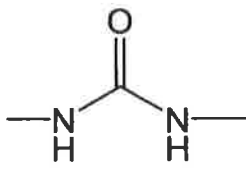
CLAIMS

[Claim 1]

A method for producing a carbonyl compound, comprising a step (X) of reacting a compound having a urea bond represented by a formula (1) as shown below with a carbonic acid derivative having a carbonyl group (-C(=O)-) under heating at a temperature equal to or higher than the thermal dissociation temperature of the urea bond to obtain the carbonyl compound:



(1)

[Claim 2]

The method for producing the carbonyl compound according to claim 1, wherein the step (X) is carried out in the coexistence of a hydroxy compound.

[Claim 3]

The method for producing the carbonyl compound according to claim 1 or 2, wherein the carbonyl compound comprises an N-substituted carbamic acid ester.

[Claim 4]

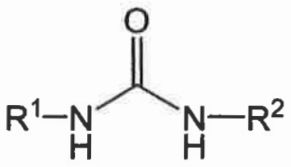
The method for producing the carbonyl compound according to any one of claims 1 to 3, wherein the carbonic acid derivative is urea or an N-unsubstituted carbamic acid ester.

[Claim 5]

The method for producing the carbonyl compound according to any one of claims 1 to 3, wherein the carbonic acid derivative is a carbonic acid ester.

[Claim 6]

The method for producing the carbonyl compound according to any one of claims 1 to 5, wherein the compound having the urea bond is a compound represented by a formula (2) as shown below, which is produced from raw material ingredients comprising an organic primary amine and a carbonic acid derivative:



(2)

wherein

R^1 and R^2 each independently represent an organic group comprising a group derived from the organic primary amine.

[Claim 7]

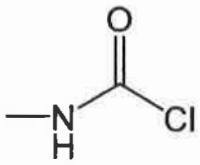
The method for producing the carbonyl compound according to any one of claims 1 to 5, wherein the compound having the urea bond is a polyurethane-urea copolymer.

[Claim 8]

The method for producing the carbonyl compound according to claim 1, wherein

the carbonic acid derivative is a phosgene, and

the carbonyl compound comprises a compound having a group represented by the following formula (3):



(3)

[Claim 9]

The method for producing the carbonyl compound according to claim 8, wherein the compound having the urea bond is a compound produced from an organic primary amine and a phosgene.

[Claim 10]

The method for producing the carbonyl compound according to any one of claims 1 to 9, wherein the step (X) is carried out in a distillation column.

[Claim 11]

A method for producing an isocyanate, comprising a step of subjecting a carbonyl compound obtained by the production method according to any one of claims 1 to 10 to a pyrolytic reaction to produce the isocyanate.

[Claim 12]

The method for producing the carbonyl compound according to any one of claims 1 to 10, wherein

the step (X) is carried out using a distillation column comprising a supply port A, a supply port B, and a discharge port C;

the step (X) comprises steps of:

supplying raw material ingredients containing the compound having the urea bond, or raw material ingredients containing a precursor of the compound having the urea bond, to the distillation column via at least one supply port A,

supplying the carbonic acid derivative to the distillation column via at least one supply port B, and

recovering a generated mixture comprising a carbonyl compound via at least one discharge port C disposed at a lower part of the distillation column; and

the at least one supply port B is disposed at a position the same as or lower than the supply port A,

the at least one discharge port C is disposed at a position the same as or lower than the supply port B, and

a temperature of the distillation column at a height of the supply port B is equal to or higher than the thermal dissociation temperature of the urea bond in the compound having the urea bond.

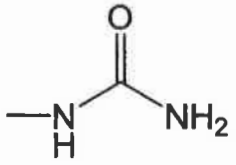
[Claim 13]

The method for producing the carbonyl compound according to claim 12, wherein the precursors of the compound having the urea bond are an organic primary amine and a carbonic acid derivative.

[Claim 14]

The method for producing the carbonyl compound according to claim 12, wherein the precursor of the

compound having the urea bond is a compound having a ureido group represented by the following formula (4):



(4)

[Claim 15]

The method for producing the carbonyl compound according to any one of claims 12 to 14, wherein the raw material ingredients to be supplied via the supply port A further contain a hydroxy compound.

