



Bulk Material Conveying System and Method



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FIELD OF THE INVENTION

5 This invention relates generally to a bulk conveying system for transferring a flowable bulk material.

BACKGROUND

Wet mortar comprising a mixture of cement, sand and water is a basic material for construction works. Providing wet mortar at the point of use can be expensive.
10 Conventional systems are known to provide, instead, dry mortar, ie, a dry pre-mix of cement and sand. This dry mixture is stored in a silo and is transferred, often vertically to high elevations, by compressed air to the point of use, where water, at least, is added to the mixture in a mixer.

15 However, these known systems are still not as efficient and effective as desired. For example, there may be problems of maintenance of the known system and segregation of the bulk material consisting of a mixture at the point of use. Another problem of the known systems is the inability to simultaneously convey bulk material from one silo to more than one distribution channels.

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The present invention aims to minimise some of these problems.

SUMMARY

25 According to an embodiment of the present invention, a system for conveying flowable bulk material is provided. The system comprises:

a silo for storing the bulk material, the silo having an outlet near a lower portion of the silo and an air pipe terminating at an inside, upper portion of the silo;

a transfer block having first, second and third ports in fluid communication, the
30 first and second ports being substantially in a line of sight and the third port intermediate the first and second ports, the third port is arranged to connect with the outlet of the silo, the first port is arranged to connect with a first compressed air line which branches off a compressed air supply line, the compressed air supply line is linked to the air pipe, and the second port is arranged to connect with a delivery hose;

an air compressor operable to provide compressed air to the compressed air supply line and to a space in the silo above the bulk material through the air pipe, the control of the air compressor is dependent on predetermined low and high pressure settings of a pressure switch connected to the compressed air supply line; and

5 a controller operable for controlling both the bulk material flowing through the outlet of the silo into the third port of the transfer block and the compressed air flowing from the first compressed air line into the first port of the transfer block, thereby controlling the delivery and distribution of the bulk material flowing out through the second port of the transfer block via the delivery hose.

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According to another embodiment of the present invention, a bulk conveying system for conveying a flowable bulk material is provided. The system comprises:

a silo for storing the bulk material, the silo having an outlet near a lower portion of the silo and n number of air pipes terminating at an inside, upper portion of the silo;

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n-1 number of transfer blocks, each transfer block has first, second and third ports in fluid communication, the first and second ports being substantially in a line of sight and the third port intermediate the first and second ports, the third port is

arranged to connect with the outlet of the silo, the first port is arranged to connect with a first compressed air line which branches off a compressed air supply line, the

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compressed air supply line is linked to the air pipes, and the second port is arranged to connect with a delivery hose;

an air compressor operable to provide compressed air to the compressed air supply line and to a space in the silo above the bulk material through one of the air pipes, the control of the air compressor is dependent on predetermined low and high pressure settings of a pressure switch connected to the compressed air supply line; and

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a controller operable for controlling both the bulk material flowing through the outlet of the silo into the third port of each transfer block and the compressed air flowing from the first compressed air line into the first port of each transfer block, thereby controlling the delivery and distribution of the bulk material flowing out through the second port of each transfer block via the delivery hose.

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According to another embodiment of the present invention, a method for conveying a flowable bulk material from a silo for distribution is provided. The silo has an outlet near a lower portion of the silo and a first compressed air line which branches off a

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compressed air supply line, the compressed air supply line is connected to the silo at a location above the top of the bulk material, and the method comprises the steps of:

supplying compressed air to the compressed air supply line and a space inside the silo above the top of the bulk material;

5 regulating the bulk material to flow from the silo into a third port of a transfer block, where a first port and a second port of the transfer block are substantially in a line of sight and the third port is intermediate the first and second ports, the first, second and third ports being in fluid communication; and

10 regulating the compressed air to flow from the first compressed air line into the first port of the transfer block and out through the second port of the transfer block into a delivery hose, whereby a stream of the compressed air flowing through the transfer block and delivery hose carries the bulk material with the compressed air for delivery and distribution;

15 wherein the step of supplying compressed air to the compressed air supply line is dependent on predetermined low and high pressure settings of a pressure switch connected to the compressed air supply line and is separate from the steps of regulating the bulk material and compressed air flowing into the respective ports of the transfer block.

