CALIBRATION DEVICE FOR WEIGHING SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a weighing system, and in particular to a calibration device for a weighing system.

2. The Related Art

[0002] In the prior art, the calibration of a weighing system for large- and medium-sized tanks has been a problem that has bothered users for many years. It is well known that calibration with certified test weights is the most accurate calibration method that is most widely accepted by the people with knowledge of weighing, but in practical applications, the operation is extremely difficult.

[0003] However, for many of the existing tanks of several tons to hundreds of tons, it is impossible to find a place to hang weights on the tank, and the handling of the weights is time-consuming and laborious. It is therefore almost impossible to calibrate these weighing systems with test weights, even if that amount of test weights were available. People then also come up with methods such as material substitution and material transfer, which are not only time-consuming and laborious, but also costly and inaccurate.

[0004] In recent years, some people have tried to use hydraulic calibration methods, but these methods still have some defects, or are not accepted in practice, have too many limitations, and are thus not practically applied in the market. Like the apparatus for checking and/or calibrating a weighing device for a container, GB 2 027 542 A, includes means for pushing or pulling the container against the

restraint exerted thereon by the weighing device and incorporating in said means at least one force measuring transducer having energizing means and output signal means, said output signal means being utilized to indicate the load applied to the container by the pushing or pulling means. A hydraulic compression cylinder supplied by a pump is connected between two members so that the cylinder causes contraction of means for pushing or pulling the container. Means for connecting to the container comprises turnbuckles in series with adjustable length chains. Means are provided for reversing the signal from the transducer, so that it can be incorporated in connecting means between framework and the top of container to measure compression. Another application, JP H09 236482 A, discloses a similar device for a meter checking loading device capable of applying a checking loading load on a meter with a simplified operation. More recently WO 2004/088259 A1 was filed for an apparatus and a method for calibrating weighing equipment, such as weighing hoppers.

[0005] In view of this, a person skilled in the art urgently needs to develop a new calibration device for a weighing system.

SUMMARY

[0006] The technical problem to be solved by the present invention is to overcome the current deficiencies such as time-consuming and laborious calibration methods and high costs of weighing system calibration for existing large- and medium-sized tanks, and thus provide a practical calibration device for weighing systems.

~~**[0007]**~~**[0001]** ~~The above-mentioned technical problem is solved in the present invention by the following technical solutions:~~

~~[0008]~~**[0007]** A calibration device for a weighing system, the weighing system comprising a tank, with a plurality of support legs being provided at a lower part of the tank, the calibration device comprising at least one calibration module, a hydraulic system and a calibration terminal; wherein an upper end of the calibration module is fixedly connected to an upper part of the corresponding support leg, and a lower end of the calibration module is fixedly connected to the foundation; the calibration module is connected via a hose to the hydraulic system for applying a force to the tank; and the calibration terminal is connected to the calibration module for displaying, in real-time, the force applied to the tank.

~~[0009]~~**[0008]** According to ~~one~~ the above embodiment ~~of the present invention~~, the calibration module further comprises a calibration load cell for converting the applied force from the calibration module into an analogue signal, and the calibration device further comprises at least one A/D-converter for converting the analogue signal from the calibration load cell into a digital signal, wherein for each calibration load cell, a A/D-converter is located at the calibration terminal for converting the analogue signal and providing a digital output signal for processing at the calibration terminal, or wherein for each calibration load cell, a A/D-converter is located at the calibration load cell for converting the analogue signal and providing a digital output signal for processing at the calibration terminal, or wherein the calibration device further comprises a smart junction box having an A/D-converter for each calibration load cell and providing a digital output signal per calibration load cell for processing at the calibration terminal.

~~[0010]~~**[0009]** According to ~~one~~ the above embodiment ~~of the present invention~~, the hydraulic system comprises a pump, a pressure gauge, a manifold, a number of hoses, a number of one-way stop valves, a ~~a~~ number of hydraulic cylinders and a number of quick-change connectors, wherein one side of the manifold is connected to the corresponding hydraulic cylinder via some of the hoses, and each

of the one-way stop valves are mounted to the corresponding hosees and close to the hydraulic cylinders; and wherein the other side of the manifold is connected to one end of the pressure gauge, and the other end of the pressure gauge is connected to the pump.

