H_2 Recovery and CO_2 Capture from Hydrogen Tail Gas by Integrated Separation Process: Dynamic-Model-Based Artificial Neural Network

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This study developed an integrated process for H_2 recovery and CO_2 capture from the hydrogen tail gas. The developed dynamic model of the integrated process was validated through reference data. In addition, the sensitivity analysis highlighted the potential of the suggested process for high-purity H_2 recovery and CO_2 capture. Due to the complexity of the interconnections, a dynamic-model-based artificial neural network (ANN) for the integrated process was developed to optimize the process performance. The synthetic datasets for the ANN models of the cryogenic, membrane, and PSA units were trained and tested within a marginal error (<2%). Subsequently, a process-driven model, developed by the integration of ANN models with the algebraic equations of compressor, HX, and economic evaluation, was validated with reference data. The optimization, derived from the process-driven model, was carried out using differential evolution approach. The optimum cost (2.045 $/kg) of H_2 recovery with purity up to 99.99% was economically comparable to the H_2 production from natural gas. Furthermore, the cost covered for 91% CO_2 capture with 98.6 vol.% CO_2. As a result, the suggested process can be a feasible direction to improve value of the hydrogen tail gas. In addition, the dynamic-model-based ANN can be used as the potential algorithm for process design, operation, and optimization.