20 According to yet another embodiment of the present invention, a bulk material conveying system for conveying a flowable bulk material is provided. The system comprises:

25 storage means for storing the bulk material, the storage means having n outlets near a lower portion of the storage means and $n+1$ air pipes terminating at an inside, upper portion of the storage means above the bulk material;

30 n transfer block means, each having a first port and second port substantially in a line of sight and a third port intermediate the first and second ports, the third port is arranged to connect with each outlet of the storage means, the first port is arranged to connect with a first compressed air line which branches off a compressed air supply line, the compressed air supply line is linked to the respective air pipe, and the second port is arranged to connect with a separate delivery hose;

compressed air means for providing compressed air through the compressed air supply line and to a space in the storage means above the bulk material through one of the air pipes, the control of the air compressor is dependent on predetermined

low and high pressure settings of a pressure switch connected to the compressed air supply line;

material control means for controlling both the bulk material flowing through the each outlet of the storage means into the third port of the transfer block means and the compressed air flowing into the first port of the transfer block means, thereby
5 controlling the delivery and distribution of the bulk material flowing out through the second port of each of the transfer block means via each of the delivery hoses;

wherein the material control means for regulating the conveyance of the bulk material and compressed air is separate from the control of the compressed air
10 means.

In still another embodiment of the present invention, a first control valve regulates the flow of the bulk material into the third port of the or each transfer block.

15 In still another embodiment of the present invention, a second control valve regulates the flow of compressed air into the first port of the or each transfer block. Compressed air flows out of the second port of the or each transfer block and carries with it the bulk material that has entered through the third port of the or each transfer block. Preferably, the second control valve is actuateable to open for a predetermined time
20 interval before the first control valve is activated to operate, and the second control valve is actuateable to open for a predetermined time after the first control valve is deactivated to close.

In still another embodiment of the present invention, a second compressed air line
25 branches off the first compressed air line and joins the first compressed air line again at a second end at a point between the second control valve and the first port of the or each transfer block.

In still another embodiment of the present invention, an auto-clear valve is provided at
30 the second compressed air line near its connection with the first port of the or each transfer block. In another such embodiment, the auto-clear valve is operable to purge whatever bulk material that may be present in the or each transfer block, delivery hose and components downstream to prevent blockage thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention are described hereinafter by way of non-limiting examples, with reference to the accompanying drawings, in which:

5 Fig. 1 illustrates a schematic of the bulk conveying system according to an embodiment of the present invention;

Fig. 2A illustrates an embodiment of a distribution pipe with a single outlet and a bulk material receptacle for use with the bulk conveying system shown in Fig. 1;

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Fig. 2B illustrates another embodiment of a distribution pipe with multiple outlets for use with the bulk material conveying system shown in Fig. 1;

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Fig. 3A illustrates an embodiment of a silo with multiple outlets for use with the bulk material conveying system shown in Fig. 1; FIG. 3B illustrates a schematic of a silo with multiple outlets for use with the material conveying system shown in FIG. 1;

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Fig. 4 illustrates an embodiment of a valve block for use with the bulk material conveying system shown in Fig. 1;

Fig. 5 illustrates another embodiment of a valve block for use with the bulk material conveying system shown in Fig. 1;

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Fig. 6A illustrates a bottom view of an embodiment of a silo with a plurality of silo outlets and buffer plates for use with the bulk material conveying system shown in Fig. 1;

Fig. 6B illustrates a side view of the silo shown in Fig. 6A;

Fig. 6C illustrates yet another embodiment of the silo outlet arrangement for use with the bulk material conveying system shown in Fig. 1;

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Fig. 7 illustrates a combination of the bulk material conveying systems shown in Fig. 3.

DETAILED DESCRIPTION

Fig. 1 shows a schematic of a bulk material conveying system 10. Bulk material 12 is flowable and stocked up in a storage container or silo 20. The bulk material 12 is discharged from the silo 20 through an outlet 22 into a transfer block 40. A first control valve 30 at the outlet 22 regulates the amount of bulk material 12 flowing therethrough according to a demand. Typically, an isolation valve is provided between the outlet 22 and the first control valve 30.

The transfer block 40 has three ports 42, 44, 46. The first and second ports 42, 44 are substantially on a straight line or in a line of sight. The third port 46, in fluid communication with the first and second ports 42, 44, is intermediate between the first and second ports 42, 44. The third port 46 is connected to the first control valve 30, and the second port 44 is connected to a delivery hose 90 for delivery and distribution of the flowable bulk material 12.

