Effect of solvent concentration on the energy demand of an absorption-based natural gas sweetening plant

M. Berchiche [a,b], M. Garcia [c], S. Belaadi [a], G. Léonard [b]

[a] Université des Sciences et de la Technologie Houari Boumediene, LGR, FGMGP, BP32 El-Alia, 16000, Algeria
[b] Université de Liège, Department of Chemical Engineering, B6a Sart-Tilman, 4000 Liège, Belgium,
[c] IEAGHG, Pure Offices, Hatherley Lane, Cheltenham GL51 6SH, United Kingdom

Abstract : Amine-based chemical absorption is the most advanced CO_2 capture system. Yet, high energy requirement is a major hinder to its wide deployment. Among the possible routes of improvement is the use of novel amines that can achieve the trade-off between robustness and low regeneration energy. Our work investigates the use of MDEA/DEA as solvent for the capture of CO_2 from natural gas. The presence of BTEX (Benzene, Toluene, Ethyl Benzene and Xylene) in the raw natural gas was taken into account. AspenHysys v9 was used to simulate the chemical absorption system. The impact of solvent composition on key process variables, the required flow rate to achieve transport specification, required reboiler duty, pumping energy, BTEX incineration energy and amine losses, were studied. The optimal operating point corresponding to the lowest energy requirement was identified and the separate contribution of each process parameter was estimated.

Key words : Natural gas, CO2 capture, BTEX, MDEA/DEA,

Introduction

Natural gas has a low CO_2 emissions per kilowatt of energy produced. It has been so far a valuable "bridge fuel". This market is expected to grow by 60% until 2035. Yet, about 26.9% of the world's natural gas reservoirs have CO_2 content higher than 10%. improving the efficiency of acid gas capture processes is therefore believed to play a decisive role in securing a sustainable natural gas supply.

Chemical absorption is the most advanced technique in the power sector and is well established for acid gas removal from natural gas. However, this process is still facing some serious drawbacks related mainly to the high operational costs arising from the high energy demand of the process.

The use of solvent blends, such as MDEA/DEA, is a practical solution to take benefit from the most suitable characteristics of each solvent and presents therefore an interesting route for improving the efficiency of the capture process.

Model Validation

A natural gas sweetening unit was simulated with AspenHysys V9 :

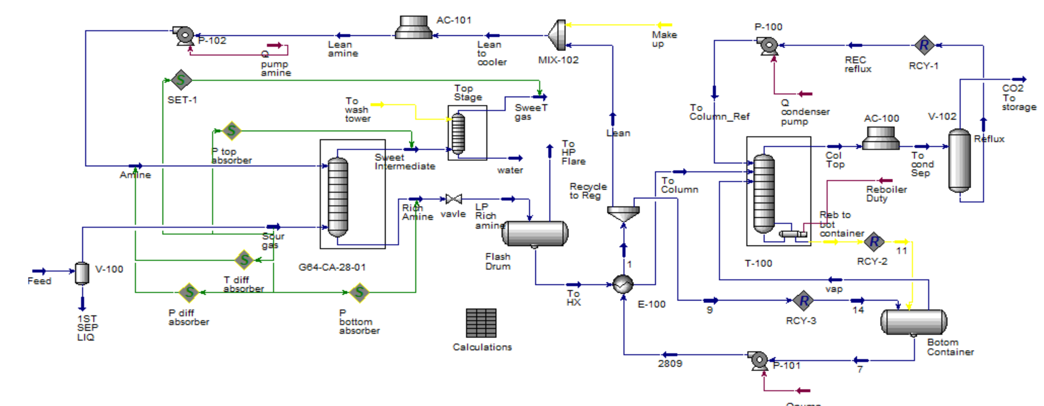
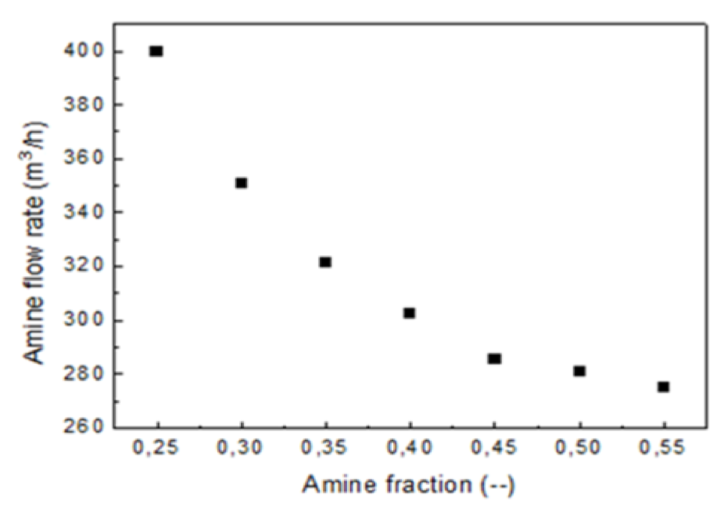