[Claim 16]

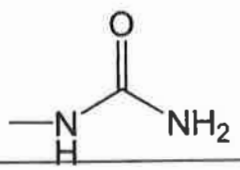
The method for producing the carbonyl compound according to claim 12, wherein

the raw material ingredients to be supplied via the supply port A are indicated by a combination (i) or (ii) described below, and

the mixture to be recovered via the discharge port C comprises an N-substituted carbamic acid ester and a hydroxy compound:

combination (i): an organic primary amine, urea, and a hydroxy compound; or

combination (ii): a hydroxy compound and a compound having a ureido group represented by the following formula (4):



(4)

[Claim 17]

The method for producing the carbonyl compound according to claim 12, wherein

the raw material ingredients to be supplied via the supply port A are indicated by combination (iii): an organic primary amine, a carbonic acid ester, and a hydroxy compound, and

the mixture to be recovered via the discharge port C comprises an N-substituted carbamic acid ester and a hydroxy compound.

[Claim 18]

The method for producing the carbonyl compound according to claim 12, wherein

the raw material ingredients to be supplied via the supply port A are indicated by combination (iv): a polyurethane-urea copolymer and a hydroxy compound, and

the mixture to be recovered via the discharge port C comprises an N-substituted carbamic acid ester and a hydroxy compound.

[Claim 19]

The method for producing the carbonyl compound according to any one of claims 12 to 18, wherein a hydroxy compound is further supplied to the distillation column via the supply port B.

[Claim 20]

The method for producing the carbonyl compound according to any one of claims 12 to 19, wherein

the distillation column comprises a plurality of the supply ports B, and

a mixture of a carbonic acid derivative and a hydroxy compound is supplied to the distillation column via the plurality of supply ports B.

[Claim 21]

The method for producing the carbonyl compound according to claim 12, wherein

the distillation column further comprises a condenser;

the method further comprises a step of condensing a portion of gas discharged from a top of the distillation column using the condenser to obtain a condensate;

a hydroxy compound is further supplied to the distillation column via the supply port A and/or the supply port B;

the carbonic acid derivative to be supplied via the supply port B is urea and/or an N-unsubstituted carbamic acid ester;

the gas discharged from the top of the distillation column comprises a compound having a carbonyl group derived from the carbonic acid derivative and/or a compound having a carbonyl group derived from the compound having the urea bond, a hydroxy compound, and ammonia; and

the condensate contains a compound having a carbonyl group and a hydroxy compound.

[Claim 22]

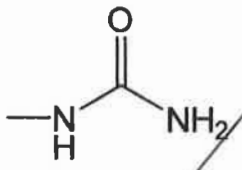
The method for producing the carbonyl compound according to claim 21, wherein a part of or an entire condensate is circulated inside the distillation column.

[Claim 23]

The method for producing the carbonyl compound according to claim 21, wherein a part of or an entire condensate is supplied to the distillation column via the supply port B.

[Claim 24]

The method for producing the carbonyl compound according to claim 21, wherein a part of or an entire condensate is recycled as a raw material ingredient for producing a compound having a ureido group represented by the following formula (4):



(4)

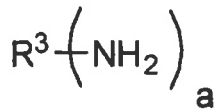
[Claim 25]

The method for producing the carbonyl compound according to claim 21, further comprising a step of reacting the ammonia contained in the gas discharged from the top of the distillation column with carbon dioxide to produce urea, the urea being recycled.

[Claim 26]

The method for producing the carbonyl compound according to any one of claims 6, 9, 13, 16, and 17,

wherein the organic primary amine is a compound represented by the following formula (5):



(5)

wherein

R^3 represents an organic group containing 1 to 85 carbon atoms, and

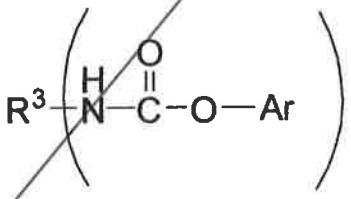
a represents an integer from 1 to 10.

[Claim 27]

The method for producing the carbonyl compound according to any one of claims 2 and 15 to 21, wherein

the hydroxy compound is an aromatic hydroxy compound, and

the carbonyl compound comprises an N-substituted carbamic acid-O-aryl ester represented by the following formula (6):



(6)

wherein

R^3 represents an organic group containing 1 to 85 carbon atoms,

Ar represents a group derived from an aromatic hydroxy compound, which is a residue obtained by removing one hydroxy group from the aromatic hydroxy compound, and

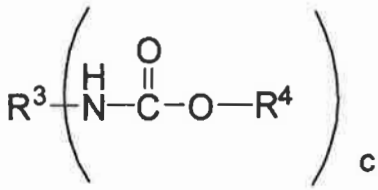
b represents an integer from 1 to 10.

