EDITORIAL

The foundation of a new journal, *Atomization and Sprays,* reflects the growing activity and interest in this field. The application and utilization of sprays has a very long history. It was known to the earliest civilizations and to primitive man. In modern industrial society, sprays are used so extensively that there is hardly an industry or household that does not use a spray in one form or another. There is a popular conception that making a spray is very easy, i.e., that it can be done simply by pressurizing liquid in a vessel and then forcing it through an orifice. It appeared to be unnecessary to invoke science or engineering analysis.

The scientists who have turned their attention to atomization have found the need to understand the physical structure of liquids under conditions of high rates of shear and interaction with gaseous flows. The breakup of liquids requires breaking of bonds between molecules in the liquid. Shear forces act against the restraining influences of surface tension and viscosity. Shear within the liquid and within gas streams is dependent on the respective velocity gradients in the region of the interface between liquid and gas. Liquid densities are usually two-to-three orders of magnitude greater than gas densities and this affects the relative momenta between the gas and liquid streams. Turbulence within the liquid and gas streams generates fluctuating velocities with components normal to the interface that can produce protuberances and indentations to the liquid gas boundary. In slurries, solid particles provide material surfaces within the liquid that tend to strengthen the intermolecular bonds in the vicinity of solid particles and increase the effective viscosity of the liquid.

Classical theories, based on wave dynamics, have hypothesized that disturbances on the liquid surface grow with progressive increase in wavelength and wave amplitude. Wall roughness, disturbances in the nozzle, and disturbances from the gas stream provide the initial triggering of waves followed by their subsequent growth by wave mechanisms. There is evidence that high relative velocities between gas and liquid can result in massive breakup near the nozzle exit. High momentum forces appear to overcome or reduce the importance of viscosity and surface tension forces.

Swirling flows, generated in liquid and gas streams with atomizers, have been found to be very effective in reducing drop size and in increasing spray angle. Tangential shear is generated in addition to axial shear, whereas centrifugal forces generate radial components of velocity resulting in larger spray angles. Distributions of velocity components and turbulence intensities within injectors require measurement for determination of the exit conditions from the orifice which become the initial conditions for the spray.

In many industrial and other practical applications, heat and mass transfer processes occur within and around the spray. Heat transfer by convection and radiation to and from the spray can result in drop evaporation or vapor condensation and reduction or increase in drop diameter. A vaporized liquid, for example, diffuses into the surrounding gas to form local gas/vapor concentration ratios, which in turn determine local chemical reaction rates. These rates can be important for the overall efficiency of the process.

The full understanding of reacting sprays will require more research into the fundamentals of the physical structure of liquids, hydrodynamics, aerodynamics, particle mechanics, two-phase flow, wave mechanics, turbulence, vaporization, drag, and chemical kinetics. There is a growing awareness of special problems such as pulsations in sprays by hydrodynamic instabilities in liquid sheets and jets. These pulsations can trigger combustion instabilities, which can devastate combustion chambers. Many industrial applications require sprays that are axisymmetric and provide a steady flow of liquid. This requirement is difficult to satisfy since many sprays are unsteady, resulting in cluster formation of drops. Axisymmetry is difficult to achieve because of the unsteady nature of break-off and breakup of liquids.

Aircraft gas turbine engines have the most sophisticated and expensive liquid fuel injection systems because of the extreme importance of maintaining thrust while an aircraft is in flight. Current designs of engines are calling for shorter lengths, reduced weight, and increased thrust. Within the combustion chambers, there will be reduced air flow rates and higher temperatures moving toward stoichiometric combustion. Under these conditions, the importance of the spray will be much greater than in the past. Drop clusters and flame eddies can impinge on combustion chamber walls causing hot-spot damage. Asymmetries in the spray will lead to asymmetries in the exit temperature profiles, which could cause damage to turbine blades. Gas turbine engine companies are increasing their research and efforts in order to obtain more information and better control of fuel sprays. The very advanced knowledge that is being obtained in this combustion field will percolate toward other branches of spray application.

Emissions of pollutants are closely related to spray structure. The size and quantity of particulate emissions are a function of drop size distributions in the spray. Drop trajectories determine location for vapor release and, hence, local gas/vapor ratios, which determine local reaction rates. Formation and emission of nitric oxides can be controlled by avoiding stoichiometric mixture ratios and achieving staged combustion. In the incineration of toxic wastes where 99.999% combustion efficiency is required, the presence of only a few large drops in the spray could result in a shut-down of the incinerator because the emission levels were too high.