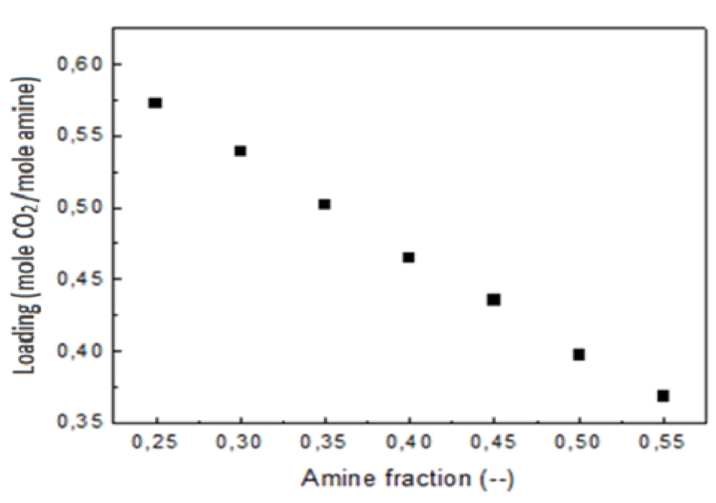
Fig1, AspenHysys model

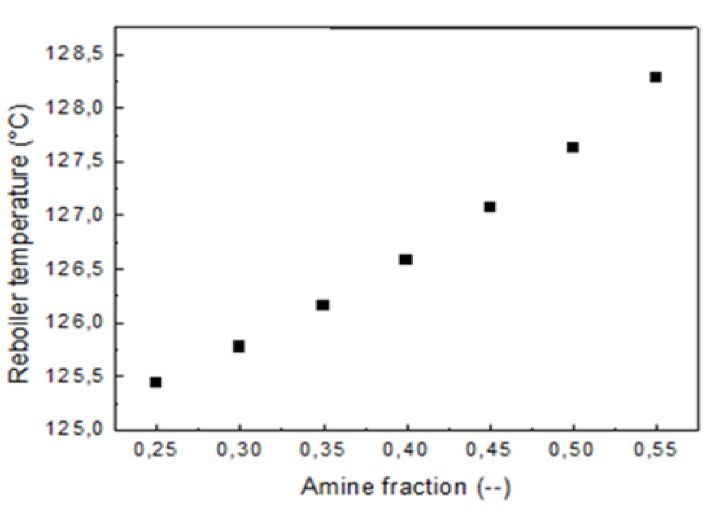
The predictions of the model were validated against one day averaged data from an industrial plant and are presented in the next table.

