

Pipe connection

The invention concerns a pipe connection, in particular a gas tight pipe screw connection wherein the parts in the connecting region are connected by means of joining according to DIN 8593 by way of contact-pressing and insert-pressing,
5 comprising an inner pipe part and an outer pipe part, or two inner pipe parts with an outer collar.

Pipes, mostly seamless pipes that can be formed from different materials, are utilized for the conveyance of oil field- and/or gas field products vertically and horizontally also over large distances and require, because of the significant demands, a high sealing
10 quality of the connections during practical operation or application.

A pipe connection that has already been utilized over the long term, and represents essentially prior art in regard to the geometric basic concepts, is designed in such a manner that an inner pipe part and an outer pipe part features sealing surfaces that are truncated cone shaped and abut against one another, with an inclination toward one
15 another in the distal direction of the inner pipe part of about 1: 10, and that act together with stop surfaces that are truncated cone shaped and are aligned opposite the axis direction. A sealing effect can thereby be achieved by means of a mutual, axial contact-pressing (fully engaged) of the pipe endings for example by means of a thread connection or similar.

20 In order to improve the tightness or the quality of the pipe connection in the case of the demands on the pipe lines present in the field, but also to achieve in the case of a

dismantling and reassembling of the pipe components maintenance of the sealing quality of the pipe connections, a plurality of geometric embodiment forms have already been proposed with particular design of the seal- and stop surfaces of the connection. Complex sealing surface shapings are however usually associated with higher
5 expenditures for the chip-removing processing of the connecting regions of the pipe endings and with lowered cost effectiveness of manufacture.

The US 7 334 821 B2 discloses a pipe connection with a barrel-shaped sealing surface of the pipe inner part that is convex in cut, followed by a protruding extension with a distal stop surface. Thereby, during full engagement of the pipe connection, the press
10 surfaces of the pipe components are to obtain a higher conicity and achieve an improved sealing effect. The manufacturing effort for the construction of the complex shaped sealing regions appears however to be high.

Building on the essential geometric concepts of a pipe connection according to prior art it is the object of the invention to indicate, while providing high cost effectiveness of the
15 manufacturability, a novel pipe connection that effects improved usage characteristics of the pipe lines in practical field applications and is beneficial for a dismantling and a reassembly of pipes.

The improved usage characteristics of the pipe lines concern in particular the maintenance of the seal tightness of the respective pipe connections in the case of high
20 interior pressure as well as in the case of high external pressure, as well as overlaying tensile-, pressure-, and bending-load of the pipe strand, whereby so-called seizing

symptoms in the connecting region are minimized and a release and a renewed full engagement of the connection is to be improved.

The posed problem is solved according to the invention by means of a pipe connection of the type mentioned above in that the connection is implemented with three regions,
5 wherein the connecting regions of the press fit and stop of the pipe parts or collar comprise cooperating press fit surfaces that have a truncated cone shape and that are inclined in the end direction from the inner pipe part toward the pipe axis, and at the front comprise stop surfaces, which have a truncated cone shape and are directed counter to said press fit surfaces and a transition from press fit and stop of the parts that
10 are connected is provided for said parts without contact with a coaxial intermediate space or hollow space.

The advantages achieved with the invention are, acting together, essentially an increase of the surface pressure on the press fit surfaces and an advantageous positioning of said surfaces spaced apart from the stop surfaces. Associated with that is a general
15 optimization of the size of the local, mechanical material stress in the connecting region and an avoidance of tension spikes in respect to the appearance of plastic deformations and the initiation of tears in the material.

By means of extensive investigations it was determined that the sealing characteristics of the pipe connections according to the invention are completely maintained during
20 pressures beyond the nominal and during overlaying tensile-, pressure-, and bending loads.

Calculations according to the FE method as well as elasticity determinations have established that through a geometry according to the invention in the connecting region and namely with the implementation of a hollow space between press fit- and stop surfaces a plurality of advantages is achieved.

- 5 For one, the press fit- and sealing fit surfaces are shortened or reduced by means of the hollow space at, relative to prior art, the same longitudinal extent of the connection, which leads to higher sealing surface pressures.

The transition that is implemented contact-free provides load-kinetically an elevated, largely homogeneous, specific surface pressure and thereby the sealing at the press fit
10 surfaces, wherein, because of an axial spacing apart relative to the stop surfaces, only tolerable differences in the local surface pressure are created in the case of a bending of the system. Overlaying tensile stresses and pressure tensions, if applicable, have only a negligible effect on the sealing of the connection because the press fit surfaces feature a slight inclination of about 1:10.

- 15 Advantageously the hollow space in the connecting region of the pipe parts acts as a greasing means pocket and improves the distribution and lowers the pressure of the grease material during the sealing assembly of the field pipeline.

