

Silos and installations for the production of concrete

Technical field of the invention

The present invention relates to a silo into which constituents for the production of concrete, so-called components, are introduced separately from one another and stored separately from one another, in order to then transport them to a construction site and there on the construction site, taking into account the environmental conditions, to mix them into concrete, in particular into aerated lightweight concrete, also called foam concrete, with an individually determinable formulation. The present invention also relates to an installation comprising a silo according to the invention.

State of the art

Usually, the concrete components are already mixed in a dry mortar plant and are then delivered into a silo by means of a dry mortar vehicle (silo vehicle) and processed in this way. Alternatively, the concrete components can also be blown into a truck designed for this purpose and thus processed as dry mortar or delivered as bagged goods and processed. With the methods known from the state of the art, it is not possible to adjust the composition of the concrete ad hoc, e.g. to take account of external conditions. It was also not possible to transport the material at low temperatures, as there was a risk of frost damage to the material. Another problem was to ensure efficient and reliable filling of the silo or the dry mortar vehicles, since this often resulted in overflow of the material.

It was therefore the object of the present invention to provide a silo which eliminates these disadvantages.

Description of the invention

This object is achieved by a silo for the production of concrete
 5 comprising a main chamber for storing a first component and at least one secondary chamber located therein for storing a second component, wherein the longitudinal axes of the main chamber and the at least one secondary chamber are arranged parallel to one another; the main chamber and the at least one secondary chamber each have first,
 10 preferably lower, openings that are designed such that the main chamber and the at least one secondary chamber can be filled independently of one another through these openings; the main chamber and the at least one secondary chamber each have second, preferably lower, openings that are designed such that the main chamber and the
 15 at least one secondary chamber can be emptied independently of one another through these; the main chamber has a third, preferably lower, opening that is designed such that the main chamber can be vented; each of the at least one secondary chamber has at least one additional, preferably first upper, opening configured such that the second-
 20 ary chamber can be vented and de-vented; wherein these openings can be opened and closed by correspondingly configured shut-off elements.

Preferably, the main chamber and the at least one secondary chamber are cylindrical, which means that the main chamber and the
 25 at least one secondary chamber are hollow cylinders. However, the cross-section of the main chamber and the at least one secondary chamber may not only be circular, but may also be angular, i.e. for

example square, rectangular, pentagonal, hexagonal, octagonal or have any other suitable shape.

The secondary chambers preferably have approximately the same cross-section over their entire longitudinal extent. Preferably, the cross-section of a secondary chamber varies over the entire longitudinal extent by no more than 50%. Preferably, the cross-section of a secondary chamber varies over the entire longitudinal extent by at most 30%, more preferably by at most 20%, most preferably by at most 10%.

The fact that the longitudinal axes of the main chamber and the at least one secondary chamber are arranged parallel to each other means that the at least one secondary chamber is not located in the middle or center of the main chamber, but at least partially outside of it (see, for example, Fig. 22). Preferably, the at least one secondary chamber is also not partially located in the middle or center of the main chamber, but completely outside of it. Most preferably, all existing secondary chambers are located completely outside the middle or the center of the main chamber. By middle or center of the main chamber, its central longitudinal axis is meant (see Fig. 6c).

In a first preferred embodiment of the silo according to the invention, at least three secondary chambers are located in the main chamber. Preferably, the main component of the concrete is located in the main chamber, and further concrete additives are located in the secondary chambers, in order to ensure adaptation of the product as in a concrete plant. In a further preferred embodiment, a powdery component, in particular a concrete component, is located in the main chamber, and in the at least one secondary chamber or the secondary chambers the liquid component or the liquid components, in particular

liquid concrete components and/or foaming agents. Advantageously, the main chamber of the silo is therefore made of steel, and the secondary chambers of the silo are made of stainless steel. The chambers can also be made of other materials known to the skilled person which are
5 suitable for the storage and/or transport of concrete or concrete additives.

However, the present invention is not limited to a silo with three secondary chambers, but can have any number of secondary chambers, preferably at least two secondary chambers. However, to ensure
10 that the structural configuration of the silo or the installation according to the invention remains advantageously manageable, the number of secondary chambers is preferably in the range of 2 to 6, more preferably in the range of 2 to 5, and most preferably in the range of 2 to 4.

The secondary chambers may be of equal size or of different
15 sizes. They extend in the longitudinal direction of the silo in the erected position. In one embodiment of the silo according to the invention, each of the existing secondary chambers has a volume of at least 2 m³ and the silo has a total volume of up to 100 m³. These specifications are purely illustrative and the silo according to the invention is not limited
20 thereto.

In a second preferred embodiment of the silo according to the invention, the silo comprises means for holding the silo in a vertical position. Advantageously, this means is a support frame which comprises vertical longitudinal struts attached to the silo, a frame that can be placed
25 on the ground, and additional feet. This ensures a stable position of the silo on the ground and in the vertical alignment. In addition, the vertical longitudinal struts serve to stably store the silo in a horizontal position on a

transport vehicle or on the ground. This support frame advantageously complies with the German DIN standard DIN 30734.

In a third preferred embodiment of the silo according to the invention, the silo comprises a control device by means of which the fill
5 level of the main chamber and/or the at least one secondary chamber and/or the temperature of the first component in the main chamber and/or the temperature of the second component in the at least one secondary chamber can be controlled. If more than one secondary
10 secondary chambers can advantageously be controlled by the control device. Likewise, the pressure of the main chamber and/or the at least one secondary chamber can be controllable.

