Claims

1. Apparatus for the continuous inactivation of viruses in a product stream, which comprises a tube or hose (1) having an inlet (4) and an outlet (5) in each case connected to a product flow line (8) for conveying the product stream,
   - where the tube or the hose (1) is curved and/or helically coiled with a number n of windings around a coil axis h and has one or more changes in direction and/or bends 2 in the coil axis h having an angle α of from 45° to 180° to alter the direction of action of the normals of the centrifugal force and
   - the apparatus is characterized by a Dean number > 0 and a torsion parameter > 0.

2. Apparatus according to Claim 1, characterized in that the apparatus is characterized by a Dean number ≥ 2, preferably ≥ 3, and a torsion parameter ≥ 300, preferably ≥ 500.

3. Apparatus according to Claim 1 or 2, characterized in that the apparatus comprises a holding stand (6) which is joined to one or more frames (3).

4. Apparatus according to any of Claims 1 to 3, characterized in that the apparatus is sterilizable, preferably autoclavable, and particularly preferably gamma-sterilizable.

5. Apparatus according to any of Claims 1 to 4, characterized in that the internal diameter d_i of the curved and/or helically coiled tube or hose (1) is in the range from 1 to 20 mm.

6. Production plant comprising one or more apparatuses according to any of Claims 1 to 5.

7. Process for the continuous virus inactivation of a product stream, which comprises the following steps:
   a) provision of the product stream to be inactivated,
   b) introduction of the product stream into the inlet (4) of a tube or hose (1) having an inlet (4) and an outlet (5), where the tube or the hose (1) is curved and/or helically coiled with a number n of windings around a coil axis h and has one or more changes in direction and/or bends (2) in the coil axis having an angle α of from 45° to 180° to alter the direction of action of the normals of the centrifugal force, where the apparatus is characterized by a Dean number > 0 and a torsion parameter > 0,
   c) flow of the product stream through the tube or the hose 1 under virus-inactivating conditions and
   d) exit from the tube or the hose 1 through the outlet 5.

8. Process according to Claim 7, characterized in that the apparatus in step b) is characterized by a Dean number ≥ 2, preferably ≥ 3, and a torsion parameter ≥ 300, preferably ≥ 500.

9. Process according to Claim 7 or 8, wherein the pH of the product stream in step a) is set to a value of ≤ 4 if the pH of the material to be inactivated does not already have the required value.

10. Process according to any of Claims 7 to 9, characterized in that the solution to be inactivated is a solution of macromolecules, preferably a protein or peptide solution, particularly preferably an antibody solution.

Claims

1. Process for the continuous virus inactivation of a product stream, which comprises the following steps:
   a) provision of the product stream to be inactivated,
   b) introduction of the product stream into the inlet (4) of a tube or hose (1) having an inlet (4) and an outlet (5), where the tube or the hose (1) is curved and/or helically coiled with a number n of windings around a coil axis h and has one or more changes in direction and/or bends (2) in the coil axis having an angle α of from 45° to 180° to alter the direction of action of the normals of the centrifugal force, where the apparatus is characterized by a Dean number ≥ 2 and a torsion parameter > 100,
   c) flow of the product stream through the tube or the hose 1 under virus-inactivating conditions and
   d) exit from the tube or the hose 1 through the outlet 5.

2. Process according to Claim 1, characterized in that the apparatus in step b) is characterized by a Dean number ≥ 3, and a torsion parameter ≥ 300, preferably ≥ 500.

3. Process according to Claim 1 or 2, wherein the pH of the product stream in step a) is set to a value of ≤ 4 if the pH of the material to be inactivated does not already have the required value.

4. Process according to any of Claims 1 to 3, characterized in that the solution to be inactivated is a solution of macromolecules, preferably a protein or peptide solution, particularly preferably an antibody solution.