

Operating valve

The invention relates to an operating valve for a pressure cooker, a pressure cooker and a pressure valve.

Conventional pressure cookers have an operating valve as well as a safety valve. In the known pressure cookers, two different pressure levels corresponding to a gentle cooking stage I and a fast cooking stage II, can be usually adjusted in the cooker by means of a cooking stage selector. Here, the operating valve has a pressure control function. When the pressure of a certain cooking stage is exceeded, the operating valve opens, so that steam can escape from the cooker. In the known valves, for example, a metallic sealing part is seated on plastics. It is also possible that such an operating valve additionally comprises an integrated spherical valve via which steam can escape at the beginning of the cooking procedure. At a certain internal pressure in the cooker, this valve closes, so that overpressure can build up in the cooker. This valve can simultaneously also be used as vacuum protection, as in case of a vacuum in the cooker, the spherical valve opens and air can flow inside. The additionally provided safety valve is, for example, a not self-reversing pressure valve and also functions as overpressure protection, integrated automatic venting and integrated vacuum prevention.

There are strict international standards for the response characteristic of the operating valves. The start-to-leak pressure in cooking stage I is, for example, 40 kPa (0.4 bar), and in cooking stage II, for example, 80 kPa (0.8 bar). Corresponding to some national provisions, a maximum tolerance of ± 20 kPa (± 0.2 bar) is admissible here. The response and stabilization characteristics of known valves cannot always observe the predetermined exacting tolerances, so that a great difference pressure from the start-to-leak to the stabilization pressure is required.

In known operating valves, where a sealing surface is made of plastics or rubber, accuracy is further affected as rubber or plastics ages over time, so that by this sufficient response accuracy can neither be granted. The large sealing surfaces moreover result in a high closing force, so that the setting mechanism for the different cooking stages at the cooker is difficult to actuate.

Starting from this situation, the object underlying the present invention is to provide an operating valve, a pressure cooker with such an operating valve as well as a pressure valve, which exhibit improved response and stabilization values.

According to the invention, this object is achieved by claims 1, 11 and 16.

By employing a spherical sealing element in combination with a conically shaped surface as a valve seat, the response characteristic of the valve can be essentially improved. Tolerances of $< \pm 20$ kPa ($< \pm 0.2$ bar) can be reliably observed. Spherical sealing element is here defined as a sealing element which at least comprises one spherical segment seated on the conically shaped surface for sealing.

This results in a small sealing surface between the spherical sealing element and the valve seat, having a positive effect on the response characteristic. By the above mentioned design, the valve does not only open more quickly when the start-to-leak pressure is achieved, but it also closes more quickly again after temperature has been reduced. The design according to the invention furthermore offers the advantage that the escaping steam results in a self-cleaning effect, so that the operating valve does not soil or get sticky. Moreover, less dirt will settle on the straight conical sealing surfaces than in the known valves which have edges and corners in the sealing area where dirt can settle, which, however, is not acceptable when it comes to food.

The compression spring which applies the adjustable compressive force onto the spherical

sealing element is advantageously a torsion bar spring. Thus, pressure can be transmitted from an operating element at the grip to the spherical sealing element in a simple way.

As the annular sealing surface is small due to the design of the operating valve, the closing force can be clearly reduced compared to prior art. This on the one hand offers the advantage that the operating element can be more easily actuated, and moreover that a softer torsion bar spring can be used. The compressive force can be e.g. within a range of 0 to 5 N at maximum (up to cooking stage II). The softer springs can here advantageously have a reduced diameter of e.g. 1 - 1.4 mm.

An extremely good response characteristic shows when the conical surface conically diverges at an angle α of 30° to 40°, preferably 32° to 37°, in particular 35°. Here, tolerances of up to ± 5 kPa (± 0.05 bar) can be achieved for the start-to-leak pressure.

It has a particularly advantageous effect on the response characteristic if the spherical sealing element and the conical surface are made of metal, in particular stainless steel.

