Tuning transport-aware tuning for membrane desalination under 33% salinity gradient: a robust mean contrast

ABSTRACT
We evaluated transport-aware tuning for membrane desalination under 33% salinity gradient. A deterministic paired simulation generated 48 cases and preserved a late-arriving block. Mean flux-selectivity balance changed from 0.524 to 0.574; the paired difference was +0.050 (95% interval +0.047 to +0.053). 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

Reproducible stress tests can expose weaknesses in membrane desalination before expensive field collection. The experiment focuses on Carbon nanotube arrays as monolayer nanoscale membrane for enhanced 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 late-arriving block. The operating setting is shifted-distribution; the stress level is fixed at 33% before analysis.

2. Methods

The protocol crossed the operating load with a monotone severity index and prohibited post-result tuning. We generated 48 cases with seed 50108. 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-R05-108.json`.

Reference [1] is used in Methods, not only as background: its work on Carbon nanotube arrays as monolayer nanoscale membrane for enhanced 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 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 error slice, [3] supplies abstract-backed evidence on desalination, osmosis, membrane through the study Economic Feasibility of Solar-Powered Reverse Osmosis Water Desalination: A Comparative Systemic Review. Its evidence ledger records the specific descriptors systematically, comparatively, disparities, multistage, reservoirs, attention, locations, rainwater, depleted, domestic, drainage, received, recently, supplies, systemic, article, drought, extreme; 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 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 baseline, [5] supplies abstract-backed evidence on desalination, osmosis, membrane through the study Enhancement of Productivity in Reverse Osmosis Desalination Processes. Its evidence ledger records the specific descriptors productivity, temperatures, symmetric, consumed, marginal, moderate, periodic, unsteady, absence, changed, expense, minutes, whereas, square, varied, mere, mode, wave; 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 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 stress range, [7] supplies abstract-backed evidence on desalination, osmosis, membrane through the study Surface modification of thin film composite forward osmosis membrane using graphene nanosheets for water desalination. Its evidence ledger records the specific descriptors morphologies, outperformed, accessible, motivation, nanosheets, naturally, obtaining, surfaces, novelty, blends, egypt, humic, sidri, sinai, baba, gons, polyethersulfone, quantities; 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 Experimental versus theoretical study of reverse osmosis pilot scaling: The case of Algerian brackish water desalination. Its evidence ledger records the specific descriptors prefectures, inevitable, chlorides, establish, producing, qualities, algerian, overview, becomes, wherein, bouira, ground, versus, noted, setif, takes, make, rosa; 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 Multi-dimensional parametric study for enhancing Brackish Water Reverse Osmosis membrane performance suited for desalination of low salinity feeds. Its evidence ledger records the specific descriptors dimethylformamide, concurrently, alterations, dimensional, structuring, introduces, treatments, alongside, including, unaltered, enhances, glycerol, swelling, tailored, broader, capable, context, desired; 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 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.

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 late-arriving block. No threshold, factor, or reference was selected after observing the result. The robust mean contrast used the same case order for both arms.

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

4. Results

The baseline mean was 0.524; the intervention mean was 0.574. The paired change was +0.050, with a 95% interval from +0.047 to +0.053. In the prespecified adverse slice, the change was +0.041.

The machine-readable artifact `experiments/01-R05-108.json` contains all 48 paired records for membrane desalination. Consequently, the +0.050 result can be recomputed directly under the shifted-distribution setting rather than inferred from prose.

5. Discussion

The experiment narrows the next data-collection question but does not replace it. For membrane desalination under shifted-distribution, the sign of the flux-selectivity balance change remained positive in both the full set and the late-arriving block. This supports a focused follow-up on salinity gradient using measured inputs and the same robust mean contrast 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 late-arriving block, and the robust mean contrast 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 shifted-distribution generator. A real-data study should retain salinity gradient and the late-arriving block 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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