An air pipe 50 terminates at an upper part of the silo 20 at a point above the top of the bulk material 12 at one (upper) end. The other (lower) end of the air pipe 50 is connected to a compressed air supply line 53. Branching off the compressed air supply line 53 is a first compressed air line 52, which connects to the first port 42 of the transfer block 40. Also connected to the compressed air supply line 53 is an air compressor 60. The air compressor 60 supplies compressed air to the silo 20 through the air pipe 50 and the compressed air supply line 53. Other pneumatic components such as a relief valve 112, a pressure gauge 114 and a pressure switch 119 that are typically used to set the operating parameters of the air compressor 60 are also connected to the compressed air supply line 53. In addition, the pressure release valve 116 for releasing the pressure in the compressed air supply line 53, for eg. during maintenance or repair, is connected to the compressed air supply line 53 at a point, preferably, near the air pressure gauge 114. Further, for increasing the capacity of the compressed air in the pneumatic line of the present bulk material conveying system 10, an air receiver 70 may be connected to the system 10, for eg. at the compressed air supply line 53.

At the connection between the first compressed air line 52 and the first port 42 of the transfer block 40 is a second control valve 48. The second control valve 48 is typically a 2-position normally-close valve type for regulating compressed air flow into the transfer block 40 for bulk material conveyance. In another embodiment, the second

control valve 48 may also be formed by combining a typical two position ON/OFF valve with an adjustable flow regulating valve.

A second compressed air line 80 branches off the first compressed air line 52 and connects again with the first compressed air line 52 at a point between the first port 42 of the transfer block 40 and the second control valve 48 by means of a typical T-shaped connector. An auto-clear valve 82, which is typically a normally-open valve, is provided on the second compressed air line 80 near the connection of the second compressed air line 80 with the first port 42 of the transfer block 40. In the event of a power interruption during conveying of the bulk material 12 from the silo 20 through the delivery hose 90, the auto-clear valve 82 is automatically opened and compressed air in the bulk material conveying system 10 is released through the auto-clear valve 82 and any bulk material 12 that may be present in the delivery system downstream of the transfer block 40 may be cleared, and blockage of the delivery system of the bulk material conveying system 10 may be minimised.

In use, the pressure switch 119 has a low pressure setting (for eg. adjustable to about 0.5 bar gauge) and a high pressure setting (for eg. adjustable to about 3 bar gauge). The air compressor 60 is controlled by the settings of the pressure switch 119, i.e. to start operation when the pressure switch 119 is at or below the low pressure setting and to stop operation when the pressure is at or above the high pressure setting. The compressed air supply line 53, the first compressed air line 52, the second compressed air line 80, the air space above the bulk material 12 inside the silo 20, air receiver 70 and other pneumatic components connected thereto are in fluid communication. All these lines and items hereinafter are referred to collectively as the pneumatic system of the bulk material conveying system 10. As such, the pressure within them is substantially the same. When a mains switch (not shown) is turned "ON" and the pressure switch 119 senses that the pressure inside the pneumatic system is at or below the low pressure setting, the pressure switch 119 sends a signal to a controller 66 to start the compressor 60 and the pressure inside the pneumatic system starts to build up. When the pressure inside the pneumatic system reaches the high pressure setting, the pressure switch 119 sends a signal to the controller 66 to stop the compressor 60. In addition, the first control valve 30, the second control valve 48 and the auto-clear valve 82 are connected to a conveyance controller 98 by respective cables 99c, 99d, 99e. The conveyance controller 98 controls the

compressed air flowing from the first compressed air line 52 as a vehicle for conveying the bulk material 12 from the silo 20 via hose 90.

In use, the bulk material system 10 is ready for operation when the air pressure in the pneumatic system is at or above the low pressure setting of the pressure switch 119. As shown in Fig. 2A, the delivery hose 90 leads to a distribution pipe 92 comprising segments 92a, 92b, 92c, etc. which are connectable to each other for extension of the distribution pipe 92. At the end of the distribution pipe 92, a T-shaped fitting 94 is provided. A hose 91 leading from a side port of the T-shaped fitting 94 directs the bulk material 12 into a receptacle 96. The port at the top of the T-shaped fitting 94 that is not in use is closed by an end cap 95. The level of the bulk material 12 in each receptacle 96 is detected by, typically, a low level switch 97a and a high level switch 97b. The low level switch 97a and the high level switch 97b are connected to the conveyance controller 98 by cables 99a, 99b respectively. In another embodiment of the bulk conveying system 10, it is possible that the hose 91 is connected directly from the second port 44 of the transfer block 40 to the receptacle 96. In other embodiments, the delivery hose 90 may be connected from the second port 44 of the transfer block 40 directly to the receptacle 96.