According to a preferred embodiment of the invention, the operating valve has a valve box as well as a valve core which comprises the conical surface. The advantage of such a valve core is that different materials can be used for the valve box and the valve core. The valve core can then be simply inserted into the valve box and fixed therein, e.g. by clipping or clamping.

The valve box can in this case, for example, be formed of flexible plastics, in particular of silicone. This offers the advantage that the valve box is flexible and thus can be, for example, easily pressed in from inside the cooker lid through an opening in the cooker lid and seal the opening itself. Even if, for example, the flexible material of the valve box ages, the valve core, which is made, for example, of metal, can maintain its original sealing properties. It is particularly advantageous if silicone is used as the material for the valve box as silicone is food-safe and does not include any softeners etc., which would be critical when it comes to food chemistry.

It is also particularly advantageous for the flexible valve box to be formed of a transparent material, in particular transparent silicone, as no pigments that are critical when it comes to food chemistry can escape from such a material. The translucent material is moreover particularly suited because the user can immediately see if the valve is heavily soiled inside.

It proved to be particularly suited to embody the spherical sealing element as a valve pin with an upper region which, as a sealing surface, at least comprises one spherical element, and with a rod-shaped extension adjacent to it.

This extension can then extend through a through opening in the valve box and thus stabilize the position of the spherical surface. Moreover, the configuration of the spherical sealing element as a valve pin permits an easier handling of this element compared to a ball. By orienting the spherical sealing element, one can ensure that an upper surface onto which, for example, the compression spring presses, is always oriented correctly, perpendicularly to the longitudinal axis of the valve, so that pressure is uniformly distributed, in turn promoting the response characteristic.

A through opening extends through the valve box, the valve core being accommodated at least in the upper region. The valve box advantageously comprises at least one opening extending essentially radially to the outside and being in connection with the through opening. This opening ensures that, if the opening in the lower region of the operating valve is closed by food, steam can escape via these openings to the outside.

Advantageously, the rod-shaped extension in the valve box is floating.

A pressure cooker according to the present invention comprises a lid in which an operating valve is inserted. Furthermore, the pressure cooker lid comprises a pressure valve.

The pressure valve is in particular embodied with a ball, a compression spring, a valve box and a conically shaped surface as a valve seat, and with a sealing ring which is externally pushed on around the valve box, the valve box comprising an upper collar and the pressure valve being arranged in an opening of the lid such that the lid is situated between the collar and the sealing ring, where the pressure valve can be vertically moved in the lid.

This means that the function of the operating valve is restricted to the adjustment of the pressure stages and evaporation, and, due to its design, the pressure valve takes on the functions of automatic venting, overpressure protection ($p > 150 \text{ kPa}$ (1.5 bar)) and vacuum prevention. Due to the design of the pressure valve with a ball and a conical surface as a valve seat, here, too, the response characteristic of the pressure valve can be clearly improved. Here, too, the ball and the conical surface of the valve seat are made of metal. The angle at which the conical surface diverges is also preferably 30° to 40° , more preferred 33° to 37° , in particular 35° .

At least one opening extends radially in the valve box above the sealing ring.

The present invention will be illustrated below in greater detail with reference to the following figures.

Fig. 1 schematically shows a side view of an operating valve according to the present invention.

Fig. 2 schematically shows a longitudinal section through the operating valve shown in Fig. 1.

Fig. 3 shows the operating valve according to the invention in a perspective representation.

Fig. 4 shows a perspective sectional representation through the operating valve according to the invention.

Fig. 5 shows an exploded view of the operating valve according to the invention.

Fig. 6 schematically shows a side view of a pressure valve according to the present invention.

Fig. 7 shows a longitudinal section through the pressure valve shown in Fig. 6.

Fig. 8 shows the pressure valve shown in Figs. 6 and 7 in a perspective representation.

Fig. 9 shows a section of the pressure valve according to the invention in a perspective representation.

Fig. 10 shows an exploded view of the pressure valve according to the invention.

Fig. 11 schematically shows a pressure cooker according to the present invention.

Fig. 12 shows a section through the lid of the pressure cooker shown in Fig. 11.