If, according to a preferred embodiment of the invention the transition between the pipe parts, that is produced without contact of the connecting region's press fit and stop, is
20 formed by means of a coaxial recess from the interior wall surface of the outer pipe part,

optimal mechanical material stresses as well as also tension states that promote the sealing of the connection are achieved.

During the insert-pressing of the inner pipe part into the outer pipe part in the case of a complete engagement setting of the connection, significant, primarily radially oriented
5 forces are created in the region of the press fit surfaces that leads in this region to an expansion with a tangential, elastic stretching of the material of the outer pipe wall.

By means of a coaxial recess on the interior wall surface of the outer pipe part in the following transition region, and therefore a contact removal of the pipe parts in the region up to the stop surfaces, no elastic stretchings of the outer pipe wall in the
10 tangential direction are provided, however axially directed tensional forces act in said region that come to bear, by means of a press-on of the stop surface of the inner pipe, on those of the outer pipe and produce an elastic stretching in the axial direction.

In the connecting region local complex tension states are thereby largely reduced according to the invention, wherein according to the invention the implementation of
15 the transition region produces larger, elastic stretching values and assures the seal tightness of the connection even in the case of complex demands on the pipe strand.

In an optimal way the recess in the transition region features in its cross section a corner-free profile because as a result tension spikes on the interior surface of the outer pipe part are largely avoided and the initiation of tears and the danger of a breach is
20 eliminated.

If the inner pipe part is implemented in a rounded manner in the region of the transition from the distally continued press fit surface to the stop surface, then local tension spikes can be eliminated with local plastic material deformations and the cooperation of the stop surfaces can be improved. Particularly good results were achieved with an edge
 5 rounding with a radius of $R_c = 0.9$ to 1.5mm or for TUBINGS of $R_t = 0.2$ to 0.6mm .

It is advantageous if the coaxial recess is implemented in the outer pipe part in the cross section of the press fit surface with a transition radius of 0.5 to 1.0 mm and is shaped up to the stop surface edge-free. Thereby pressure tension spikes are assuredly avoided in the border region of press fit surface and recess.

10 Extensive and specific investigations have revealed that the quotient of the length of the transition that is implemented without contact to the length of the effective press fit should have in an optimal sense a value of 0.4 to 1.7 , preferably of 0.6 to 1.5 , in order to achieve optimal sealing conditions of a pipe connection according to the invention.

This apparently broad value range was obtained from an inclusion of all common pipe
 15 diameters.

Dimensionally-related evaluations revealed that the quotient, for pipes that are so-called casings with an outer diameter of larger than $4\frac{1}{2}$ inches, is optimized around 0.4 to 1.2 , preferably around 0.6 to 1.0 .

On the other hand, for riser or conveying pipes that feature an external diameter of
 20 smaller/equal $4\frac{1}{2}$ inches to about 1.66 inches and lower, i.e. in the case of so-called tubings, optimized quotients of length of the transition that is implemented without

contact to the length of the press fit were determined to be 0.9 to 1.7, preferably 1.1 to 1.5.

In order to achieve an optimal and high-value compact embodiment form of the pipe connection with increased seal tightness, the outer pipe part should feature an
5 inclination of the press fit surface of about 1: 10 relative to the diameter of the stop surfaces, and the stop surface should feature, oriented oppositely, an angle beta of $\beta = 10^\circ$ to 20° , preferably of $\beta =$ about 15° relative to the axis normal.

If, as experiments have revealed, the press fit surfaces and/or the stop surfaces feature a surface roughness of less than $R_a = 3.2\mu\text{m}$, however more than $R_a = 0.4\mu\text{m}$ measured as
10 a mean roughness value according to DIN 4777 ISO/DIN4287/1, then a high specific pressure load is applicable without a so-called seizure of the press fit surfaces and a largely unrestricted dismantling of the pipe connection is possible. It is assumed in this regard that in the depressions of the rough surface profile in the upper roughness limits an optimal greasing means amount can be positioned in order to achieve the desired
15 properties.

Effect-related the pipe connection according to the invention can be placed in full engagement through different means that press the pipe parts axially together. The known screw connections have proven themselves to be advantageously effective.

By means of a schematic illustration only one embodiment form of a pipe connection
20 according to the invention is to be represented in what follows.

It is shown:

Figure 1 a pipe connection in an axial cut.

In Figure 1 a pipe connection of an inner pipe I and an outer pipe A is shown in an axial cut.

In the connecting region of the pipes the inner pipe part I features a truncated cone surface with a press fit surface 1I that are, in reference to the pipe diameter, inclined distally at a value of 1:10. Following the press fit surface 1I distally a stop surface 2I is shaped that is inclined toward the pipe's longitudinal axis x at an angle β of 15° in an oppositely oriented manner and that represents a stop 2 with a sealing surface on the front and the inner pipe end.

