CHAPTER 1
INTRODUCTION

1.1 Rationale

Although aerated stirred tanks and bubble columns have been generally used in the fermentation industries, they often encounter serious limitations, for example, high power requirement per unit volume, lacking of uniformity in the circulation of liquid. Recently, airlift contactor devices are being researched as alternative bioreactor types. In particular, airlift contactors (ALCs) are suitable for the processing of shear-sensitive cultures. *(Kawase, 1987)* Inside airlift contactors, the rising gas induces the liquid circulation with patterned flow which is attributed to the difference in local liquid densities. Not only does this reduce the shear that could cause certain damage to microorganisms, but it is also operated with reasonably low energy consumption. Moreover, airlift contactors provide a better-defined flow pattern than bubble columns which allows a proper control of liquid circulation rate. Table 1.1 summarizes advantages and limitations of each reactor.

Recently, there are many applications of airlift contactors, for example, the growth of microorganisms, the cultivation system for single cell algae, and the treatment of waste containing nitrogen compounds from shrimp farm.*(Loataweesup, 2002; Silapakul, 2002)* This indicates the potential for further development of this system for aquacultural industries. For each system, the optimization of the reactor configuration and operation requires that basic understanding of the system be established.

Previously, the research of airlift contactors with air-water systems have been studied extensively regarding the effect of geometrical parameters such as shape of airlift contactor (square, cylinder column and external, internal column), size, area ratio and position of sparger on hydrodynamics and mass transfer. *(Zhao et al., 1994; Pironti et al., 1995; Vorapongsathorn et al., 2001; Krichanavaruk, and Pavasant, 2002a; Wongsuchoto et al., 2003)* Some results were obtained for effect of liquid properties, i.e., viscosity, surface tension and the results showed that the properties of liquid and the additives, i.e., antifoam and surfactant played important roles on rate of hydrodynamics and mass transfer in airlift reactors. *(Al-Masry et al., 1998; Snape, 1992)*

Surprisingly, although a large volume of research on airlift performance and its application have been published, there have been few reports on the study of the effect of saline content on hydrodynamics, and mass transfer in ALCs.

Our previous research involves the applications using sea water and it is imperative at this stage that hydrodynamics and mass transfer in such systems be characterized. Thus, this work concentrates on the experimentally determination of the effect of saline concentration on the hydrodynamics and mass transfer behavior of internal loop airlift contactor. This research is fundamental for the future development of airlift systems for various aquaculture applications.

1.2 Objectives

1.2.1 To investigate the effect of sea water on hydrodynamics and gas-liquid mass transfer performance in internal loop airlift contactors.

1.2.2 To investigate the effect of downcomer/riser cross sectional area ratio on hydrodynamics and gas-liquid mass transfer in internal loop airlift contactors with sea water as liquid phase.

1.2.3 To investigate the effect of gas velocities on hydrodynamics and gas-liquid mass transfer in internal loop airlift contactors with sea water as liquid phase.

1.3 Expected benefits

Potential benefits from this work include:

1.3.1 The knowledge on the behavior of airlift contactors with sea water as liquid phase.

1.3.2 Fundamentals for the operation of marine applications and scale-up of airlift systems.

1.4 Working scopes

1.4.1 The investigations are restricted to bench-scale internal loop ALCs with dimensions as shown in Table 3.1

1.4.2 The investigations are performed in an air-water and air-sea water systems with saline concentration of 15, 30, 45 ppt.

1.4.3 The investigations of mass transfer characteristics are restricted to oxygen transfer only, and in all investigations, the ALC systems are subject to the following assumptions:

- Constant gas composition.
- Isothermal system with negligible effect of the dynamics of the dissolved oxygen electrode.

1.4.4 In the investigations of hydrodynamic behavior, gas density is considered negligible compared to the density of the liquid.

