CO_2 Absorption Method in the Exhaust Gas by Droplet Impingement/Atomization Control of Absorbent using Surface Texturing (Second Report)

-Possibility of CO2 Absorption Efficiency by Combining Chemical Absorption and Physical Adsorption Methods-

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This research investigates CO_2 absorption and recovery systems for diesel-engine-powered trucks, industrial machinery, agricultural machinery, and generators as a reduction technology in combination with CN fuels. In a previous report, we investigated a chemical absorption method that uses droplet impingement and atomization on a surface-textured plate, and confirmed CO_2 absorption efficiency at room temperature. In this report, in addition to these, we compared different gas temperature/impingement plate temperatures and discovered the possibility of a new CO_2 absorption and capture system that combines a physical adsorption method using a CO_2 adsorbent installed in the place at the last position.

- This study attempted to improve CO_2 absorption and recovery methods by combining chemical absorption and physical adsorption methods for a new absorption and recovery system using CN fuel, as proposed in the previous report, for CO_2 emitted from trucks, industrial machinery, agricultural machinery, and generators equipped with diesel engines. The findings are summarized below:
- The surface tension of the CO_2 absorbent liquid and the surface free energy of the impact wall (unprocessed/microprocessed) were quantified using energy-based methods based on surface reactions and energy calculations of gas/wall temperature and instantaneous volume expansion coefficient, confirming the possibility of promoting atomization.
- Experiments to improve/visualize CO_2 absorption efficiency using chemical absorption showed that heating the impact wall to over 170° C prevented thickening of the impact wall and promoted atomization. Further atomization and evaporation promotion (≒ improved CO_2 absorption efficiency) at the impact wall through optimization of surface microprocessing were suggested.
- In experiments using physical adsorption to adsorb CO_2 from an absorbent solution/slip CO_2, we confirmed improved CO_2 adsorption efficiency at low temperatures, which conflicts with the optimal conditions for the MEA aqueous solution. The results of adsorption efficiency/saturation time at no dehumidification/gas temperature of 80°C revealed the potential of this CO_2 absorption and adsorption method.

Future plans include optimizing the impact plate with surface microfabrication tailored to the spray droplets, improving the ultra-fine atomization and surface reaction of the CO_2 absorbent solution by applying a voltage that maximizes its surface free energy and instantaneous volume expansion coefficient, and developing adsorbents that combine these absorbent solutions with CO_2 absorbent solutions capable of adsorbing slip CO_2 while simultaneously recovering the absorbent solution. This will aim for further improvements in the CO_2 absorption rate and absorbent solution recovery.

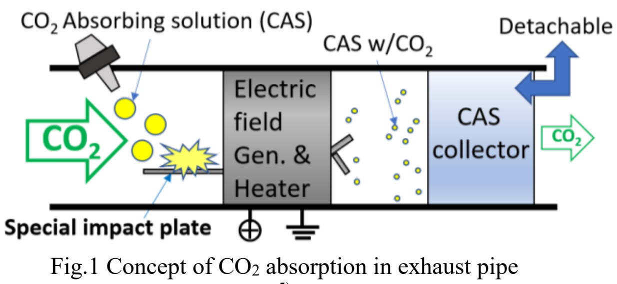

Fig.1 Concept of CO_2 absorption in exhaust pipe 5)

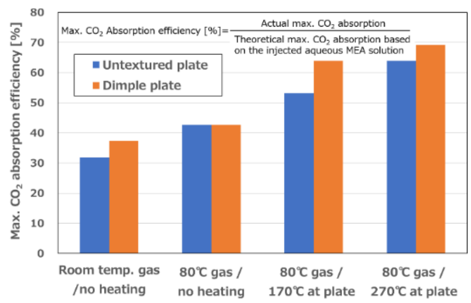

Fig.3 Comparison of untextured and dimple plates by Max. CO_2 absorption efficiency

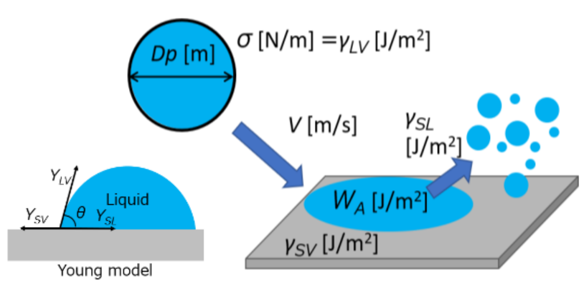

Fig.2 Impingement process of injected droplet for increasing surface area

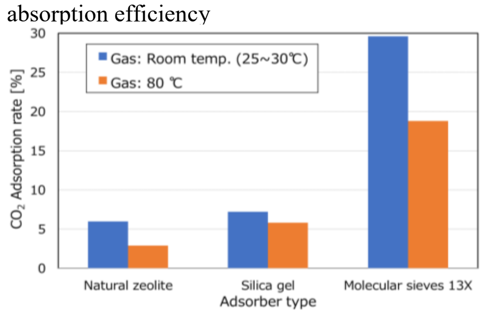

Fig.4 Comparison of average CO_2 adsorption efficiency with different gas temperatures and absorbents (300 sec, no dehumidification)