The gas holdup, the interfacial area and the mass transfer coefficient are the main variables determining the mass transfer rates in gas-liquid contacting device. The methods used to measure these parameters can be classified into two categories: local measurements with physical techniques such as light scattering and reflection techniques, photographic and electrical and electrochemical techniques, and global measurements with chemical techniques. Each method has its advantages and its drawbacks. Let us describe and comment them and give some data with a major emphasis on packed columns and trickle-bed reactors, mechanically agitated reactors, bubble columns, spray towers, jet reactors and plate columns.

1. PHYSICAL TECHNIQUES

These methods are mainly devoted to the measurement of gas holdup, bubble size and specific surface area in gas-liquid dispersions usually encountered in bubble columns, plate columns, mechanically agitated tank and spray towers. Any two of these interfacial parameters are sufficient to define all three since they are interrelated as,

\[
a' = \frac{6a}{d_{SM}} \quad \text{and} \quad d_{SM} = \frac{\sum n_i d_i^3}{\sum n_i d_i^2}
\]

(1)

where \(a\) is the gas holdup and \(d_{SM}\) is the volume-surface mean diameter of Sauter mean diameter. \(d_b\) is the diameter of a single bub-
ble or drop and $n_i$ is the number of bubbles or drops of diameter $d_b$.

1.1 Gas Holdup

The gas holdup $\alpha$ is determined by directly measuring the height of aerated liquid $Z_a$ and that of the clear liquid without aeration, $Z$. The average gas holdup is then evaluated from the relation,

$$\alpha = \frac{Z_a - Z}{Z_a}$$

(2)

This method, most often used for plate columns, vertical bubble column and for mechanically agitated tank (1) is not time consuming but is not very accurate (15–20% accuracy) especially when waves or foams are occuring on the top of the dispersion.

An alternate and more accurate manometric technique has been used by Reith et al. (2) and Burgess and Calderbank (3) where the gas holdup in the dispersion is computed from measurements of the clear liquid height in the dispersion at successive manometer tapings on the side of the froth container. Linek and Mayrhoferova (4) used an electrical technique to measure the dispersion height. The method is based on measuring the surface elevation at certain selected points by means of an electrically conductive tip. The height is determined by the vertical position of the tip at which the sum of contact times equals one half of the measurement period. The accuracy of the measured value of the total surface elevation is claimed by the authors to be ± 0.2 mm, and the gas holdup is then calculated from the total surface elevation and the cross section of the reactor.

The gamma-ray transmission technique previously employed by Vermeulen et al. (5) has been used to determine the point gas holdup in mechanically agitated tank by Calderbank, in plate columns and in packed columns (1). The principles of the application of gamma-ray absorption to holdup measurements depend on the use of the relationship,

$$\ln \frac{I_0}{I} = \lambda \rho s$$

(3)

$I_0/I$ is the intensity ratio between incident beam of radiation ($I_0$) and transmitted beam ($I$), $\lambda$ is the mass absorption coefficient, values of which for most atoms have been published (6), $\rho$ is the density to be measured (simply related to gas holdup) and $s$ is the thickness of the absorbing medium.