

NEW JOINT FOR STEEL PIPE WHICH IS OIL TIGHT AT HIGH PRESSURE AND
INSENSITIVE TO THE PHENOMENON OF SEIZURE

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The present invention relates to a new joint for steel pipes and in particular for pipes intended for the oil industry. The invention refers more especially to joints in which oiltightness is ensured by pairs of sealing surfaces of slightly conical shape which come into contact with one another upon tightening up the joint.

In this known type of joint there is employed on the male member a sealing surface the diameter of which is slightly greater than the corresponding diameter of the sealing surface on the female member, so that at the time of tightening up the joint high contact pressures are exerted between the two sealing surfaces, these being pressures which must be sufficient to ensure oiltightness under the highest pressure which the assembly of pipes must withstand.

Known joints of this type may include only one pair of sealing surfaces, situated either at the end of the male member or at the end of the female member. They may equally well include two pairs of sealing surfaces arranged on opposite sides of the threads which are respectively on the end of the male member and on the end of the female member.

Furthermore the conditions of exploitation of oil fields are at present such that one is led to collect the petroleum at greater and greater depths, which makes it essential to achieve joints which remain oiltight at working pressures which may exceed $1,000 \text{ kg/cm}^2$.

Again it may likewise happen that one is led to exploit oil fields at great depth, which contain high contents of corrosive agents such as sulphuretted hydrogen or carbon dioxide, and that one is obliged to employ stainless steels containing chromium, nickel as well as other additive elements. These two requirements which are met more and more often simultaneously cause the joints which are known at present, not to give satisfaction. That is, the stainless steels the employment of which is necessary in order to be able to withstand corrosive agents have a natural tendency to seizure which becomes considerably increased by the necessity of employing high contact pressures at the level of the metal sealing surfaces.

This is the reason why the only joints known today which enable this problem to be solved, include very steeply inclined sealing surfaces (of the order of 30°) with respect to the axis of the pipe, a stop for restricting screwing up immediately becoming opposed to further screwing as soon as contact has been obtained at the level of the sealing surfaces. It will be understood that this type of joint is difficult to put into use and to machine, because the stop for restricting screwing up must be positioned extremely precisely with respect to the steeply conical sealing surfaces.

The present invention relates to a metal-to-metal oiltight joint which includes slightly conical sealing surfaces and which is oiltight at high pressures without there being any risk of giving rise to seizure phenomena even when these joints are

produced from steel or from steel which is stainless or heavily loaded with chromium, with nickel and with other additive elements.

According to the present invention is a joint for pipes, especially of steel or alloy, which is oiltight at high pressure, being the type including at least one pair of slightly conical sealing surfaces arranged at at least one end of the male member or of the female member, in which pair the first contact of the sealing zone lying at the end of one member occurs against the corresponding sealing surface of the other member, in which at the time of this first contact the taper of the sealing surface which is situated at the end of one of the members of the joint is less than the taper of the corresponding sealing surface which is situated on the other member of the joint, the generatrices of said pair of conical sealing surfaces having an angular difference which corresponds with a slope of 0.5 to 2%, the sealing surfaces at the time of tightening the joint, becoming applied as a whole against one another with a contact pressure sufficient to ensure oiltightness, the said joint being insensitive to seizure.

Tests which have been made by the Applicant Company have revealed that for a reason which it has not been possible to determine with certainty, the joints which exhibit the characteristics which have just been defined above, may be screwed up to apply the sealing surfaces against one another with very high pressures without harmful seizure occurring and with satisfactory oiltightness and with preservation of the good quality of these

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surfaces, this being even when the members of the joint are produced from steel or alloy heavily loaded with chromium, nickel and other additive elements and consequently having a particular propensity to seizure.

- 5 Preferably the angular difference between the generatrices of the two sealing surfaces is the greater, the lower the ratio of thickness to diameter of the pipes.

10 In accordance with the invention the joint advantageously includes a stop for restricting screwing up so that excessive tightening does not engage the male member too deeply in the female member, so exceeding uselessly the necessary contact pressures between the sealing surfaces and risking impairing them.

15 The present invention may be employed on joints having taper threads or cylindrical threads. It may likewise be employed on joints which include only one pair of sealing surfaces or on those which include two pairs of sealing surfaces arranged one at the end of the male member and the other at the end of the female member on opposite sides of the threads.

