Claims

1. A process for preparing isocyanates by reacting the corresponding amines with phosgene, if appropriate in the presence of at least one inert medium, in the gas phase, in which n amine streams are reacted with n+1 phosgene streams in a reactor, where n is a positive integer of at least 1, and all amine and phosgene streams are introduced into the reactor via annular gaps for mixing.

2. The process according to claim 1, wherein the isocyanate is selected from the group consisting of 1,6-diisocyanatohexane, 1-isocyanato-3,3,5-trimethyl-5-(isocyanatomethyl)cyclohexane, 4,4'-di(isocyanatocyclohexyl)methane and tolylene diisocyanate isomer mixtures.

3. The process according to either of the preceding claims, wherein at least one inert medium selected from the group consisting of nitrogen, helium, argon, chlorobenzene, chlorotoluene, o-dichlorobenzene, toluene, xylene, chloronaphthalene, decahydronaphthalene, carbon dioxide and carbon monoxide is present.

4. The process according to claim 3, wherein the gas volume of inert medium to amine or to phosgene is from >0.0001 to 30.

5. The process according to any of the preceding claims, wherein the temperature in the process is from 200 to 600°C.

6. The process according to any of the preceding claims, wherein a molar ratio of phosgene to amino groups of from 1.1 : 1 to 20 : 1 is set.

7. The process according to any of the preceding claims, wherein the outermost stream introduced into the reactor at the outer wall and innermost stream introduced into the reactor are each a phosgene stream.

8. The process according to any of the preceding claims, wherein the ratio of the area of the respective outer phosgene stream to the area of the amine stream to the area of the respective adjacent inner phosgene stream is 0.3 - 5 : 1 : 0.3 - 5.

9. The process according to any of the preceding claims, wherein the ratio of the total area of the amine streams to the total area of the phosgene streams is greater than 0.00002 and less than 5.

10. The process according to any of the preceding claims, wherein the individual starting materials are conveyed in the mixing device at a flow velocity of from

20 to 400 meter/second into the reactor.

11. The process according to any of the preceding claims, wherein the reactor in which the reaction is carried out is an annular gap space.

12. The process according to claim 10, wherein the reactor comprises a volume body in its interior to form the annular gap space.

13. The process according to claim 11, wherein the volume body tapers to a diameter of zero along the reactor.

14. The process according to claim 10, wherein the area of the reactor through which flow occurs does not change during passage through the reactor.

15. The process according to claim 10, wherein the area of the reactor through which flow occurs increases in a first section during passage through the reactor and subsequently remains constant in a second section.

16. The process according to claim 10, wherein the area of the reactor through which flow occurs remains constant in a first section during passage through the reactor, increases in a second section and remains constant in a third section.

17. The process according to claim 10, wherein the area of the reactor through which flow occurs remains constant in a first section during passage through the reactor, decreases in a second section, increases in a third section and remains constant in a fourth section.

18. The process according to claim 10, wherein the area of the reactor through which flow occurs decreases in a first section during passage through the reactor, increases in a second section and remains constant in a third section.

19. The process according to claim 10, wherein the area of the reactor through which flow occurs decreases in a first section during passage through the reactor, remains constant in a second section, increases in the third section and remains constant in a fourth section.

20. The process according to any of the preceding claims, wherein the mean contact time of the reaction mixture is from 0.001 seconds to <5 seconds.

21. The process according to any of the preceding claims, wherein the flow in the reaction has a Bodenstein number of more than 10.

22. The process according to any of the preceding claims, wherein the flow of the reaction mixture has a Reynolds number of least 2300.

23. The process according to any of the preceding claims, wherein the conversion of amine in the space in which mixing of the starting materials takes place to a degree of 99% is not more than 15%.

24. An apparatus comprising at least one tube reactor whose one end face is provided with (2n + 1) annular gaps arranged in a circular fashion around one another, where n is a positive integer of at least 1, of which each second annular gap is connected to at least one feed line for a feed stream and the annular gaps located in between are connected to at least one feed line for another feed stream, with the annular gaps being arranged concentrically around the longitudinal axis of the reactor at the end face and a volume body which is arranged around the longitudinal axis of the reactor and projects into the tube reactor being located in the middle thereof, with the external diameter of the volume body and the internal diameter of the tube reactor enclosing a reaction space.

