

**ELONGATE TUBULAR PRODUCT, ESPECIALLY OF THE
INSTALLATION DUCT TYPE**

5 The present invention relates to an elongate
tubular product, having in general the same cross
section over its entire longitudinal direction, and
comprising a solid tube consisting of at least one
plastic, which is both sufficiently flexible for it to
itself be wound up and unwound and sufficiently rigid
for it itself to withstand a centripetal or centrifugal
10 radial force.

 By the above generic definition, the present
invention is intended to encompass under the same
concept, for example, equally well an installation
duct, for at least one cable or one pipe, subsequently
15 contained in said installation duct, or a protective
sheath for at least one cable, for example an electric
cable.

 Moreover, by the terms "cable" or "pipe", the
present invention should be understood to cover any
20 duct which allows, in general, transfer or transport of
a flow, whether this is of a fluid (water or gas, for
example), of energy (electricity, for example), or
alternatively of information or signals (video
transmission via optical cable, for example), or of
25 data in the form of electrical signals, be they
analogue, digital, etc.

 In order to introduce and define the present
invention, reference is now made, by way of example, to
installation ducts and/or to cables or pipes installed
30 in said ducts.

 In order to limit the amount of civil engineering
work, and in particular the number of jointing
chambers, it is known to lubricate the friction
surface, corresponding to the inner surface of the
35 solid tube forming the installation duct, and/or the



outer surface of the protective sheath, for example the cable protection sheath. This makes it possible in fact to increase the length of tube which can be installed.

5 This lubrication is generally provided in a surface layer on the inside and/or outside of the tube, the free surface of which constitutes a friction surface.

Various solutions have been proposed for this purpose.

10 According to document WO 93/14546, the surface layer consists of a lubricating film or coating, either in solid or liquid form. In the case of a solid lubricating coating, this may, for example, be a plastic matrix made of polyethylene in which solid
15 particles, for example graphite particles, may be distributed. In the case of a liquid lubricating coating, this may, for example, be a silicone-based oil.

20 Document EP 0,326,711 describes a solution comparable to that defined above, in the sense that the solid surface layer constitutes the internal layer of a tube coextruded with an external layer.

25 According to document DE 3,539,304, the surface layer, consisting of a grease or paste which is lubricating, but adherent, is added and remains on the inside of the tube.

This lubricating paste or grease itself consists of a mixture of a liquid lubricant and particles of a solid lubricant.

30 The subject of the present invention is an elongate tubular product, with permanent, almost dry lubrication of the friction surface or surfaces of the solid tube, significantly decreasing the frictional forces, including those compared with the solutions
35 identified and discussed above.

For this purpose, according to the invention, a synergistic action has been discovered between:

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- on the one hand, particles of a solid-type lubricant, which are distributed in the plastic matrix of the surface layer and are at least partly flush with the free surface of the latter; and

5 - on the other hand, a liquid-type lubricant, compatible with the plastic matrix, which lubricant is dispersed in the surface layer virtually without wetting the free surface of the latter.

10 The observed synergistic effect may be explained by the fact that the particles of the solid lubricant which are flush with the surface are as it were lubricated in turn by the liquid lubricant wetting them.

15 By virtue of the present invention, an installation duct becomes, as it were, a universal duct in the sense that it is compatible, without any other modification, with all the current installation techniques, whether they be pulling techniques, for example using a small cable, or blowing techniques, for example using a pig, or by blowing-pushing.

20 Moreover, when the solid lubricant is an electrical conductor, the lubricating system according to the invention makes it possible to eliminate, at least in part, the static charges generated by the friction between the duct and the cable while the latter is being installed.

25 The present invention also has the following secondary characteristics:

30 - the solid lubricant has a lamellar structure, and is, for example, graphite, or else has a polymeric structure with oriented long straight chains, and is, for example, a polytetrafluoroethylene;

35 - the particles of the solid lubricant are microspheres having a diameter of at most 20 μm , and preferably of between 1 and 15 μm ;

 - the liquid lubricant is preferably, but not exclusively, a silicone; it has a viscosity of at most

1000 centistokes, at room temperature, and, for example, of between 10 and 1000 centistokes, the thickness of the film of liquid lubricant on the free surface of the surface layer not exceeding 1 μm ;

5 - the solid lubricant constitutes a filler;
 - the surface layer is irregular over the periphery of the solid tube and corresponds, for example, to longitudinal ribs or grooves; however, this same surface layer may be continuous over the periphery
10 of the solid tube.