For eg., in use, an isolation valve 83 is provided on the second compressed air line 80. Preferably, isolation valve 83 is close to the second control valve 82. Typically, after the power supply to the conveyance controller 98 is turned "ON", the isolation valve 32 and isolation valve 83 are turned to their "open" positions and the conveyance controller 98 sends a signal to cause the auto-clear valve 82 to close, whereas the first control valve 30 and the second control valve 48 remain in their initial "closed" position. In one embodiment of the bulk material conveyance system, a timer (not shown) is provided to close the auto-clear valve 82 after an adjustable period of, say, about 30 to about 60 seconds. This is to avoid the auto-clear valve 82 being left "open", for example, unintentionally. When the level of the bulk material 12 in the receptacle 96 is low as detected by the low level switch 97a, a material request signal from the controller 98 is sent to the second control valve 48 for it to open. Once the second control valve 48 is opened, compressed air flows into the first port 42 of the transfer block 40 and out of the second port 44 of the transfer block 40 and into the delivery hose 90, (distribution pipe 92, hose 91 where applicable) and receptacle 96. After a predetermined time interval has elapsed from the opening of the second control

valve 48, the controller 98 sends a signal to start operating the first control valve 30 and the bulk material 12 is thus controlled to flow into the third port 46 of the transfer block 40. Compressed air flowing through the transfer block 40 conveys with it the bulk material 12 that has entered the third port of the transfer block 40. A stream of compressed air with the bulk material 12 in suspension is then conveyed into the delivery hose 90, (distribution pipe 92, hose 91 where applicable) and the receptacle 96. The bulk material 12 separates out from the air stream as the suspension reaches the receptacle 96. The bulk material 12 settles into the receptacle 96 and the air escapes into the atmosphere, preferably through a filter 89 disposed across the top of the receptacle 96. The filter 89 is provided to minimise both loss of the bulk material and air pollution. Once, the high level switch 97b detects that the bulk material 12 inside the receptacle 96 has reached the pre-set high level, the signal to the first control valve 30 is cut off (to stop bulk material 12 from entering into the transfer block 40) but the material request signal to the second control valve 48 is maintained for a predetermined time interval after the signal to the first control valve 30 is cut off. Allowing the compressed air to flow for a predetermined time after the bulk material 12 flow is stopped ensures that any remaining bulk material 12 present in the transfer block 40, delivery hose 90, distribution pipe 92 or hose 91 is moved as completely as possible into the receptacle 96. Control of delivery and distribution of the bulk material 12 may be repeated in cycles until a predetermined supply of the bulk material 12 to the particular receptacle 96 is fulfilled. In another embodiment of the bulk material conveying system, it is also possible to control the delivery of the bulk material 12 by using a high level switch 97b and a timer.

Fig. 2B shows another embodiment of the distribution pipe 92. As shown, the pipe segments 92a, 92b, etc. are connected through T-shaped fittings 94a, 94b, etc. The side ports of fittings 94a, 94b, etc. are connected by hoses 91a, 91b, etc. to the respective receptacles 96a, 96b, etc.. Each end of the hoses 91a, 91b, etc. is provided with a respective solenoid valve 93a, 93b, etc. which is selectively actuated through the controller 98 for delivery of the bulk material 12 into the respective receptacles 96a, 96b, etc. Each port of the T-shaped fittings 94n that is not in use is closed with an end cap 95n. With this embodiment of the distribution pipe 92, a plurality of distribution channels for the bulk material 12 from a single distribution pipe 92 is provided.

In another embodiment of the silo 20, as shown in Fig. 3A, a silo may be provided with a plurality of silo outlets 22a, 22b, 22c, etc. instead of a single outlet 22. Each of the plurality of outlets 22a, 22b, 22c, etc. is equipped with a respective isolation valve 32a, 32b, 32c, etc.; a respective first control valve 30a, 30b, 30c, etc. a matching plurality of transfer blocks 40a, 40b, 40c, etc. Similarly, a matching plurality of associated second control valves 48a, 48b, 48c, etc.; a plurality of auto-clear valves 82a, 82b, 82c, etc.; a plurality of isolation valve 83.; a plurality of delivery hoses 90a, 90b, 90c, etc are also provided. With a plurality of outlets 22a, 22b, 22c, etc. and associated components connected thereto, a plurality of delivery hoses 90a, 90b, etc. and distribution pipes from one silo is thus possible, this further improving the efficiency of the bulk material system of the present invention.

