

REVIEWER'S REPORT

Manuscript No.: IJAR- 59009

Title: Smart Control and Instrumentation Strategies for Optimizing Gasification Processes in Saudi Arabia's Integrated Energy Facilities

Recommendation:

Accept

Rating	Excel.	Good	Fair	Poor
Originality	Yes			
Techn. Quality		Yes		
Clarity	Yes			
Significance		Yes		

Reviewer Name: Dr. Ashish Yadav

Detailed Reviewer's Report

Reviewer's Comment for Publication.

Acceptance Comment are mentioned below suitable for the paper titled "*Smart Control and Instrumentation Strategies for Optimizing Gasification Processes in Saudi Arabia's Integrated Energy Facilities*"

Reviewer Comments: Accept

Reviewer Comments –

1. Introduction:

The manuscript addresses a highly relevant and timely topic concerning the integration of smart control and advanced instrumentation into gasification processes. The introduction effectively highlights the nonlinear behaviour, severe measurement conditions, feedstock variability, and strong interactions among key gasification variables. The focus on integrated energy facilities in Saudi Arabia provides an important regional and industrial perspective. Overall, the introduction establishes a clear rationale for investigating intelligent and adaptive process-control strategies.

2. Literature Review:

The literature review provides a comprehensive and contemporary overview of smart instrumentation, state estimation, advanced control, machine learning, and digital-twin technologies for gasification. The focus on literature from 2020–2025 ensures that the review captures recent technological developments and emerging research directions. The PRISMA-informed integrative approach and assessment of methodological quality, validation, real-time applicability, and transferability strengthen the review

REVIEWER'S REPORT

framework. The identification of gaps in industrial-scale validation, uncertainty quantification, sensor fouling, cybersecurity, and cross-unit coordination is particularly valuable.

3. Solution Approach / Methodology:

The proposed implementation framework is well structured and appropriately combines safety-certified basic control with soft sensors, supervisory model predictive control, equipment-health analytics, and plantwide economic optimization. The layered architecture is especially suitable for complex integrated facilities where process safety must remain independent of advanced optimization functions. The integration of sensor fusion, Kalman filtering, machine learning, and bidirectional digital twins provides a technically coherent pathway toward intelligent gasification control. The phased roadmap also enhances the practical applicability of the review for Saudi Arabian energy facilities.

4. Results and Discussion:

The synthesis effectively demonstrates the transition from conventional regulatory control toward predictive, data-driven, and digital-twin-enabled gasification management. The reported benefits of constrained MPC, state prediction, and online spectroscopy provide strong evidence of the potential for improved process stability, syngas monitoring, and operational efficiency. The discussion appropriately recognizes that advanced technologies must be evaluated not only for predictive accuracy but also for robustness, uncertainty, cybersecurity, and real-time deployment. The specific relevance to Jazan-type gasification-power-steam-hydrogen complexes significantly strengthens the practical value of the findings.

5. Conclusion:

The conclusion is consistent with the review findings and provides a clear vision for the gradual implementation of smart instrumentation and intelligent control in integrated gasification facilities. The proposed phased approach offers a realistic pathway for improving availability, syngas consistency, hydrogen quality, energy efficiency, and carbon performance while maintaining process safety. The manuscript makes a meaningful contribution by connecting recent technological advances with the specific operational requirements of Saudi Arabia's integrated energy infrastructure.