 Preferably, it is the solid tube which consists of just the plastic matrix in which, on the one hand, particles of the dry lubricant are distributed, these particles being partly flush with at least one, inner
15 or outer, free surface and constituting a dry-friction surface, and, on the other hand, a liquid lubricant is diffused, virtually without wetting either the outer surface or the inner surface of this same matrix.

 According to this preferred solution, the solid
20 lubricant constitutes a filler, the proportion by weight of which is at least equal to 5% of the plastic matrix, in particular between 5% by weight and 20% by weight of this same matrix.

 Still according to this same preferred solution,
25 the matrix includes, in the diffused state, a liquid lubricant, which constitutes as it were an additive, its proportion being at least equal to 0.02% by weight of the plastic matrix, and in particular between 0.02% by weight and 0.08% by weight of this same matrix. In
30 this case, by way of example, the solid lubricant/ liquid lubricant proportion is at least equal to 5% and is in particular between 5% and 20%.

 The present invention will now be described with reference to the appended drawing, in which:

35 - Figure 1 shows diagrammatically, in axial section, an installation duct according to the invention;

- Figure 2 shows, in axial section, a sheath for protecting a cable according to the invention; and

- Figure 3 shows, in cross section, an installation duct according to the invention, but in another embodiment of the latter.

According to Figure 1, an installation duct consists of a solid or rigid tube 1, made of a filled plastic (for example, high-density polyethylene), which is both sufficiently flexible for it itself to be wound up and unwound and sufficiently rigid for it itself to withstand a centripetal or centrifugal radial force. This solid tube has a dry-friction surface corresponding to its inner surface.

According to the present invention, at least one surface layer 3 is formed in the solid tube 1, the free surface of this layer constituting the dry-friction surface (inner surface 2). This surface layer comprises a plastic matrix, corresponding to that of the solid tube, in which particles 4 (microspheres) of a solid lubricant are distributed, these particles being partly flush with the free surface 2.

According to another embodiment of an installation duct according to the invention, shown in Figure 3, the latter comprises three concentric layers 6, 7 and 8, optionally made of respectively different plastics, namely the outer layer 7, the inner layer 6, in which the surface layer 3 is incorporated, and the other, middle layer or interlayer 8. The surface layer 3 is discontinuous over the periphery of the solid tube 1, and comprises, for example, longitudinal ribs 9 or corresponding longitudinal adjacent grooves.

However, of course, this same surface layer 3 may be continuous over the periphery of the solid tube 1.

As shown in Figure 4, the surface layer 3 is obtained by spraying or diffusing, inside the tube 1, after extrusion but in the viscoelastic phase, the

solid lubricant in particulate form and mixed with the liquid lubricant.

In this way, the solid lubricant and the liquid lubricant are incorporated in the plastic matrix of the tube, at least on the surface.

EXAMPLE 1:

A tube made of high-density polyethylene (HDPE), (commercial reference DAPLEN 4610 from the French company PCD), having an inside diameter of 27 mm and a thickness of 3 mm, is extruded on a CMS60 machine from the company Cincinatti.

A suspension of a polytetrafluoroethylene (PTFE) powder (commercial reference UNILUB T3 from the company Uniflon) having an average particle size of 16 μm , in a silicone oil (commercial reference 47V100 from the company Pennwhite) having a viscosity of 100 centistokes, is sprayed in divided form, at the exit from the extrusion head, into the extruded tube while it is still viscoelastic. The PTFE powder represents 20% by weight (PTFE) with respect to the oil.

The friction coefficient between the internal surface of such a tube and a sheath made of HDPE (same commercial reference as above) is 0.075.

Everything else being equal, the PTFE powder and the silicone oil act synergistically in order to decrease the friction coefficient since:

- the friction coefficient obtained without treatment of the internal surface of the tube is 0.19;
- the friction coefficient obtained with just silicone oil being sprayed is 0.102.

