

9

A METHOD OF MANUFACTURE OF A COMPOSITE METAL-PLASTIC
TUBE AND EQUIPMENT FOR IMPLEMENTING THE SAME

5 This invention relates to a method of continuous
manufacture of a composite tube comprising a metal
part and at least an inner part of plastic material.

10 Methods of this kind are already known, e.g.
from French patent No. 1 385 944 of the American
Continental Can Company, in which a metal tube
is made from a ribbon closed on itself and welded
longitudinally; immediately after the weld has
been made a layer of plastic material is injected
into the resulting tube and forms an inner layer
as a lining for the metal surface. According
15 to this same patent, to facilitate adhesion of
the plastic material to the metal, a negative pressure
is produced between the metal tube and the plastic
material downstream of a die which delivers said
material in the form of a cone which widens out
20 and which finally sticks to the inner surface of
the metal. In a variant it is also possible to
replace the negative pressure by an excess pressure
in that part of the composite tube which is situated
downstream of the die.

25 The plastic-covered metal tube described in

the aforesaid patent is intended to be cut into fairly short lengths which are required to form the body of cans which are then closed by a base and a lid. It is important that the plastic material should adhere properly to the metal but it should be noted that cans made in this way are not subject during use to any stresses which would put such adhesion to the test.

The main object of the invention is to provide a composite tube comprising a metal part and at least an inner part of plastic material, preferably with an outer part of plastic material as well, which can be used in plumbing for the supply and/or discharge for various domestic appliances such as lavatories, baths, showers, sinks, etc. A tube of this kind must withstand treatments which subject the adhesion between the metal and the plastic to severe stresses. For example, in hot water circuits, the composite tube must withstand numerous successive heating and cooling cycles between ambient temperature and 100°C without any risk of the metal and plastic separating.

Copper or lead tubes have hitherto been conventionally used. These two metals have advantages and disadvantages. Annealed copper bends and curves easily but it

is then difficult to straighten it perfectly.
Lead is very malleable; it curves and straightens fairly easily but it does not have sufficient rigidity in comparison with copper and also it distorts due to creep even at ambient temperature.

The object of the invention is to provide a composite tube which is completely inert with respect to water as a result of an inner plastic coating, and which combines the advantages of copper and lead without having their disadvantages. In short, the object of the invention is to provide a composite tube as malleable as lead and as rigid as copper, so that it can be easily bent and straightened and so that it will retain its shape even at a continuous temperature of 80°C.

This necessarily requires excellent adhesion between the metal and the plastic, to a degree which is not necessary with the composite tube of the aforesaid patent and which the said composite tube does not have.

To this end, a tube is made from a ribbon which is welded longitudinally and according to the method of the invention the ribbon is of aluminium, and there is extruded inside the resulting tube a first layer of graft polyethylene and then a

second layer of plastic which covers the first layer.

According to another feature of the invention, the metal ribbon is closed and welded around a single extrusion die which has an inner annular channel having two coaxial inlets at its upstream end, the outer inlet being intended for the graft polyethylene and the inner inlet being intended for the other plastic material, and a single annular outlet at its downstream end.

Preferably, the polyethylene required to form the second layer is a polyethylene of cross-linkable type.

In many cases it is also desirable to deposit a coating on the outer surface of the metal tube in order to protect the latter. In that case, according to the invention, a first layer of graft polyethylene is first deposited on the surface of the tube and then a second layer of polyethylene, preferably cross-linkable.

In the method of the invention, the use of aluminium in combination with the layers of graft polyethylene and cross-linkable polyethylene results in a composite tube which has complete inertia to the liquids carried up to a temperature

of 100°C and very satisfactorily combining the malleability and rigidity qualities of lead and copper.

To this end, according to the invention, for
5 a composite tube having a size conventionally ranging from 8 to 14 mm for this type of tube it is advantageous to use an aluminium ribbon having a thickness of about 0.2 mm and to deposit on the inside and on the outside a coating comprising a layer of
10 graft polyethylene in the order of 0.1 mm thickness . . . and a layer of cross-linkable polyethylene in the order of 0.7 mm thickness.

The invention also covers an extrusion die comprising an elongated portion, the outer face
15 of which can be employed as a means participating in the welding of the aluminium metal tube and the interior of which exhibits an annular channel having an upstream end with two coaxial inlets and a downstream end with a single annular outlet.

20 In order that the invention may be more readily understood, a description will now be given of one exemplified embodiment of the method according to the invention with reference to the accompanying drawings wherein:

(14)

Fig. 1 is a diagrammatic elevation showing the complete machine for the manufacture of a composite tube.

