A SIMPLE LABORATORY AIRLIFT FERMENTOR

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Summary. A glass airlift fermentor for laboratory use has been constructed and tested. Its design is based on hydrodynamic requirements. Because of its simple construction it can be easily dismantled and reassembled.

Introduction
Airlift reactors are known to be used for various gas-liquid reactions; they have recently gained interest also as fermentors. They can be designed in two different ways. Either the up-flowing gassed liquid and the down-flowing liquid are separated by a so-called draft tube inside the reactor, or the two streams flow in two separate pipes connected at top and bottom. The first construction is called internal loop, the second one, external loop. Both types of airlift reactors have been investigated as to hydrodynamic behaviour and other design data (Bohner and Blenke, 1972, and Blenke, 1979, for the internal loop; Lin et al., 1976, and Onken and Weiland, 1980, for the external loop).

Reactor design
In spite of the fact that airlift reactors are employed in several fermentation processes on an industrial scale, they are scarcely used as laboratory fermentors with a volume up to 20 l. This is rather surprising, because small-scale airlift fermentors also have all the advantages of simplicity in construction: they are easy to make, reliable in use and low in cost.
Laboratory airlift-fermentors on the internal loop principle which are presently available commercially, are not at all satisfactory. They are in fact stirred fermentors which have been adapted to airlift operation. This means that their dimensions are not optimal for this purpose; e.g. for the fermentors available from Giovanola, Monthey CH (b 10, used by Vogelmann et al., 1978), and from Braun, Melsungen BRD (similar in construction to the fermentor used by Wahl, 1977) the ratio of height to diameter is only 1,7 and 2,7 resp., whereas it can be concluded from Bohner and Blenke, 1972, that values of 5 and more are necessary to ensure efficient mixing.

In aerobic fermentations, good oxygen transfer to the broth and to the suspended microorganisms is necessary. This prerequisite can be satisfied by airlift reactors with favourable mixing behaviour. On the basis of the experimental results, we constructed a simple laboratory airlift fermentor from glass (Fig. 1), which was successfully tested with various cultures. It consists of standard glass elements, meaning cost of construction is low. Besides the hydrodynamic requirements already mentioned, several other demands had to be considered. Firstly its height had to be limited so that it can be sterilized in a laboratory autoclave. Secondly it should be easy to operate. This, together with the demands for non-corrosiveness and low manufacturing cost, induced us to use glass as the construction material for the fermentor.

With these differing requirements the resulting fermentor had a working volume of 4,0 l. In its design, dimensions have been optimized in order to minimize pressure drops at a height to diameter ratio large enough to yield effective mixing via sufficiently high liquid velocities in the loop. At the top the diameter is widened to allow for degassing and reduction of foaming. The middle part of the reactor is provided with a jacket for cooling or heating. Aeration of the airlift can be performed in various ways by means of exchangeable bottom parts equipped with different gassing devices (porous or