EXAMPLE 2:

An 8 mm cable is pushed by blowing, with a pig, into a 2400 m installation duct made of high-density polyethylene (HDPE), having an inside diameter of 26 mm

and a thickness of 2.2 mm. In the first case, the inner surface of the installation duct is coated with the liquid lubricant (silicone oil) identified in Example 1. In the second case, the inner surface is coated with a solid lubricant powder identical to that in Example 1.

In the first case, it is not possible to install a length of tube exceeding 400 m, whereas in the second case it was possible to install lengths of tube ranging up to 700 m, all other things being equal.

EXAMPLE 3:

An installation duct, made of high-density polyethylene, having an inside diameter of 27 mm and a thickness of 3 mm, for an installed cable of 17.6 mm outside diameter, is used with the inner surface of the duct coated firstly with a silicone oil having a viscosity of 100 cP, secondly with a Teflon® powder having a particle size of 10 μ m and thirdly with a mixture of powder in the aforementioned oil, with a level of 10% by weight of the powder with respect to the oil.

In the three cases, the friction coefficients measured during the pushing/conveying of the cable are 0.102, 0.071 and 0.0061, respectively.

EXAMPLE 4:

An installation duct made of high-density polyethylene, having an inside diameter of 27 mm and a thickness of 3 mm, for an installed cable of 17.6 mm outside diameter, is used with the inner surface of the duct coated with a lubricating mixture consisting of a liquid lubricant (silicone) having a viscosity of 100 cP and an increasing proportion by weight of a solid lubricant (Teflon® powder) having the same

particle size as previously, namely 5, 10, 15 and 20% by weight, respectively.

In the above four cases, the friction coefficients measured during the blowing/conveying of the cable are 0.086, 0.085, 0.089 and 0.090, respectively.



CLAIMS

1. Elongate tubular product, having the same cross section over its entire longitudinal direction, comprising a solid tube (1) consisting of at least one plastic, which is both sufficiently flexible for it
5 itself to be wound up and unwound and sufficiently rigid for it itself to withstand a centripetal or centrifugal radial force, said solid tube having, on the inside and/or the outside, a surface layer (3), the
10 free surface of which constitutes a friction surface, said surface layer comprising a plastic matrix in which a lubricant is dispersed, characterized in that, synergistically, on the one hand, particles (4) of a solid-type lubricant are distributed in the plastic
15 matrix, these particles being at least partly flush with the free surface of the surface layer, and, on the other hand, a liquid-type lubricant, compatible with the plastic matrix, is dispersed in the surface layer, virtually without wetting the free surface of the
20 latter.

2. Tubular product according to claim 1, characterized in that the liquid lubricant is a silicone.

3. Tubular product according to Claim 1, characterized in that the liquid lubricant has a viscosity of at most
25 1000 centistokes, at room temperature, and, for example, of between 10 and 1000 centistokes.

4. Tubular product according to Claim 1, characterized in that the particles (4) of the solid lubricant are microspheres having a diameter of at most 20 μm , and
30 preferably of between 1 and 15 μm .



5 5. Tubular product according to Claim 1, characterized in that the solid tube (1) consists of just the plastic matrix in which particles (4) of the dry lubricant are distributed, these particles being partly flush with at least one, inner or outer, free surface (2) constituting a dry-friction surface.

10 6. Tubular product according to Claim 5, characterized in that the solid lubricant constitutes a filler, the proportion of which is at least equal to 5 % by weight, and comprised between 5 and 20 % by weight of said matrix.

15 7. Tubular product according to Claim 5, characterized in that the liquid lubricant is essentially in the liquid state and is diffused into the plastic, virtually without wetting either the outer surface or the inner surface of the said matrix.

20 8. Tubular product according to Claim 7, characterized in that the liquid lubricant constitutes an additive, the proportion of which is at least equal to 0.02% by weight of the plastic matrix, and in particular between 0.02% and 0.08% by weight of said matrix.

9. Tubular product according to Claim 8, characterized in that the solid lubricant/liquid lubricant proportion is at most equal to 5%.

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