~~[0011]~~**[0010]** According to ~~one~~ the above embodiment ~~of the present invention~~, the hoses are high-pressure flexible hoses.

~~[0012]~~**[0011]** According to ~~one~~ the above embodiment ~~of the present invention~~, the hydraulic cylinder is a pull-type hydraulic cylinder.

~~[0013]~~**[0012]** According to ~~one~~ the above embodiment ~~of the present invention~~, the pump is a manual pump or an electric pump.

~~[0014]~~**[0013]** According to the above~~one~~ embodiment ~~of the present invention~~, the calibration module comprises a plurality of U-clevises, a plurality of rod ends, a coupling nut, a threaded rod, a calibration load cell and a pull-type hydraulic cylinder; wherein the lower end of the calibration load cell is connected to the rod of the pull-type hydraulic cylinder, the U-clevis and the rod end in succession; and wherein the upper end of the calibration load cell is connected to the threaded rod, the coupling nut, the rod end and the U-clevis in succession.

~~[0015]~~**[0014]** According to ~~one~~ the above embodiment ~~of the present invention~~, lifting lugs are arranged at the top of the support legs or support brackets, and the U-clevises are fixedly connected to the corresponding lifting lugs.

~~[0016]~~**[0015]** According to ~~one~~ the above embodiment ~~of the present invention~~, the bottom ends of the support legs or support brackets are supported by a solid foundation, a mezzanine floor or steel structure via anchor plates, and the rod ends are fixed to the anchor plates.

~~[0017]~~**[0016]** According to ~~one~~ the above embodiment ~~of the present invention~~, one, two, three or four calibration modules are provided.

~~[0018]~~**[0017]** According to ~~one~~ the above embodiment ~~of the present invention~~, a pull-type calibration load cell is connected in series with a pull-type hydraulic cylinder, and is used to display, in real time, a tension load value generated by the pull-type hydraulic cylinder, via the calibration terminal.

[0018] The above-mentioned technical problem is solved in the present invention by the following technical solution~~s~~:

[0019] A calibration device for a weighing system, the weighing system comprising a tank, with a plurality of support legs or support brackets being provided to mount the tank on a solid foundation, a mezzanine floor or a steel structure; wherein the calibration device comprising at least one calibration module for applying a force to the tank fixedly connected at the upper end of the calibration module to one of each support leg or support bracket, and fixedly connected at the lower end of the calibration module to the solid foundation, the mezzanine floor or the steel structure, the calibration module comprising a calibration load cell for converting the applied force from the calibration module into an analogue signal; the calibration device further comprising a calibration terminal for processing the analogue signal of the calibration load cell and displaying, in real time, the applied force from the calibration module~~; and at least one A/D-converter for converting the analogue signal from the calibration load cell into a digital signal~~. The solution is characterized in that the calibration device further comprising at least one A/D-converter for converting the analogue signal from the calibration load cell into a digital signal, wherein for each calibration load cell, a A/D-converter is located at the calibration terminal for converting the analogue signal and providing a digital output signal for

processing at the calibration terminal, or in that for each calibration load cell, a A/D-converter is located at the calibration load cell for converting the analogue signal and providing a digital output signal for processing at the calibration terminal, or in that the calibration device further comprises a smart junction box having an A/D-converter for each calibration load cell and providing a digital output signal per calibration load cell for processing at the calibration terminal.

[0020] The positive progress effects of the present invention lie in: the calibration device for a weighing system of the present invention can greatly improve the production efficiency, and in use, it takes only two hours to complete the calibration, which is far better than the test weight and other calibration methods. The uncertainty of the calibration process can reach 0.1% or better.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The above-mentioned and other features, properties and advantages of the present invention will become more apparent from the following description of the embodiments with reference to the accompanying drawings, and the same reference numerals in the figures denote the same features throughout the drawings, in which:

[0022] Fig.1 is a reference diagram of a service state of a calibration device for a weighing system of the present invention.

[0023] Fig.2 is a front view of a calibration module in the calibration device for a weighing system of the present invention.

[0024] Fig.3 is a side view of the calibration module in the calibration device for a weighing system of the present invention.

