

Abstract

This thesis presents the design, construction, and testing of a prototype system intended to capture and convert carbon dioxide (CO_2) emissions from ships into sodium carbonate (Na_2CO_3), using a sodium hydroxide (NaOH) solution as the reactive medium. The goal is to demonstrate a feasible and simplified system inspired by principles of the Solvay process, offering a potential method to reduce maritime CO_2 emissions while generating a commercially valuable product.

The research was conducted in two phases: initial experiments and prototype testing at the Antwerp Maritime Academy (Belgium), followed by further development and refinement at the Universidad Central “Marta Abreu” de Las Villas (Cuba). The Belgian phase focused on proof-of-concept experiments in which CO_2 was bubbled through NaOH solutions, with pH measurements confirming a chemical reaction. In Cuba, a more advanced prototype was developed using real exhaust gases from a generator as the CO_2 source. Experimental variables such as reagent concentration, gas temperature, and flow rate were tested to optimize reaction conditions.

Key challenges included the slow reaction kinetics and limitations in measurement due to sensor range. A comparative test using calcium hydroxide ($\text{Ca}(\text{OH})_2$) showed similar CO_2 reduction but highlighted issues with by-product handling and lower commercial value. NaOH remains the preferred reagent for long-term use due to the higher value of both Na_2CO_3 and NaHCO_3 , and their compatibility with continuous processes.

Final experiments revealed a clear inverse relationship between NaOH concentration and CO_2 levels in the exhaust after treatment. Although full system optimization, including automation and industrial scaling, lies beyond the scope of this bachelor’s thesis, the results provide a solid foundation for future research into onboard CO_2 capture systems for ships and related industries.