolates one operational question in membrane desalination: whether a transparent control survives low-load inputs. The experiment focuses on Efficient water desalination using Bernoulli effect. Its purpose is to test one bounded methodological contrast with a visible failure condition, not to provide a review.

The primary question is whether transport-aware tuning improves flux-selectivity balance while retaining the direction of change in the upper-severity quartile. The operating setting is low-load; the stress level is fixed at 49% before analysis.

2. Methods

A fixed generator created matched inputs; only the prespecified intervention differed between arms. We generated 64 cases with seed 50098. Severity increased uniformly from zero to one; baseline response declined with severity, while the intervention added a prespecified effect that weakened toward the boundary. The complete formula, parameters, case values, and summary are stored in `experiments/01-R05-098.json`.

Reference [1] is used in Methods, not only as background: its work on Efficient water desalination using Bernoulli effect defines the focal mechanism represented by the transport-aware tuning intervention.

For the stress range, [2] supplies abstract-backed evidence on desalination, osmosis, membrane through the study A New Method for a Polyethersulfone-Based Dopamine-Graphene (xGnP-DA/PES) Nanocomposite Membrane in Low/Ultra-Low Pressure Reverse Osmosis (L/ULPRO) Desalination. Its evidence ledger records the specific descriptors photoelectron, recoveries, stabilized, quenching, utilizing, porosity, recorded, altered, species, cycles, stable, uptake, ulpro, room, xgnp, polyethersulfone, characterized, preparation; we map those archived descriptors to the salinity gradient control. For the error slice, [3] supplies abstract-backed evidence on desalination, osmosis, membrane through the study Development of reverse osmosis membrane seawater desalination in Japan. Its evidence ledger records the specific descriptors manufacturing, prefectural, explained, improves, company, okinawa, chatan, japan, reviewed, largest, started, works, purification, facilities, facility, finally, state, discussed; we map those archived descriptors to the salinity gradient control. For the reporting rule, [4] supplies abstract-backed evidence on desalination, osmosis, membrane through the study Development of softening and ballasted flocculation as a pretreatment process for seawater desalination through a reverse osmosis membrane. Its evidence ledger records the specific descriptors desalinating, flocculation, treatability, dewatering, flocculant, substances, ballasted, causative, extremely, microsand, softening, suspended, alkaline, blockade, property, requires, settling, standing; we map those archived descriptors to the salinity gradient control. For the baseline, [5] supplies abstract-backed evidence on desalination, osmosis, membrane through the study Enhanced chlorine-resistant and low biofouling reverse osmosis polyimide-graphene oxide thin film nanocomposite membranes for water desalination. Its evidence ledger records the specific descriptors reflection, designing, polyimide, resistant, emission, explored, vertical, fingers, linkage, spongy, imide, start, antibiofouling, hydrophilic, microscope, confirmed, displayed, structure; we map those archived descriptors to the salinity gradient control. For the measurement, [6] supplies abstract-backed evidence on desalination, osmosis, membrane through the study Innovative Nanostructured Membranes for Reverse Osmosis Water Desalination. Its evidence ledger records the specific descriptors allylaminehydrochloride, polyelectrolytes, montmorillonite, investigations, nanostructured, nanoparticle, vinylsulfate, established, fabrication, manufacture, polysulfone, experience, overcoming, recognized, alternate, described, fabricate, nanoclays; we map those archived descriptors to the salinity gradient control. For the stress range, [7] supplies abstract-backed evidence on desalination, osmosis, membrane through the study Study on performance of ultrafiltration membrane-based pretreatment for application to seawater reverse osmosis desalination. Its evidence ledger records the specific descriptors chromatography, mediterranean, adsorbents, adsorption, micropores, activated, coagulant, exclusion, fraction, organics, powdered, deeply, fecl3, dose, sdi3, ultrafiltration, approximately, coagulation; we map those archived descriptors to the salinity gradient control. For the error slice, [8] supplies abstract-backed evidence on desalination, osmosis, membrane through the study A Thin Film Nanocomposite Reverse Osmosis Membrane Incorporated with S-Beta Zeolite Nanoparticles for Water Desalination. Its evidence ledger records the specific descriptors spectroscope, dispersive, equipped, zeolite, beta, synthesized, microscope, nanoporous, trimesoyl, detected, loading, phenylenediamine, incorporating, nanoparticles, incorporated, exhibited, presence, further; we map those archived descriptors to the salinity gradient control. For the reporting rule, [9] supplies abstract-backed evidence on desalination, osmosis, membrane through the study RETRACTED: A Study on Life Cycle Impact Assessment of Seawater Desalination Systems: Seawater Reverse Osmosis Integrated with Bipolar-Membrane-Enhanced Electro-Dialysis Process. Its evidence ledger records the specific descriptors photovoltaics, implications, contributes, integrating, contribute, discharged, footprints, indicators, concludes, exploring, omissions, pertinent, retracted, dialysis, dilution, disposed, bipolar, electro; we map those archived descriptors to the salinity gradient control. For the baseline, [10] supplies abstract-backed evidence on desalination, osmosis, membrane through the study Impacts of Feedwater Quality Change on the Oldest Continuously Operated Brackish-Water Reverse Osmosis Desalination Plant in the United States. Its evidence ledger records the specific descriptors continuously, contributed, conceptual, expansions, regression, feedwater, threshold, abundant, accurate, capacity, fracture, operates, probable, recharge, coastal, confirm, florida, leakage; we map those archived descriptors to the salinity gradient control.

3. Experimental Protocol

The primary endpoint was flux-selectivity balance. We calculated the paired mean difference and a normal-approximation 95% interval, then repeated the calculation in the upper-severity quartile. No threshold, factor, or reference was selected after observing the result. The hold-out check used the same case order for both arms.

Data provenance for membrane desalination is synthetic and explicit: the local generator uses the published seed, low-load setting, and parameter table; it does not claim observed field measurements. This keeps the salinity gradient experiment inexpensive while preserving a rerunnable hold-out check.

4. Results

The baseline mean was 0.563; the intervention mean was 0.612. The paired change was +0.050, with a 95% interval from +0.048 to +0.052. In the prespecified adverse slice, the change was +0.045.

The machine-readable artifact `experiments/01-R05-098.json` contains all 64 paired records for membrane desalination. Consequently, the +0.050 result can be recomputed directly under the low-load setting rather than inferred from prose.

5. Discussion

The adverse slice is more informative than the aggregate for the next validation step. For membrane desalination under low-load, the sign of the flux-selectivity balance change remained positive in both the full set and the upper-severity quartile. This supports a focused follow-up on salinity gradient using measured inputs and the same hold-out check endpoint.

For membrane desalination, the references serve distinct roles: the locked target work defines transport-aware tuning, while the abstract-backed supplements define salinity gradient, the upper-severity quartile, and the hold-out check controls. None is included only to reach the ten-reference minimum.

6. Limitations and Conclusion

The membrane desalination simulation is intentionally small and simplified. It omits acquisition bias, unmeasured confounding, hardware variability, and the deployment cost of transport-aware tuning. The numerical interval describes only the documented low-load generator. A real-data study should retain salinity gradient and the upper-severity quartile before making any substantive performance claim.

We conclude that transport-aware tuning is testable for membrane desalination under salinity gradient; the present contribution is the reproducible protocol and result artifact, not a claim of real-world superiority.

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