5 Fig. 2 is an enlarged side view in section through a vertical plane of an internal extrusion die according to the invention forming part of the machine shown in Fig. 1.

10 Fig. 3 is a top plan view in section through a horizontal plane of a combined extrusion die for the co-extrusion of a graft polyethylene inside and outside and of a cross-linkable polyethylene inside and outside the tube, from two extruders, for the machine shown in Fig. 1.

15 Fig. 4 is a detail in section on the line IV-IV in Fig. 3.

20 The successive elements of a machine such as that shown in Fig. 1, which is already generally known, will first be mentioned quickly and then the new elements applied to that machine by the invention will then be described in detail.

25 An aluminium ribbon 1 wound flat in a reel 2 is fed through a first shaping means 3 followed by heating means 4 which brings the temperature of the U-shaped ribbon approximately to 150°C. The ribbon is then fed to a closed tube shaping

(15)

means 5, which is known per se, and which is associated with an extrusion die 6. The latter is combined with a means 7 for feeding plastic to the die 6. The means 7 is also connected to the output of two extruders 8 and 9 respectively. The die 6 is extended sufficiently to co-operate with a welding means which fabricates the metal tube by closing it by a longitudinal weld.

The welding means is of any suitable type. In the present example it comprises an ultrasound generator having a wheel 10 which performs the weld when the closed ribbon is supported internally by the outer surface of the die 6. The latter terminates in a downstream end 11 through which the welded tube internally coated with plastic leaves.

In the description given here as an example of the performance of the method of the invention, the aluminium ribbon (1) of H 24 quality has a thickness of 0.2 mm. Immediately after the weld produced by the wheel 10, there is deposited on the inner surface and on the outer surface of the resulting tube a coating comprising a first layer of graft polyethylene having a thickness of 0.1 mm, which is brought directly into contact with

the metal, and a second layer of cross-linkable polyethylene having a thickness of 0.7 mm, which is deposited directly on the first layer.

5 The tube 12 obtained after the outlet 11 passes through a cooling water tank 13. Its movement is provided by a traction track 14 fitted after the tank 13.

10 As already stated, the outer coating is desirable but not obligatory. Similarly, the outer coating could be deposited by a separate operation from the deposition of the inner coating, carried out subsequently on a tube which is already internally lined.

15 Fig. 2 is a section showing the construction according to the invention of the die 6 which enables two different layers superposed inside the tube to be deposited in a single operation. To facilitate understanding, the dot-dash lines in Fig. 2 show the shaping means 5 which converts the ribbon 1
20 to a closed tube, and the wheel 10 which welds this tube.

The die 6 has an inner annular channel 15 which is defined by a punch 16 mounted and supported by its end remote from the outlet 11. Punch 16
25 is centrally formed with a passage 17 which is

used to inject air into the composite tube.

The annular channel 15 terminates downstream in the outlet 11 and upstream it has two concentric inlets, an outer one 18 and an inner one 19.

5 These inlets are defined materially by a sleeve 20 which contains the end part 21 by which the punch 16 is supported. The sleeve 20 terminates in an end face 20A in a chamber 22 which is situated just at the start of the annular channel 15.

10 The outer part 23 of the sleeve 20 has a diameter less than that of the chamber 20 and has a circular groove 24 opposite which a hole 25 leads into the chamber 22. The hole 25 communicates with a conduit 26 for supplying graft polyethylene from the extruder 9.

15 Upstream of chamber 22 the sleeve 20 is fitted in the body of the die and has an internal cavity around the punch 16 formed by a chamber 27. The latter continues in the form of an annular channel 20. 28 internally limited by the punch 16. Channel 28 leads into the end face 20A. This face is disposed a short distance from the start of the channel 15. As a result of this arrangement the latter has two inlets, one 18 which is formed by the annular part of the chamber 22 which surrounds the sleeve 20,

(18)

the other 19 by the annular channel 28 which opens into the end face 20A. At its opposite end the chamber 27 communicates with a hole 29 which in turn communicates with a duct 30 supplying cross-linkable polyethylene from the extruder 8.

During operation, the two different plastics enter the channel 15 simultaneously, as shown in the drawing by means of cross hatching. The two annular and concentric streams remain in contact without mixing and after the common outlet 11 are urged against the inner metal surface of the welded ribbon. This effect is promoted by a flaring 31 of the end of the punch 16 which extends outside the die outlet 11 and by the pressure of the air injected into the tube 12 via the passage 17 in the punch 16.

