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METHOD OF PRODUCING STERILE TEST TUBES
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1 Claim

ABSTRACT OF THE DISCLOSURE

A method of producing test tubes having sterile interiors without separate sterilization treatment, which comprises extruding tubing from plastic material at a sterilizing temperature while injecting a gaseous substance at a sterilizing temperature into the tubing as it is being formed to maintain said tubing in an inflated condition, subjecting the leading end of the emerging tubing to compression while it is still at a sterilizing temperature to fuse the flattened walls of said end and thus seal said end hermetically, subjecting succeeding axially spaced sections, of limited axial length, of the emerging tubing to compression to fuse said sections and thus convert the tubing into a sequence of separate compartments having hermetically-sealed ends, and severing said compartments from each other by cutting across said fused sections without impairing the seals formed by said fused sections.

The present invention relates to test tubes, especially those used for medical purposes, such as blood tests, urine analyses, and the like. Such tubes should always be chemically clean and sterile at the time of use.

It is an object of the invention to provide a simple and effective method of producing chemically clean and sterile test tubes, without need for separate sterilizing and cleaning treatments.

Another object of the invention is to provide tubes whose interior is sterile and chemically clean and which remain clean and sterile without special precautions, such as sterile packaging, until they are prepared for practical use.

These and other objects of the invention will be apparent from the following description of the accompanying drawings which illustrate certain preferred embodiments thereof and wherein.

FIG. 1 is a schematic illustration of the first step in the method of my invention;

FIG. 2 is a schematic illustration, in the form of a flow line, of a complete continuous process of producing the test tubes of my invention;

FIG. 3 is a schematic flow line similar to FIG. 2 illustrating a slightly modified embodiment of my invention;

FIG. 4 is a side elevation of a test tube produced in accordance with my invention;

FIG. 5 is a plan view of the test tube shown in FIG. 4; and

FIG. 6 is a plan view of another type of test tube produced in accordance with my invention.

In accordance with my invention I extrude tubing from plastic material at a sterilizing temperature while injecting a gaseous substance, such as nitrogen heated to a sterilizing temperature, at a superatmospheric pressure into the tubing as it is formed by and emerges from the extruder; and I subject the leading end of the newly formed tubing to compression while it is still at a sterilizing temperature, to fuse its flattened side walls and thus seal it hermetically. From then on as the tubing flows from the extruder and increases axially in length, I subject it at a predetermined point of the production line intermittently to compression under heat to fuse axially spaced sections of limited axial length of said tubing and

thus convert it into a sequence of tubular compartments having hermetically sealed ends; and I sever said compartments from each other at a subsequent point of the production line by suitable cutting means which are arranged to cut across the fused tube sections without impairment of the hermetic seals formed at the opposite ends of the compartments. The resultant tube sections have completely sterile and chemically clean interiors that remain sterile and clean because their ends are hermetically sealed, and which may be shipped and stored and are ready for use without requiring any additional sterilization treatment or sterile packaging. All that is necessary is to cut off one of their ends, or cut them into half, at their place of use whereupon one or two chemically clean and completely sterile test tubes are immediately available.

In FIG. 1, the reference numeral 10 identifies an extruder of conventional design. Powdered or pelleted plastic material such as polypropylene, polyvinyl chloride or the polyethylene known under the trade name Surlyn, is poured into the hopper of the extruder as shown at 12, wherein it is heated to its melting point in the conventional manner, and from where it is extruded through the extrusion nozzle 14 in the form of a tube 16 by rotation of the extrusion screw 18. The powdered or pelleted plastic raw material delivered into the extruder must be chemically clean, and the softening points of all the exemplary materials mentioned hereinbefore lie above the minimum temperatures required for sterilization. Thus, powdered polypropylene is heated to a temperature of 320° F. for the purpose of extrusion. As the extruder is operated to expel a tube 19 of plastic material through its nozzle 14, heated nitrogen is continuously injected at a superatmospheric pressure into the newly formed tubing 19, as schematically indicated by the line 20 which passes through the extruder into the extrusion nozzle 14. As the gas in line 20 passes through the interior of the extruder, it is subjected to the heat applied to the extruder and heated to a sterilizing temperature so that it cooperates with the heat of the extruded material to maintain the interior of the newly formed tubing 19 sterile.

To penetrate into the newly formed tubing and to keep said tubing and the sterile compartments subsequently formed from the tubing by the method of my invention in inflated condition, the heated gas should be injected into the newly formed tubing at a superatmospheric pressure, the exact magnitude of which depends upon the nature of the plastic material and the temperature employed to soften it. In the hereinbefore mentioned practical embodiment of my invention wherein polypropylene was used as raw material and a temperature of 320° F. was employed to establish the required viscosity of the material, injection of the heated gas into the newly formed tubing at a pressure of about 2 atmospheres was found satisfactory.

In accordance with the invention I subject the leading end 22 of the tubing emerging from the extrusion nozzle 14 to compression while it is still at a sterilizing temperature, to flatten it out and to fuse its flattened side walls together so that it forms a hermetical seal. Thus, it is impossible for any microorganisms to enter and contaminate the interior of the tubing 19 from the outside, as it progresses from the extrusion nozzle 14 and cools below sterilizing temperatures. The described sealing process may be performed manually with a suitable pair of pliers or automatically by suitable placed sealing pads schematically indicated at 24 between which the emerging tubing is conducted and which are briefly actuated but once at the beginning of the test tube production method of my invention as shown in FIG. 1.