Fig. 13 shows, in a schematic representation, a top view onto the bottom side of the lid of the pressure cooker according to the present invention.

Fig. 14 shows, in a schematic representation, a longitudinal section of the spherical sealing element configured as a valve pin.

Fig. 11 shows a pressure cooker in a perspective representation which comprises a cooker 37, a lid 34 as well as a grip composed of an upper grip 33a and a lower grip 33b. Here, the grip comprises an operating element 38 in the form of a slide by which, with the aid of a torsion bar spring (see Fig. 12), a start-to-leak pressure corresponding to a cooking stage, for example cooking stage I (corresponding to a predetermined pressure value within a range of 20 - 30 kPa (0.2 - 0.3 bar)), or cooking stage II (corresponding to a predetermined pressure value within a range of 80 - 90 kPa (0.8 - 0.9 bar)) of the operating valve 1 can be adjusted. Furthermore, the cooker can also be vented and opened via the operating element.

Figs. 1 to 5 show a possible embodiment of the operating valve 1 according to the present invention. As can be taken from the drawings, the operating valve 1 comprises a valve box 2 which is preferably formed of transparent plastics, in particular of flexible silicone. The silicone has a Shore hardness of, for example, $60^{\circ} \pm 5^{\circ}$. The valve box 2 is advantageously formed of a transparent material offering the advantage that the user can immediately notice soiling inside the operating valve 1. Silicone moreover does not comprise any substances critical when it comes to food chemistry, and in translucent materials it neither comprises any pigments. Moreover, silicone is perfectly temperature resistant. The valve box 2 has a through opening 12 which extends from the top to the bottom along the central axis L. In the outer region, the valve box comprises an annular groove 14 and a surrounding projecting lip situated under the groove, as well as a projecting ring 16 arranged above the recess 14. The groove 14 as well as the lip 15 and the ring 16 are designed such that the valve body can be inserted from the bottom side of the lid 34 through a corresponding opening in the lid, where the lid then comes to lie in the groove 14 and is clamped by the ring 16 and the lip 15 and sealed, as can be taken in particular from Fig. 12. Thus, the operating valve 1 can be easily inserted and removed for cleaning purposes.

As can be taken in particular from Figs. 2, 4 and 5, a valve core 3 is inserted in the valve box 2 which has a hollow design and has at its inner side a conical surface as a valve seat 5. The valve core 3 comprises at its upper and lower end annular projections 10a and 10b by means of which it can be clamped in the flexible valve box 2. Advantageously, the valve core 3 is made of metal, in particular bright stainless steel. The valve core 3 extends at least through the upper region of the through opening 12. In the upper region of the valve box 2, there are ribs 11 inside the through opening 12 which facilitate the insertion of the valve core and the assembly of the complete operating valve 1 into the lid 34.

As can be seen in Figs. 2, 4 and 5, a spherical sealing element 4 movable in the direction of arrow is provided within the valve core 3. The spherical sealing element 4 can be embodied as a ball, but here comprises at least one spherical segment which comes to lie on the conical surface 5 for sealing, as can be in particular also seen in Fig. 14. Fig. 14 shows, in the upper region, a section through a virtual ball 50, where the shaded segment can function as sealing surface 7. In this embodiment, the spherical sealing element 4 is embodied as a valve pin and moreover comprises a rod-shaped extension 8b next to the upper region 8a. At the upper end of the spherical sealing element 4, a circular surface 6 is provided whose dimension k essentially corresponds to the diameter d of the virtual ball $\pm 10\%$. The height h of the lower region 8b is at least $1.5d$. The diameter b of the lower region 8b is smaller than the diameter d of the virtual ball 50. At the lower end, the lower region 8b comprises a surrounding projecting edge 19.