[0025] Fig.4 is a schematic structural diagram of a hydraulic system in the calibration device for a weighing system of the present invention.

[0026] Fig.5 is a principle diagram of the hydraulic system in the calibration device for a weighing system of the present invention.

[0027] Fig.6 is a wiring connection scheme in a calibration device for a weighing system of the prior art.

[0028] Fig.7 is a first wiring connection scheme in the calibration device for a weighing system of the present invention.

[0029] Fig.8 is a second wiring connection scheme in the calibration device for a weighing system of the present invention.

[0030] Fig.9 is a third wiring connection scheme in the calibration device for a weighing system of the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

[0031] To make the above objects, features and advantages of the present invention more obvious and easier to understand, the present invention will be described in detail below in conjunction with the accompanying drawings and particular embodiments.

[0032] Embodiments of the present invention will now be described in detail with reference to the accompanying drawings. Reference will now be made in detail to preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. The same reference numerals used in all the figures denote identical or similar parts wherever possible.

[0033] Furthermore, although the terms used in the present invention are selected from well-known common terms, some of the terms mentioned in the

description of the present invention may have been selected by the applicant according to his or her judgement, and the detailed meaning thereof is described in the relevant section described herein.

[0034] Furthermore, the present invention must be understood, not simply by the actual terms used but also by the meanings encompassed by each term.

[0035] Fig. 1 is a reference diagram of a calibration device for a weighing system of the present invention in a service state. Fig. 2 is a front view of a calibration module in the calibration device for a weighing system of the present invention. Fig. 3 is a side view of the calibration module in the calibration device for a weighing system of the present invention. Fig. 4 is a schematic structural diagram of a hydraulic system in the calibration device for a weighing system of the present invention. Fig. 5 is a diagram of the principle of the hydraulic system in the calibration device for a weighing system of the present invention.

[0036] As shown in Figs. 1 to 5, the present invention discloses a calibration device for a weighing system, the weighing system comprising a tank 10, with a plurality of support legs 11 being provided at a lower part of the tank 10, and the calibration device comprising a number of calibration modules 20, a hydraulic system 30 and a calibration terminal 40. An upper end of the calibration module 20 is fixedly connected to an upper part of the corresponding support leg 11, and a lower end of the calibration module 20 is fixedly connected to the foundation. The calibration modules 20 are connected to the hydraulic system 30 via a number of hoses 34. The calibration terminal 40 is connected to the hydraulic system 30 for real-time display of load distribution applied to the tank 10.

[0037] From the above, the hydraulic system 30 comprises a pump 31, a pressure gauge 32, a manifold 33, a number of hoses 34, a number of one-way

stop valves 35, a hydraulic cylinder 36 and a quick-change connector 37, one side of the manifold 33 being connected to the corresponding hydraulic cylinder 36 via a number of hoses 34, and the one-way stop valve 35 being mounted to the corresponding hose 34 close to the hydraulic cylinder 36. The other side of the manifold 33 is connected to one end of the pressure gauge 32, and the other end of the pressure gauge 32 is connected to the pump 31 via the quick-change connector 37. The one-way stop valve 35 is directly mounted to an input and output port of the hydraulic cylinder 36, and quick-change connectors 37 are mounted at all joints of the hoses 34.

[0038] Specifically, the hose 34 is preferably a high-pressure flexible hose. The hydraulic cylinder 36 is preferably a pull-type or tension hydraulic cylinder. The pump 31 is preferably a manual pump or an electric pump.

[0039] Further, the calibration module 20 comprises a plurality of U-clevises 21, a plurality of rod ends 22, a coupling nut 23, a threaded rod 24, a calibration load cell 25 and a pull-type hydraulic cylinder 26. The lower end of the calibration load cell 25, is connected to the rod of the pull-type hydraulic cylinder 26, the U-clevis 21 and the rod end 22 in succession. In addition, the upper end of the calibration load cell 25, is connected to the threaded rod 24 is connected to the coupling nut 23, the rod end 22 and the U-clevis 21 in succession.

[0040] In the implementation process, the upper end of the calibration module 20 is connected to the tank 10, and the lower end of the calibration module 20 is connected to the foundation. If the target tank is to reach the calibration precision of 0.1%, the load cell used should at least meet the precision requirement of 0.03%.