Table 1.1 Comparison of gas-liquid contacting devices

Type of gas-liquid contacting devices	Advantages	Limitations
1. Stirred tank reactor (STR)	1) Well defined performance and scale up 2) High mass transfer 3) Easy control of the gas dispersion and medium mixing by stirrer speed 4) Efficient gas dispersions by stirrers 5) Suitable for highly viscous media	1) High power consumption per unit volume of liquid 2) Difficulty in avoiding contamination due to seal of shaft 3) High shear stress and lack of uniformity in the fields of shear 4) Low oxygen transfer efficiency with respect to power input 5) Production of high degree of heat
2. Bubble column (BC)	1) Simplicity of design and construction: no moving mechanical part needed for agitation 2) Ease of maintenance 3) Eliminating the danger of contamination through seals 4) Low power consumption 5) Low capital cost	1) Low mass transfer efficiency in gas-liquid system 2) Lack of uniformity of liquid flow path

Type of gas-liquid contacting devices	Advantages	Limitations
3. Airlift contactor (ALC)	1) Simplicity of design and construction: no moving mechanical part needed for agitation 2) Ease of maintenance 3) Eliminating the danger of contamination through seals 4) Low power consumption 5) Low capital cost 6) Low shear stress 7) Better defined flow pattern 8) Controllable liquid circulation rate	1) Low mass transfer efficiency in gas-liquid system

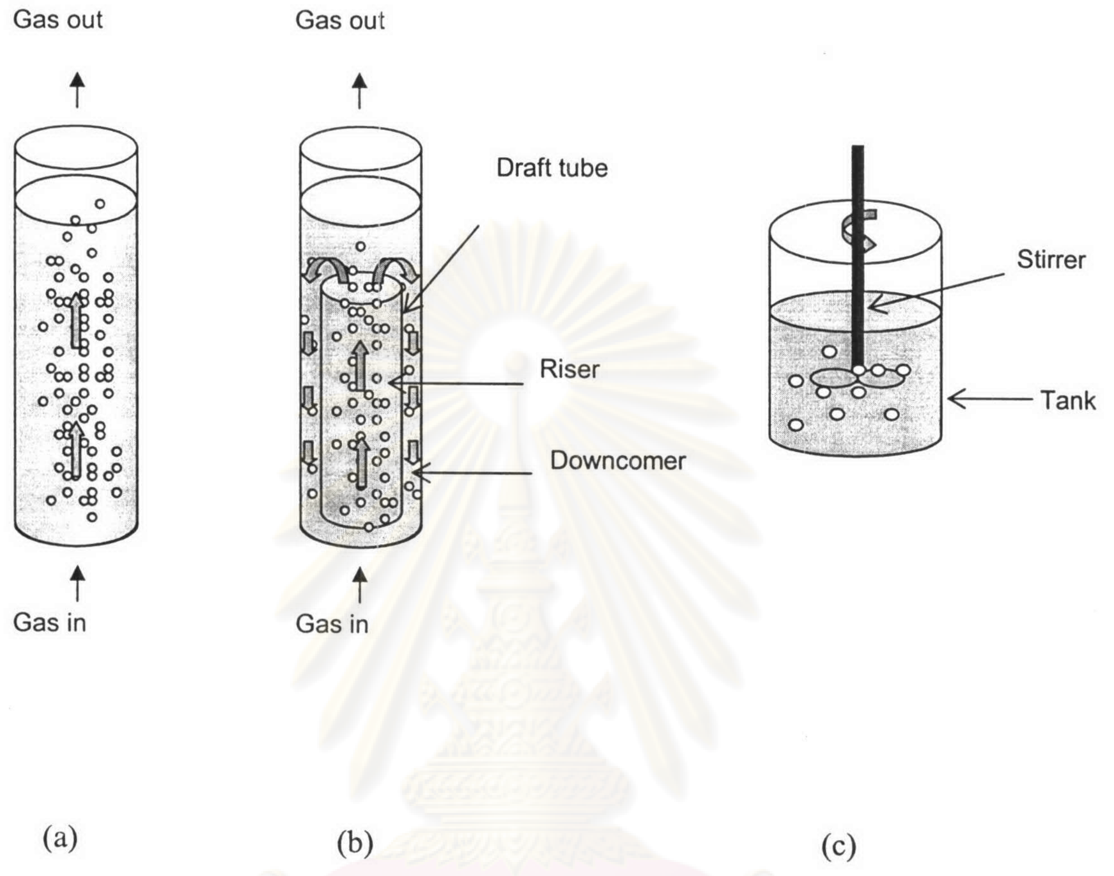

Figure 1.1 Schematic of reactors: (a) Bubble column (BC), (b) Airlift contactor (ALC), (c) Stirred tank reactor (STR)