[Claim 28]

The method for producing the carbonyl compound according to any one of claims 2 and 15 to 21, wherein

the hydroxy compound is alcohol, and

the carbonyl compound comprises an N-substituted carbamic acid-O-alkyl ester represented by the following formula (7):



(7)

wherein

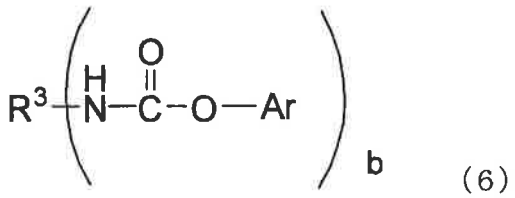
R^3 represents an organic group containing 1 to 85 carbon atoms,

R^4 represents a group derived from alcohol, which is a residue obtained by removing one hydroxy group from the alcohol, and

c represents an integer from 1 to 10.

[Claim 29]

The method for producing the carbonyl compound according to claim 28, further comprising a step of reacting the N-substituted carbamic acid-O-alkyl ester with an aromatic hydroxy compound to obtain an N-substituted carbamic acid-O-aryl ester represented by the following formula (6) and alcohol:



(6)

wherein

R^3 represents an organic group containing 1 to 85 carbon atoms,

Ar represents a group derived from an aromatic hydroxy compound, which is a residue obtained by removing one hydroxy group from the aromatic hydroxy compound, and

b represents an integer from 1 to 10.

[Claim 30]

A method for producing an isocyanate, comprising a step of subjecting an N-substituted carbamic acid-O-aryl ester obtained by the production method according to claim 27 or claim 29 to a pyrolytic reaction to obtain a product comprising an isocyanate and an aromatic hydroxy compound.

[Claim 31]

The method for producing the carbonyl compound according to any one of claims 2 and 15 to 21, wherein the hydroxy compound is alcohol obtained by the production method according to claim 29.

[Claim 32]

The method for producing the carbonyl compound according to any one of claims 2, 15 to 21, and 29, wherein the hydroxy compound or the aromatic hydroxy

compound is an aromatic hydroxy compound obtained by the production method according to claim 30.

[Claim 33]

The method for producing the isocyanate according to claim 30, further comprising a step of separating the product obtained by the pyrolytic reaction into a gaseous phase ingredient and a liquid phase ingredient and then recovering a part of or an entire liquid phase ingredient, wherein

the liquid phase ingredient contains a compound having a urea bond.

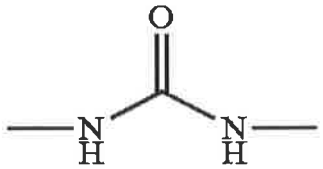
[Claim 34]

The method for producing the carbonyl compound according to claim 1, wherein the compound having the urea bond is a compound having a urea bond comprised in the liquid phase ingredient obtained by the production method according to claim 33.

CLAIMS

1. A method for producing a carbonyl compound, comprising a step (X) of reacting a compound having a urea moiety of a formula (1) as shown below with a carbonic acid derivative selected from the group consisting of a carbonic acid ester, an N-unsubstituted carbamic acid ester, urea, and phosgene under heating at a temperature equal to or higher than the thermal dissociation temperature of the nitrogen-carbonyl bond to obtain the carbonyl compound;

(1)



wherein the step (X) is carried out in a distillation column comprising a supply port A, a supply port B and a discharge port C, the step X comprising:

supplying raw material ingredients containing the compound having the urea moiety, or raw material ingredients containing a precursor of the compound having the urea moiety, to the distillation column via at least the supply port A,

supplying the carbonic acid derivative to the distillation column via at least the supply port B, and

recovering a generated mixture comprising the carbonyl compound via at least the discharge port C disposed at a lower part of the distillations column; and

the supply port B is disposed at a position the same as or lower than the supply port A,

the discharge port C is disposed at a position the same as or lower than the supply port B, and

a temperature of the distillation column at a height of the supply port B is equal to or higher than the thermal dissociation temperature of the nitrogen-carbonyl bond in the compound having the urea moiety.

2. The method for producing the carbonyl compound according to claim **1**, wherein the step (X) is carried out in the coexistence of a hydroxy compound.

