outlet port of the fine channel without causing substantial mutual contamination while said at least two kinds of fluid, flowing as laminar flows, contact with each other at the fluid boundary which can be kept stably by the partition walls arranged with intervals and capable of stirring a fluid containing a raw material for reaction and/or a reaction product, or capable of proceeding a rapid chemical reaction, solvent extraction or separation by stirring a fine particle-containing fluid in the fine channel of the fine channel device, and a chemically operating method using such fine channel device.

Example 10

[0172] In Example 10, a fine channel device as shown in **FIG. 22**(*b*) was prepared. The fine channel device used had a fine channel **19** having two Y-letter like branch portions, one of which was branched to two channel portions communicated with an inlet port A **28** and an inlet port B **29** and the other of which was branched to two fine channel portions communicated with an outlet port C **30** and an outlet port D **31**. The width of the fine channel was 100 μm, the depth was 25 μm and the length was 400 mm. The inner structure of the fine channel was such that as shown in **FIG. 22**(*a*) partition walls **22** having the maximum length of 50 μm and a height of 25 μm were formed intermittently in a flowing direction of fluid with intervals of 50 μm in a substantially central portion of the fine channel.

[0173] The fine channel was formed in a Pyrex (trademark) glass substrate **32** having a size of 70 mm×38 mm×1 mm (thick) according to conventional photolithographic and wet etching techniques, and a cover member **34** comprising a Pyrex (trademark) glass substrate having the same size as the fine channel substrate in which penetration orifices **35** having a diameter of 0.6 mm were formed by mechanical processing means at positions corresponding to the inlet ports A **28**, B **29** and outlet ports C **30**, D **31**, was prepared. The cover member was thermally bonded on the fine channel substrate to seal hermetically the fine channel. Thus, the fine channel device was prepared.

[0174] By using such fine channel device, a decomposition reaction of p-chlorophenol by laccase having a function of decomposing environmental pollutants, as one of the catalytic reactions, was carried out. A succinic acid buffer solution (pH: 5.0) containing 30 μM laccase, as an aqueous phase, was supplied at a flow rate of 5 μL/min from the inlet port A, and an isooctane solution containing 100 μM p-chlorophenol, as an organic phase, was supplied at a flow rate of 5 μL/min from the inlet port B. Amounts of p-chlorophenol in both phases before and after the reaction were measured with a liquid chromatography.

[0175] As a result, it was found that fluid separation could be achieved at the branch portion at a side of the fluid outlet port; the aqueous solution could be discharged from the outlet port C and the organic phase could be discharged from the outlet port D without causing substantially mutual contamination. Further, it took about 8 sec. until the decomposition of p-chlorophenol reached 80%. Further, when the degree of enzyme activity was measured by a phenolaminoantipyrine method (P-4AA method), the enzyme activity could maintain 90% or more even though such reaction was repeated 10 times.

Comparative Example 2

[0176] Into a sample bottle of 50 ml, 15 ml of a succinic acid buffer solution (pH: 5.0) containing 30 μM laccase, as an aqueous phase, and 15 ml of an isooctane solution containing 100 μM p-chlorophenol, as an organic phase were charged followed by stirring severely with a magnetic stirrer. Amounts of p-chlorophenol in both phases before and after the reaction were measured. As a result, it was found that it took about 30 min. until the decomposition of p-chlorophenol reached 80%. Further, when the degree of enzyme activity was measured by a phenolaminoantipyrine method (P-4AA method), the enzyme activity decreased to about 80% after a lapse of about 30 min, and degreased to about 5% after a lapse of about 90 min.

[0177] From result of Examples 10 and Comparative Example 2, it is understood that the present invention provides a rapid catalytic reaction, without requiring mechanically stirring, due to a large interfacial surface area and a short diffusion distance of molecules as a feature of the fine space, in the reaction wherein at least two kinds of fluid, flowing as laminar flows, contact with each other at the fluid boundary which can be kept stably by the partition walls arranged with intervals, and the recovery of enzyme for reuse without losing the enzyme activity due to a physical action such as mechanically stirring or a catalyst being suspended in an organic phase.

[0178] According to the present invention, the following advantages can be obtained.

[0179] The fine channel device of the present invention comprises a fine channel provided with at least two inlet ports for feeding fluid, inlet channels communicated with the inlet ports, a confluent portion communicated with the inlet channels, a branch portion communicated with the fine channel, from which at least two outlet channels are branched to feed predetermined amounts of fluid, and outlet ports communicated with the outlet channels, wherein the fine channel is provided with a plurality of partition walls arranged along the boundary formed by at least two kinds of fluid fed from the inlet ports so as not to cause mutual contamination of fluid. Accordingly, a change of the position of the fluid boundary due to a change of the flow rate per unit time which is caused by a liquid supply pump can be suppressed; a wraparound phenomenon of fluid due to a difference of affinity between the inner wall of the fine channel and fluid to be supplied can be prevented, and at least two kinds of fluid can be discharged through respective fluid outlet ports of the fine channel without causing mutually contamination.

[0180] Further, when flow rates of all kinds of fluid to be supplied to the fine channel are the same, and distances between adjacent partition walls arranged in a flowing direction of fluid are fixed to be a distance of a predetermined value or less (i.e., about 800 μm or less, preferably, about 400 μm or less), adjacent flows of fluid having the same viscosity can be discharged from outlet ports through the fine channel at a predetermined range of flow rate without causing the mutual contamination of fluid.

[0181] In a case that the ratio of the product of the viscosity coefficient and the flow rate of fluid having a relatively high affinity to the wall surface of the fine channel is different from the ratio of the product of the viscosity