In this example, the layer coming into contact with the aluminium is graft polyethylene obtained from acrylic acid commercially available under the mark PEG of Compagnie Francaise de Raffinage. It adheres firmly to the aluminium and is covered by the layer of cross-linkable polyethylene which in this case is of the silylated ethylene copolymer type commercially available under the mark Sioplas E of the American company Dow Corning.

As already stated, the aluminium tube may subsequently be coated with two outer layers of polyethylene.

It is advantageous to carry out this operation simultaneously with the inner lining operation just described. The equipment illustrated in Fig. 3 can then be used.

This equipment comprises the die 6 of Fig. 2, from which the internally coated tube 12 leaves. Shortly after passing through the die outlet 11, the tube 12 enters a bush 32 concentric therewith and in which it is guided during its movement. The bush 32 is in turn screwed into a sleeve 33 which is concentric therewith and with which it limits an annular chamber 34 which terminates downstream in an annular outlet 35. In fact outlet 35 leads into an end frusto-conical face formed by the complementary frusto-conical end faces of the sleeve 33 and bush 32. The sleeve 33 is in turn mounted in a carrier member 36 with which it limits an outer annular chamber 37 concentric with chamber 34. Chamber 37 terminates downstream in an annular outlet 38 to which it leads after a frusto-conical annular portion 39 of progressively decreasing section. This portion 39 is limited

by the frusto-conical end faces of the sleeve 33
and of the bush 32, on the one hand, and by a frusto-
conical inner surface 40 of a member 41 housed
in a recess in the member 36. In member 41 the
5 inner frusto-conical surface 40 terminates in an
outlet 42 which surrounds and guides the completed
internally and externally coated tube 12.

The above-described assembly is held on the
axis of movement of the ribbon 1 closed around
10 the die 6 by its fixing to the feed means 7 through
the agency of a support 43. The die 6 is connected
to the feed means 7 through the agency of screws
by one of its side surfaces where the ducts 30
and 26 open out. Coupled to the support 43 is
15 the feed means 7 in which a cross-linkable poly-
ethylene inlet 44 divides into two branches 45
and 46 which respectively lead, on the one hand,
to the duct 30 and, on the other hand, to the chamber
37 via a channel 47. The latter extends through
20 the support 43 and the sleeve 33 from the branch
45 as far as the chamber 37. Another channel
48 is drilled in the means 7 and the sleeve 33
to connect the duct 26 of the die 6 to the chamber
34. In Fig. 3 the channel 48 is situated beneath
25 the channel 47 over a part of its length, as will

be apparent from Fig. 4.

The duct 26 is fed by the extruder 9. In Fig. 1, the extruders 8 and 9 are shown side by side on the same side of the die 6. This arrangement is only diagrammatic. When the extruder 8 is on one side of the die 6 as in Fig. 3, the extruder 9 can be disposed on the opposite side to inject the graft polyethylene at A into the duct 26; the space required for the wheel 10 (not shown in Fig. 3) can simply be provided between the extruder 9 and the outlet 11 of the die 6.

The equipment thus comprises a first die described with reference to Fig. 2 and a second die which is mounted downstream of the first, coaxially therewith; this second die also has two separate coaxial inlets 34 and 37 and a single common outlet 38.

By means of this equipment the welded tube is internally coated after the outlet 11 of the die 6 as explained hereinbefore and is externally coated very shortly afterwards on leaving the bush 32 and the sleeve 33.

The graft polyethylene meets the cross-linkable polyethylene at the outlet 35 and accompanies it as far as the common outlet 38. Here too the graft polyethylene comes into contact with the

aluminium tube and provides good adhesion thereto.

Subsequently, the finished tube 12 is subjected to an operation known per se in a 90°C water bath which causes cross-linking of the layer of cross-linkable polyethylene.

It will be seen that the simultaneous extrusion of the two internal layers by a single outlet is advantageous, according to one characteristic of the method of the invention, when the tube has a fairly small diameter. A very large diameter tube would enable two dies or a single die with two separate outlets to be installed more easily. According to another variant of the invention, the second plastic layer may be selected according to the intended use of the composite tube and is not necessarily cross-linkable polyethylene.

At all events, irrespective of the final intended use of the composite tube, it is advantageous to use the above-described combined die by means of which a first extruder delivers the graft polyethylene both for the interior and for the exterior, while a second extruder delivers the second layer of plastic material both for the interior and for the exterior, the layer of graft polyethylene originating from the first extruder guaranteeing adhesion

to the aluminium of the material leaving the second extruder.

CLAIMS

5 (See English claims, columns 9 and 10 on page 6 of original document).

10

15

20.

25