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With the aim of letting the invention be better understood, there will now be described by way of illustration and without any restrictive character, a number of embodiments given by way of example and represented in the drawing in which:

- 5 - Figure 1 is a diagrammatic section showing how the first contact of the sealing zone lying at the end of one of the members must occur against the conical sealing surface on the other member;
- Figure 2 corresponds with Figure 1 but in the case in which the
10 first contact does not occur in accordance with the invention;
- Figures 3 and 4 represent diagrammatically the differences in diameter which the pairs of sealing surfaces must exhibit in order that the first contact shall occur in accordance with the invention;
- 15 - Figures 5 and 6 represent diagrammatically a joint in accordance with the invention in which the sealing surfaces are situated at the end of the female member;
- Figures 7 and 8 represent diagrammatically a joint in accordance with the invention in which the sealing surfaces are
20 situated at the end of the male member;
- Figures 9 and 10 represent diagrammatically a joint having a double cylindrical thread and in accordance with the invention, in which the sealing surfaces are situated at the end of the male member;
- 25 - Figures 11 and 12 represent a joint in accordance with the invention equipped with a frustoconical thread and two pairs of sealing surfaces situated at the end of the female member;

- Figures 13, 14 and 15 represent a joint in accordance with the invention equipped with a frustoconical thread and including a first pair of sealing surfaces at the end of the female member and a second pair of sealing surfaces in the vicinity of the end of the male member.

In Figure 1 there is shown diagrammatically how the first contact must occur between two sealing surfaces of a joint in accordance with the invention.

In the embodiment shown in Figure 1 the sealing is effected at the end of the male member. In this Figure are found the male member 1, the female member 2, the frustoconical sealing surface 3 of the male member 1 and the frustoconical sealing surface 4 of the female member 2. In accordance with the invention the first contact between the sealing zone at the end of the male member and the sealing surface on the female member must take place on the frustoconical surface 4 of the female member 2 as is seen shown at 5 in Figure 1.

In Figure 2 is shown the way in which on the contrary the first contact occurs between the end of the male member and the female member in a manner which is not in accordance with the invention. In this case the point of first contact 5 is not situated on the frustoconical sealing surface 4 of the female member but on the zone which connects this frustoconical surface with the thread.

In Figure 3 the portions are shown again which concern the sealing of the joint as Figure 1. The point 6 has likewise been

plotted which is the end of the theoretical line of the generatrix of the conical surface 3 of the male member 1 as well as the point 7 which is the theoretical end of the generatrix of the frustum of the cone of the sealing surface 4 of the female member 2.

In order that the condition in accordance with the invention represented in Figure 1 shall be achieved it is sufficient that the diameter D_1 of the male member at the point 6 is slightly less than the diameter D_2 of the female member at the point 7.

10 It will be understood that under these conditions the first contact of the male member occurs against the frustoconical sealing surface 4 of the female member.

In Figure 4 the case is shown in which the sealing in accordance with the invention occurs at the end of the female member 8,
15 the male member being shown diagrammatically at 9.

The end point of the theoretical line of the generatrix of the frustoconical sealing surface 10 of the female member is shown at 12 whereas the corresponding point of the theoretical line of the generatrix of the frustoconical surface 11 of the male member
20 is shown at 13. In order that the condition in accordance with the invention shall be achieved it is sufficient that the diameter D'_1 corresponding with the point 13 shall be slightly less than the diameter D'_2 corresponding with the point 12.

It goes without saying that both in the case of Figure 3 and in

that of Figure 4 the difference existing between the diameters D_1 , D_2 and D'_1 , D'_2 must be sufficiently small to enable a force fit of the two sealing surfaces into one another in order to obtain the contact pressure necessary to the oiltightness which it is desired to impart to them.

In Figure 5 a joint in accordance with the invention is shown, in which the sealing surfaces are situated on the outside of the pipe at the end of the female member 8. The thread 14 is shown diagrammatically, which enables the assembly of the two tubular members, as well as the stop 15 created inside the female member, against which the end of the male member comes to bear in order to avoid excessive screwing up of the joint.

Figure 6 repeats on a larger scale the portion VI from Figure 5. It represents the joint at the instant at which the end of the female member 8 comes into contact at 5 with the frustoconical sealing surface 11 of the male member 9 in accordance with one of the characteristics of the invention.

In Figure 6 there are shown at A_1 and A_2 the angles which the generatrices of the frustoconical sealing surfaces 11 of the male member 9 and 10 of the female member 8, make with respect to the axis of the pipe.

In accordance with the invention the slope A_2 of the sealing surface 10 which lies at the end of the female member 8 is less than the slope A_1 of the sealing surface 11 on the male member 9 which is separated from the end of the male member by the whole

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length of the threads 14. That is shown in Figure 6 by the fact that the angle A_1 is greater than the angle A_2 , which at the time at which first contact occurs at 5, leaves between the two sealing surfaces 10 and 11 an angle B equal to $A_1 - A_2$.

- 5 It is clear that when screwing up is continued so that the end of the male member 9 comes into contact with the stop 15, this angular difference B tends progressively towards zero, the sealing surface 10 of the female member becoming completely applied against the sealing surface 11 of the male member.
- 10 In Figure 7 an embodiment of the invention is shown in which the sealing occurs inside the joint at the end of the male member 1 which at the end of tightening up comes to bear against the stop 15 for restriction of screwing up, which is situated on the female member 2.
- 15 As may be seen in Figure 8 which represents on a larger scale the portion VIII from Figure 7, the first contact of the male member 1 occurs at 5 against the frustoconical sealing surface 4 of the female member 2.

