

A MIXING SILO

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The invention concerns a mixing silo comprising a silo container with a generally conical bottom which terminates at a generally central container outlet.

A mixing silo of that kind can be designed both in the form of a pure gravitational mixer and also a circulatory mixer. In regard to both types of construction, there are numerous proposals in the state of the art for achieving a high level of quality of mixing action, that is to say good homogenisation of different loose materials which are usually introduced into the silo container in succession, when the loose material has already passed just once through the mixing silo, by virtue of suitable installation fittings fitted into the silo container, and - in the case of circulatory mixers - for keeping down the number of circulations of material and thus keeping the mixing time short. For example German Published Specification (DE-AS) 1 298 511 and EP-A1-0 060 046 each disclose a mixing silo whose interior is divided by vertical sheet metal segments which extend radially from the outside wall of the container to the centre line thereof, into a plurality of chambers which, as a result of suitably stepped upper edges on the sheet metal segments, with suitable positioning of the filling opening, successively fill with material on the basis of the overflow principle, whereby that arrangement frequently provides for a vertical pre-mixing effect which is dependent on the batch size, instead of the purely horizontal layering effect which otherwise occurs. Furthermore, German Patent Specification No 2 219 397 already discloses a mixing silo which is in the form of a circulatory mixer and in which a central riser pipe is surrounded by a further pipe which is shorter in comparison therewith so that the further pipe, with the central pipe, forms a first annular space, while with the wall of the silo container or the conical bottom thereof, it forms a second annular space. During the circulatory movement of the material or removal of the loose material, different speeds of downward movement of the loose material occur in the two annular spaces so that portions of loose material which originate from different levels in respect of height are mixed or blended with each other in the outlet region. The gravitational-circulatory mixer which is known from German Laid-Open

Application (DE-OS) No 30 29 393 is also based on a similar principle, but in that arrangement the circulatory effect is produced not by way of a central pipe but by way of a vertical riser pipe which extends outside the silo container.

5 The common disadvantage of those known mixing silos is that the installation fitments which are provided in the silo container are exposed to considerable static and dynamic loadings which make it necessary to involve expensive strength and dimensioning calculations and generally exclude the subsequent conversion of a storage silo into
10 a mixing silo. Although the known mixing silos are without exception designed for mass flow conditions, deposits of loose material also occur, which at least give rise to difficulties in being able to wash out the silo container. However the requirement that a silo container can be easily washed out before being filled with another type of loose
15 material is one which is being increasingly made.

According to the invention there is provided a mixing silo comprising a silo container with a generally conical bottom which terminates at a generally central container outlet, wherein, a hopper which has a casing which narrows towards the container outlet is
20 installed in the bottom region, the longitudinal axis of the hopper coincides with the centre line of the silo container, the interior of the hopper is divided, by sheet metal segments extending from the hopper casing towards the longitudinal axis of the hopper, into a plurality of chambers which are disposed in succession in the
25 peripheral direction and at least part of the height of successive sheet metal segments in the peripheral direction are tilted in alternate directions through a small angle (α) relative to the corresponding longitudinal planes containing the centre line of the silo container so that respectively adjacent chambers have intake
30 and/or outlet cross-sections of different sizes.

Such a mixing silo can achieve a high level of quality of mixing by installation fitments which do not cause problems from the static point of view and which are accordingly of a simple structure and which if necessary can be subsequently fitted to a silo. The installation
35 fitments are to comply with the requirement for easy washability of the mixing silo and can be used regardless of whether the mixing silo is in the form of a gravitational mixer or in the form of a circulatory

mixer.

The basic concept of the solution lies in the formation of approximately tubular flow zones outside the hopper but in which the respective amounts of loose material move downwardly at different rates due to the intake and/or outlet cross-sections being of different sizes for the chambers which are distributed over the periphery of the hopper. Accordingly, amounts of loose material which come from different regions in respect of height of the silo container are blended with each other at the level of the outlet cross-sections of the hopper. Added thereto is also the amount of loose material which flows thereto from the annular space between the casing of the hopper and the inner wall surface of the conical bottom of the silo container. A self-evident requirement is that the overall construction is designed to maintain mass flow conditions.

Preferably, the sheet metal segments terminate at a central pipe. This is a design which is particularly simple from the structural point of view.

Conveniently, the central pipe is in the form of a riser pipe for loose material circulation.

Thus the design can operate as a circulatory mixer.