In a fourth preferred embodiment of the silo according to the invention, the main chamber has a first upper opening and/or the at
15 least one secondary chamber has a second upper opening through which a measuring probe can be inserted, by means of which the fill level F1 of the main chamber and/or the fill level F2 of the at least one secondary chamber can be determined, wherein these openings can
20 be opened and closed by means of correspondingly designed shut-off elements. With the measuring probe, the limit level up to which the filling is to be carried out can also be determined. Alternatively, a limit level indicator is introduced into a further upper opening of the at least one
25 secondary chamber, which indicates when the secondary chamber is maximally filled. This opening can also be opened and closed by means of a correspondingly designed shut-off element.

In order to further increase the safety of the installation and the filling process, the filling level measuring probe, for example a radar

probe, of the main chamber or of the at least one secondary chamber is designed such that it triggers the automatic closing of all valves when the desired filling level is exceeded, so that the filling process is stopped. This ensures that the chambers do not overflow.

- 5 In a fifth preferred embodiment of the silo according to the invention, the upper openings of the main chamber and/or of the at least one secondary chamber are designed as sockets with internal threads.

- In a sixth preferred embodiment, the correspondingly designed shut-off elements of these upper openings are solenoid valves. This en-
 10 sures that the openings are closed even when the silo is in a horizontal position, without the need to check this. Instead of using solenoid valves, it would also be possible to design the shut-off elements such that they can be opened and closed via a control system. Advantageously, the silo according to the invention therefore comprises such a control sys-
 15 tem, which can be attached directly to the silo. To increase safety, it is also possible to design the valves so that they automatically close the openings when the installation is taken out of operation. This ensures that the transport of the silo can take place without loss of the powdery and liquid components. In addition, a further safety function can be installed
 20 which ensures that a safety relay is triggered and all openings are electronically closed as soon as the silo tilts or becomes inclined. This ensures that the chambers are closed when the silo falls over and that no loss of the powdery and liquid components can occur.

- In a preferred embodiment, the filling of the main chamber
 25 and the at least one secondary chamber is preferably carried out from below, but can also take place through a corresponding opening from above or from the side. The latter variants are used in particular when

the silo is filled in a horizontal position. The filling of the main chamber and the at least one secondary chamber from below is preferably carried out by pressing the respective component into the chamber through the respective lower opening under pressure. The pressure triggers the opening of the corresponding valve. The necessary pressure equalization takes place via the openings designed for venting. As soon as a signal is transmitted to the control device that a corresponding fill level has been reached, the filling process is stopped by automatically closing the shut-off elements of the openings designed for venting as well as the shut-off elements of the openings designed for filling. These shut-off elements can also be designed such that they close automatically when the respective filling hose is removed.

In order to increase safety during filling and to ensure that the respective chamber, i.e. the main chamber or the respective secondary chamber, is always filled with the same component, it is possible to provide the different openings or chambers with different colors or different connections in order to increase distinguishability.

In a seventh preferred embodiment of the silo according to the invention, the ends of the lower openings of the at least one secondary chamber are designed as flanges, to which corresponding counterparts can be flanged as shut-off elements. Advantageously, quick couplings are used, preferably Storz couplings for the lower openings of the main chamber.

In an eighth preferred embodiment of the silo according to the invention, the main chamber and/or the at least one secondary chamber have a trace heating system. Ideally, the main chamber and each of the existing secondary chambers have a trace heating system. Since

the individual components are accommodated in the main chamber and the at least one secondary chamber, they are exposed to the same environmental conditions such as pressure and temperature, which is also advantageous. The trace heating systems also ensure year-round
5 use of the silo according to the invention. As soon as the temperature of the components in the main chamber and/or the at least one secondary chamber reaches the critical low temperature, the respective trace heating system is automatically switched on in order to prevent frost damage to the components.

10 In a ninth preferred embodiment of the silo according to the invention, the main chamber and/or the at least one secondary chamber have a further lower opening into which a temperature sensor can be inserted. The opening can then be opened and closed by means of a correspondingly designed shut-off element.

15 In a tenth preferred embodiment of the silo according to the invention, the trace heating systems are designed as heating rods which can likewise be inserted into the main chamber and/or the at least one secondary chamber through corresponding further lower openings. These openings can then in each case be opened and closed by means
20 of a correspondingly designed shut-off element.

In an eleventh preferred embodiment of the silo according to the invention, the silo comprises a sensor by means of which the moisture content and/or the temperature of the surroundings of the silo can be determined. Instead of the sensor, these parameters could also be ob-
25 tained by an external weather station, for example via the Internet. The moisture content of the environment has an influence on the speed of the curing of the concrete, as does the water content of the concrete.

Thus, in outdoor applications it is possible to adapt the composition of the concrete to the environmental conditions by mixing the individual components with water available on site. Therefore, by determining the moisture content of the environment, the water content as well as the dosing of the required individual construction components can be optimized accordingly. Depending on the temperature of the environment, the trace heating system of the main chamber and/or of the at least one secondary chamber is also switched on or the heating level is adjusted or the individual construction components are kept at temperature in order to prevent possible frost damage.