The spherical sealing element 4 can be inserted into the valve box 2 from above. Underneath the valve core 3, the through opening 12 comprises several ribs 13 distributed around the inner circumference of the through opening 12 and extending in a direction along the axis L, however,

the distance of opposite ribs 13 is greater than the dimension b of the lower region 8b of the spherical sealing element 4, so that the spherical sealing element 4 is here floating. The longitudinal ribs 13 do not extend completely to the lower end of the through opening 12. By the projecting edge 19 of the spherical sealing element 4, whose diameter is greater than the distance between the flexible opposite longitudinal ribs 13, the spherical sealing element 4 is retained in the valve box 2 and cannot slip out to the top by itself. Thus, the spherical sealing element 4 can be correctly oriented in the valve box, so that the upper side 6 can essentially perpendicularly orient to the longitudinal axis L , and a uniform pressure can be exerted from the torsion bar spring onto the surface 6. In the closed state, the surface 6 does not protrude beyond the projection 10a of the valve core. Advantageously, the spherical sealing element 4 is also made of metal, in particular of stainless steel.

Underneath the valve core 3, the valve box 2 comprises at least one opening 9 essentially extending radially to the outside which is in connection with the through opening 12. It is thus ensured that, even if the lower opening of the valve box is covered by food, steam can exit through the openings 9 to the outside.

The spherical sealing element is made of metal, in particular of bright stainless steel.

By the design of the operating valve 1, and in particular by the spherical sealing element 4 and the conical surface as a valve seat 5, the response characteristic of the valve can be clearly improved. Thus, tolerances of ± 0.2 bar for the start-to-leak pressure until the valve is completely opened can be realized. A particularly good response characteristic results if the angle α at which the conical surface diverges is within a range of 30° to 40° , preferably 33° to 37° or $35^\circ \pm 0.5$. With such an arrangement, a tolerance of ± 5 kPa (± 0.05 bar) can be even realized.

The diameter d of the spherical sealing element is preferably within a range of 6 to 9 mm. The lower diameter of the conical surface of the valve seat is selected to be small enough for the ball to be seated on the surface above the lower edge 70. Due to the small annular sealing surface 7, a lower closing force for the compression spring 21 is required. The torsion bar spring 21 which presses onto the surface 6 (see Fig. 12) requires, for example, instead of 9.5 N, now only 4.15 N at an internal pressure of 90 kPa (0.9 bar), stage II. At stage I, the closing force is e.g. 1.4 N at an overpressure of 30 kPa (0.3 bar). So, the closing force is within a range of up to about 5 N. At an internal pressure of 150 kPa, the closing force would be 6.9 N. For this reason, the torsion bar spring can be embodied to be clearly softer and has, for example, a smaller diameter within a range of preferably 1 - 1.4 mm. The length of the torsion bar spring is between 50 and 90 mm (preferably 75 mm), and as the material, spring steel, in particular Nirosta spring steel (1.4310) having a modulus of rigidity G for spring steel of in particular e.g. 73000 N/mm² is suited. Such soft springs can e.g. have a spring rate, i.e. a ratio of torsional moment / angle of twist < 10 N mm / degree of angle of twist, in particular 1 - 7 N mm / degree of angle of twist.

As the closing force is lower, the operating device, i.e. the slide 38, at the cooker grip can also be actuated more easily. The geometry of the conical surface and the spherical sealing element result in a cleaning effect by the escaping steam, so that no dirt can settle at the smooth surfaces, which in turn leads to a stable functioning of the valve.

As already mentioned before, a spring force is applied onto the spherical sealing element 4, where the operating valve opens when a certain start-to-leak pressure is achieved in the cooker.

As can be taken from Figs. 12, 13 and Figs. 6 to 10, the pressure cooker moreover comprises, apart from the operating valve, the pressure valve 20. The self-reversing pressure valve here functions as overpressure protection, automatic venting and vacuum prevention. As can be taken from Fig. 6, this valve 20 also comprises a valve box 24 which has a through opening 41.

The valve box 24 is preferably made of metal, in particular of bright stainless steel. The pressure valve comprises a ball 23 onto which pressure is applied via the spring 22. The spring 22 is preferably embodied as a conical spring, heat treated and has a diameter increasing to the top. The through opening 41 of the valve box 24 comprises a conical surface 28 as a valve seat. For sealing, the ball here rests on the conical surface, where the diameter of the ball (e.g. 4 to 6 mm) and the lower diameter of the conical surface are adapted such that the ball is seated on the surface 28 above the lower edge 71.