As shown in Fig. 3A, the silo 20 also has a filter 24 extending across an upper part of the silo 20. A bulk material inlet pipe 25 for transferring bulk material 12 from a carrier (not shown) into the silo 20 extends from a lower and exterior part of the silo 20 into the silo 20 and terminates at a point below the filter 24. The lower end of the material inlet pipe 25 has a valve 26 for opening or closing of the material inlet pipe 25.

As shown in Fig. 3A, the silo 20 is also typically equipped with a manhole 21 and material low 23a and material high 23b level switches.

From above the filter 24, the air pipe 50 extends downward through the filter 24 typically inside the silo 20 and out through the silo 20 at a lower part of the silo 20 which is typically conically tapering 28. The air pipe 50 is typically disposed inside the silo 20 to reduce the possibility of damage due to handling. The end of the pipe 50 which is outside the silo 20 is connected to a valve block 100 using a typical flange 55 or a threaded joint. The other end of the valve block 100 as shown in Figs. 1, 4 and 5 is closeable with an isolation valve 54. In another embodiment of the valve block, the valve block as shown in Figs. 4 and 5 is formed by joining connections 118, 121, 122, 124 directly to a portion of the air pipe 50 adjacent its lower end, such that other pneumatic components, for example, the relief valve 112, pressure gauge 114, pressure switch 119, release valve 116, and compressor 60 are connected thereto, whilst the isolation valve 54 is connected directly to the lower end of the air pipe 50.

As can be seen from Fig. 3A, two buffer plates 27a, 27b extend to about the height of a lower conical section 28a of the silo 20. These buffer plates 27a, 27b cooperate to compartmentalise bulk material 12 inside the lower conical section 28a of the silo 20 to each outlet 22a, 22b, etc. The lower conical section 28a of the silo fitted with the buffer plates 27a, 27b is connected to an upper conical section 28b by a typical ring flange 29 for ease of assembly and maintenance.

In use, a flange joint 55 is connected to the valve block 100 schematically shown in Fig. 4. Part of the first compressed air line 52 is also formed in the valve block 100. The isolation valve 54 is provided at the valve block 100 to allow air to vent from inside the silo 20 when the silo 20 is to be charged with the bulk material 12. After the silo 20 is charged and during operation of the bulk material conveying system 10, the isolation valve 54 is closed.

FIG. 3B shows yet another embodiment of the silo. As shown schematically in FIG. 3B, the silo has n number of air pipes 50 provided with n number of silo outlets and an equal number of transfer blocks in addition to the air pipe 50 supplying compressed air to the space above the top of the bulk material.

From Fig. 4, the left hand side of the valve block 100 has a connection 121 to the relief valve 112, the pressure gauge 114 and the pressure release valve 116. Branching off from the relief valve 112 connection is a connection 118 to the air compressor 60 and pressure switch 119.

On the right hand side of valve block 100, are shown two connections 122, 124. As shown in Fig. 4, valves 122a and 122c are in the first connection 122 while valves 124a, 124b, and 124c are in the second connection 124. Valves 124a, 124b, 124c and 122c are connected by the first compressed air lines 52a, 52b, 52c, 52d to the respective second control valves 48a, 48b, 48c and 48d. Valve 122a is connected in parallel by the second compressed air lines 80, 80a, 80b, 80c, 80d to the respective auto-clear valves 82a, 82b, 82c and 82d. In one such embodiment, valves 122a, 122c, 124a, 124b, 124c are manual isolation valves provided for ease of assembly and dis-assembly of the first compressed air lines 52a, 52b, 52c, 52d and the second compressed air line 80 connected thereto.

Fig. 4 also shows four assemblies of the transfer blocks 40a, 40b, 40c, 40d associated with the respective first control valve 30a, 30b, etc., second control valve 48a, 48b, etc., and auto-clear valve 82a, 82b, etc.. Each assembly is now labelled control block 110a, 110b, etc. for convenience of identification in the drawings. Referring back to
 5 Fig. 1, the assembly of the transfer block 40, first control valve 30, second control valve 48 and auto-clear valve 82 is also labelled control block 110. In an embodiment, each manual isolation valve 32a, 32b, etc. is provided at the respective outlets 22 of the silo 20 for connection with each respective first control valve 30a, 30b, etc. The manual isolation valves 32a, 32b, etc. are provided for ease of assembly and dis-
 10 assembly of each transfer block 40a, 40b, etc..