In a twelfth preferred embodiment of the silo according to the invention, the main chamber has solar panels on at least part of its surface, advantageously for supplying energy to the control system and/or the monitoring device, which are located, for example, in a control cabinet. Ideally, the solar panels are located at least partially or completely on the lateral surface of the main chamber. Ideally, sufficient electricity is generated so that the mixing of the components can also be carried out with the aid of the solar power. As a result, the silo is independent of external power sources. Additionally, batteries can also be used. These batteries can be continuously charged via the solar panels. For this purpose, a photovoltaic inverter is used, for example. In order to ensure fast charging, a so-called fast charger system is advantageously used. In order to reliably guarantee continuous temperature monitoring of the components, it may be useful to connect them to an external power source. The external power source can advantageously also be used to partially or completely charge the batteries so that the silo according to the invention is already fully operational at the next construction site.

In a thirteenth preferred embodiment of the silo according to the invention, a flange is located in the center of the main chamber, with which the mixing installation including dosing unit can be firmly bolted. The secondary chambers can likewise each be equipped indi-
5 vidually with dosing pumps so that individual dosing of the individual components is made possible. Thus, for example, various settings such as setting behavior, flow behavior and density can be adjusted as desired by the customer.

In a fourteenth preferred embodiment of the silo according to
10 the invention, a vibrator support and/or a vibrator arm is attached to the main chamber. Preferably, the vibrator arm extends into a vibrator basket which is located inside the main chamber of the silo. A corresponding vibrator support can then be attached to the vibrator carrier. By means of this, the silo, as well as the movable vibrator arm, can be set
15 into vibrations. This ensures faster emptying of the main chamber, even in the case of material that is difficult to empty.

In a fifteenth preferred embodiment of the silo according to the invention, the main chamber and/or the at least one secondary chamber are cylindrical.

20 In a sixteenth preferred embodiment, the silo according to the invention is transportable. In that case, it is a mobile silo. However, non-mobile silos, i.e. mounted silos, so-called "fixed" silos, are also included in the present invention.

Advantageously, transport aids are also attached to the top
25 side of the main chamber, so that the silo can be attached to a crane

via these and lifted in order to tilt it onto a transport vehicle and transport it in a horizontal position, as described for example in EP 3 170 696.

Preferably, a lateral opening is located on the lateral surface of the silo, particularly preferably in the middle area, which can advantageously be opened and closed with a manhole cover. This opening enables the filling of the main chamber when the silo is in a horizontal position.

In addition, an empty cable conduit pipe can also be attached along the longitudinal axis on the lateral surface of the silo, through which the electrical cables for the measuring probes can be guided, with which the fill level F1 of the main chamber and/or the fill level F2 of the at least one secondary chamber can be determined.

The present invention also relates to an installation comprising the silo of the invention and at least one mixer into which the components from the main chamber and the at least one secondary chamber can be introduced as aqueous mixtures and mixed to form concrete, in particular lightweight aerated concrete, also known as foam concrete, wherein the introduction of these components into water is preferably carried out via individual, separate metering pumps, and their respective aqueous mixtures are then mixed together in at least one mixer, and the concrete, in particular the aerated lightweight concrete/foam concrete, can be discharged from the at least one mixer.

The installation according to the invention may also include additional mixers or metering pumps, so that, for example, individual components from the secondary chambers can be pre-metered and mixed together before being diluted with water. It is also possible to pre-

mix individual components with water. Ideally, the installation should include additional barrels from which these premixes can be dispensed in measured quantities. Further details can be found in the figures and their description.

- 5 The features of the preferred embodiments mentioned above may be combined in any manner within a silo or an installation, and are encompassed by the present invention. This includes the features revealed in the figures.

10 In addition, another object of the present invention is a method for producing concrete, in particular aerated lightweight concrete/foam concrete, in an installation according to the invention, comprising the following steps:

- 15 a) Providing a first, preferably powdery, component in the main chamber of the silo according to the invention, as well as at least one second, preferably liquid, component in the at least one secondary chamber of the silo;
- 20 b) Introducing the first component from the main chamber and water into a first mixer, preferably via individual, separate dosing pumps, and mixing the first component and the water to form a concrete slurry;
- c) Introducing the second component to water, preferably using a metering pump, and mix the second component and water to form an aqueous mixture (when producing concrete) or a foam (when producing aerated lightweight concrete/foam concrete);
- 25 d) Introducing the concrete slurry produced in step b) to a second mixer while incorporating the aqueous mixture produced in step c) or the foam produced in step c), and mixing the concrete slurry

and the aqueous mixture or the foam in the second mixer to form concrete, specifically aerated lightweight concrete/foam concrete;

- 5 e) Removing the finished concrete, particularly the finished aerated lightweight concrete/foam concrete, from the second mixer.

10 Preferably, steps b), c), d) and e) are carried out continuously, more preferably steps b) and c) are carried out continuously at the same time. However, it is also possible to carry out steps b), c), d) and e) in batches.

Steps b) to d) are now explained in more detail:

- Step b): The introduction of the first, preferably powdery, component from the main chamber into the first mixer, preferably into a continuous mixer, is preferably carried out via a rotary valve into a pump hopper
15 and further transport via a downstream screw conveyor. The rotary valve is advantageously equipped with two probes in order to be able to dose the amount of the first, preferably powdery, component. Thus, one probe switches off the rotary valve when a certain upper fill level is reached, and another probe switches the rotary valve on again when a
20 certain lower fill level is fallen below.