In many other industries spray structure also has an important influence on the environment. In agricultural sprays, small drops can result in drift of insecticides, herbicides, and fungicides on neighboring crops. In paint spraying as much as 40% of the paint drops may not succeed in hitting their target. In powder metallurgy, drop size distribution is extremely important for material properties. In coating of materials, drop velocity, diameter, and number density determine the effectiveness, thickness, and strength of the coating. In inhalation therapy, drop size is critical to ensure passage to and deposition on lung surfaces. In coal–water slurry combustion, liquid drop size has been found to be more important than coal particle size for combustion efficiency. In diesel and two-stroke engines, performance and emissions can be improved by changing spray structure. In multi-component fuels and with the use of emulsions, micro-explosions can result in drop shattering with improved performance.

During the last decade, two importance advances have taken place that have elevated atomization to a higher level in science and technology. The development, testing, and proving of laser diagnostics techniques has provided a wealth of detailed information on sprays. At first, the Fraunhofer laser diffraction techniques permitted drop size measurement for sections of sprays. More recently, the phase Doppler particle analyzer (PDPA) provides accurate and reliable simultaneous measurement of drop diameter and velocity of individual droplets passing through a small measurement volume in the spray. Histograms of size and velocity are generated in less than a second, from which size-velocity correlations, drop number density, and liquid flux are computed, displayed on a screen, and printed out. By traversing the probe, a complete description of the important characteristics of spray are determined and mapped out. The influences of dispersion, acceleration, deceleration, drag, and evaporation are shown by changes in profiles as a function of downstream distance. The PDPA has been effectively used with transparent drops (forward-scatter), opaque drops (back-scatter), evaporation, combustion, and liquid metal sprays. Excimer pulsed lasers are used to excite exciplex fluorescence, which together with image processing is providing two-dimensional fuel distribution for liquid and vapor simultaneously. Laser sheet illumination is providing two-dimensional visualization of drop and flow fields. Laser-induced fluorescence is providing detailed instantaneous maps of temperature and individual gas concentration distributions. X-rays are yielding information on very dense sprays.

The other major impact on spray science is the development in computational fluid dynamics. It was only several years ago that two-phase turbulent, reacting, particle, and fluid mechanics systems were beyond the capability of computation lists and computers. The advent of very large high-speed super-computers has changed this situation. The computer codes developed at Los Alamos, General Motors, and several universities have demonstrated abilities to make some predictions about sprays. These still require the specification, usually determined by measurement, of initial conditions for the sprays. Computations have been initiated to predict the details of the liquid breakup process. Some degree of modeling is still required in these computations, and verification by experiment is still necessary. Computations are particularly valuable when showing the influence of changing input parameters. They are also useful when it is difficult or expensive to make measurements. The combined influences of advanced laser diagnostic techniques and computational fluid dynamics have elevated atomization to a level in science and technology where it is attracting the interest of leading scientists and engineers.

A study of the literature on atomization shows early studies from Germany (Sauter, Ohnesorge) and the United States (Castleman, Lee, De Juharz) followed by Japan (Nukiyama–Tanasawa), and England (Fraser, Joyce, Dombrowski). The Japanese were the first to form a national society and to initiate the first international meeting. Today, there are three major institutes of liquid atomization and spray systems (ILASS): they are found in Japan, North and South America, and Europe. Regional meetings are held annually and newsletters are distributed to members. These societies include members from many industries with spray applications as well as university and government research workers. An International Conference on Liquid Atomization and Spray Systems (ICLASS) is held every 3 years. At ICLASS-88, held in Sendai, Japan, an international council was established and a decision was made to found a new journal, *Atomization and Sprays,* which would be the official journal of all three liquid atomization and spray systems societies worldwide. An international editorial board has been appointed.

The editorial policy of *Atomization and Sprays* is to publish high-quality articles including research, application, and review papers. All subjects relevant to sprays, including atomization, atomizer design, spray characterization, heat and mass transfer, reaction kinetics, deposition, etc., for a wide range of industries and applications will be considered. Development of instrumentation, detailed measurements, computations, theoretical analyses, and design are particularly encouraged. The effective communication between industrial engineers and academic and government scientists and engineers, which has been so successful at ILASS and ICLASS meetings, will be reflected in papers published in this journal.

In order to qualify as a respected, high-quality archival journal, *Atomization and Sprays* has adopted a strong editorial policy. Papers that have been published or submitted to other archival journals will not be accepted. Each submitted paper will be refereed by at least two experts in the subject area of the paper. Referees are asked to provide critical comments, corrections, and recommendations for revision. Authors are required to carry out all revisions recommended by the editor and by the referees except where authors wish to rebut or argue against the recommendations. Final decisions on publication are made by the editor. Authors can anticipate that the majority of papers will require revision. The refereeing and revision process adds greatly to the quality and comprehension of published papers. We look forward to submission of papers from any person actively engaged in research or application of sprays.