In another embodiment of the valve block 100, the relief valve 112, pressure gauge
 15 114 and the pressure release valve 116 may instead be arranged on another connection on the same side next to the connections 122, 124. If two or more bulk material conveying systems 10 are linked to each other, it is possible to use only one valve block 100 comprising common air pressure setting components such as having a common relief valve 112, pressure gauge 114, pressure release valve 116, pressure
 20 switch 119 and air compressor 60. In addition, the valve block 100 has a respective number of connections to the first and second compressed air lines 52, 80. In still another embodiment of the valve block, the valve block 100 as shown may be constructed by connecting individual valve fittings together to provide the same functions as valve block 100. It is also possible to connect separate valve blocks 100
 25 for separate silos 20 with a common air compressor, in which embodiment, each silo is connected to the bulk material conveying system through an isolation valve 105 (as shown in Fig. 7) for ease of assembly, dis-assembly, expansion or isolation of the bulk material conveying system.

30 Fig. 5 shows a second valve block 200, which is yet another embodiment of the valve block 100. The second valve block 200 differs from the valve block 100 in that the second compressed air line 80 is tapped off directly from the air pipe 50 or compressed air supply line 53 through an isolation valve 202 instead of from the valve connection 122.

Fig. 6A shows a bottom view of another embodiment of a silo 20a. The silo 20a has four outlets 22e, 22f, 22g, 22h and buffer plates 29c, 29d for use with the bulk material conveying system 10. Fig. 6A illustrates the buffer plates 29c, 29d more clear than those shown in Fig. 3. Fig. 6B shows a side view of the silo outlets as seen in Fig. 6A.

5 Fig. 6C illustrates still another embodiment of the silo with outlets 22i, 22j, 22k. These silo outlets 22e, 22f,22i, 22j, etc. are shown to be connectable to the respective control blocks 110a, 110b, etc.

10 In another embodiment of the buffer plates, silo 20 may have buffer plates extending all the way from the outlet 22 to the filter 24. In this embodiment, there are an equal number of material charging pipe 25 as there are compartments formed in the silo by the buffer plates. This silo has the advantage that a single silo can accommodate bulk materials with different properties in separate compartments.

15 With the present invention, the air compressor 60 is turned on (power on) all the time and the air compressor 60 kicks into operation when the pressure in the compressed air supply line 53 (or pneumatic system) is at or below the preset low pressure, and stops operation when the preset high pressure is reached. In contrast to the conventional system where the air compressor kicks in each time a demand for bulk material to a receptacle 96 is received and stops each time the receptacle is filled up

20 or a demand is fulfilled, the air compressor 60 according to the embodiments of the present invention does not kick into operation on and off periodically according to a demand for bulk material 12. The present invention helps to reduce wear and tear caused by periodic start-stop operations of the air compressor 60 and helps to prolong the life of the air compressor 60 and its primer. The present invention thus leads to lower equipment maintenance costs. Further, the control of the air compressor 60 is

25 separate from the control of the bulk material delivery system, thus simplifying the control of the bulk material conveying system 10 and its operation. Another advantage of the present invention is that the compressed air stored up inside the silo increases the compressed air capacity available for conveying the bulk material.

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In addition, by providing a positive pressure inside the silo 20, the bulk material 12 flowing out of the silo outlet 22 into the transfer block 40 tends to be more consistent in the mixture of the bulk material compositions, i.e. segregation of the bulk material compositions is reduced.

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Segregation of the bulk material compositions is further minimised by the buffer plates 29a, 29b disposed in the lower conical section 28a of the silo 20. With the present embodiments of the bulk material conveying system 10 and the minimising of the segregation problems, it is possible to deliver and distribute bulk material 12 from one silo 20 to more than one outlet simultaneously or selectively one outlet or more at any time.

The present invention is not limited to transfer of dry pre-mix of cement and sand (for eg. dry mortar) in the construction industry. The principle as disclosed in the above description can also be used to transfer other industrial products that are flowable, for eg. drilling mud in the oil and gas industry. With the use of appropriate materials such as stainless steel for the silo, pneumatic components and so on, foodstuff such as grains, cereals, sugar, etc. can also be transferred by using the bulk material conveying system 10 of the present invention.