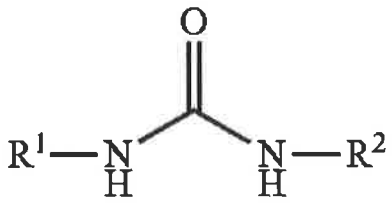
3. The method for producing the carbonyl compound according to claim **1**, wherein the carbonyl compound comprises an N-substituted carbamic acid ester.

4. The method for producing the carbonyl compound according to claim **1**, wherein the carbonic acid derivative is urea or an N-unsubstituted carbamic acid ester.

5. The method for producing the carbonyl compound according to claim **1**, wherein the carbonic acid derivative is a carbonic acid ester.

6. The method for producing the carbonyl compound according to claim **1**, wherein the compound having the urea moiety is a compound of a formula (2) as shown below, which is produced from raw material ingredients comprising an organic primary amine and a carbonic acid derivative:

(2)



wherein

R^1 and R^2 are each independently an organic group comprising a group derived from the organic primary amine.

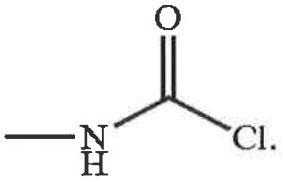
7. The method for producing the carbonyl compound according to claim **1**, wherein the compound having the urea moiety is a polyurethane-urea copolymer.

8. The method for producing the carbonyl compound according to claim **1**, wherein

the carbonic acid derivative is phosgene, and

the carbonyl compound comprises a group of the following formula (3):

(3)



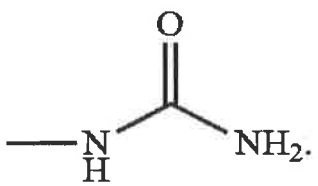
9. The method for producing the carbonyl compound according to claim **8**, wherein the compound having the urea moiety is a compound produced from an organic primary amine and a phosgene.

10. The method for producing the carbonyl compound according to claim **3**, further comprising a step of heating the carbonyl compound at a temperature in the range of 100° C. to 300° C. to prepare an isocyanate.

11. The method for producing the carbonyl compound according to claim **1**, wherein the precursors of the compound having the urea moiety are an organic primary amine and a carbonic acid derivative.

12. The method for producing the carbonyl compound according to claim **1**, wherein the precursor of the compound having the urea moiety is a compound having a ureido group of the following formula (4):

(4)



13. The method for producing the carbonyl compound according to claim **1**, wherein the raw material ingredients to be supplied via the supply port A further contain a hydroxy compound.

14. The method for producing the carbonyl compound according to claim **1**, wherein

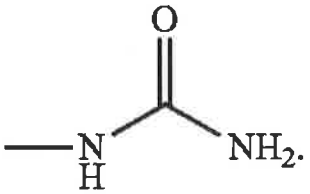
the raw material ingredients to be supplied via the supply port A are a combination (i) or (ii) described below, and

the mixture to be recovered via the discharge port C comprises an N-substituted carbamic acid ester and a hydroxy compound:

combination (i): an organic primary amine, urea, and a hydroxy compound; or

combination (ii): a hydroxy compound and a compound having a ureido group of by the following formula (4):

(4)



15. The method for producing the carbonyl compound according to claim **1**, wherein

the raw material ingredients to be supplied via the supply port A are combination (iii): an organic primary amine, a carbonic acid ester, and a hydroxy compound, and

the mixture to be recovered via the discharge port C comprises an N-substituted carbamic acid ester and a hydroxy compound.

16. The method for producing the carbonyl compound according to claim **1**, wherein

the raw material ingredients to be supplied via the supply port A are combination (iv): a polyurethane-urea copolymer and a hydroxy compound, and

the mixture to be recovered via the discharge port C comprises an N-substituted carbamic acid ester and a hydroxy compound.

17. The method for producing the carbonyl compound according to claim **1**, wherein a hydroxy compound is further supplied to the distillation column via the supply port B.

18. The method for producing the carbonyl compound according to claim **1**, wherein

the distillation column comprises a plurality of the supply ports B, and

a mixture of a carbonic acid derivative and a hydroxy compound is supplied to the distillation column via the plurality of supply ports B.