[0041] According to the above structure, the calibration module 20 is installed to the tank 10 by: arranging lifting lugs 12 at the top of the support legs

11 of the tank 10, and fixedly connecting the U-clevis 21 of the calibration module 20 to the corresponding lifting lugs 12. The bottom of the support legs 11 are fixed to the foundation via anchor plates 13, and the rod ends 22 of the calibration modules 20 are fixed to the anchor plates 13.

[0042] Preferably, one, two, three or four calibration modules 20 in this embodiment can be preferably provided.

[0043] Furthermore, a pull-type load cell (not referred in figure 1) is connected in series on the pull-type hydraulic cylinder 26, and is used to display a tension value generated by the pull-type hydraulic cylinder 26 on the calibration terminal 40 in real time.

[0044] As described above for the structure, a tank weighing system with four weigh modules is taken as an example in this embodiment, but can be applied to any industrial weighing system such as hopper, bin, silo or reactor vessel supported on one or more load cells or weigh modules. In particular, four lifting lugs 12 are arranged on the tank 10 according to the proposal of MT hydraulic calibration, the anchor plates 13 are pre-embedded on the foundation, and a number of hoses can be connected around the tank 10.

[0045] The calibration modules can also be connected to the tank in many different ways, e.g. if the lugs are welded to the body of the tank, or the threaded rod 20 can connect directly to a tank’s mounting brackets in a through-floor situation. The calibration modules can also connect to the tank foundation in many different ways, e.g., a lug can be welded to the foundation, especially when this is a steel structure. Only one connection point on the tank and one connection point on a solid foundation that is required for each calibration module to apply the calibration force to the tank.

[0046] In Figures 6 to 9 the electrical cabling of the calibration device is shown. Figure 6 represents the cabling according to the prior art. The analogue junction box 12 sums the analog signals from the calibration load cells 25 by the analogue summing board 13 and provides an average summed analogue signal to the terminal 20 via analogue home-run cable 14. Before further processing on the motherboard 45, an analogue-to-digital conversion is made by the A/D converter 42.

[0047] In one embodiment of the current inventive solution, each analogue calibration load cell 25 is connected to its own A/D converter 42 within the terminal 20 (Figure 7). The A/D converters provide digital weight information for each calibration load cell to the terminal 20 which then does further processing of the digital signals on the motherboard 45, e.g. summing the signals for determining the total applied force.

[0048] In a further embodiment of the current inventive solution, as shown in Figure 8, a so-called smart junction box 43 as an alternative to that shown in Figure 7 is interposed between the analogue calibration load cells 25 and the terminal 20. Each analogue calibration load cell 25 is connected to its own A/D converter 42 located inside the smart junction box 43. The digital weight information for each calibration load cell 25 remains separate and all are provided over a digital communications cable 44 to the terminal 20 which then does the further processing.

[0049] In another embodiment of the current inventive solution is shown in Figure 9. Each analogue calibration load cell 25 has its own A/D converter 42 located inside its enclosure, becoming a digital calibration load cell 25'. The digital weight information for each digital calibration load cell 25 remains separate and all are provided over a digital communications cable 44 typically

connected in a daisy-chain arrangement as shown, although other connection topologies are possible. The terminal ~~20~~ 40 receives individual load cell weight information and does the further processing.

[0050] The calibration device for a weighing system of the present invention can be temporarily assembled onto a tank to complete the calibration, and is mainly composed of a calibration module, a calibration terminal and a manual pump. Herein, one, two, three or four calibration modules can be used according to actual requirements. The pull-type hydraulic cylinder is used to generate a predetermined tension force, which is applied to each leg of the tank, and the pull-type load cell is connected in series with the pull-type hydraulic cylinder for real-time display of the tension force(s) to the calibration terminal. The hydraulic system is connected to the required number of calibration modules 20 through the manifold 33, which can ensure that the oil pressures in the calibration modules are roughly equal, thus ensuring equal force applied through each calibration module on the tank 10. The calibration terminal 40 is a multi-channel device, and can display a combined force value applied to the tank 10 in real time and can display the force value of each calibration module, so as to monitor load distribution on the tank weighing system (being the same as the principle of using a digital load cell). Finally, the force value displayed by the calibration terminal 40 is used to calibrate the tank weighing system. This method is simple and rapid and is suitable for large-scale promotion.

