Combining Global rainbow refractometry and PDA to extract the refractive index value by class of size: Application to CO2 capture by MEA spray.

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Abstract

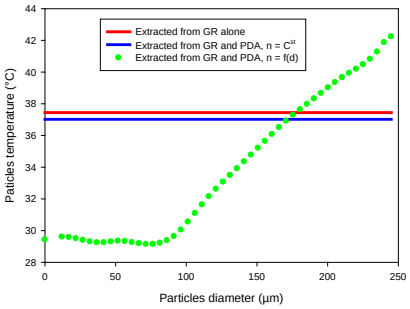
In the study of spray, it is now a challenge to know the geometrical parameters which characterize the spray (droplets velocity and size) as well as thermo-physical properties (temperature and composition). To extract the velocity and size information several techniques can be used but the most popular is the PDA which measure the size and the velocity of individual droplets. To measure the temperature and composition, the rainbow refractometry is attractive as the refractive index value is a function of both of them. Rainbow refractometry exists under two main configurations:

- Standard refractometry where the rainbow issues from one droplet is recorded
- Global refractometry where the collective rainbow created by a large number of droplets is recorded.

The standard rainbow is very sensitive to the droplet shape, and then it is essentially used on lines of monodispersed droplets. Global rainbow has been successfully used in complex spray but gives only access to an average value of the refractive index.

In our presentation to ICLASS 2012, by using the size distribution measured by PDA to process global rainbow signal, the value of the refractive index by class of size will be extracted. The approach will be detailed, and then proved on numerical simulations and experiments on sprays of n-octane.

As an example, the next figure displays the measured behavior of n-octane droplets injected at 46°C in air at 25°C. The spray has been created by an ultrasonic nozzle (SONIC USVC 130 AT) working at 20 kHz. The measurements have been carried out at 75 mm after the injection.



Measured refractive index versus particle diameter.
A) From global rainbow signal alone (the refractive index and size distribution are extracted from the signal). B) From global rainbow signal by using the size distribution measured by PDA but assuming the refractive index constant. C) From global rainbow signal by using the size distribution measured by PDA but assuming that the refractive index is a function of the particle diameter.

Afterward, the dual device will be applied to characterize the thermo-chemical behavior of Monoethanolamine drops (MEA drops) during CO_2 capture in a close tank. During the capture of CO2, the temperature and composition of the droplets change. These modifications affect the value of the refractive index which increases of typically 0.02. Then, the measurement of the refractive index value is a measurement of the chemical extent.

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