The end or the lower edge of the conical region is rounded. The ball is also made of metal, in particular of bright stainless steel.

The valve box 24 has, at its upper end, a surrounding projecting edge 27 as well as a sealing ring 30, for example of silicone, which is slid onto an annular groove. The pressure valve is inserted from the upper side of the lid into an opening in the lid (Fig. 12) and is seated with the edge 27 on the lid. Then, the sealing ring 30 is pushed into the groove from the bottom side. So, the lid 34 is then lying between the seal 30 and the projecting edge 27. So, the pressure valve can then, as is represented in Fig. 6 by the arrow, moved up and down in the lid bore in the lid 34.

As in the operating valve, the angle β of the conical surface 28 is preferably 30° to 40° , in particular 33° to 37° . Best results with respect to the response characteristic showed at an angle of $35^\circ \pm 0.5^\circ$. In the upper region, above the sealing ring 30, at least one opening 31 radially extending to the outside is provided. The transverse openings prevent incorrect installation and venting.

In the manufacture and assembly of the pressure valve, first the ball 23 and the spring 22 are introduced into the valve box 24 via the upper opening of the valve box 24. Here, an edge 42 projects upwards at the upper side of the valve box 24. The edge 42 is then folded inwards after the ball and the spring have been assembled to retain the spring in the pretensioned state. The previously determined spring force acting on the ball 23 is constant.

As can be in particular taken from Figs. 12 and 13, the operating valve 1 and the pressure valve 20 are arranged in a recess underneath the grip 33a which extends over the lid's upper side, where openings to the outside are provided to discharge steam.

The pressure cooker 12 according to the present invention functions as follows.

First, the food to be heated is put into the cooker 37 together with liquid (water), and the lid is closed in a known manner, e.g. by a bayonet catch and a locking mechanism 36. Via the slide or the operating element 38, respectively, a certain cooking stage is adjusted, so that the compression spring 21 exerts a corresponding spring force onto the surface 6 of the spherical sealing element 4 corresponding to this cooking stage. At cooking stage I, the pressure in the cooker corresponds, for example, to a pressure value within a range of 20 - 30 kPa, at cooking stage II to a pressure value within a range of 80 - 90 kPa. At this point in time, the spherical sealing element 4 onto which a spring force by the spring 21 is applied is in its lower closed position such that the operating valve 1 is closed.

Due to the normal pressure in the cooker, the pressure valve 20 is in a position in which the edge 27 rests on the lid 34, as is represented in Fig. 6. The ball 23, onto which pressure is applied by the spring 22 and which rests on the conical surface 28, keeps the valve 20 closed.

By heating the cooker, water evaporates and the pressure in the cooker rises. Steam can escape to the outside via the openings 31 in the pressure valve as well as in the annular gap

between the lid bore and the pressure valve. If the pressure in the cooker rises to a certain pressure, e.g. 4 kPa (0.04 bar), the pressure valve moves upwards, as is represented by the arrow in Fig. 6, so that the seal 30 is lying against the lower lid edge and here seals the opening or lid bore.

Now, the pressure in the cooker can rise when it is further heated.

When the selected start-to-leak pressure (stage I or II) is reached in the cooker, the spherical sealing element 4 moves upwards, as is represented by the arrow in Fig. 2, and the valve 1 opens. Due to the design according to the invention as described above, the operating valve has a very good response characteristic with a tolerance of $< \pm 20$ kPa (0.2 bar).

Temperature must be reduced now, so that the pressure falls again below the start-to-leak pressure of the operating valve 1.

Due to the design of the operating valve 1 according to the invention, the valve can also close again very quickly when this pressure is reached, as the response characteristic is better than in prior art.

The pressure inside the cooker can be identified via a pressure display 32. Here, a cylinder rises upwards depending on pressure in a known manner.

