may be of particular concern regarding biopharmaceuticals because it can cause aggregation of certain proteins, thereby rendering the biopharmaceutical unusable for injection.

[0004] A second aspect is the occurrence of small bumps or asperities on the inner surface of the insertion tube that may be present as a by-product of the insertion tube manufacturing process. Typically, these asperities have no effect on a stopper as the silicone in the insertion tube allows the stopper to pass over the asperities without issue. However, if silicone or another suitable lubricant is not applied or is inadvertently omitted, damage or destruction of the stopper may cause failure in the syringe or similar injectable device.

[0005] Therefore, a need exists for a method of inserting a lubricant free stopper into a lubricant free barrel or a lubricant free cartridge tube in a manner that both reduces the potential for drug contamination and minimizes damage to the stopper.

SUMMARY

[0006] In one aspect, the present disclosure comprises a method includes (1) providing a syringe including a barrel flange and a non-lubricated barrel, (2) inserting a non-lubricated stopper that includes a sealing rib into a placement region located at a proximal end of hybrid insertion device, where the hybrid insertion device includes, sealing gasket, a conduit, and an insertion tube, and where the non-lubricated stopper is at least partially covered by a polymer layer, (3) lowering the hybrid insertion device until a distal end of a body of the insertion tube is located a desired distance above a liquid solution located within the syringe, (4) creating a seal between a sealing gasket of the hybrid insertion device and the barrel flange of the syringe, (5) applying a vacuum through a vacuum port fluidly connected to a vacuum gap where the vacuum port is located at a distal end of a vacuum chamber portion of the hybrid insertion device, (6) translating the stopper through insertion tube and the non-lubricated barrel with an insertion rod until a desired headspace between a front edge of the sealing rib and a liquid solution located in the non-lubricated cartridge tube is achieved, (7) retracting the insertion rod away from the hybrid insertion device, and (8) retracting the hybrid insertion device away from the non-lubricated barrel.

[0007] In another example, the insertion tube is sized smaller than an inner diameter of the conduit to allow the vacuum gap to be formed therebetween.

[0008] In another example, the hybrid insertion device moves into the barrel without contacting an inner surface of the barrel.

[0009] In another example, the liquid solution is added to the non-lubricated barrel prior to creating the vacuum seal between the sealing gasket and the barrel flange.

[0010] In another example, the liquid solution is a therapeutic substance.

[0011] In another example, the therapeutic substance contains therein a biologic, a therapeutic compound, or a combination thereof.

[0012] In another example, the vacuum chamber has been electropolished, extrude honed, or a combination thereof.

[0013] In another example, at least the stopper, the sealing gasket, the conduit, the insertion tube, the syringe barrel, the barrel flange, and the insertion pin are free or substantially free of lubricants.

[0014] In another example, a transition zone in the hybrid insertion device tapers from a placement region to the tube body at a taper angle a for transitioning the non-lubricated stopper from the placement region to a proximal end of the barrel.

[0015] In another example, the taper angle is between about 0.1 degree and about 20 degrees.

[0016] In another example, the desired headspace ranges from about 0.1 mm to about 25 mm, or from 0.1 mm to about 10 mm, or from about 0.1 mm to about 5 mm, or from about 0.5 mm to about 10 mm, orfrom about 0.5 to 5 mm, or from 1 mm to about 25 mm, or from about 1 mm to about 10 mm, or from about 1 mm to about 5 mm.

[0017] In another example, the insertion rod includes a pin tip end and the non-lubricated stopper contains therein a cavity to receive the pin tip end.

[0018] In another example, the polymer layer includes an expanded fluoropolymer layer.

[0019] In another example, the expanded fluoropolymer layer comprises an expanded polytetrafluoroethylene layer.

[0020] In another example, the hybrid insertion device is positioned above and is aligned with the non-lubricated barrel.

[0021] In another example, the insertion rod and hybrid insertion device are retracted simultaneously.

[0022] In another example, the insertion rod is retracted prior to retracting the hybrid insertion device.

[0023] In another aspect, the present disclosure comprises a method includes (1) providing a syringe including and barrel flange and a non-lubricated barrel, (2) inserting an insertion tube into a conduit of a vacuum chamber to form a hybrid insertion device, the insertion tube including a body, an insertion body and a distal end, (3) inserting a non-lubricated stopper that includes a sealing rib into a placement region located at a proximal end of the vacuum chamber, the non-lubricated stopper being at least partially covered by a polymer layer, (4) lowering the hybrid insertion device until the insertion body of the insertion tube is located a desired distance above a liquid solution located within the non-lubricated barrel, (5) creating a seal between a sealing gasket of the vacuum chamber and the barrel flange of the syringe, (6) applying a vacuum through a vacuum port fluidly connected to a vacuum gap and being located at a distal end of the vacuum chamber, (7) translating the stopper through insertion tube and the non-lubricated barrel with an insertion rod until a desired headspace between a front edge of the sealing rib and a liquid solution located in the non-lubricated barrel is achieved, (8) retracting the insertion rod away from the hybrid insertion device, and (9) retracting the hybrid insertion device away from the non-lubricated barrel.