The water added to the first component is preferably water to which at least one further, preferably liquid, component has been added, so that the water added to the first component contains at least one further, preferably liquid, component.

The mixing of the first component and the water to form a concrete slurry is preferably carried out in a mortar mixing pump as described in WO 2004/080 676.

5 The concrete slurry produced in step b) is preferably a homogeneous, thixotropic mass.

Step c): The production of the foam from the second component and water is preferably carried out in a foam generator, in which the second, preferably liquid, component and the water are mixed together with the addition of air. Preferably, the second component is a liquid foaming agent. In particular, the foam can also be generated in a device as described in NL-A 9302111.

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Step d): The concrete slurry produced in step b) is preferably pumped via a hose to a second mixer, preferably a static mixer, wherein the hose preferably has a T-piece between the pump outlet and the second mixer, through which the aqueous mixture produced in step c) or the foam produced in step c) is added. Alternatively, the pump outlet can also have a foam injection. Particularly preferably, the further mixing of the concrete slurry and the aqueous mixture or the foam is carried out not only in one, but in two static mixers connected in series. Instead of a static mixer, an electric mixer can also be used.

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A further subject of the invention is also the use of the silo according to the invention or the installation according to the invention for the production of concrete, in particular for the production of aerated lightweight concrete/foam concrete.

Brief description of the drawings

Figures 1–6c illustrate a preferred embodiment of the silo 100 of the invention; Figure 22 illustrates another preferred embodiment of the silo of the invention; Figures 7–9 illustrate a preferred embodiment of the installation 1000 of the invention for producing aerated lightweight concrete/ foam concrete, wherein the silo 100 comprises three secondary chambers 2, 3, 4. Figures 10–21 show schematic representations of preferred embodiments of the installation 1000 according to the invention; Figures 11–17 show installations 1000 for producing aerated lightweight concrete/foam concrete, while Figures 18–21 show installations 1000 for producing concrete.

Figure 1 shows a perspective view of a preferred embodiment of the silo according to the invention.

Figure 2 shows a sectional view of this embodiment of the silo according to the invention.

Figure 3 shows a side view of this embodiment of the silo according to the invention.

Figure 4 shows this embodiment of the silo according to the invention from below along the axis A-A indicated in Figure 2.

Figure 5 shows this embodiment of the silo according to the invention from above.

Figure 6 a) shows the section axes N-N and O-O through the silo; Figure 6 b) the sectional view along axis N-N and Figure 6 c) the sectional view along axis O-O.

Figure 7 shows the part of the installation according to the invention below the silo, to which the mixer has been attached, from the front.

Figure 8 shows the mixer and the other equipment located below the silo according to the invention in a perspective view from the front.

Figure 9 shows the mixer and the other equipment located below the silo according to the invention in a perspective view from behind.

Figure 10 shows a schematic diagram of the installation according to the invention, as depicted in Figures 7–9, also known as a aerated lightweight concrete installation or foam concrete installation.

Figure 11 shows a schematic diagram of an embodiment of an installation according to the invention, which includes a cold water connection or barrel, an instantaneous water heater, and a mixer in which the cold and hot water are mixed together.

Figure 12 shows a schematic diagram of an embodiment of an installation according to the invention, which comprises a silo with four secondary chambers.

Figure 13 shows a schematic diagram of an embodiment of an installation according to the invention, which comprises a silo with four secondary chambers and an additional mixer. Instead of water, an activator liquid can also be used, which is provided in a corresponding barrel.

Figure 14 shows a schematic diagram of an embodiment of an installation according to the invention, which comprises a silo with five secondary chambers.

Figure 15 shows a schematic diagram of an embodiment of an installation according to the invention, which comprises a silo with five secondary chambers and an additional mixer.

Figure 16 shows a schematic diagram of an embodiment of an installation according to the invention, which comprises a silo with three secondary chambers, a further mixer, and an additional barrel.

Figure 17 shows a schematic diagram of an embodiment of an installation according to the invention, which comprises a silo with three secondary chambers, two additional mixers, and an additional barrel.

Figure 18 shows a schematic diagram of an embodiment of an installation according to the invention, which comprises a silo with three secondary chambers.

Figure 19 shows a schematic diagram of an embodiment of an installation according to the invention, which comprises a silo with four secondary chambers.

Figure 20 shows a schematic diagram of an embodiment of an installation according to the invention, comprising a silo with two secondary chambers, as well as an additional mixer and a barrel.

Figure 21 shows a schematic diagram of an embodiment of an installation according to the invention, comprising a silo with two secondary chambers, as well as two additional mixers and a barrel.

Figure 22 shows an embodiment of the silo according to the invention in a horizontal position with three secondary chambers of different sizes.

10 Preferred embodiments of the invention

In Figure 1, the silo 100 is shown in a vertical position with the main chamber 1 and the three secondary chambers 2, 3, 4, as well as the supporting frame 10. On the lateral surface 81 of the main chamber of the silo, vertical struts 111, 112 are mounted, which lead into a frame 110 with cross struts 113, 114, 115, 116, 117, 118 (for clarity, these reference numerals are not shown here) and feet 130, 131, 132, 133. On the upper side 91 of the main chamber, the upper sides 122, 123, 124 of the three secondary chambers 2, 3, 4 are visible, into which three openings each provided with shut-off elements are integrated. In addition, the lower sides 102, 103, 104 of the secondary chambers protruding from the underside 101 of the main chamber can be seen, which are designed as flanges.

