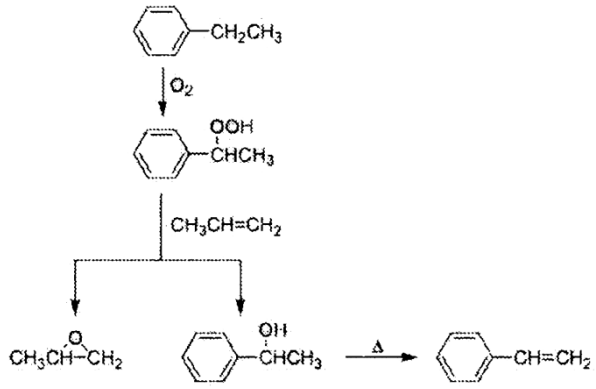
~~DEVICE AND~~ METHOD FOR PREPARING ETHYLBENZENE HYDROPEROXIDE BY CONTACTING ETHYLBENZENE WITH OXYGEN CONTAINING GAS~~OXIDIZING ORGANIC SUBSTANCE~~

TECHNICAL FIELD

The present disclosure relates to a method for oxidizing an organic substance such as ethylbenzene or cumene or cyclohexane and, in particular, to a method for preparing ethylbenzene hydroperoxide by contacting and reacting ethylbenzene with an oxygen-containing gas.

BACKGROUND

The coproduction of propylene oxide (PO) and styrene (SM) (i.e., PO/SM method) is one of the best processes for producing PO at present. The PO/SM method mainly includes three steps: (1) contacting and oxidizing ethylbenzene with air to produce ethylbenzene hydroperoxide (EBHP); (2) oxidizing propylene by EBHP into propylene oxide, where EBHP is reduced to phenyl methyl alcohol; (3) dehydrating phenyl methyl alcohol to produce styrene. The reaction route may be represented by Formula (1):



The oxidation of ethylbenzene to ethylbenzene hydroperoxide is the key to the PO/SM method. While ethylbenzene is oxidized to EBHP, EBHP is further subjected to a series of side reactions, resulting in a decrease in the selectivity of EBHP. Therefore, the single pass conversion of ethylbenzene in industrial processes is generally lower than 10%.

At present, an ethylbenzene oxidation reactor used in industry is generally a horizontal bubble column reactor. U.S. Pat. Nos. US4066706 and US4262143 have disclosed a horizontal reactor. The reactor is divided into 5 to 10 zones by baffles, an ethylbenzene reaction liquid enters the reactor from one side and is discharged from the other side after passing through these zones in sequence, and air is bubbled from the bottom into the corresponding zones and is discharged

What is claimed is:

1. A method for preparing ethylbenzene hydroperoxide by contacting ethylbenzene with an oxygen-containing gas~~A device for oxidizing an organic substance~~, wherein a device in the method comprising a vertical bubble reactor and a horizontal bubble reactor, wherein the horizontal bubble reactor is connected to a reaction product outlet of the vertical bubble reactor and internally provided with a plurality of reaction compartments arranged along the axial direction of the horizontal bubble reactor, and a liquid phase channel is provided between adjacent reaction compartments~~.~~;

wherein the vertical bubble reactor comprises a liquid inlet and a gas inlet arranged at the lower portion of the vertical bubble reactor and a liquid outlet and a gas outlet arranged at the upper portion of the vertical bubble reactor; and the vertical bubble reactor is internally provided with a flow guide cylinder along a longitudinal direction, wherein the flow guide cylinder allows a fluid to pass through;

wherein the vertical bubble reactor is further internally provided with a first gas distributor connected to the gas inlet, wherein the first gas distributor has distribution holes that are distributed inside the flow guide cylinder or an annular gap between the flow guide cylinder and the inner wall of the vertical bubble reactor;

wherein the concentration of ethylbenzene hydroperoxide at the outlet of the vertical bubble reactor is controlled at 0.5%-1.5%.