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After the leading end 22 of the tubing 19 has been hermetically sealed in the described manner, it is passed through a cooling bath indicated schematically at 25 in FIG. 2. This may be a trough containing running water at tap temperature. In the cooling bath the newly formed tubing acquires greater firmness and after leaving the bath it may now be engaged into a suitable mechanism for advancing it automatically, such as between two endless belt conveyors 26a and 26b as indicated in FIG. 2, whose belts are preferably made from rubber to grip the tubing and advance it at the desired speed in the desired direction.

The conveyors 26a, 26b deliver the semi-hardened tubing to a station whereat axially spaced sections 30 of limited length of said tubing are subjected to compression to flatten these sections and fuse their opposite walls together. This can be done manually with suitable pliers or automatically by suitably placed heated pressure pads indicated at 28a and 28b in FIG. 2. These pressure pads operate at predetermined time intervals depending upon the speed of advance of the extruded tubing and depending upon the desired length of the tubes produced in accordance with my invention. In this manner the tubing 19 produced by the extruder 14 is converted into a sequence of separate tubular compartments 32 that are hermetically sealed from each other by the fused sections 30, and whose interior is completely sterile since entrance of living microorganisms into the interior of the tubing 19 was prevented by permanent closure of its leading end 22 while said end was still at a sterilizing temperature.

It remains to separate the sealed tubular compartments thus formed without impairment of the hermetic seals at their opposite ends. Again, this may be done manually with scissors at a subsequent point of the production line established by the advancing tube, or it can be done by automatic cutting mechanism symbolically indicated by the transverse cutting blades 33a and 33b in FIG. 2 at a point which is preferably removed from the sealing station 28 by a distance equal to the desired axial length of the tube, or a suitable multiple of this distance. Said cutting mechanism operates intermittently to cut transverse cutting blades 33a and 33b in FIG. 2 at a point which is preferably removed from the sealing station 28 by a distance equal to the desired axial length of the tube, or a suitable multiple of this distance. Said cutting mechanism operates intermittently to cut transversely across the fused and flattened sections 30 of the tubing, whenever these sections pass beneath the cutting knife.

An alternative arrangement is illustrated in FIG. 3 wherein the fusing of the tube sections and the separation of the tube compartments 32 into individual test tubes is done at one and the same station. This can again be done manually or automatically by cutting pliers of conventional design, i.e., pliers such as schematically indicated at 35 in FIG. 3, of the type which can be operated to exert initially only a sealing pressure upon the tube sections 30, and upon increased pressure project a cutting blade or blades 36 to cut transversely through the compressed tube sections after fusion has been accomplished. In other words, the arrangement schematically indicated at 35 in FIG. 3 may be manually or automatically actuated to effect both the sealing of the dividing tube sections 30 and their separation in quick succession at the same production station.

FIGS. 4 and 5 illustrate the shape of a test tube 32 produced in accordance with the invention. As best shown in FIG. 4, its ends 37 and 38 are flattened out, and the opposite side areas produced by the flattening operation, are fused as shown at 40 to form hermetical seals. While FIG. 5 shows the fused end portion 40 of the tube as

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establishing straight or rectilinear edge lines 42, appropriate conformation of the compression pads and of the cutting edges makes it possible to give these end edges a round or parabolic shape if desired, such as shown at 43 in FIG. 6, but care must be taken in the production of such rounded ends that the seal 40 established at the ends of the tubes by the flattened and fused end portion thereof be not damaged. FIGS. 4 and 5 show the products of the invention to be single-compartment tubular containers, which can be readily converted into one or two sterile test tubes at their place of use by cutting off one end thereof, or by cutting them into halves. By the process of the invention as illustrated in FIG. 2 it is possible, however, to produce multi-compartment containers, i.e., containers where interior is divided into two or more compartments by a centrally located fused tube section 45, with each compartment having a chemically clean and completely sterile interior, such as illustrated in FIG. 6. It is merely necessary to synchronise the operation of the clamping mechanism 28 and the cutting mechanism 33 in such a manner that the latter will operate but once for a predetermined multiple of phases of operation of the former.

The process of my invention makes it possible to produce chemically clean and interiorly completely sterile test tubes in large quantities in a simple and inexpensive manner, without special sterilization treatment; and the interior of these test tubes stays sterile up to the moment when they are used, without the necessity of providing for sterile packaging.

While I have explained my invention with the aid of certain preferred embodiments thereof, it will be understood that the invention is not limited to the specific mechanisms schematically illustrated by way of example nor the exemplary material and the temperatures given by way of example, all of which may be departed from without departing from the scope and spirit of the invention.

I claim:

1. The method of producing test tubes having sterile and chemically clean interiors which comprises extruding tubing from plastic material at a sterilizing temperature while injecting a gaseous substance heated to a sterilizing temperature at a superatmospheric temperature into said tubing to maintain said tubing in an inflated condition, subjecting the leading end of said tubing to compression while it is still at a sterilizing temperature to fuse and thus seal said leading end hermetically, then passing said tubing through a coolant to lower its temperature, subjecting the tubing emerging from said coolant intermittently to compression to fuse axially spaced sections thereof and thus convert said tubing into compartments having hermetically sealed ends, and severing said compartments from each other across said fused sections while preserving the hermetic seals formed by said fused sections.

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