Figure 2 shows a first side view of the silo 100 with the empty cable conduit pipe 80 arranged on the lateral surface 81 of the main chamber and the lateral opening 70. Here, the three lower openings 11,

21, 31 of the main chamber can be seen, via which it is filled (11), emptied (21) and ventilated (31).

In Figure 3, the silo 100 shown in Figure 2 is shown rotated by 90° towards the viewer. The lateral opening 70 is clearly visible here, via
 5 which the main chamber 1 of the silo can be filled when the silo 100 is in a horizontal position. Also visible is the vibrator support 60, to which a vibrator motor can be attached.

In the representation of the silo 100 from below shown in Figure 4, the frame 110 with the cross struts 113, 114, 115, 116, 117, 118 and the
 10 feet 130, 131, 132, 133 can be seen. Clearly visible are the lower sides 102, 103, 104 of the secondary chambers 2, 3, 4 designed as flanges, into each of which four openings are incorporated: The first lower openings 12, 12', 12'' of the secondary chambers 2, 3, 4, which serve for filling them, the second lower openings 22, 23, 24 of the secondary chambers
 15 2, 3, 4, via which they can be emptied, the third lower openings 82, 83, 84 of the secondary chambers 2, 3, 4, into each of which a measuring probe 40', 40'', 40''' for temperature measurement can be inserted, and the fourth lower openings 92, 93, 94 of the secondary chambers 2, 3, 4, into each of which a heating rod as trace heating system 72, 73, 74 can
 20 be inserted. Also visible are the three openings 11, 21, 31 of the main chamber, as well as the vibrator support 60 and the vibrator arm 61.

In the representation of the silo 100 from above shown in Figure 5, the frame 110 with the feet 130, 131, 132, 133 can be seen. Clearly visible are the transport aids 140, 141, 142, 143, 144, 145, which make it possible to tilt the silo and transport it lying secured on a transport vehicle to a
 25 construction site. The upper sides 122, 123, 124 of the secondary chambers 2, 3, 4 each have three openings which, in particular designed as

sleeves with internal thread, can be opened and closed with corresponding shut-off elements, in particular magnetic valves: a first upper opening 32, 33, 34 for ventilation, a second upper opening 42, 43, 44 for inserting a measuring probe in order to determine the filling level of the secondary chamber 2, 3, 4, as well as a third upper opening 32', 33', 34' for venting. The upper openings for aeration and venting could also each be designed as only a single opening instead of two openings. Also visible is the first upper opening 41 of the main chamber, into which a measuring probe 40 can likewise be inserted to determine the filling level.

Figure 6 shows the section axes N-N and O-O through the silo; Figure 6 b) the sectional view along axis N-N and Figure 6 c) the sectional view along axis O-O. In Figure 6 b), the position of the filling pipe can be seen, which ends in the first lower opening 11 of the main chamber 1. It runs through the silo and ends on the inner side of the upper side of the silo in an impact pot, from where the first component is distributed in the silo. In Figure 6 c), the position of the vent pipe can be seen, which ends in the third lower opening 31 of the main chamber 1. It runs along the longitudinal axis through the silo, and may additionally be provided with a filter at its end 31.

Figure 7 shows an installation 1000 according to the invention, which comprises the silo 100 shown in Figures 1–6. As can be seen in Figure 7, the second lower opening of the main chamber 1 is connected to a rotary valve 180, through which the preferably powdery component of the main chamber 1 is fed into the mixer 150, preferably the continuous mixer 150. The dosing of the, preferably liquid, components of the secondary chambers 2 and 3 into water takes place via the respective

dosing pumps 161 and 162. The water containing the two liquid components is then conveyed via hoses (not shown) into the mixer 150 and mixed there with the first, preferably powdery, component to form a concrete slurry. This is then transported via the delivery pump 190 to a further mixer 151, preferably a static mixer. The pump outlet 175 has a T-piece via which the foam generated in the foam generator 170 from water, air and the preferably liquid component taken from the secondary chamber 4 is added. The concrete slurry containing the first, preferably powdery, component as well as the two, preferably liquid, components from the secondary chambers 2 and 3 and the foam containing the preferably liquid component taken from the secondary chamber 4 are then further mixed together in the mixer 151. Advantageously, a further mixer 151', preferably a static mixer, is connected downstream of the mixer 151, in which the concrete slurry and the foam are further mixed. The water connector 165 is connected on the one hand via hoses (not shown) to the dosing pumps 161 and 162, as well as to the dosing pump 163 (not shown) for the preferably liquid component, particularly preferably for the foaming agent, from the secondary chamber 4. Also visible are the control cabinet 220 as well as the photovoltaic inverter 210 with the battery storage, through which the silo 100 according to the invention can be electronically controlled and monitored.

Figure 8 shows the installation 1000 of the invention depicted in Figure 7, with the equipment located beneath silo 100, in a perspective view from the front.

Figure 9 shows the installation 1000 of the invention depicted in Figure 7, with the equipment located beneath silo 100, in a perspective

view from behind. Here, the water barrel 155 can also be seen, which serves as an intermediate storage for the water used in the process.