~~2. The device according to claim 1, wherein the vertical bubble reactor comprises a liquid inlet and a gas inlet arranged at the lower portion of the vertical bubble reactor and a liquid outlet and a gas outlet arranged at the upper portion of the vertical bubble reactor; and the vertical bubble reactor is internally provided with a flow guide cylinder along a longitudinal direction, wherein the flow guide cylinder allows a fluid to pass through.~~

~~3~~2. The method~~device~~ according to claim ~~2~~1, wherein the height of the flow guide cylinder is 10-90%, preferably 20-80%, more preferably 40-70% of the height of the vertical bubble reactor; and the cross-sectional area of the flow guide cylinder is 5-60%, preferably 10-25% of the cross-sectional area of the vertical bubble reactor.

~~4. The device according to claim 2 or 3, wherein the vertical bubble reactor is further internally provided with a first gas distributor connected to the gas inlet, wherein the first gas distributor has distribution holes that are distributed inside the flow guide cylinder or an annular gap between the flow guide cylinder and the inner wall of the vertical bubble reactor.~~

~~5~~3. The method~~device~~ according to any one of claims ~~2~~ 1 to ~~4~~2, wherein the inner wall of the vertical bubble reactor is provided with a vertical reactor outlet overflow weir located at the liquid outlet, and the upper end of the flow guide cylinder is lower than the upper end of the vertical reactor outlet overflow weir.

~~6~~4. The method~~device~~ according to any one of claims ~~2~~ 1 to ~~5~~3, wherein the horizontal bubble reactor is provided with a reaction liquid inlet and a reaction liquid outlet at two ends in the axial direction, respectively, and each of the plurality of reaction compartments is provided with a reaction gas inlet at the lower end, a reaction gas outlet at the upper end, and a second gas distributor connected to the reaction gas inlet inside; and

the plurality of reaction compartments are separated by partition plates arranged inside the horizontal bubble reactor, and the liquid phase channel is a liquid phase channel disposed on the partition plates, preferably a liquid phase channel disposed at the bottom of the partition plates.

~~7~~5. The method~~device~~ according to claim ~~6~~4, wherein each of the plurality of reaction compartments is internally provided with at least one vertical baffle arranged along a liquid flow direction in a normal operation, and the bottom of the baffle is not higher than the second gas distributor of the reaction compartment where the baffle is located, preferably, the baffle is provided with a plurality of openings, the bottom of the baffle has a distance not smaller than 50 mm from the inner wall of the horizontal bubble reactor, and the height of the baffle is 10-70%, more preferably 20-50% of the height of the horizontal bubble reactor.

~~8~~6. The method~~device~~ according to claim ~~7~~5, wherein the side surface of the baffle is provided with a plurality of flow guide plates inclined downwards, preferably the ratio of the sum of areas of the plurality of flow guide plates to the area of the baffle is 0.01-0.15, more preferably 0.05-0.1; more preferably, each of the plurality of flow guide plates is tongue-shaped.

~~9~~7. The method~~device~~ according to any one of claims 1 to ~~8~~6, wherein the heights of the gas phase spaces in each of the vertical bubble reactor and the horizontal bubble reactor are not lower than 0.5 m.

~~10. A method for oxidizing an organic substance, comprising using the device according to any one of claims 1 to 9 for preparing ethylbenzene hydroperoxide by contacting ethylbenzene with an oxygen-containing gas.~~

~~11~~8. The method according to any one of claims 1 to7~~claim 10~~, wherein the concentration of ethylbenzene hydroperoxide at the outlet of the vertical bubble reactor is controlled at ~~0.5%-1.5%, preferably~~ 1%-1.5%.

~~12~~9. The method according to any one of claims 1 to 8~~claim 10 or 11~~, wherein in a case where ethylbenzene hydroperoxide with a concentration of C is obtained at the reaction liquid outlet of the horizontal bubble reactor comprising N reaction compartments, the concentration of ethylbenzene hydroperoxide at the outlet of the vertical bubble reactor is controlled at 80%-95% of $\frac{C}{N+1}$.