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SEPARATION OF CO_2 AND H_2S MIXTURE

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INTRODUCTION & AIM

Carbon dioxide (CO_2) and hydrogen sulfide (H_2S) separation from sour gas streams is vital for emission control and gas purification. This study presents an Aspen Plus rate-based simulation of a chemical absorption process using various solvents for CO_2/H_2S removal. Two gas streams from the Shurtan Gas Chemical Complex were modeled: a raw feed (3.42% CO_2, 0.09% H_2S) and a treated gas (2.1% CO_2). Optimal absorber operation (40–45 °C) and solvent circulation achieved over 98.6% CO_2 and 99.9% H_2S removal, with 2.3 GJ/t CO_2 regeneration energy. The captured CO_2 is utilized in sodium carbonate production at the Dehkanabad Potash Plant, converting 20 t/h CO_2 into 296,000 t/year soda (77% efficiency). This model demonstrates a scalable, low-energy pathway for carbon capture and utilization (CCU) in the Uzbek chemical sector.

METHOD

- **Simulation tool:** Aspen Plus V12
- **Approach:** Rate-based absorption–regeneration model
- **Chemical System:** CO_2–H_2S–CH_4–H_2O mixture
- **Key Equipment:** Absorber and Stripper columns
- **Objective:** ≥99.5% CO_2 purity, ≥98% removal
- **Optimization Variables:**
  - Solvent type and flow rate
  - Absorber temperature (40–45 °C)
  - Reboiler duty (minimized)

SIMULATION RESULTS

Parameter	Raw Gas	Treated gas	Removal efficiency
CO_2 (%)	3.42	0.05	98.6%
H_2S (%)	0.09	<0.001	99.9%
Temperature (°C)	40–45	—	—
Regeneration energy (GJ/t CO_2)	—	2.3	—
CO_2 Purity (%)	—	≥99.5	—

TECHNO-ECONOMIC EVALUATION

Indicator	Value
CO_2 Capture rate	20 t/h
Na_2CO_3 production	296,000 t/year
Process efficiency	77%
Estimated energy cost	2.3 GJ/t CO_2
Payback potential	<5 years (for integrated CCU system)

Captured CO_2 reuse reduces both flaring emissions and natural gas consumption in Dehkanabad's soda process.

IMPLEMENTATION PATH TIMELINE (PLANNED)

Year	Stage	Focus
2026	Pilot simulation validation	Shurtan CO_2 absorption unit
2027–2028	Pilot-scale integration	Continuous absorber–stripper testing
2028	Industrial demonstration	Dehkanabad Potash Plant integration
2029–2030	Commercial operation	Full CCU implementation (20 t/h CO_2 → 296 kt Na_2CO_3/year)

CONCLUSION

- CO_2 and H_2S removal efficiency exceeded 98.6% and 99.9%, respectively.
- Energy consumption (2.3 GJ/t CO_2) meets industrial benchmarks.
- Feasible for scale-up to industrial CCU applications in Uzbekistan.

REFERENCES

Adhi, Tri Partono et al. H2S–CO2 gas separation with ionic liquids on low ratio of H2S/CO2. Heliyon, Volume 7, Issue 12, 2021