The blending or homogenisation principle which is embodied by means of the division of the hopper into chambers may also be applied to the annular space between the casing of the hopper and the inside wall surface of the conical bottom of the silo container. A corresponding preferred design configuration is one in which the space between the hopper casing and the inside wall surface of the conical bottom of the silo container is divided, e.g. by second sheet metal segments which are similar to said sheet metal segments, into second chambers, of which respectively adjacent chambers have different intake and/or outlet cross-sections.

When dealing with loose material which contains what is known as angel's hair, that is to say constituents in thread or strip form, which have usually occurred in a preceding conveyor operation, the above-mentioned design configurations or developments thereof respectively are recommended, in order to prevent the angel's hair from being deposited on the upper edges of the sheet metal segments which define the chambers, and correspondingly reducing the respective intake

cross-sections.

The invention is diagrammatically illustrated by way of example in the accompanying drawings, in which:

Figure 1 is a perspective view of a first embodiment of a mixing
5 silo according to the invention;

Figure 2 is a second, very similar embodiment;

Figure 3 is a diagrammatic view in longitudinal section
corresponding to Figure 2;

Figure 4 is a perspective view on an enlarged scale of the hopper
10 of the mixing silo shown in Figure 3;

Figure 5 shows a development of the hopper of Figure 4;

Figure 6 shows a detail indicated at X in Figure 5 on an even
larger scale;

Figure 7 is a plan view of the hopper shown in Figure 5;

Figure 8 is a view in section taken on line VIII-VIII in
15 Figure 5;

Figure 9 is a perspective view of the bottom portion of a second
embodiment of the mixing silo;

Figure 10 is a plan view of the bottom portion shown in Figure 9;
20 and

Figure 11 is a view in section taken on line XI-XI in Figure 9.

Mixing silos shown in Figures 1 and 2 each comprise a silo
container 1 having a conical bottom 1a, and a top which has a filling
opening 2. The bottom 1a of the silo container 1 terminates in a
25 central container outlet 3. As this is an embodiment in the form of a
circulatory mixer, a mixing container 4 with a connecting member 4a for
the feed of the circulating air connects to the container outlet 3. A
central pipe 5 serves for circulatory purposes in known manner, the
central pipe 5 terminating at some distance from a deflection cone 6.
30 The central pipe 5 is surrounded in the region of the bottom 1a of the
silo container 1 by a hopper 7 whose interior is divided into chambers
9a, 9b ... 9n by sheet metal segments 8 which extend substantially
radially from a casing of the hopper 7 to the central pipe 5. The
chambers 9a to 9n have intake cross-sections of the same size (at the
35 top) but outlet cross-sections of different sizes (at the bottom).
This will be described in greater detail hereinafter.

The mixing silo of Figure 2 differs from that shown in Figure 1

only by virtue of the nature of a hopper 27 which here is shorter and has a greater cone angle than the hopper 7 shown in Figure 1. That is only intended to show that neither the length (height) of the hopper 7, 27 nor its hopper angle are important considerations, in the send of
 5 maintaining quite specific values in those respects. The hopper 7, 27 also does not necessarily have to extend into the central container outlet 3 but may already terminate above the corresponding outlet cross-section. In other words the design configuration of the hopper
 10 amy be optimised for the respective situation of use, which is a consideration of considerable importance in particular in regard to subsequent fitment to already existing storage or mixing silos.

In the case of a pure gravitational mixer, instead of the mixing container 4, the silo has a conventional closure or discharge member, for example a cell-wheel discharge valve. The central pipe 5 can then
 15 be closed at the top side and in that case would only serve as a structural fixing element for the inwardly disposed, approximately vertical edges of the sheet metal segments 8. The deflection cone 6 (or at least the underneath conical surface thereof) is also unnecessary. Figure 3 diagrammatically shows a corresponding
 20 embodiment in which a silo container 31 has a cell-wheel discharge valve 30 as the closure member. Disposed on the outlet side thereof is feed shoe 39a of a pneumatic conveyor conduit 39 which is only indicated in the drawings and which is supplied with compressed air by way of a connection 39b and which has a conduit portion 39c by means of
 25 which, if necessary, the discharged loose material can be circulated, that is to say conveyed back into the silo container 31. A central pipe 35 thereof serves only for fixing sheet metal segments 38 which divide a hopper 37 into individual chambers.

