CLAIMS

1. Duct rod system to be pushed in a conduit (12) of a defined configuration for installing an elongated element in the conduit (12) and comprising at least one rod (2, 2a, 2b, 2c) having a flexible main body, characterized in that the flexible main body has a bending stiffness arrangement defined in relation to the defined configuration of the conduit (12) to permit a friction reduction of the flexible main body in the conduit (12).

2. Duct rod system as claimed in claim 1, wherein the conduit (12) has a length and the defined configuration of the conduit (12) comprises at least its length to define the bending stiffness arrangement of the main body.

3. Duct rod system as claimed in any one of claims 1 or 2, wherein the conduit (12) has bends and/or junctions and the defined configuration of the conduit (12) comprises at least its number, and/or kinds, of bends and/or junctions to define the bending stiffness arrangement of the main body.

4. Duct rod system as claimed in claim 3, wherein the bending stiffness arrangement is defined in relation to a bend of the conduit (12) with the formula:

$$B \geq \frac{14\left(D_d - D_c + \frac{\alpha^2}{8} R_b\right)^2}{\alpha^2} P_F \ ;$$

wherein B is the bending stiffness, D_d is the inner diameter of the conduit, D_c is the diameter of the rod, R_b is the bend radius of the bend and α is the angle of the bend and P_F is the local pushing force applied to the rod.

5. Duct rod system as claimed in claims 1 to 3, wherein the defined configuration of the conduit comprises undulations with amplitude A and period P, and wherein the bending stiffness arrangement is defined in relation to the undulations of the conduit (12) with the formulas :

$$B \geq \frac{14\left(D_d - D_c + \frac{\alpha^2}{8} R_b\right)^2}{\alpha^2} P_F \ ;$$

$$R_b = \frac{(\pi - 2)P^2}{4\pi^2 A} \ ;$$

$$\alpha = \frac{4\pi A}{P} \ ;$$

wherein B is the bending stiffness, A is the amplitude of the undulations, P is the period of the undulations, D_d is the inner diameter of the conduit, D_c is the diameter of the rod, R_b is the bend radius of the bend and α is the angle of the bend and P_F is the local pushing force applied to the rod.

6. Duct rod system as claimed in any one of claims 1 to 5, wherein the flexible main body has a first end (3) to be first introduced into the conduit (12), characterized in that there is at least one first point located on the main body at a first distance from the first end (3) and in that there is at least one second point located on the main body at a second distance from the first end (3), the second distance being greater than said first distance and the bending stiffness of the flexible main body at the second point being greater than the bending stiffness at the first point.

7. Duct rod system as claimed in any one of claims 1 to 6, characterized in that the main body comprises at least a first and a second elongated part being disconnectable, with the first elongated part to be first introduced into the conduit (12), the bending stiffness of the second elongated part being greater than the bending stiffness of the first elongated part.

8. Duct rod system as claimed in any one of claims 1 to 7, characterized in that it comprises a sleeve (15) able to be introduced into the conduit (12) and covering at least one portion of the main body of the rod (2, 2a, 2b, 2c).

9. Duct rod system as claimed in claim 8, characterized in that the friction factor between the sleeve (15) and the flexible main body is lower than 0.1.

10. Duct rod system as claimed in any one of claims 1 to 9, wherein when bended, the main body has a reaction moment in a portion where the main body is bended, characterized in that the reaction moment of the main body is lowered in the portion where the main body is bended.

11. Duct rod system as claimed in claim 10, wherein the main body has a cross section with an area moment of inertia, characterized in that the bending stiffness is lowered by a reduction of the area moment of inertia in the portion where the main body is bended.

12. Duct rod system as claimed in any one of claims 10 or 11, wherein the main body has a cross sectional shape and characterized in that the cross sectional shape is concavo-convex.

13. Duct rod system as claimed in claim 12, characterized in that the sides of the main body are equipped with circular rods.

14. Duct rod system as claimed in any one of claims 1 to 13, characterized in that the main body comprises an attachment device located at the first end (3) to be first introduced into the conduit (12).

15. Duct rod system as claimed in claim 14, characterized in that the attachment device is detachable from the main body.

16. Duct rod system as claimed in any one of claims 1 to 15, characterized in that it comprises pigs to be installed along the length of the main body, to apply on the rod (2, 2a, 2b, 2c) a pulling force from a fluid flow created in the conduit (12).

17. Duct rod system as claimed in any one of claims 1 to 16, characterized in that the length of the main body is greater than 20 meters.