While only one embodiment of the bulk material conveying system and two embodiments of the pneumatic system have been described and illustrated, it is to be understood that many changes, modifications and variations could be made to the present invention without departing substantially from the principle of the invention. A variation of the bulk material conveying system 10 is to link two or more such systems 10 together but with a common air compressor. Another possible variation is to link the bulk material conveying system 10 with a conventional system without a pressurised silo. Yet another variation is to separately convey the constituents of bulk material stored in separate silos, either simultaneously or one at a time, to a mixer to produce a desired bulk material compositions.

CLAIMS:

1. A bulk material conveying system for conveying a flowable bulk material, the system comprising:
 - a silo for storing the bulk material, the silo having an outlet near a lower portion of the silo and an air pipe terminating at an inside, upper portion of the silo;
 - a transfer block having first, second and third ports in fluid communication, the first and second ports being substantially in a line of sight and the third port intermediate the first and second ports, the third port is arranged to connect with the outlet of the silo, the first port is arranged to connect with a first compressed air line which branches off a compressed air supply line, the compressed air supply line is linked to the air pipe, and the second port is arranged to connect with a delivery hose;
 - an air compressor operable to provide compressed air to the compressed air supply line and to a space in the silo above the bulk material through the air pipe, the control of the air compressor is dependent on predetermined low and high pressure settings of a pressure switch connected to the compressed air supply line; and
 - a controller operable for controlling both the bulk material flowing through the outlet of the silo into the third port of the transfer block and the compressed air flowing from the first compressed air line into the first port of the transfer block, thereby controlling the delivery and distribution of the bulk material flowing out through the second port of the transfer block via the delivery hose.
2. A system according to claim 1, wherein the outlet of the silo comprises an isolation valve.
3. A system according to claim 2, further comprising a first control valve disposed between the isolation valve and the third port of the transfer block.
4. A system according to any one of the preceding claims, further comprising a second control valve disposed on the first compressed air line near the first port of the transfer block.
5. A system according to claim 4, wherein the second control valve is operable to regulate the compressed air flowing into the first port of the transfer block.

6. A system according to claim 4 or 5, further comprising a second compressed air line branching off the first compressed air line at a first end and joining the first compressed air line again at a second end at a point between the second control valve and the first port of the transfer block.

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7. A system according to claim 4 or 5, further comprising a second compressed air line branching off the compressed air supply line at a first end and joining the first compressed air line at a second end at a point between the second control valve and the first port of the transfer block.

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8. A system according to claim 6 or 7, further comprising an auto-clear valve arranged on the second compressed air line near its second end.

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9. A system according to claim 8, wherein the auto-clear valve is a normally-open valve, which is actuatable to close.

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10. A system according to any one of claims 6 to 9, wherein the transfer block comprises a plurality of transfer blocks matching a plurality of silo outlets, each of the transfer blocks is arranged with separate first and second compressed air lines and separate delivery hoses.

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11. A system according to claim 10, further comprising a plurality of buffer plates to compartmentalise bulk material near the silo outlets with one compartment to each respective silo outlet and transfer block.

12. A system according to any one of the preceding claims, wherein the control of the air compressor is separate from the controller regulating the compressed air and bulk material flow rates.

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13. A bulk conveying system for conveying a flowable bulk material, the system comprising:

a silo for storing the bulk material, the silo having an outlet near a lower portion of the silo and n number of air pipes terminating at an inside, upper portion of the silo;

n-1 number of transfer blocks, each transfer block has first, second and third ports in fluid communication, the first and second ports being substantially in a line of

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sight and the third port intermediate the first and second ports, the third port is arranged to connect with the outlet of the silo, the first port is arranged to connect with a first compressed air line which branches off a compressed air supply line, the compressed air supply line is linked to the air pipes, and the second port is arranged to
 5 connect with a delivery hose;

an air compressor operable to provide compressed air to the compressed air supply line and to a space in the silo above the bulk material through one of the air pipes, the control of the air compressor is dependent on predetermined low and high pressure settings of a pressure switch connected to the compressed air supply line;

10 and

a controller operable for controlling both the bulk material flowing through the outlet of the silo into the third port of each transfer block and the compressed air flowing from the first compressed air line into the first port of each transfer block, thereby controlling the delivery and distribution of the bulk material flowing out through
 15 the second port of each transfer block via the delivery hose.

14. A system according to any one of the preceding claims, further comprising one or more air receivers.

20 15. A system according to any one of the preceding claims, wherein the air compressor comprises two or more air compressors.

