Introduction

In the experiments of cell culturing and component analysis using microfluidic chips, infusion or circulation of liquid such as culture medias and reagents is essential and pumps are used in a lot of cases. It is often difficult to set up desired flow level due to the characteristics of the pump types and in that context, there is a need for such micro flow meter that has practical accuracy and, above all, that is disposable in order to avoid contamination in using culture medias and reagents. We have developed the flow measuring device which is consisted of measuring part and fluidic path separately, by comprising liquid path on a microfluidic chip which is separated from the measuring device.

Development of sensor which detects the difference of refraction indexes.

In the left figure, a light goes on at entry angle (i) towards the boundary of (n1) and (n2). In the flow meter we developed, (n1) is acrylic resin which is the material of flow meter chip and (n2) is water or air which flows in the path.

Considering the refraction index of acrylic, water and air as 1.49, 1.33 and 1 respectively, the smallest angle (critical angle) at which total reflection occurs at the boundary can be calculated by the formula \[ \text{arcsin} \left( \frac{n_2}{n_1} \right) \] of which results are as follows:

- Acrylic → Air : 42.16 degree
- Acrylic → Water : 63.46 degree

From the above difference of critical angles, we can arrange following conditions by setting up appropriate entry angle of light.

- In the presence of liquid in the path, a light passes through the boundary with the refraction angle of the liquid.
- In the presence of air in the path, a light makes total reflection.

Using above results, the detection of liquid movement in the path filled with air became possible.

Detection principle of using refraction characteristics and its development onto microfluidic chip

Diagram showing detection principle by total refraction and refraction index. Detect air layer and liquid layer by using refraction characteristics.

Explanation of performance for newly developed flow meter RE-FM10.

Using newly developed sensor, measurement is done by filling air in the liquid filled path and make boundary of liquid and air.

Operating sequence:

1. The path for flow measurement shall be closed and liquid flow shall be detoured.
2. Air shall be filled into the path for flow measurement and the liquid is evacuated.
3. Valve is switched to fill the liquid to be measured into the path for flow measurement and then, the flow volume can be calculated by the elapsed time (t) of boundary of air and liquid to pass between A point and B point.

Image and specification of RE-FM10

Aquatech Co., Ltd.

http://www.ringpump-aquatech.co.jp/
2-6-31, Inadashimacho, Higashi-Osaka City, Osaka 577-0004, Japan
Phone: 81-6-6748-2820 Fax: 81-6-6748-2821

Specification of the flow meter chip sample

- Size of flow path for measuring : W 0.8 x H 1.0 x L 25 mm
- Volume of flow path for measuring : 20 mm³ (20 μL)