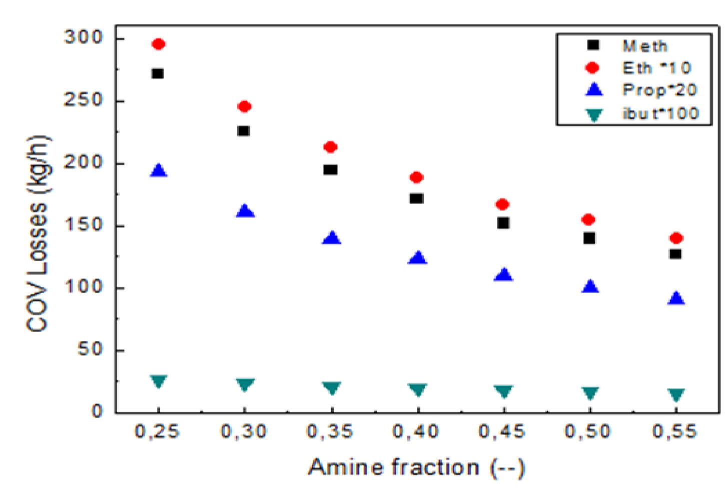
	Absorber/Regenerator			Sweet gas composition, Mole %			
	Sim.	**plant**	**R Error%**	**Comp.**	**Sim.**	**plant**	**R Error%**
T 3rd stage	59.18	58.2 ±0,8	1,59	**CO_2**	1.93	1.98	2.53
T 4th stage	60.16	60.5 ±1	0,66	**C1**	82.2	85.69	4.05
T Bottom	78.23	79.9 ±1,5	2,15	**C2**	6.72	6.62	1.51
Liquid Flow	305.2	288.5 ±20	5,82	**C3**	2.27	2.23	1.68
T Top (Reg)	86.3	90.9 ±7	5,10				
T Bottom (Reg)	126.1	127.5 ±1	1,13				
Liquid Flow	760.1	755.2 ±3	0,64				