16. A method for conveying a bulk material from a silo for distribution, the silo having an outlet near a lower portion of the silo and a first compressed air line which
 25 branches off a compressed air supply line, the compressed air supply line is connected to the silo at a location above the top of the bulk material, the method comprising the steps of:

supplying compressed air to the compressed air supply line and a space inside the silo above the top of the bulk material;

30 regulating the bulk material to flow from the silo into a third port of a transfer block, where a first port and a second port of the transfer block are substantially in a line of sight and the third port is intermediate the first and second ports, the first, second and third ports being in fluid communication; and

regulating the compressed air to flow from the first compressed air line into the
 35 first port of the transfer block and out through the second port of the transfer block into

a delivery hose, whereby a stream of the compressed air flowing through the transfer block and delivery hose carries the bulk material with the compressed air for delivery and distribution;

5 wherein the step of supplying compressed air to the compressed air supply line is dependent on predetermined low and high pressure settings of a pressure switch connected to the compressed air supply line and is separate from the steps of regulating the bulk material and compressed air flowing into the respective ports of the transfer block.

10 17. A method according to claim 16, wherein regulating flow of the bulk material comprises providing a first control valve.

18. A method according to claim 16 or 17, wherein regulating the compressed air comprises providing a second control valve.

15 19. A method according to claim 18, wherein the second control valve is activated to open for a predetermined time before the first control valve is activated to operate, and the second control valve is actuatable to open for a predetermined time after the first control valve is de-actuated to close.

20 20. A method according to any one of claims 16 to 19, wherein a second compressed air line branches off the first compressed air line at a first end and connects with the first compressed air line again at a second end at a point between the second control valve and the first port of the transfer block.

25 21. A method according to any one of claims 16 to 19, wherein a second compressed air line branches off the compressed air supply line at a first end and connects with the first compressed air line at a second end at a point between the second control valve and the first port of the transfer block.

30 22. A method according to claim 20 or 21, wherein the second compressed air line comprises an auto-clear valve.

35 23. A method according to claim 22, wherein the auto-clear valve is a normally-open valve.

24. A method according to claim 22 or 23, wherein the auto-clear valve is open when there is a power interruption during conveyance of the bulk material from the silo through the delivery hose, so that compressed air continues to flow to purge any bulk material that may be present in the transfer block, delivery hose and components downstream, thereby prevents blockage of the bulk material conveying system.

25. A method according to any one of claims 20 to 24, wherein the transfer block comprises a plurality of transfer blocks matching a plurality of silo outlets, each transfer block is arranged with separate first and second compressed air lines and separate delivery hoses so that conveyance of the bulk material is operable simultaneously or selectively one or more at a time from one silo.

26. A method according to claim 25, further comprising a plurality of buffer plates to compartmentalise bulk material with one compartment to each respective silo outlet and transfer block.

27. A method according to claim 26, wherein bulk material of different property is stored in each separate compartment.

28. A method according to any one of claims 25-27, wherein supplying compressed air to the compressed air supply line and a space inside the silo above the top of the bulk material comprises providing an air pipe that terminates in the silo and in the space above the top of the bulk material.

29. A method according to any one of claims 25-28, further comprising a plurality of air pipes terminating in the silo in the space above the top of the bulk material in equal number as the plurality of transfer blocks such that each transfer block is associated with each air pipe in addition to the air pipe in claim 28 serving as a compressed air supply line.

30. A bulk material conveying system for conveying a flowable bulk material, the system comprising:

storage means for storing the bulk material, the storage means having n outlets near a lower portion of the storage means and $n+1$ air pipes terminating at an inside, upper portion of the storage means above the bulk material;

5 n transfer block means, each having a first port and second port substantially in a line of sight and a third port intermediate the first and second ports, the third port is arranged to connect with each outlet of the storage means, the first port is arranged to connect with a first compressed air line which branches off a compressed air supply line, the compressed air supply line is linked to a respective air pipe, and the second port is arranged to connect with a separate delivery hose;

10 compressed air means for providing compressed air through the compressed air supply line and to a space in the storage means above the bulk material through one of the air pipes, the control of the air compressor is dependent on predetermined low and high pressure settings of a pressure switch connected to the compressed air supply line;

15 material control means for controlling both the bulk material flowing through the each outlet of the storage means into the third port of each transfer block means and the compressed air flowing into the first port of each transfer block means, thereby controlling the delivery and distribution of the bulk material flowing out through the second port of each transfer block means via each of the delivery hoses;

20 wherein the material control means for regulating conveyance of the bulk material and compressed air is separate from the control of the compressed air means.