As can be seen in Figure 10, the, preferably liquid, components of the secondary chambers 2 and 3 are dosed via the respective dosing pumps 161 and 162 into water (H₂O) from the water barrel 155 and thus enter the mixer 150 as an aqueous mixture. The second lower opening of the main chamber 1 is connected to a rotary valve 180, through which the, preferably powdery, component of the main chamber 1 is fed into the mixer 150, preferably the continuous mixer 150. The water containing the two liquid components is then mixed in the mixer 150 with the first, preferably powdery, component to form a concrete slurry. This is then transported via the delivery pump 190 to a further mixer 151, preferably a static mixer. The pump outlet 175 of the mixer 150 has a T-piece, via which the foam generated in the foam generator 170 from water, air and the preferably liquid component taken from the secondary chamber 4 is added. The concrete slurry containing the first, preferably powdery, component as well as the two, preferably liquid, components from the secondary chambers 2 and 3 and the foam containing the preferably liquid component taken from the secondary chamber 4 are then further mixed together in the mixer 151. Advantageously, a further mixer 151', preferably a static mixer, is connected downstream of the mixer 151, in which the concrete slurry and the foam are further mixed. The water barrel 155 and the foam generator 170 can obtain water from the same line or from two different lines. Preferably, water is supplied from a cold water connection.

Figure 11 shows a schematic diagram of an embodiment of the installation 1000 according to the invention, which includes a cold-

water barrel 155 and an instantaneous water heater 156, as well as a mixer 300 in which the cold and hot water drawn from the water barrel 155 and the instantaneous water heater 156 are mixed together. The temperature of the water can therefore be adjusted to the outside conditions. Into this temperature-adjusted water, on the one hand, the components from the secondary chambers 2 and 3 are mixed via the dosing pumps 161 and 162, and on the other hand, the water is fed into the foam generator. The temperature of the water supplied to the mixer 150 (containing the components from the secondary chambers 2 and 3) or the temperature of the concrete slurry in the mixer 150 can be determined via the measuring probe 240, and the temperature of the water or the foam in the foam generator can be determined via the measuring probe 241.

Figure 12 shows a schematic of an embodiment of an installation 1000 according to the invention which has a silo 100 with four secondary chambers 2, 3, 4 and 5 and an additional mixer 301. In this case, the component from the secondary chamber 5 is first mixed with water in a mixer 301 before it is supplied as a mixture to the foam generator 170.

The embodiment of an installation 1000 according to the invention shown schematically in Figure 13 differs from the installation 1000 shown in Figure 12 in that the silo 100 has five secondary chambers 2, 3, 4, 5, 6.. Instead of water, an activator liquid can also be used, which is transported to the construction site in the secondary chamber 6 of the silo 100 and then provided in a corresponding barrel 260. The components from the secondary chambers 2 and 3 are then mixed into the activator liquid via the dosing pumps 161 and 162.

Figure 14 shows a schematic diagram of an embodiment of the installation 1000 according to the invention, which comprises a silo with five secondary chambers 2, 3, 4, 5, and 6. Water is added to the components from secondary chambers 2, 3, and 6 via metering pumps 161, 162, and 163, and the mixture is fed into mixer 150. Instead of water, a corresponding pre-mixed liquid or liquid component from a further secondary chamber 4 or 5 can also be fed into the foam generator 170. The foaming agent is then located in the other of the two secondary chambers 4 and 5.

10 In the embodiment of the installation 1000 according to the invention, shown in Figure 15, the substitute liquid for water has not yet been filled into the secondary chamber 5 of the silo 100; instead, the concentrate or powder for it has been filled in, so that this replacement liquid must first be produced in mixer 301 from the concentrate or powder in secondary chamber 5 using water supplied to the construction site.

Figure 16 shows a schematic of an embodiment of an installation 1000 according to the invention for the production of cellular lightweight concrete/foam concrete, wherein the installation 1000 has a silo with three secondary chambers 2, 3 and 4 and a further mixer 302 as well as an additional barrel 250. In the secondary chamber 4, the foaming agent is stored, which is then fed into the foam generator 170. This can also be done using a dosing pump not shown. In the embodiment shown in Figure 16, the components from the secondary chambers 2 and 3 are first mixed via respective dosing pumps 161 and 162 in a mixer 302 before they are diluted with water in a

barrel 250 and supplied as a diluted mixture to the mixer 150. Fig. Figure 20 shows the installation used for concrete production.

In the embodiment of the installation 1000 according to the invention, shown schematically in Figure 17, the components from the secondary chambers 2 and 3 are additionally mixed together in the additional mixer 302'—in contrast to the system shown in Figure 16. Figure 17 shows the installation for the production of lightweight aerated concrete/foam concrete, Fig. 21 shows the corresponding installation for the production of concrete.

In Figure 18, installation 1000 is shown schematically; it produces concrete, not foam concrete. Therefore, this installation 1000 does not have a foam generator. The production takes place here by dosing the components from the secondary chambers 2, 3 and 4 via respective dosing pumps 161, 162 and 163 into water and mixing with concrete from the main chamber 1 in the mixer 150. Here too, a further mixer could be connected downstream.

The installation 1000, shown schematically in Figure 19, features an additional secondary chamber 5 compared to the installation shown in Figure 18; the component stored there is also metered into the water using a metering pump 164 and then fed as an aqueous mixture, together with the other components from secondary chambers 2, 3, and 4 into the mixer 150, where it is further mixed with the concrete from the main chamber 1 to form a concrete slurry. The embodiment of the silo 100 according to the invention shown in Figure 22 in a horizontal position has three secondary chambers 2, 3 and 4 of different sizes. These are not all located in the center of the main chamber 1 and extend along the longitudinal axis of the silo. In the embodiment shown here, the three

secondary chambers 2, 3, 4 and the main chamber are hollow cylinders, however, other shapes are also conceivable.

