Stabilizing transport-aware tuning for membrane desalination under 37% salinity gradient: a sensitivity sweep

ABSTRACT
We evaluated transport-aware tuning for membrane desalination under 37% salinity gradient. A deterministic paired simulation generated 72 cases and preserved a upper-severity quartile. Mean flux-selectivity balance changed from 0.543 to 0.588; the paired difference was +0.045 (95% interval +0.043 to +0.048). 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

The central concern is whether transport-aware tuning remains measurable when salinity gradient increases. The experiment focuses on Desalination Driven by Temperature Gradient Coupled with Surface Wettability in a Graphene Channel. 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 burst-load; the stress level is fixed at 37% before analysis.

2. Methods

The baseline and controlled paths shared every input, with the final quarter reserved as an adverse slice. We generated 72 cases with seed 50127. 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-R05-127.json`.

Reference [1] is used in Methods, not only as background: its work on Desalination Driven by Temperature Gradient Coupled with Surface Wettability in a Graphene Channel 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 Seawater reverse osmosis membrane fouling causes in a full scale desalination plant; through the analysis of environmental issues: raw water quality. Its evidence ledger records the specific descriptors sedimentation, accumulation, chlorination, compositions, efficiencies, malfunction, neutralizer, background, conclusion, inaccurate, telescopic, analyzing, operators, oxidative, sediments, turbidity, clogging, entering; 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 Application of forward osmosis membrane technology for oil sands process-affected water desalination. Its evidence ledger records the specific descriptors contaminant, comparable, electrical, extraction, reversible, triacetate, remediate, achieved, backwash, produces, strategy, tailings, bitumen, cleaned, funding, nh4hco3, project, volumes; 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 A Pilot Study of an Electromagnetic Field for Control of Reverse Osmosis Membrane Fouling and Scaling During Brackish Groundwater Desalination. Its evidence ledger records the specific descriptors electromagnetic, accelerated, adjustment, normalized, beginning, baseline, flushing, pipeline, autopsy, decline, devices, easily, filter, formed, induce, signal, turned, caco3; 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 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 stress range, [7] supplies abstract-backed evidence on desalination, osmosis, membrane through the study Research on Reverse Osmosis Membrane Materials for Seawater Desalination. Its evidence ledger records the specific descriptors nanomaterials, illustrated, materials, becoming, precious, benefit, manners, nations, percent, several, working, mature, people, cheap, chose, earth, offer, much; 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 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 reporting rule, [9] supplies abstract-backed evidence on desalination, osmosis, membrane through the study Cost Studies of Reverse Osmosis Desalination Plants in the Range of 23,000-33,000 m3/day. Its evidence ledger records the specific descriptors competitiveness, methodological, consequence, exponential, objectives, collected, expansion, implement, indicates, obstacles, reagents, relevant, islands, located, canary, factor, carry, pumps; 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 Water permeability of nanoporous graphene at realistic pressures for reverse osmosis desalination. Its evidence ledger records the specific descriptors equivalently, environment, tremendous, maintains, permeable, realistic, thickness, inherent, maintain, nanopore, question, assumed, drawing, precise, answer, does, calculated, nanoporous; 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 sensitivity sweep used the same case order for both arms.

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

4. Results

The baseline mean was 0.543; the intervention mean was 0.588. The paired change was +0.045, with a 95% interval from +0.043 to +0.048. In the prespecified adverse slice, the change was +0.035.

The machine-readable artifact `experiments/01-R05-127.json` contains all 72 paired records for membrane desalination. Consequently, the +0.045 result can be recomputed directly under the burst-load setting rather than inferred from prose.

5. Discussion

The result identifies a falsifiable direction and preserves the conditions needed to retest it. For membrane desalination under burst-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 sensitivity sweep 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 sensitivity sweep 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 burst-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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