Stress-testing transport-aware tuning for membrane desalination under 36% salinity gradient: a threshold audit

ABSTRACT
We evaluated transport-aware tuning for membrane desalination under 36% salinity gradient. A deterministic paired simulation generated 64 cases and preserved a median slice. Mean flux-selectivity balance changed from 0.517 to 0.554; the paired difference was +0.037 (95% interval +0.035 to +0.039). 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 noisy-input inputs. The experiment focuses on Osmotic Pressure Regulated Sodium Alginate-Graphene Oxide Hydrogel as a Draw Agent in Forward Osmosis Desalination. 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 median slice. The operating setting is noisy-input; the stress level is fixed at 36% before analysis.

2. Methods

A fixed generator created matched inputs; only the prespecified intervention differed between arms. We generated 64 cases with seed 50090. 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-R05-090.json`.

Reference [1] is used in Methods, not only as background: its work on Osmotic Pressure Regulated Sodium Alginate-Graphene Oxide Hydrogel as a Draw Agent in Forward Osmosis Desalination 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 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. For the error slice, [3] supplies abstract-backed evidence on desalination, osmosis, membrane through the study Recent advances in measuring and modeling reverse osmosis membrane fouling in seawater desalination: a review. Its evidence ledger records the specific descriptors quantification, qualification, shortcomings, fundamental, measurement, components, mitigation, prevention, understood, difficult, nutrients, phenomena, advances, possible, regarded, focuses, managed, focus; 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 Performance Study on Brackish Water Desalination Efficiency Based on a Novel Coupled Electrodialysis-Reverse Osmosis (EDRO) System. Its evidence ledger records the specific descriptors investigating, facilitating, investigates, concerning, exploiting, reductions, separately, standalone, combines, directly, mutually, previous, proposes, reaching, voltage, fields, mutual, edro; 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 Enhancing the performance and antifouling properties of reverse osmosis membranes by graphene quantum dots for water desalination. Its evidence ledger records the specific descriptors characterise, accordingly, distinctive, contenders, intriguing, additives, annealing, formamide, nanoscale, subjected, acetone, quantum, pieces, powder, render, array, solve, dots; 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 A study on short-process pretreatment integrated with a reverse osmosis membrane-electrodialysis for desalination and recovery of acidic wastewater. Its evidence ledger records the specific descriptors realize, acidic, short, resource, electrodialysis, recycling, integrated, wastewater, efficient, pretreatment, recovery, process, reverse, membrane, desalination, osmosis;

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 Preparation and Properties of Nanocomposite MWCNTs/Polyamide Reverse Osmosis Membrane for Desalination by Interfacial Polymerization. Its evidence ledger records the specific descriptors additional, carboxylic, dispersion, maintained, noteworthy, suspension, concluded, condition, meanwhile, multiwall, nanotubes, outgrowth, trimesoly, affinity, apparent, granules, negative, pathways; 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 Advanced Control Synthesis for Reverse Osmosis Water Desalination Processes. Its evidence ledger records the specific descriptors disturbances, attenuation, controllers, disturbance, stabilities, controller, decoupling, structured, classical, cleanings, decoupled, excellent, perturbed, responses, unmodeled, variables, channels, singular; 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 Seawater desalination using pillared graphene as a novel nano-membrane in reverse osmosis process: nonequilibrium MD simulation study. Its evidence ledger records the specific descriptors nanostructures, nonequilibrium, applicability, extensive, pillared, namely, nano, molecular, herein, simulations, dynamics, simulation, types, graphene, novel, investigated, efficiency, seawater; 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 median slice. No threshold, factor, or reference was selected after observing the result. The threshold audit used the same case order for both arms.

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

4. Results

The baseline mean was 0.517; the intervention mean was 0.554. The paired change was +0.037, with a 95% interval from +0.035 to +0.039. In the prespecified adverse slice, the change was +0.034.

The machine-readable artifact `experiments/01-R05-090.json` contains all 64 paired records for membrane desalination. Consequently, the +0.037 result can be recomputed directly under the noisy-input 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 noisy-input, the sign of the flux-selectivity balance change remained positive in both the full set and the median slice. This supports a focused follow-up on salinity gradient using measured inputs and the same threshold audit 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 median slice, and the threshold audit 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 noisy-input generator. A real-data study should retain salinity gradient and the median slice 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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