

REVIEWER'S REPORT

Manuscript No.: JNCS-077

Title: Zero-Water Closed-Loop Direct-to-Chip Cooling Architectures for HighDensity AI Data Centers Using Elevated Coolant Temperatures .

Recommendation:

Accept as it is

Accept after minor revision.....

Accept after major revision yes...

Do not accept (*Reasons below*)

Rating	Excel.	Good	Fair	Poor
Originality			Y	
Techn. Quality			Y	
Clarity			Y	
Significance			y	

Reviewer's ID: JPR- Dr.Shaweta Sachdeva

Detailed Reviewer's Report

1. The manuscript proposes the Multi-Stage Elevated Temperature Closed-Loop Architecture (MET-CLA), but the novelty should be articulated more clearly. The authors should explicitly distinguish the proposed architecture from existing elevated-temperature DTC, dry-cooler, and zero-water data-center cooling approaches.
2. The abstract reports WUE of 0.02–0.05 L/kWh and PUE of 1.06–1.12, but the methodology used to derive these values is not sufficiently detailed. The authors should provide the principal equations, boundary conditions, and calculation procedure supporting these performance figures. 6ac72ea8f301c_JNCS-077-sampleFi...
3. The study is entirely modeling-based, and the authors themselves acknowledge the absence of full-scale experimental validation. Therefore, the conclusions should be phrased more cautiously, particularly where the manuscript describes MET-CLA as a “practical” or broadly deployable solution. 6ac72ea8f301c_JNCS-077-sampleFi...
4. The assumption of a 100 MW steady IT load needs stronger justification. Real AI data centers experience substantial temporal variation in workload. A sensitivity analysis using different IT-load profiles would significantly improve the practical relevance of the study.
5. The selection of 40–45 °C coolant inlet temperature should be technically justified in greater depth. The manuscript should discuss the thermal limits of representative GPUs/CPU, thermal-interface materials, cold plates, seals, pumps, and other components under continuous operation at these temperatures. 6ac72ea8f301c_JNCS-077-sampleFi...
6. The choice of PG-25 (25% propylene glycol) requires further analysis. Temperature-dependent viscosity, specific heat, thermal conductivity, and density should be reported, preferably over the complete operating range. The effect of glycol concentration on pumping power and heat-transfer performance should also be quantified. 6ac72ea8f301c_JNCS-077-sampleFi...
7. The assumed flow rate of approximately 1.2 L/min/kW should be supported with calculations or experimental references. A sensitivity analysis showing how flow rate affects pressure drop, pumping power, cold-plate thermal resistance, and junction temperature would strengthen the methodology. 6ac72ea8f301c_JNCS-077-sampleFi...

REVIEWER'S REPORT

8. The manuscript uses TMY climate data, but the specific locations, weather datasets, time resolution, and climate classification criteria are not sufficiently described. The authors should identify representative locations for temperate, hot-dry, and mixed climates and explain how these profiles were selected. 6ac72ea8f301c_JNCS-077-sampleFi...
9. The results claim 7,200–8,100 free-cooling hours/year in temperate climates. These values should be accompanied by the exact definition of “free cooling,” including the allowable ambient temperature, approach temperature of the dry cooler, coolant supply/return temperatures, and fan operating conditions. 6ac72ea8f301c_JNCS-077-sampleFi...
10. There appears to be a need for greater consistency between the numerical tables and graphical representations. For example, the values shown in Fig. 3 should be checked against Table 3, and the graphical presentation in Fig. 5 should be reviewed for readability and numerical consistency with Table 5.
11. Figure 4 should be revised because the visual presentation appears potentially confusing, particularly the legends and plotted series. Each architecture should be clearly distinguishable, and the plotted values should correspond exactly to Table 4.
12. Figure 5 is labeled as an “AI Generated” source in the figure itself. This is inappropriate for a scientific manuscript unless the journal specifically permits such figures. The authors should replace it with a professionally generated plot directly based on the numerical results in Table 5. 6ac72ea8f301c_JNCS-077-sampleFi...
13. The statement that cooling energy decreases by approximately 3–4% per 1 °C increase should be carefully qualified because the relationship is unlikely to remain linear across all temperatures and climate conditions. The authors should explain the applicability range of this assumption. 6ac72ea8f301c_JNCS-077-sampleFi...
14. The comparison among traditional evaporative cooling, conventional DTC, and MET-CLA should use identical system boundaries. The authors should clearly state whether IT equipment power, pumps, fans, chillers, CDUs, heat exchangers, and other auxiliary loads are included in the PUE and cooling-energy calculations.
15. The manuscript should provide a complete energy balance for the proposed system. In particular, pump power, dry-cooler fan power, CDU losses, heat-exchanger losses, and any residual mechanical/adiabatic cooling should be separately quantified.
16. The WUE calculations require additional clarification. Since the proposed system is described as “zero-water” or “near-zero-water,” the authors should explicitly define whether WUE includes only operational onsite water consumption or also makeup water, maintenance losses, blowdown, leakage, and emergency adiabatic operation. 6ac72ea8f301c_JNCS-077-sampleFi...
17. The manuscript would benefit from a sensitivity/uncertainty analysis. Important parameters such as ambient temperature, coolant temperature, cold-plate thermal resistance, flow rate, heat-exchanger effectiveness, fan efficiency, pump efficiency, and IT load should be varied to determine which parameters most strongly influence PUE and WUE.
18. The predictive-control component is described conceptually, but the manuscript does not provide sufficient information about the control algorithm. The authors should specify whether the approach is model predictive control, machine-learning-based control, rule-based control, or another method, and provide the objective function, control variables, constraints, and forecasting horizon. 6ac72ea8f301c_JNCS-077-sampleFi...
19. Since predictive control is one of the claimed contributions, the study should compare predictive control with a conventional rule-based or fixed-setpoint strategy. This would demonstrate the actual benefit of the proposed control layer rather than assuming its effectiveness.
20. The analysis of hot-humid climates is insufficient. Since dry coolers are strongly affected by ambient conditions, the authors should quantify performance degradation under representative