CLAIMS

1. Duct rod system to be pushed in a conduit (12) of a defined configuration for installing an elongated element in the conduit (12) and comprising at least one rod (2, 2a, 2b, 2c) having a flexible main body, wherein the flexible main body has a bending stiffness arrangement defined in relation to the defined configuration of the conduit (12) to permit a friction reduction of the flexible main body in the conduit (12), wherein the conduit (12) has bends and/or junctions and the defined configuration of the conduit (12) comprises at least its number, and/or kinds, of bends and/or junctions to define the bending stiffness arrangement of the main body, characterized in that the bending stiffness arrangement is defined in relation to a bend of the conduit (12) with the formula:

$$B \geq \frac{14\left(D_d - D_c + \frac{\alpha^2}{8} R_b\right)^2}{\alpha^2} P_F \ ;$$

wherein B is the bending stiffness, D_d is the inner diameter of the conduit, D_c is the diameter of the rod, R_b is the bend radius of the bend and α is the angle of the bend and P_F is the local pushing force applied to the rod.

2. Duct rod system to be pushed in a conduit (12) of a defined configuration for installing an elongated element in the conduit (12) and comprising at least one rod (2, 2a, 2b, 2c) having a flexible main body, wherein the flexible main body has a bending stiffness arrangement defined in relation to the defined configuration of the conduit (12) to permit a friction reduction of the flexible main body in the conduit (12), wherein the conduit (12) has bends and/or junctions and the defined configuration of the conduit (12) comprises at least its number, and/or kinds, of bends and/or junctions to define the bending stiffness arrangement of the main body, wherein the defined configuration of the conduit comprises undulations with amplitude A and period P, and characterized in that the bending stiffness arrangement is defined in relation to the undulations of the conduit (12) with the formulas :

$$B \geq \frac{14\left(D_d - D_c + \frac{\alpha^2}{8} R_b\right)^2}{\alpha^2} P_F \ ;$$

$$R_b = \frac{(\pi - 2)P^2}{4\pi^2 A} \ ;$$

$$\alpha = \frac{4\pi A}{P} \ ;$$

wherein B is the bending stiffness, A is the amplitude of the undulations, P is the period of the undulations, D_d is the inner diameter of the conduit, D_c is the diameter of the rod, R_b is the bend radius of the bend and α is the angle of the bend and P_F is the local pushing force applied to the rod.

3. Duct rod system as claimed in claim 1 or 2, wherein the conduit (12) has a length and the defined configuration of the conduit (12) comprises at least its length to define the bending stiffness arrangement of the main body.

4. Duct rod system as claimed in any one of claims 1 to 3, wherein the flexible main body has a first end (3) to be first introduced into the conduit (12), characterized in that there is at least one first point located on the main body at a first distance from the first end (3) and in that there is at least one second point located on the main body at a second distance from the first end (3), the second distance being greater than said first distance and the bending stiffness of the flexible main body at the second point being greater than the bending stiffness at the first point.

5. Duct rod system as claimed in any one of claims 1 to 4, characterized in that the main body comprises at least a first and a second elongated part being disconnectable, with the first elongated part to be first introduced into the conduit (12), the bending stiffness of the second elongated part being greater than the bending stiffness of the first elongated part.

6. Duct rod system as claimed in any one of claims 1 to 5, characterized in that it comprises a sleeve (15) able to be introduced into the

conduit (12) and covering at least one portion of the main body of the rod (2, 2a, 2b, 2c).

7. Duct rod system as claimed in claim 6, characterized in that the friction factor between the sleeve (15) and the flexible main body is lower than 0.1.

8. Duct rod system as claimed in any one of claims 1 to 7, wherein when bended, the main body has a reaction moment in a portion where the main body is bended, characterized in that the reaction moment of the main body is lowered in the portion where the main body is bended.

9. Duct rod system as claimed in claim 8, wherein the main body has a cross section with an area moment of inertia, characterized in that the bending stiffness is lowered by a reduction of the area moment of inertia in the portion where the main body is bended.

10. Duct rod system as claimed in any one of claims 8 or 9, wherein the main body has a cross sectional shape and characterized in that the cross sectional shape is concavo-convex.

11. Duct rod system as claimed in claim 10, characterized in that the sides of the main body are equipped with circular rods.

12. Duct rod system as claimed in any one of claims 1 to 11, characterized in that the main body comprises an attachment device located at the first end (3) to be first introduced into the conduit (12).

13. Duct rod system as claimed in claim 12, characterized in that the attachment device is detachable from the main body.

14. Duct rod system as claimed in any one of claims 1 to 13, characterized in that it comprises pigs to be installed along the length of the main body, to apply on the rod (2, 2a, 2b, 2c) a pulling force from a fluid flow created in the conduit (12).

15. Duct rod system as claimed in any one of claims 1 to 14, characterized in that the length of the main body is greater than 20 meters.