The invention claimed is:

1. A process for preparing an isocyanate, comprising reacting, in the gas phase, an amine with phosgene, in the presence of an inert medium,

wherein

n amine streams are reacted with n+1 phosgene streams in a reactor,

n is a positive integer of at least 1,

all amine and phosgene streams are introduced into a mixing space through annular gaps,

mixing of the n amine streams and the n+1 phosgene streams occurs in the mixing space, which comprises an annular gap space for mixing, and

an interior of the annular gap space for mixing is filled out by an internal displacement body.

2. The process according to claim **1**, wherein the isocyanate is at least one selected from the group consisting of 1,6-diisocyanatohexane, 1-isocyanato-3,3,5-trimethyl-5-(isocyanatomethyl)cyclohexane, 4,4'-di(isocyanatocyclohexyl) methane and tolylene diisocyanate isomer mixtures.

3. The process according to claim **1**, wherein the inert medium is at least one selected from the group consisting of nitrogen, helium, argon, chlorobenzene, chlorotoluene, o-dichlorobenzene, toluene, xylene, chloronaphthalene, decahydronaphthalene, carbon dioxide and carbon monoxide.

4. The process according to claim **3**, wherein a gas volume of inert medium to amine or to phosgene is from >0.0001 to 30.

5. The process according to claim **1**, wherein the temperature in the process is from 200 to 600° C.

6. The process according to claim **1**, wherein a molar ratio of phosgene to amino groups is from 1.1:1 to 20:1.

7. The process according to claim 1, wherein an outermost stream introduced into the mixing space at an outer wall and an innermost stream introduced into the mixing space are each a phosgene stream.

8. The process according to claim 1, wherein:

each amine stream is introduced into the mixing space between two respective phosgene streams; and

a ratio of the area of a respective outer phosgene stream, to the area of an amine stream, to the area of a respective adjacent inner phosgene stream is 0.3-5:1:0.3-5.

9. The process according to claim 1, wherein a ratio of the total area of the n amine streams to the total area of the n+1 phosgene streams is greater than 0.00002 and less than 5.

10. The process according to claim 1, wherein individual starting materials are conveyed in a mixing device at a flow velocity of from 20 to 400 meter/second into the mixing space.

11. The process according to claim 1, wherein the reactor, in which the reaction occurs, comprises an annular gap space for reaction.

12. The process according to claim 11, wherein an interior of the annular gap space for reaction comprises a volume body to form the annular gap space for reaction.

13. The process according to claim 12, wherein the volume body tapers to a diameter of zero along the reactor.

14. The process according to claim 11, wherein the area of the reactor through which flow occurs does not change during passage through the reactor.

15. The process according to claim **11**, wherein the area of the reactor through which flow occurs increases in a first section during passage through the reactor and subsequently remains constant in a second section.

16. The process according to claim **11**, wherein the area of the reactor through which flow occurs remains constant in a first section during passage through the reactor, increases in a second section and remains constant in a third section.

17. The process according to claim **11**, wherein the area of the reactor through which flow occurs remains constant in a first section during passage through the reactor, decreases in a second section, increases in a third section and remains constant in a fourth section.

18. The process according to claim **11**, wherein the area of the reactor through which flow occurs decreases in a first section during passage through the reactor, increases in a second section and remains constant in a third section.

19. The process according to claim **11**, wherein the area of the reactor through which flow occurs decreases in a first section during passage through the reactor, remains constant in a second section, increases in the third section and remains constant in a fourth section.

20. The process according to claim **1**, wherein a mean contact time of a reaction mixture is from 0.001 seconds to <5 seconds.

21. The process according to claim **1**, wherein a flow in the reactor has a Bodenstein number of more than 10.

22. The process according to claim **1**, wherein a flow of a reaction mixture has a Reynolds number of least 2300.

23. The process according to claim **1**, wherein the conversion of amine, in a space in which mixing of the starting materials takes place to a degree of 99%, is not more than 15%.