# KINETIC ANALYSIS OF CO2 GAS HYDRATES BY THE USE OF THREE DIFFERENT IMPELLERS

**S.N. Longinos[1,3*], D. Longinou[2], F. Gogus[3], M. Parlaktuna[3]**

[1]School of Mining & Geosciences, Nazarbayev University, Astana, Kazakhstan

[2]Economics & Sustainable Development Department, Harokopio University, Athens, Greece

[3]Petroleum & Natural Gas Engineering Department, Middle East Technical University, Ankara, Turkey

(*s.n.longinos@gmail.gr)

## ABSTRACT

Gas hydrates are crystalline compounds formed from water and suitable-sized gas molecules. Depending on which gas molecules are present, crystals are divided into three distinct structures. Structure I (sI), structure II (sII), and structure H (sH) are the three gas hydrate structures. Contingent implementation for $CO_2$ is for gas storage. Hence to apprehend thoroughly the use of $CO_2$ gas hydrates for gas storage or greenhouse gas sequestration, it is crucial to study the kinetics of $CO_2$ hydrate formation. The aim of this work is the kinetic analysis of $CO_2$ gas hydrates by the use of three different flow regimes. This study aims to analyze the $CO_2$ hydrate formation kinetics by using a novel experimental set-up equipped with a continuous stirred tank reactor (CSTR) having a diameter of 15 cm and a height of 31.2 cm [1-3,4]. $CO_2$ gas hydrates were formed at a constant temperature of 5 $^oC$ and pressure between 32.5 and 33 bars. Mixing conditions were changed by using three different types of impellers such as pitched blade turbine-downward trending (PBT-d), Rushton turbine (RT), and marine propeller (MP) with full baffles hence to include three different flow regimes and different numbers of impellers such as single and dual. Kinetic analysis of the six experiments comprises the calculations of rate growth, induction time, driving force, and power consumption. The hydrate formation rate was calculated with an interval of 30 minutes showing that for a single impeller, PBT-d has the highest (RT-d > PBT-d > MP) while for dual impellers the highest rate was obtained by RT (RT > PBT-d > MP). Pitched blade turbines in both single and dual impellers had the highest values in power consumption but they also had the highest amount of water which was converted to hydrates. Induction time for both single and dual impeller experiments was smaller than 2 minutes.

**KEYWORDS:** Gas hydrates, Kinetics, Carbon dioxide

## REFERENCES

[1] Gudmundsson, J.S., Parlaktuna, M. and Khokhar, A.A., 1994. Storage of natural gas as frozen hydrate. SPE Production & Facilities, 9(01), pp.69-73.

[2] Hao, W., Wang, J., Fan, S. and Hao, W., 2008. Evaluation and analysis method for natural gas hydrate storage and transportation processes. Energy conversion and management, 49(10), pp.2546-2553..

[3] Longinos, S.N. and Parlaktuna, M., 2021. Kinetic study of the effect of amino acids on methane (95%)—propane (5%) hydrate formation. Reaction Kinetics, Mechanisms and Catalysis, 133(2), pp.753-763.

[4] Longinos, S.N. and Parlaktuna, M., 2021. Examination of asparagine, aspartic acid and threonine in methane (95%)-propane (5%) gas hydrates as kinetic inhibitors. Reaction Kinetics, Mechanisms and Catalysis, 134(1), pp.87-94.