REVIEWER'S REPORT

hot-humid conditions rather than discussing this limitation only qualitatively. 6ac72ea8f301c_JNCS-077-sampleFi...

21. The manuscript should discuss the reliability and long-term degradation associated with continuous operation at elevated coolant temperatures, including corrosion, fouling, seal degradation, thermal-interface-material aging, and coolant chemistry changes.
22. The comparison with NVIDIA and Microsoft designs in Table 6 should be made more rigorous. The authors should clearly identify the source and technical specifications of each reference architecture and avoid implying direct quantitative comparability when the systems have different boundaries and operating conditions. 6ac72ea8f301c_JNCS-077-sampleFi...
23. The manuscript would benefit from a cost analysis. Capital expenditure and operating expenditure of cold plates, CDUs, dry coolers, pumps, controls, and associated infrastructure should be compared with conventional cooling systems.
24. The sustainability assessment is primarily focused on operational water and energy consumption. A life-cycle assessment including manufacturing, transportation, installation, replacement, and end-of-life impacts would provide a more complete sustainability evaluation. The authors acknowledge this limitation, but it should be discussed more explicitly in relation to the principal claims. 6ac72ea8f301c_JNCS-077-sampleFi...
25. Several claims concerning “zero-water” operation should be replaced with “near-zero operational water consumption” unless the authors can demonstrate that all water requirements, including emergency/backup cooling and maintenance-related consumption, are negligible.
26. The manuscript contains several broad statements regarding current industry practice and hyperscale operators. These should be supported by primary peer-reviewed sources or authoritative technical reports wherever possible rather than relying heavily on company blogs and commercial sources.
27. The reference list should be carefully checked for bibliographic completeness, consistency, DOI information, publication details, and accessibility. References [4]–[6], for example, are industry/company sources and should be clearly distinguished from peer-reviewed literature. 6ac72ea8f301c_JNCS-077-sampleFi...
28. The terminology should be standardized throughout the manuscript. Terms such as “zero-water,” “near-zero water,” “zero operational water,” and “on-site water use” appear to be used somewhat interchangeably, although they may have different meanings.
29. The manuscript would benefit from a clear mathematical formulation of the proposed architecture. At minimum, equations for heat balance, coolant flow, heat-exchanger effectiveness, dry-cooler heat rejection, pumping/fan power, WUE, and PUE should be included.
30. The conclusion is generally consistent with the modeled results, but it should better emphasize the conditions under which the reported performance is achievable rather than presenting the results as universally applicable. 6ac72ea8f301c_JNCS-077-sampleFi...
31. The manuscript should undergo substantial language and technical editing. Several sentences are lengthy and contain multiple claims, while some terminology and capitalization are inconsistent.
32. The figures and tables should be reformatted to meet journal standards. In particular, figure fonts, legends, axis labels, units, resolution, and table formatting should be standardized.
33. The authors should explicitly state the software/tool used for the thermal-fluid modeling, if applicable, along with model version, numerical solver, convergence criteria, time step, and computational procedure so that the results can be reproduced.
34. A validation section comparing the model against at least one experimentally validated elevated-temperature DTC dataset would substantially strengthen the credibility of the proposed performance ranges.
35. Overall, the manuscript addresses an important and emerging problem and presents an interesting systems-level architecture. However, the quantitative claims currently appear stronger than the

Jana Nexus: Journal of Computer Science

Publisher's Name: Jana Publication and Research LLP

<https://www.jananexuscs.com>

REVIEWER'S REPORT

level of model validation and methodological detail provided. I recommend major revision with particular emphasis on model transparency, validation, uncertainty analysis, climate sensitivity, energy/water accounting, and consistency of figures and tables.