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Experimental study of carbon dioxide capture from synthetic industrial incinerator flue gas with a pilot and laboratory measurements

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Abstract

In this study, we evaluate the sustainability of absorption/desorption technology for CO_2 capture from a targeted unit specialized in industrial waste incineration. The purpose of our study is to fill in this shortage by using a pilot set-up to investigate chemical interactions between synthetic flue gas and solvents and their impacts on process performance. At the same time, we complete our prospection by laboratory experiments to study the influence of specific degradation products on process performance. In this paper, we choose to focus on gas absorption. First, we provide our feedback on experimental methods for overall mass transfer coefficient ($K_G a_W$) measurements for CO_2 absorption. Second, absorption of acidic pollutants, leading to heat stable salts formation, was investigated. Therefore, we used laboratory tools to study the influence of these salts on process performance.

Keywords: Industrial waste incineration ; CO_2 absorption ; mass transfer

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1. Introduction

The European Commission has described climate change as "one of the greatest environmental, social and economic threats facing the planet". Many mechanisms have been suggested for tackling rapid climate change and warming by soaking up carbon dioxide. The power plants are one of the largest CO_2 world sources and several research programs are studying the CO_2 capture form this type of flue gas. Nevertheless, Coussy et al. [1] have shown that industrial sources including the incinerator flue gases are predominant compared to power plants for French emissions.

No industrial references are currently available for carbon dioxide capture from industrial incinerator flue gas composition. In this study, we evaluate the sustainability of absorption/desorption technology for a targeted unit specialized in industrial wastes e.g., oilfield and refinery industry.

Nomenclature

a_{pck}	Packing specific surface area (m^2 / m^3)
a_w	Wetted specific surface area (m^2 / m^3)
C_p	Heat capacity of the solvent (J / (g K))
G	Gas mass flow rate (kg/s)
g	Standard acceleration of gravity (m / s^2)
G_I	Inert gas flow rate (mol / m^2 s)
K_Ga_W	Overall mass transfer coefficient (mol / Pa.s.m^3)
L	Liquid mass flow rate (kg/s)
M_{CO2}	CO_2 molecular weight (g / mol)
M_{slv}	Solvent molecular weight (g / mol)
P^*_{CO2}	CO_2 partial pressure in equilibrium with the solvent (Pa)
P_{CO2}	CO_2 partial pressure (Pa)
P^S_{slv}	Vapor pressure of the solvent (Pa)
T	Temperature (K)
U_{slv}	Solvent superficial velocity (m / s)
V_{pck}	Absorption packing volume (m^3)
x_{slv}	MEA mole fraction in the solvent without CO_2 (-)
Y_{CO2}	CO_2 mole gas ration (-)
Z/Z_T	normalized absorption packing height (-)
α	Solvent CO_2 loading (mol CO_2 / mol MEA)
Δh_{des}	Molar enthalpy of CO_2 desorption (kJ/mol)