If the pressure in the cooker would rise above a certain limiting value, e.g. 1.5 bar, the pressure valve 20 would open, and then the ball would be pressed against the spring 22 upwards, so that steam can escape.

When the cooking process is terminated, pressure can be relieved from the spherical sealing element 4 via the operating element 38 and via the spring 21, so that the steam can escape via the operating valve 1, and the cooker lid can be opened at normal pressure. As pressure falls, the pressure valve 20 also sinks downwards, so that the edge 27 rests on the lid 34 around the lid bore. Thus, a vacuum in the cooker can also be prevented.

Claims

1. Operating valve for a pressure cooker (60), having
 - a movable spherical sealing element (4),
 - a valve box (2) comprising a through opening (12) which extends through the valve box (2); and a conically shaped surface as a valve seat (5) provided in an upper region of the through opening (12), wherein the surface of the valve seat (5) conically diverges at an angle α of 30° to 40°, and
 - a compression spring (21) which applies an adjustable compressive force onto the spherical sealing element (4),
 - wherein the spherical sealing element (4) comprises an upper region (8a) which comprises a spherical segment as a sealing surface (7); a rod-shaped extension (8b); and a projecting edge provided at a lower end of the rod-shaped extension (8b)
 - wherein the valve box (2) comprises a plurality of ribs (13) which are provided at a lower position than the valve seat (5) in the through opening (12), distributed around an inner circumference of the through opening (12), and extending along a direction of extension of the through opening (12),
 - a diameter of the projecting edge (19) is larger than a distance between ribs (13) opposite each other and is smaller than a diameter of the through opening (12) at its lower position than the plurality of ribs (13).
2. Operating valve according to claim 1, characterized in that the compression spring (21) is a torsion bar spring.
3. Operating valve according to claim 2, characterized in that the compressive force of the torsion bar spring (21) can be adjusted to at least two pressure stages and can be adjustable within a range of 0 to 5 N.
4. Operating valve according to at least one of claims 1 to 3, characterized in that the spherical sealing element (4) and the valve seat (5) are made of metal.
5. Operating valve according to at least one of claims 1 to 4, characterized in that the operating valve (1) comprises a valve box (2) with a valve core (3) comprising the valve seat (5).
6. Operating valve according to claim 5, characterized in that the valve box (2) is made of flexible, preferably transparent plastics, in particular of silicone.
7. Operating valve according to at least one of claims 1 to 6, characterized in that the spherical sealing element (4) is embodied as a valve pin with an upper region (8a) which comprises a spherical segment as a sealing surface (7), and a rod-shaped extension (8b).
8. Operating valve according to at least one of claims 1 to 7, characterized in that the valve box (2) comprises a through opening (12) which extends through the valve box (2) and in which, at least in the upper region, the valve core (5) is received, the valve box comprising at least one opening (9) essentially extending radially outside which is in connection with the through opening (12).

9. Operating valve according to at least one of claims 1 to 8, characterized in that the rod-shaped extension (8b) is floating in the valve box (2).
10. Pressure cooker in the lid (34) of which an operating valve according to at least one of claims 1 to 9 is inserted, the lid furthermore comprising a pressure valve (20) which opens at a predetermined pressure in the pressure cooker.
11. Pressure cooker according to claim 10, characterized in that the pressure valve (20) comprises: a ball (23), a compression spring (22), a valve box (24) with a conically shaped surface (28) as a valve seat, where the valve box (24) comprises an upper collar (27), and the pressure valve (20) is arranged in an opening of the lid (34) such that the lid is lying between the collar (27) and the sealing ring (30), such that the pressure valve (20) can be vertically moved in the lid (34).
12. Pressure cooker according to claim 11, characterized in that the ball (23) and the conical surface (28) are made of metal.
13. Pressure cooker according to claim 11 or 12, characterized in that the surface (28) conically diverges at an angle α of 30° to 40°, preferably 33° to 37°, in particular 35°.
14. Pressure cooker according to at least one of claims 10 to 12, characterized in that at least one radially extending opening (31) is formed in the valve box (24) above the sealing ring (25).