As has been shown on the drawing and in accordance with the
20 invention the angle A_1 which the generatrix of the sealing surface 3 which is at the end of the male member 1, makes with the axis of the pipe, is less than the angle A_2 which the generatrix of the surface 4 of the female member, makes with the axis of the pipe, the difference $A_2 - A_1$ being represented by the angle B .

In this case likewise, of course, when the joint has been tightened up and the end of the male member 1 has come to bear against the stop for restriction of screwing up 15, the surfaces 3 and 4 are applied against one another along their whole length with the contact pressure which is sufficient to ensure oiltightness even at high pressures.

In Figure 9 is shown, half in axial section, a joint in accordance with the invention in the state screwed home, which includes a cylindrical thread 14 having two stages, a stop for restriction of screwing up 15 arranged at the end of the male member 1 and a sealing zone arranged at the end of the male member and consisting of the sealing surface 3 on the male member 1 and the sealing surface 4 on the female member 2.

In Figure 10 on a larger scale the portions of the male members 1 and 2 are shown, which surround the sealing zone.

As indicated in Figure 10 and in accordance with the invention the slope of the surface 3 of the male member is less than the slope of the surface 4 of the female member 2.

In the embodiment shown and with a pipe of which the outer diameter is 180 millimetres and the thickness 9 millimetres, produced from a steel having a chromium content higher than 20%, the slope of the sealing surface 3 on the male member, represented by the angle A_1 is equal to 4.25%, whereas the slope of the surface 4 of the female member represented by the angle A_2 is equal to 5%, which in accordance with the invention corresponds before

tightening up, to a difference of angular slope of 0.75%.

In Figure 11 a particular embodiment of the invention is shown, which includes a joint having a frustoconical thread with sealing surfaces arranged at the end of the female member, which likewise includes a stop 15 for restriction of screwing up, against which the end of the female member 8 comes to bear.

As may be seen in Figure 12, the slope of the sealing surface 10 on the female member 8, which is represented by the angle A_2 is equal to 24%, whereas the slope of the sealing surface 11 on the male member 9 is represented by the angle A_1 which is equal to 25%.

In accordance with the invention the slope of the surface 10 which is at the end of the female member 8 is less by 1% than the slope of the sealing surface 11 on the male member.

Finally in Figure 13 an embodiment is shown, of a joint in accordance with the invention which includes two sealing zones arranged respectively at the end of the male member 1 and at the end of the female member 2.

In Figures 14 and 15 these two sealing zones are shown on a larger scale.

In Figure 14 may be seen the slopes A'_1 and A'_2 of the sealing surfaces 11 and 10 and in Figure 15 the slopes A''_1 and A''_2 of the sealing surfaces 3 and 4. In accordance with the invention A'_1

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corresponds with a slope of 25% (or 14 degrees), A'2 corresponds with a slope of 24% (or 13.5 degrees) and A''1 corresponds with a slope of 5.25% (or 3 degrees) and A''2 corresponds with a slope of 6% (or 3.5 degrees).

It will be observed that the difference in angular slope is equal to 1% in the case of Figure 14 and that in the case of Figure 15 it is equal to 0.75%.

In both cases in accordance with the invention it is the sealing surfaces which are situated at the end of a member (10 in Figure 14 and 3 in Figure 15) which have the smaller tapers.

It is quite clear that the embodiments which have been described above are indicated only by way of example and that they might be modified without thereby departing from the scope of the invention.

In particular the invention may be applied to any pipe and is not restricted to certain grades of steel.



CLAIMS

1. A joint for pipes especially of steel or alloy, which is oiltight at high pressure, being of the type including at least one pair of slightly conical sealing surfaces arranged at at least one end of the male member or of the female member, in which
5 pair the first contact of the sealing zone lying at the end of one member occurs against the corresponding sealing surface of the other member, in which at the time of this first contact the taper of the sealing surface which is situated at the end of one of the members of the joint is less than the taper of the correspond-
10 ing sealing surface which is situated on the other member of the joint, the generatrices of said pair of conical sealing surfaces having an angular difference which corresponds with a slope of 0.5 to 2%, the sealing surfaces at the time of tightening the joint, becoming applied as a whole against one another with a contact
15 pressure sufficient to ensure oiltightness, the said joint being insensitive to seizure.
2. A joint as in claim 1, in which the angular difference corresponds with a slope of about 0.75 to 1%.
3. A joint as claimed in claim 1 or claim 2, which includes a
20 stop for restricting screwing up, which restricts tightening of the joint as soon as the necessary pressures have been obtained between the various points on the sealing surfaces.
4. A joint as claimed in any one of the preceding claims, which has taper threads.



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5. A joint as claimed in any one of the claims 2 and 3 and which has cylindrical threads.

6. A joint as claimed in one of the claims 1 to 5, which includes two pairs of sealing surfaces arranged one at the end
5 of the male member and the other at the end of the female member on opposite sides of the threads.

7. A joint as claimed in any one of the preceding claims, in which the angular difference between the generatrices of the two sealing surfaces is the greater, the lower the ratio of
10 thickness to diameter of the pipes.