A outer pipe part A abuts in the case of a completely engaged pipe part connection in the connecting region 1 proximal against the press fit surface 1I of the inner pipe with the press fit surface A1.

Between the connecting region 1, which encompasses the press fit surfaces 1I and 1A, and the region 2 with the stop surfaces of the pipe parts there is a transition region 3 provided in which a recess RA from the interior wall of the outer pipe A is present, a hollow space R is formed between the pipe parts I and A and the parts in this zone are placed without contact.

In the outer pipe part A the border region between press fit surface 1A and recess profile 3A is rounded with a radius of 0.8 mm, wherein in what follows the entire interior wall surface 3A of the coaxial recess RA up until the stop surface 2A is implemented in an edge-free rounded manner.

Patent Claims

1. Pipe connection, particularly a gas-tight pipe screw connection, comprising an inner pipe part (I) and an outer pipe part (A), or two inner pipe parts (I) having an outer collar (A), by which connection the parts in the connecting region are connected by means of joining according to DIN 8593 by way of contact-pressing and insert-pressing, wherein the connecting regions comprise press fit (1) and stop (2) of the pipe parts or the pipe parts and collar, and comprise cooperating press fit surfaces (1I, 1A) that have a truncated cone shape and that are inclined in the end direction from the inner pipe part toward the pipe axis (x), and at the front comprise stop surfaces (2I, 2A), which have a truncated cone shape and are directed counter to said press fit surfaces (1I, 1A), characterized in that a transition (3) is formed by the press fit (1) and stop (2) of the connected parts for said parts without contact with a coaxial intermediate space or hollow space (R), with the proviso that the quotient of the length of the transition (3) that is implemented without contact to the length of the press fit (1) yields a value from 0.4 to 1.7.
2. Pipe connection according to claim 1, characterized in that the transition (3), which is implemented without contact between the pipe parts, is the connecting region press fit and stop that is formed by means of a coaxial recess (RA) from the interior wall surface (3A) in the outer pipe part (A).
3. Pipe connection according to claim 1 or 2, characterized in that the recess (RA) in the transition region (3) features a corner-free profile (3A) in cross section.
4. Pipe connection according to claims 1 to 3, characterized in that the inner pipe part (I) is shaped in a rounded manner in the region of the transition (3) by the distally continued press fit surface (1I) and stop surface (2I).

5. Pipe connection according to any one of the claims 1 to 4, characterized in that the coaxial recess (RA) is implemented in the outer pipe part (A) in the cross section of the press fit surface (1A) to the recess profile (3A) with a transition radius (Ro) of 0.5 to 1.0 mm ($R_o = 0.5 - 1.0$) and is shaped up to the stop surface (2A) edge-free.
6. Pipe connection according to any one of the claims 1 to 5, characterized in that the quotient of the length of the transition (3) that is implemented without contact to the length of the press fit (1) yields a value from 0.6 to 1.5.
7. Pipe connection according to claim 6, characterized in that for casing pipes according to API 5CT, which are essentially casings with an outer diameter of larger than 4 1/2 inches, the quotient of the length of the transition (3) that is implemented without contact with the inner pipe part (I) to the length of the press fit (1) yields a value from 0.4 to 1.2, preferably from 0.6 to 1.0.
8. Pipe connection according to claim 6, characterized in that for casing pipes according to API 5CT, which are essentially riser or conveying pipes with an outer diameter of 4 1/2 inches or smaller, for example 1.66 inches, the quotient of the length of the transition (3) that is implemented without contact with the inner pipe part (I) to the length of the press fit (1) yields a value from 0.9 to 1.7, preferably from 1.1 to 1.5.
9. Pipe connection according to any one of the claims 1 to 8, characterized in that the outer part (A) features a inclination of the press fit surface (1A) of about 1: 10 relative to the diameter and the stop surface (2A) features an angle beta of β from 10° to 20°, preferably of about 15° to the axis normal.
10. Pipe connection according to any one of the claims 1 to 9, characterized in that the pipe material is thermally hardened at least in the connecting region and features an increased material strength.

11. Pipe connection according to any one of the claims 1 to 10, characterized in that the press fit surfaces (1I, 1A) and/or the stop surfaces (2I, 2A) feature a surface roughness of less than $Ra = 3.2\mu m$ according to E-Norm (European Norm), however more than $Ra = 0.4\mu m$, measured as a mean roughness value according to DIN 4777 ISO/DIN4287/1.

12. Pipe connection according to any one of the claims 1 to 11, characterized in that the joining of the pipe parts is accomplished by means of a screw connection.