Claims

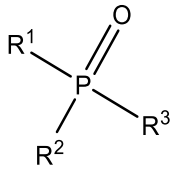
1. A method of extracting at least one selected from carbonic acid, aliphatic acid, aliphatic acid ester and aliphatic alcohol from an aqueous medium, the method comprising the steps:
   (a) contacting the carbonic acid, aliphatic acid, aliphatic acid ester and/or aliphatic alcohol in the aqueous medium with an extracting medium containing at least one alkyl-phosphine oxide for a time sufficient to extract the carbonic acid, aliphatic acid, aliphatic acid ester and/or aliphatic alcohol from the aqueous medium into the extracting medium, and
   (b) separating the extracting medium with the extracted carbonic acid, aliphatic acid, aliphatic acid ester and/or aliphatic alcohol from the aqueous medium,
   characterized in that the at least one alkyl-phosphine oxide contains at least two different alkyl radicals per alkyl-phosphine oxide molecule and the aqueous medium in (a) contains a living microorganism producing the carbonic acid, aliphatic acid, aliphatic acid ester and/or aliphatic alcohol and wherein the pH of the aqueous medium during step a) is from 5.0 to 9.0 and the microorganisms is cultured at a
   temperature ranging from about 20° C to about 80° C.

2. The method according to claim 1, characterized in that the aliphatic acid, is selected from monofunctional aliphatic acids and that in the aliphatic acid ester the aliphatic acid radical is selected from monofunctional aliphatic acid radicals and that the aliphatic alcohol is selected from monohydric alcohols.

3. The method according to claim 1 or 2, characterized in that the aliphatic acid, is selected from monofunctional alkanoic acids and that in the aliphatic acid ester the aliphatic acid radical is selected from monofunctional alkanoic acid radicals and that the aliphatic alcohol is selected from monohydric alkanoic alcohols, wherein preferably the alkanoic chains are unbranched.

4. The method according to any one of the preceding claims, characterized in that the aliphatic acid, aliphatic acid ester and/or aliphatic alcohol contains 4 to 18, preferably 4 to 12, even more preferably 6 to 8 carbon atoms, even more preferred the aliphatic acid, aliphatic acid ester and/or aliphatic alcohol is selected from the group butanol, pentanol, hexanol, butanoic acid, pentanoic acid, hexanoic acid and the methyl- and ethyl-esters of these three acids.

5. The method according to any one of the preceding claims, characterized in that the alkyl-phosphine oxide is selected from an alkyl-phosphine oxide of general formula 1



general formula 1

with R^1, R^2 and R^3 selected from alkyl radicals containing 4 to 18, preferably 6 to 12, carbon atoms,

with the proviso, that at least two of R^1, R^2 and R^3 differ from each other.

6. The method according to any one of the preceding claims, characterized in that the alkyl-phosphine oxide is selected from an alkyl-phosphine oxide of general formula 1 with R^1, R^2 and R^3 selected from alkyl radicals containing 8 to 10 carbon atoms, preferably with the proviso, that referring to all alkyl-phosphine oxide of general formula 1 contained in the extracting medium, the molar ratio of all alkyl radicals containing 8 and 10 carbon atoms is in the range of from 1.0:2.0 to 2.0:1.0, preferably from 1.0:1.5 to 1.5:1.0, even more preferably from 1.0:1.2 to 1.2:1.0.

7. The method according to any one of the preceding claims, characterized in that in the extracting medium the at least one alkyl-phosphine oxide accounts for at least 50 wt.-%, preferably at least 80 wt.-%, even more preferably at least 90 wt.-%, the most preferably at least 97 wt.-%, of the total extracting medium

8. The method according to any one of the preceding claims, characterized in that the extracting medium further contains at least one alkane comprising at least 12 carbon atoms, preferably 12 to 18 carbon atoms, even more preferably selected from the group consisting of tetradecane, pentadecane, hexadecane, heptadecane and octadecane.

9. The method according to claim 8, characterized in that the weight ratio of alkyl-phosphine oxide to alkane contained in the extracting medium is between 1:2 to 50:1.

10. The method according to any one of the preceding claims, characterized in that the extracting medium further contains at least one aromatic solvent.

11. The method according to claim 10, wherein the aromatic solvent is selected from the group consisting of a partially hydrogenated terphenyl and a dibenzyltoluol.

12. The method according to any one of the preceding claims, characterized in that the pH of the aqueous medium during step a) is from 5.8 to 8.0, and particularly preferably from 6.5 to 7.5.