where K = constant = 1.689 (35.28 in U.S. customary units)
Q_a = air flow rate at atmospheric pressure, m^3/min (ft^3/min)
h = air pressure at the point of discharge expressed in meters of water, m (ft)

The velocity gradient G achieved in pneumatic mixing is obtained by substituting P from Eq. (5–15) into Eq. (5–3).

Mechanical Aerators and Mixers. The principal types of mechanical aerators used for continuous mixing are high-speed surface aerators and slow-speed surface aerators. These devices are discussed in Sec. 5–13, which deals with aeration, and in Chap. 8. Typical power requirements for mixing with mechanical aerators range from 20 to 40 kW/10^3 m^3 (0.75 to 1.50 hp/10^3 ft^3), depending on the type of mixer and the geometry of the tank, lagoon, or basin.

New Developments in Mixing Technology

New analytical tools that are now being applied to the analysis of and design of mixing devices include (1) computational fluid dynamics (CFD), (2) digital particle image velocimetry (DPIV), (3) laser doppler anemometry (LDA), and (4) laser-induced fluorescence (LIF). Computational fluid dynamics is used to model the fluid flow patterns in mixing devices and for scale-up analysis. In respect to fluid flow, both two- and three-dimensional models are now available. Digital particle image velocimetry is used to understand fluid movement in mixing devices. The movement of neutrally buoyant fluorescent particles is photographed using laser beam illumination. Laser doppler anemometry is used to study turbulence and to obtain data on the mean velocity at a given location in the mixing chamber. To evaluate the mean velocity, two laser beams are focused so that the beams intersect. As a particle passes through the intersection of the beams, light is reflected. The wavelength of the reflected light is a function of the particle velocity. Laser-induced fluorescence is used to measure the mixedness of solutions. Dyes such as rhodimine and other materials will fluoresce when struck by laser light of a given wavelength. The scattering of light is measured to assess the degree of mixedness. This technique is being used to study the diffusion and mixing of a substance by assessing the coefficient of variation of the mixed solution and to evaluate blending times (Chemineer, Inc., 2000).

5–5 GRAVITY SEPARATION THEORY

The removal of suspended and colloidal materials from wastewater by gravity separation is one of the most widely used unit operations in wastewater treatment. A summary of gravitational phenomena is presented in Table 5–15. Sedimentation is the term applied to the separation of suspended particles that are heavier than water, by gravitational settling. The terms *sedimentation* and *settling* are used interchangeably. A sedimentation basin may also be referred to as a sedimentation tank, clarifier, settling basin, or settling tank. Accelerated gravity settling involves the removal of particles in suspension by gravity settling in an accelerated flow field. The fundamentals of gravity separation are introduced in this section. The design of facilities for the removal of grit and TSS are considered in Secs. 5–6 and 5–7, respectively.