List of reference symbols

5		
	100	Silo
	10	Means for holding the silo in a vertical position
	20	Control system
10	30	Control device
	50	Solar panel
	70	Lateral opening
	80	Empty cable conduit pipe
	90	Sensor
15		
	40, 40', 40'', 40'''	Measuring probe of the main chamber and the three secondary chambers
	1	Main chamber
20	2, 3, 4, 5, 6, 7, 8	Secondary chamber
	L1	Longitudinal axis of the main chamber 1
	L2	Longitudinal axis of the secondary chamber 2
	T1	Temperature of the first component in the main chamber
25	T2	Temperature of the second component in the secondary chamber
	F1	Filling level of the first component in the main chamber
30	F2	Filling level of the second component in the secondary chamber
	211	First opening of the main chamber (filling)
	221	Second opening of the main chamber (emptying)
35	231	Third opening of the main chamber (venting)

	11	First lower opening of the main chamber (filling)
	21	Second lower opening of the main chamber (emptying)
5	31	Third lower opening of the main chamber (venting)
	41	First upper opening of the main chamber (filling level measuring probe)
10	213	Shut-off element of the first opening of the main chamber (filling)
	214	Shut-off element of the second opening of the main chamber (emptying)
15	215	Shut-off element of the third opening of the main chamber (venting)
	13	Shut-off element of the first lower opening of the main chamber (filling)
20	14	Shut-off element of the second lower opening of the main chamber (emptying)
	15	Shut-off element of the third lower opening of the main chamber (venting)
25	51	Shut-off element of the first upper opening of the main chamber (filling level measuring probe)
	60	Vibrator support
	61	Vibrator arm
30	71	Trace heating system of the main chamber
	81	Lateral surface area of the main chamber
	91	Upper side of the main chamber
	101	Lower side of the main chamber
35	212, 212', 212''	First opening of the secondary chamber (filling)
	222, 223, 224	Second opening of the secondary chamber (emptying)
40	12, 12', 12''	First lower opening of the secondary chamber (filling)

	22, 23, 24	Second lower opening of the secondary chamber (emptying)
	82, 83, 84	Third lower opening of the secondary chamber (measuring probe for temperature measurement)
5	92, 93, 94	Fourth lower opening of the secondary chamber (heating element)
	232, 233, 234	Further opening of the secondary chamber
10	252, 253, 254	Shut-off element for further opening of the secondary chamber (ventilation)
	32, 33, 34	First upper opening of the secondary chamber (ventilation)
15	32', 33', 34'	Third upper opening of the secondary chamber (venting)
	42, 43, 44	Second upper opening of the secondary chamber (fill level measuring probe)
20	216	Shut-off element of the first opening of the secondary chamber (filling)
	217	Shut-off element of the second opening of the secondary chamber (emptying)
25	16	Shut-off element of the first lower opening of the secondary chamber (filling)
	17	Shut-off element of the second lower opening of the secondary chamber (emptying)
30	52, 53, 54	Shut-off element of the first upper opening of the secondary chamber (ventilation)
	62, 63, 64	Shut-off element of the second upper opening of the secondary chamber (filling level measuring probe)
35		
	72, 73, 74	Trace heating system of the secondary
40	chamber	
	102, 103, 104	Lower side of the secondary chamber
	122, 123, 124	Upper side of the secondary chamber

	110	Frame
	111, 112	Vertical struts
	113, 114, 115, 116, 117, 118	Cross struts
	130, 131, 132, 133	Feet
5	140, 141, 142, 143, 144, 145	Transport aid
	150, 151	Mixer
	155	Water barrel
	156	Continuous flow heater
10	160, 161, 162, 163, 164, 166	Dosing pump
	165	Connection for water and dosing agent
	170	Foam generator
	175	Pump outlet with foam injection optional T-piece
	180	Rotary valve
15	190	Delivery pump
	200	Batteries
	210	PV inverter with battery storage
	220	Control cabinet
20	300, 301, 302, 302'	Mixer
	240	Measuring probe of the mixer 150
	241	Measuring probe of the foam generator 170
	250	Barrel
	260	Barrel containing a liquid activator (as a water substitute)
25		

Patent claims

1. A silo (100) for the production of concrete comprising a main chamber (1) for storing a first, preferably powdery, component as well as at least one secondary chamber (2) for storing a second, preferably liquid, component, wherein
 - the at least one secondary chamber (2) is located in the main chamber (1);
 - the longitudinal axes (L1, L2) of the main chamber and the at least one secondary chamber are arranged parallel to one another;
 - the main chamber (1) and the at least one secondary chamber (2) each have first openings (211, 212) which are designed such that the main chamber (1) and the at least one secondary chamber (2) can be filled independently of one another through these;
 - the main chamber (1) and the at least one secondary chamber (2) each have second openings (221, 222) which are designed such that the main chamber (1) and the at least one secondary chamber (2) can be emptied independently of one another through these;
 - the main chamber (1) has a third opening (231) which is designed such that the main chamber (1) can be vented;
 - the at least one secondary chamber (2) each has at least one further opening (232) which is designed such that the secondary chamber (2) can be aerated and vented;
 wherein these openings (211, 212, 221, 222, 231, 232) can be opened and closed with correspondingly designed shut-off elements (213, 214, 215, 216, 217, 252).