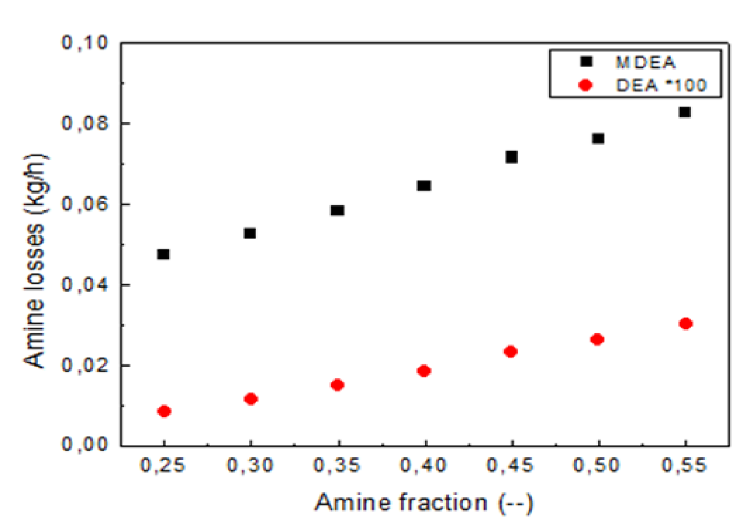
Results and discussion

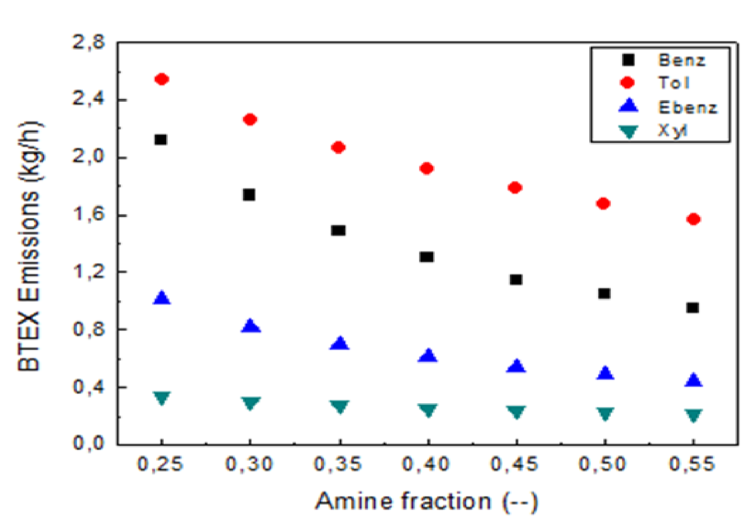


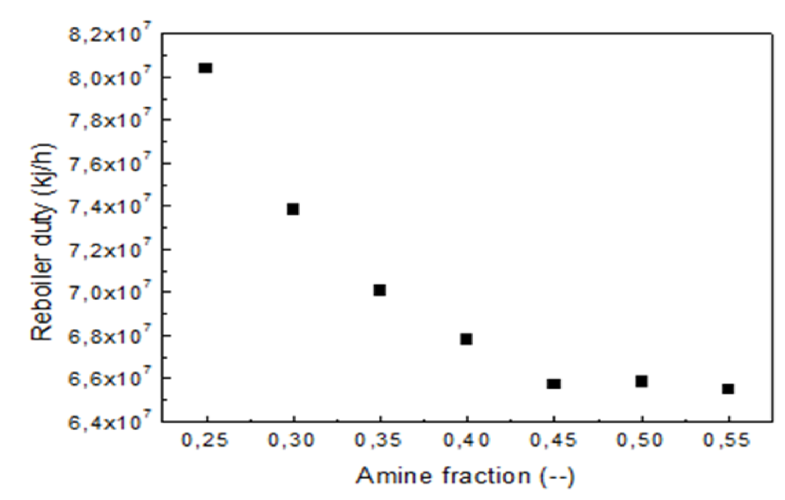


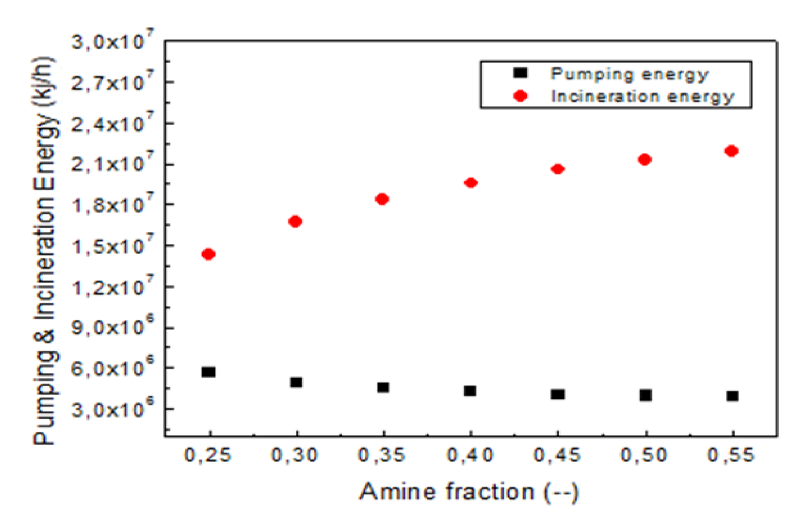


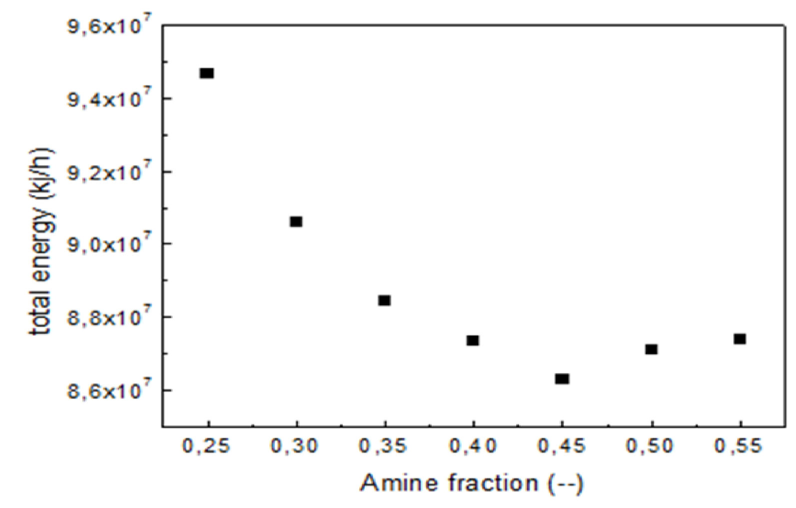


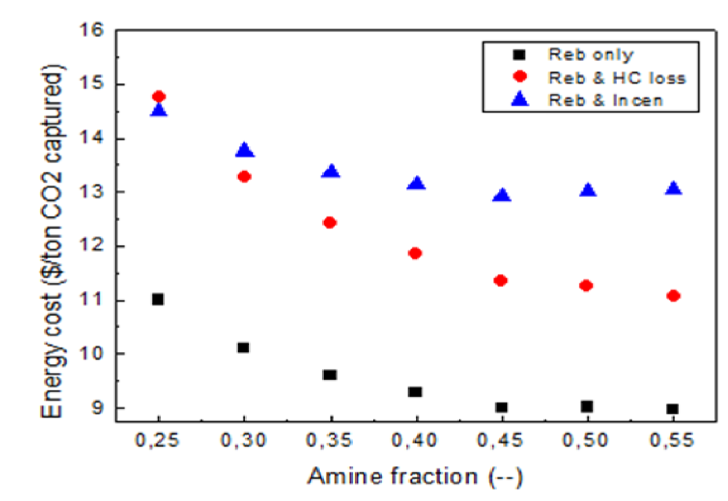


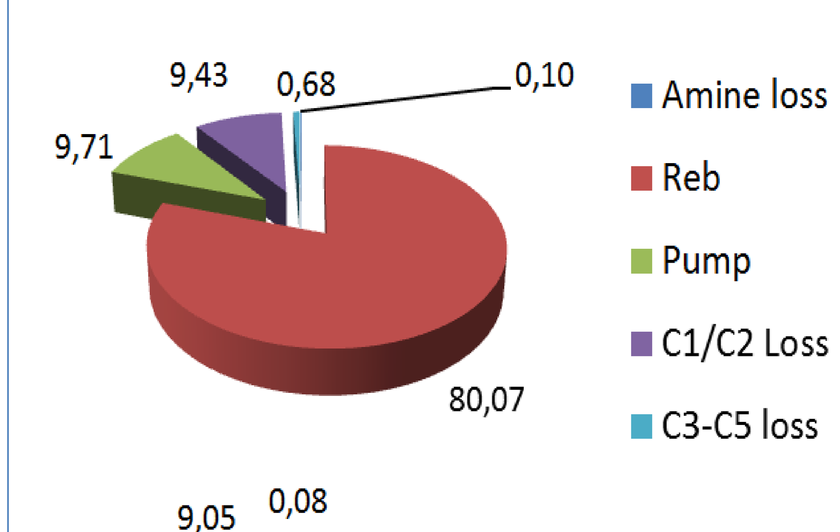


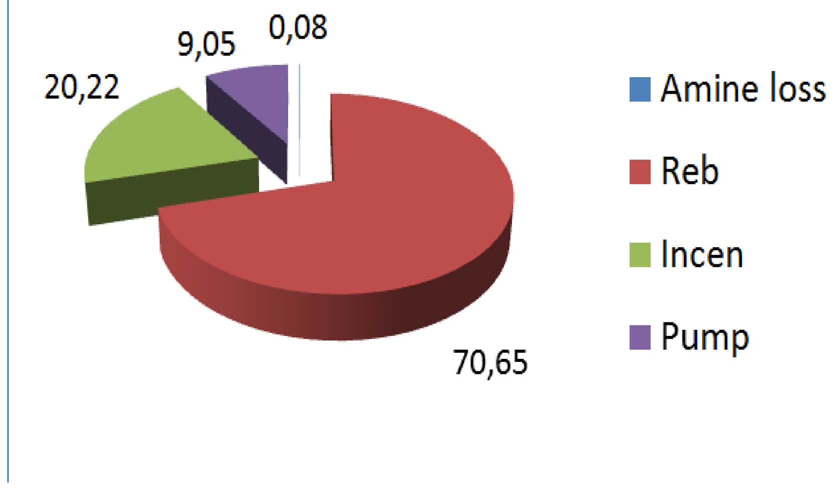












Conclusion

This work has led to the following conclusions:

- The optimal concentration was found to shift from 0.5 for the conventional case where the BTEX emission is not taken into account, to 0.45 if an incineration unit is put in place to control the emissions.
- The minimal energy costs were estimated at 11.25 and 12.93 \$/ton CO_2 captured respectively.
- The presence of BTEX in sour gas units entails an additional energy requirement to the absorption process. Addressing this aspect in the early stages of the design might achieve considerable energy and economic savings.

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