Claims

[Claim 1]

A method for producing a diol having a cyclic acetal skeleton, comprising:

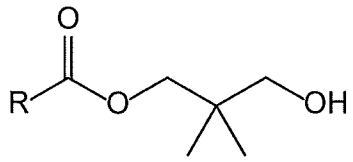
first acetalization reaction step of subjecting a raw material hydroxypivalaldehyde and at least pentaerythritol and/or trimethylolpropane to an acetalization reaction under an acid catalyst to obtain the diol having the cyclic acetal skeleton:

a separation/purification step of separating the diol having the cyclic acetal skeleton precipitated in a reaction solution to obtain a reaction mother liquor; and

second acetalization reaction step of subjecting a raw material hydroxypivalaldehyde and at least pentaerythritol and/or trimethylolpropane to an acetalization reaction under the reaction mother liquor and an acid catalyst to obtain the diol having the cyclic acetal skeleton;

wherein the separation/purification step and the second acetalization reaction step are conducted more than once,

the raw material hydroxypivalaldehyde comprises at least one impurity selected from the group consisting of formaldehyde, neopentyl glycol, an ester compound having a neopentyl glycol skeleton represented by following formula (III), and isobutyraldehyde,



(Ⅲ)

wherein R represents a hydrocarbon group having 1 to 4 carbon atoms, a hydrocarbon group having a hydroxy group and having 1 to 4 carbon atoms, or a hydrogen atom, and

when the impurity is comprised,

a content of the formaldehyde is 0.80% by mass or less based on 100% by mass of the raw material hydroxypivalaldehyde;

a total molar concentration of the neopentyl glycol and/or the ester compound having a neopentyl glycol skeleton is 0.100 mol/kg or less based on a total amount of the raw material hydroxypivalaldehyde; and

a content of the isobutyraldehyde is 0.05% by mass or less based on 100% by mass of the raw material hydroxypivalaldehyde.

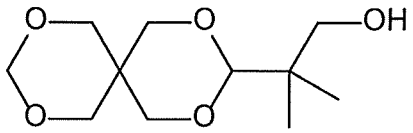
[Claim 2]

The method for producing the diol having the cyclic acetal skeleton according to claim 1, wherein

in terms of an area fractional concentration based on a sum of components having a relative retention time of 1.45 or less on an assumption that a relative retention time of the diol having the cyclic acetal

skeleton in gas chromatography analysis performed under prescribed conditions is 1.00,

the diol having the cyclic acetal skeleton obtained by the acetalization reaction contains, as an impurity, a dioxane triol monoformal represented by following formula (I) in an amount of 0.04 area% or less:



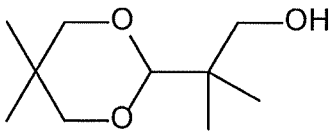
(I)

[Claim 3]

The method for producing the diol having the cyclic acetal skeleton according to claim 1 or 2, wherein

in terms of an area fractional concentration based on a sum of components having a relative retention time of 1.45 or less on the assumption that a relative retention time of the diol having the cyclic acetal skeleton in gas chromatography analysis performed under prescribed conditions is 1.00,

the diol having the cyclic acetal skeleton obtained by the acetalization reaction comprises, as an impurity, a hydroxypivalaldehyde neopentyl glycol acetal represented by following formula (II) in an amount of 0.19 area% or less:



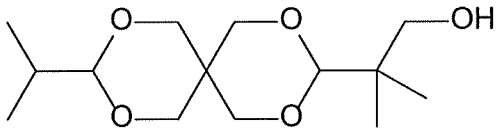
(II)

[Claim 4]

The method for producing the diol having the cyclic acetal skeleton according to any one of claims 1 to 3, wherein

in terms of an area fractional concentration based on a sum of components having a relative retention time of 1.45 or less on the assumption that a relative retention time of the diol having the cyclic acetal skeleton in gas chromatography analysis performed under prescribed conditions is 1.00,

the diol having the cyclic acetal skeleton obtained by the acetalization reaction comprises, as an impurity, a spiro monoalcohol represented by following formula (IV) in an amount of 0.15 area% or less:

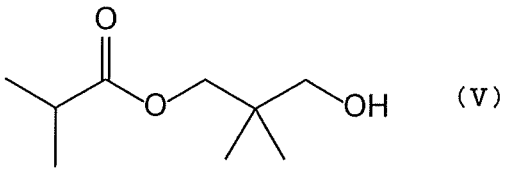


(IV)

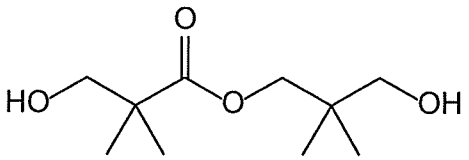
[Claim 5]

The method for producing the diol having the cyclic acetal skeleton according to any one of claims 1 to 4,

wherein the ester compound represented by the formula (III) comprises an isobutyric acid neopentyl glycol monoester represented by following formula (V) and/or a hydroxypivalic acid neopentyl glycol monoester represented by following formula (VI):



(V)



(VI)

[Claim 6]

The method for producing the diol having the cyclic acetal skeleton according to any one of claims 1 to 5, wherein the diol having the cyclic acetal skeleton is spiroglycol and/or dioxane glycol.

[Claim 7]

The method for producing the diol having the cyclic acetal skeleton according to any one of claims 1 to 6, comprising an aldol condensation reaction step of obtaining crude hydroxypivalaldehyde by an aldol condensation reaction of formaldehyde and isobutyraldehyde.

[Claim 8]

The method for producing the diol having the cyclic acetal skeleton according to claim 7, comprising at least any one of:

an extraction step of adding water and/or an organic solvent to the crude hydroxypivalaldehyde obtained in the

aldol condensation reaction step to extract the raw material hydroxypivalaldehyde;

a distillation step of distilling the crude hydroxypivalaldehyde obtained in the aldol condensation reaction step to collect the raw material hydroxypivalaldehyde as a distillate; and

a crystallization step of adding water and/or an organic solvent to the crude hydroxypivalaldehyde obtained in the aldol condensation reaction step for crystallization and collecting the raw material hydroxypivalaldehyde by solid-liquid separation.

[Claim 9]

The method for producing the diol having the cyclic acetal skeleton according to any one of claims 1 to 8, wherein

a reaction temperature employed in the acetalization reaction step is 40 to 105°C,

a pH value of a reaction solution in the acetalization reaction step is 0.1 to 4.0, and

after the acetalization reaction step, the reaction solution is solid-liquid separated into a solid of the diol having the cyclic acetal skeleton and a reaction mother liquor, and 30 to 98% by mass of the reaction mother liquor is reused to perform a subsequent acetalization reaction step.