Summary

CO_2 absorption is done physically and chemically in industrial practice. Chemical absorption using amine solvent is preferable for removal of CO_2 at low partial pressure below 140 mbar. However the regeneration of loaded solvent requires high amount of energy and causes corrosion problem. To circumvent these problems a novel solvent, called lipophilic amine solvent was investigated.

Lipophilic amine, which has limited aqueous solubility, forms biphasic – organic and aqueous phase solutions upon mixing with water. Depending on the composition of the solvent, it allows absorption starting from heterogeneous aqueous solution with high absorption rate and capacity surpassing those of conventional alkanolamines. The amine-rich organic phase disappears during absorption as the result of dissolution of ionic reaction products between CO_2 and amine into aqueous phase. Thus the loaded solvent is literally homogeneous liquid.

During regeneration at elevated temperature, the loaded solution undergoes thermally induced liquid-liquid phase separation. The regenerated amine forms a layer of organic phase at the top of the loaded solution which acts as a solvent to extract the subsequent regenerated amine and drives the equilibrium towards desorption side. With these characteristics, not only high loading approaching 1:1 (CO_2:amine) at 1 atm partial pressure of CO_2 could be achieved but also regeneration at moderate temperature 80°C could be carried out.

In this work, systematic approach had been applied to investigate the lipophilic amine characteristics for CO_2 absorption, starting from identifying suitable lipophilic amine for CO_2 absorption, absorption mechanism, determination of mass transfer properties, reaction kinetics and enthalpy, thermodynamics modelling until optimisation of the solvent composition.
Further investigation had yielded a new concept to regenerate the loaded lipophilic amine solvents by extraction using foreign inert solvent.

In brief, the lipophilic amine solvents provide a new degree of freedom for effective CO_2 absorption with low temperature and low cost regeneration.