19. The method for producing the carbonyl compound according to claim **1**, wherein

the distillation column further comprises a condenser;

the method further comprises a step of condensing a portion of gas discharged from a top of the distillation column using the condenser to obtain a condensate;

a hydroxy compound is further supplied to the distillation column via the supply port A and/or the supply port B;

the carbonic acid derivative to be supplied via the supply port B is urea and/or an N-unsubstituted carbamic acid ester;

the gas discharged from the top of the distillation column comprises a hydroxyl compound, ammonia, a compound having a carbonyl group derived from the carbonic acid derivative and/or a compound having a carbonyl group derived from the compound having the urea moiety; and

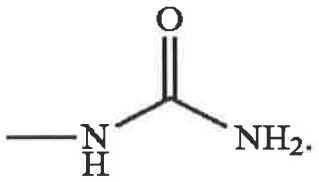
the condensate contains a compound having a carbonyl group and a hydroxy compound.

20. The method for producing the carbonyl compound according to claim **19**, wherein a part of or an entire condensate is circulated inside the distillation column.

21. The method for producing the carbonyl compound according to claim **19**, wherein a part of or an entire condensate is supplied to the distillation column via the supply port B.

22. The method for producing the carbonyl compound according to claim **19**, wherein a part of or an entire condensate is recycled as a raw material ingredient for producing a compound having a ureido group of the following formula (4):

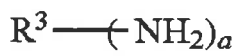
(4)



23. The method for producing the carbonyl compound according to claim **19**, further comprising a step of reacting the ammonia contained in the gas discharged from the top of the distillation column with carbon dioxide to produce urea, the urea being recycled back to the distillation column.

24. The method for producing the carbonyl compound according to claim **6**, wherein the organic primary amine is a compound of the following formula (5):

(5)



wherein

R^3 ia an organic group containing 1 to 85 carbon atoms, and

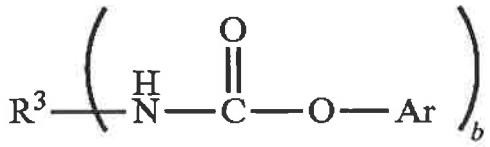
a is an integer from 1 to 10.

25. The method for producing the carbonyl compound according to claim **2**, wherein

the hydroxy compound is an aromatic hydroxy compound, and

the carbonyl compound comprises an N-substituted carbamic acid-O-aryl aster of the following formula (6):

(6)



wherein

R^3 is an organic group containing 1 to 85 carbon atoms,

Ar is a group derived from an aromatic hydroxy compound, which is a residue obtained by removing one hydroxy group from the aromatic hydroxy compound, and

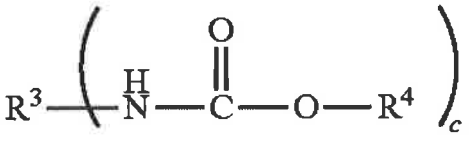
b is an integer from 1 to 10.

26. The method for producing the carbonyl compound according to claim **2**, wherein

the hydroxy compound is an alcohol, and

the carbonyl compound comprises an N-substituted carbamic acid-O-alkyl ester of by the following formula (7):

(7)



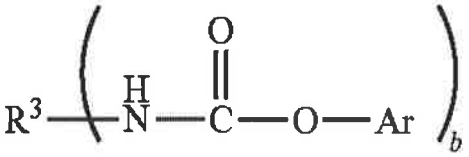
wherein

R^3 is an organic group containing 1 to 85 carbon atoms,

R^4 is a group derived from an alcohol, which is a residue obtained by removing one hydroxy group from the alcohol, and c is an integer from 1 to 10.

27. The method for producing the carbonyl compound according to claim **26**, further comprising a step of reacting the N-substituted carbamic acid-O-alkyl ester with an aromatic hydroxy compound to obtain an N-substituted carbamic acid-O-ary ester of the following formula (6) and an alcohol:

(6)



wherein

R^3 is an organic group containing 1 to 85 carbon atoms,

Ar is a group derived from an aromatic hydroxy compound, which is a residue obtained by removing one hydroxy group from the aromatic hydroxy compound, and

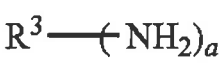
b is an integer from 1 to 10.

28. The method for producing the carbonyl compound according to claim **25**, further comprising heating the N-substituted carbamic acid-O-aryl ester at a temperature in the range of 100° C. to 300° C. to provide a product comprising an isocyanate and an aromatic hydroxy compound; and

separating the product into a gaseous phase ingredient and a liquid phase ingredient and then recovering a part of or an entire liquid phase ingredient, wherein

the liquid phase ingredient contains a compound having a urea moiety.

29. The method for producing the carbonyl compound according to claim **11**, wherein the organic primary amine is a compound of the following formula (5):



(5)

wherein

R^3 is an organic group containing 1 to 85 carbon atoms, and

a represents is an integer front 1 to 10.