2. The silo (100) according to claim 1, characterized in that the first openings (211, 212) of the main chamber (1) and the at least one secondary chamber (2), through which they can be filled independently of one another, are each first lower openings (11, 12).

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3. The silo (100) according to claim 1 or claim 2, characterized in that the second openings (221, 222) of the main chamber (1) and the at least one secondary chamber (2), through which they can be emptied independently of one another, are each second lower openings (21, 22).

10

4. The silo (100) according to one or more of the preceding claims, characterized in that the third opening (231) of the main chamber (1), which is designed such that the main chamber (1) can be vented, is a third lower opening (31).

15

5. The silo (100) according to one or more of the preceding claims, characterized in that the further opening (232) of the secondary chamber (2), which is designed such that the secondary chamber (2) can be aerated and vented, is a first upper opening (32).

20

6. The silo (100) according to one or more of the preceding claims, characterized in that the silo (100) has a control device (30) by means of which the filling level (F1, F2) of the main chamber and/or the at least one secondary chamber and/or the temperature T1 of the first component in the main chamber (1) and/or the temperature T2 of the second component in the at least one secondary chamber (2) can be controlled.

25

7. The silo (100) according to claim 6, characterized in that the main chamber (1) has a first upper opening (41) and/or the at least one secondary chamber (2) has a second upper opening (42), through which a measuring probe (40, 40') can be inserted, with which the filling
5 level (F1, F2) of the main chamber and/or the at least one secondary chamber can be determined, wherein these openings (41, 42) can be opened and closed with correspondingly designed shut-off elements (51, 62).

10 8. The silo (100) according to one or more of claims 5 to 7, characterized in that the upper openings of the main chamber (41) and/or the at least one secondary chamber (32, 42) are designed as sleeves with internal thread.

15 9. The silo (100) according to one or more of claims 5 to 8, characterized in that the shut-off element (51) of the first upper opening (41) of the main chamber and/or the shut-off element (52) of the first upper opening (32) of the at least one secondary chamber (2) and/or the shut-off element (62) of the second upper opening (42) of the at least
20 one secondary chamber are each a solenoid valve.

10. The silo (100) according to one or more of claims 2 to 9, characterized in that the ends of the lower openings (12, 22) of the main chamber and/or the at least one secondary chamber are designed as
25 flanges.

11. The silo (100) according to one or more of the preceding claims, characterized in that the main chamber (1) and/or the at least one secondary chamber (2) comprise a trace heating system (71, 72).

12. The silo (100) according to one or more of the preceding claims, characterized in that the silo (100) comprises a sensor (90) by means of which the moisture content and/or the temperature of the environment of the silo can be determined.

13. The silo (100) according to one or more of the preceding claims, characterized in that the main chamber (1) has solar panels (50) at least on part of its lateral surface (81), advantageously for supplying energy to the control system (20) and/or the control device (30).

14. The silo (100) according to one or more of the preceding claims, characterized in that the main chamber (1) and/or the at least one secondary chamber (2) are cylindrical.

15. The silo (100) according to one or more of the preceding claims, characterized in that the silo (100) comprises means (10) for holding the silo in a vertical position and/or that the silo is transportable.

16. The silo (100) according to one or more of the preceding claims, characterized in that the silo (100) comprises at least two secondary chambers (2, 3), preferably a number of secondary chambers in the range of 2 to 6, particularly preferably in the range of 2 to 5, most particularly preferably in the range of 2 to 4.

17. An installation (1000) comprising the silo (100) according to one or more of the preceding claims, as well as at least one mixer (150) into which the components of the main chamber (1) and the at least one secondary chamber (2) of the silo (100) can be introduced and mixed with water to form concrete, in particular lightweight aerated

concrete, wherein the introduction of these components into water preferably takes place via individual, separate metering pumps (160, 161), and their respective aqueous mixtures are then mixed together in the at least one mixer (150), and wherein the concrete, in particular the lightweight aerated concrete, can be discharged from the at least one mixer (150).

18. A method for producing concrete, in particular aerated lightweight concrete, in an installation (1000) according to claim 17, comprising the following steps:

- a) Providing a first, preferably powdery, component in the main chamber (1) of the silo (100), as well as at least one second, preferably liquid, component in the at least one secondary chamber (2) of the silo (100);
- b) Introducing the first component from the main chamber (1) and water into a first mixer (150), preferably via individual, separate dosing pumps (160), and mixing the first component and the water to form a concrete slurry;
- c) Introducing the second component to water, preferably using a metering pump (161), and mixing the second component and water to form an aqueous mixture (when producing concrete) or a foam (when producing aerated lightweight concrete);
- d) Introducing the concrete slurry produced in step b) to a second mixer (151) while incorporating the aqueous mixture produced in step c) or the foam produced in step c), and mixing the concrete slurry and the aqueous mixture or the foam in the second mixer (151) to form concrete, specifically aerated lightweight concrete;

e) Removing the finished concrete, in particular the finished aerated lightweight concrete, from the second mixer (151).

5 19. The method according to claim 18, wherein steps b), c), d) and e) are carried out continuously.

10 20. Use of the silo (100) according to one or more of claims 1 through 16, or of an installation (1000) according to claim 17, for the production of concrete, in particular for the production of aerated lightweight concrete.