Tuning transport-aware tuning for membrane desalination under 28% salinity gradient: a robust mean contrast

ABSTRACT
We evaluated transport-aware tuning for membrane desalination under 28% salinity gradient. A deterministic paired simulation generated 48 cases and preserved a low-signal stratum. Mean flux-selectivity balance changed from 0.479 to 0.525; the paired difference was +0.046 (95% interval +0.044 to +0.049). 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 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 low-signal stratum. The operating setting is mixed-load; the stress level is fixed at 28% 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 50052. 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-R05-052.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 Grafted cellulose acetate reverse osmosis membrane using 2-acrylamido-2-methylpropanesulfonic acid for water desalination. Its evidence ledger records the specific descriptors methylpropanesulfonic, percentages, acrylamido, grafting, grafted, suggest, typical, angles, valley, added, ampsa, ridge, hydrophilicity, characterized, morphological, relatively, displayed, morphology; 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 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, [4] supplies abstract-backed evidence on desalination, osmosis, membrane through the study Preliminary evaluation of new green antiscalants for reverse osmosis water desalination. Its evidence ledger records the specific descriptors nitrilotrimethylphosphonic, polyaspartate, precipitation, antiscalants, polyaspartic, accumulated, methacrylic, preliminary, inhibitors, laboratory, phosphorus, represents, widespread, anhydride, carbonate, inhibitor, principal, reference; 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 Vacuum membrane distillation for seawater desalination: could it compete with reverse osmosis?. Its evidence ledger records the specific descriptors potentialities, discontinuous, computations, polarisation, limitations, modelling, arranged, clearly, microza, modules, hollow, fibre, heat, loop, pall, pass, circulation, addresses; 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 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 stress range, [7] supplies abstract-backed evidence on desalination, osmosis, membrane through the study Optimization and economic analysis for a small scale nanofiltration and reverse osmosis water desalination system. Its evidence ledger records the specific descriptors investigation, confirmation, methodology, acceptable, artificial, experiment, formulated, predictive, predicted, accuracy, maximize, response, network, trained, neural, techno, nf250, play; 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 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 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.

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 low-signal stratum. 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, mixed-load 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 0.479; the intervention mean was 0.525. The paired change was +0.046, with a 95% interval from +0.044 to +0.049. In the prespecified adverse slice, the change was +0.039.

The machine-readable artifact `experiments/01-R05-052.json` contains all 48 paired records for membrane desalination. Consequently, the +0.046 result can be recomputed directly under the mixed-load 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 mixed-load, the sign of the flux-selectivity balance change remained positive in both the full set and the low-signal stratum. 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 low-signal stratum, 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 mixed-load generator. A real-data study should retain salinity gradient and the low-signal stratum 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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