Figures 4 to 8 show how intake and/or outlet cross-sections of
 30 different sizes for the chambers can be formed. In the arrangement shown in Figure 4, the intake cross-sections of the chambers 9a to 9n are of equal size, due to equidistant arrangement of upper edges 8a of the sheet metal segments 8, see also Figure 7, whereas the outlet cross-sections of respectively adjacent chambers are of different
 35 sizes. In the arrangement shown in Figure 4, for that purpose, the sheet metal segments 8 which occur in succession in the peripheral direction are respectively tilted in alternate directions through an

angle α relative to the corresponding longitudinal planes containing the centre line of the silo container. The tilting effect takes place about the point at which the upper edge $8a$ of the respective sheet metal segment 8 meets the central pipe 5. The tilting point could however lie in the centre between the upper edge $8a$ and the lower edge $8b$ of the respective sheet metal segment. In that case, respectively adjacent chambers would have both intake cross-sections of different sizes and also outlet cross-sections of different sizes. The sheet metal segments 8 could be disposed with their lower edges $8b$ equidistantly around the central pipe 5 and the tilting effect may be about the connecting point between the respective lower edge $8b$ and the central pipe 5 so that adjacent chambers have intake cross-sections of different sizes but outlet cross-sections of the same size. The two options last mentioned are not shown in the drawing.

In contrast Figure 5 shows a further possible way of arriving at intake and outlet cross-sections, corresponding to Figure 4: the sheet metal segments 5 are not tilted overall, but are each angled through the angle α at the point P. The section shown in Figure 8 shows the same outlet area cross-sections as are found in the embodiment illustrated in Figure 4.

The upper edges $8a$ of the sheet metal segments 8 extend in a rising direction at a given angle towards the central pipe 5, as viewed from the casing of the hopper 7. The angle is so selected that it is greater than the angle of the friction of rest of the loose material. Any angel's hair contained in the loose material therefore slides outwardly along the upper edges $8a$ and drops into the annular space around the hopper 7 (see for example Figure 1). That ensures that the corresponding chamber cross-sections cannot become obstructed with angel's hair, which would not only adversely affect the mixing function but also make it difficult to clean the silo container.

Diversion of angel's hair into the outer annular space is further improved if the upper edges $8a$ of the sheet metal segments 8 are additionally provided with nose-shaped extension portion $8c$ which extend beyond the upper peripheral edge of the hopper casing, as shown in Figures 5 and 6.

Figures 9 to 11 show a second embodiment of the proposed mixing silo, or, more accurately, only its bottom region which alone is of

interest here. This second embodiment differs from that shown in Figures 1 and 2 in that in addition the space between the casing of the hopper 7 and the inside wall surface of the conical bottom 1a of the silo container is also divided into second chambers 19a to 19n by sheet metal segments 18 which are similar to the sheet metal segments 8. Here too respectively adjacent chambers 19a, 19b19n are of different outlet cross-sections, see Figure 11. However, using the same structural means as previously described in relation to the sheet metal segments 8 and the chambers 9a to 9n, it is also possible for the intake cross-sections of the chambers 19a to 19n to be of different sizes alternatively or additionally, from one chamber to another. Particularly in the case of silo containers of large diameter, operating on the same principle as above the hopper 7, that arrangement provides in the peripheral direction an additional number of flow zones involving speeds of downward movement of different magnitudes, so that even better homogenisation is achieved.



CLAIMS

1. A mixing silo comprising a silo container with a generally conical bottom which terminates at a generally central container outlet, wherein, a hopper which has a casing which narrows towards the container outlet is installed in the bottom region, the longitudinal axis of the hopper coincides with the centre line of the silo container, the interior of the hopper is divided, by sheet metal segments extending from the hopper casing towards the longitudinal axis of the hopper, into a plurality of chambers which are disposed in succession in the peripheral direction and at least part of the height of successive sheet metal segments in the peripheral direction are tilted in alternate directions through a small angle (α) relative to the corresponding longitudinal planes containing the centre line of the silo container so that respectively adjacent chambers have intake and/or outlet cross-sections of different sizes.
2. A mixing silo according to claim 1, wherein the sheet metal segments terminate at a central pipe.
3. A mixing silo according to claim 2, wherein the central pipe is in the form of a riser pipe for loose material circulation.
4. A mixing silo according to any one of claims 1 to 3, wherein the space between the hopper casing and the inside wall surface of the conical bottom of the silo container is divided by second sheet metal segments which are similar to said sheet metal segments into second chambers of which respectively adjacent chambers have different intake and/or outlet cross-sections.
5. A mixing silo according to any one of claims 1 to 4, wherein the upper edges of the sheet metal segments extend in a rising configuration from the upper edge of the hopper casing in the direction towards the centre line of the silo container at an angle which is greater than the angle for friction of rest of the loose material.



6. A mixing silo according to claim 5, wherein the outward ends of the upper edges of the sheet metal segments extend beyond the upper peripheral edge of the hopper casing.

- 5 7. A mixing silo substantially as hereinbefore described and illustrated with reference to the accompanying drawings.
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