[0051] It thus can be seen that the characteristics of the calibrating device for a weighing system of the present invention lie in: the hydraulic system with one manual pump whose output is split into 4 flows potentially through the manifold and loads simultaneously the hydraulic cylinders, which ensures that all the scale lugs are loaded synchronously and uniformly; as the one-way stop valve is used and is integrated with an overflow valve, the system can achieve multi-

point calibration of a tank scale, and safety in case of extreme overloading is ensured; quick-change connectors are used at all joints of the hydraulic system to ensure convenient and quick field operation; and in the calibration system, the calibration terminal can automatically load the operating software, which can control the functions of calibration, data collection and processing, and security monitoring. With the above calibration device, 2-point, 3-point, 4-point, 5-point and 11-point calibrations and adjustments can be performed.

[0052] In summary, the calibration device for a weighing system of the present invention can greatly improve the production efficiency. In use, it takes only two hours to complete the calibration, which is far better than the test weight and other calibration methods. The uncertainty of the calibration process can reach 0.1% or better.

[0053] While particular embodiments of the present invention have been described above, a person skilled in the art should understand that these are merely illustrative, and that the scope of protection of the present invention is defined by the appended claims. Various alterations or modifications to these embodiments can be made by a person skilled in the art without departing from the principle and essence of the present invention; however, these alterations and modifications all fall within the scope of protection of the present invention.

Reference list

10	Tank
11	Support leg
20	Calibration module
30	Hydraulic system

40	Calibration terminal
31	Pump
32	Pressure gauge
33	Manifold
34	Hose
35	One-way stop valve
36, 26	Hydraulic cylinder
37	Quick-change connector
21	U-clevis
22	Rod end
23	Coupling nut
24	Threaded rod
25	Calibration load cell
25'	Digital calibration load cell
12	Analogue junction box
13	Analogue summing board
14	Analogue home-run cable
41	Analogue signal cables
42	A/D converter
43	Smart junction box
44	Digital communications cable
45	Motherboard

CLAIMS

What is claimed is:

~~1. A calibration device for a weighing system, the weighing system comprising a tank, with a plurality of support legs being provided at a lower part of the tank,~~

~~the calibration device comprising at least one calibration module, a hydraulic system and a calibration terminal; wherein~~

~~an upper end of each of the calibration module is fixedly connected to an upper part of the corresponding support leg, and a lower end of the calibration module is fixedly connected to the foundation;~~

~~the calibration module is connected via a hose to the hydraulic system for applying a force to the tank; and~~

~~the calibration terminal is connected to the calibration module for displaying, in real time, the force applied to the tank.~~

~~2. The calibration device for a weighing system as claimed in claim 1,~~

~~wherein the a calibration module further comprises a calibration load cell for converting the applied force from the calibration module into an analogue signal,~~

~~wherein the calibration device further comprises at least one A/D-converter for converting the analogue signal from the calibration load cell into a digital signal, wherein~~

~~for each calibration load cell, a A/D-converter is located at the calibration terminal for converting the analogue signal and providing a digital output signal for processing at the calibration terminal, or wherein~~

~~for each calibration load cell, a A/D-converter is located at the calibration~~

load cell for converting the analogue signal and providing a digital output signal for processing at the calibration terminal, or wherein

the calibration device further comprises a smart junction box having an A/D-converter for each calibration load cell and providing a digital output signal per calibration load cell for processing at the calibration terminal.

3. The calibration device for a weighing system as claimed in claim 1 or 2,

wherein the hydraulic system comprises a pump, a pressure gauge, a manifold, a number of hoses, a number of one-way stop valves, a number of hydraulic cylinders and a number of quick-change connectors,

wherein one side of the manifold is connected to the corresponding hydraulic cylinders via some of the hoses, and each of the one-way stop valves are mounted to the corresponding hosees and close to the hydraulic cylinder; and

wherein the other side of the manifold is connected to one end of the pressure gauge, and the other end of the pressure gauge is connected to the pump.

4. The calibration device for a weighing system as claimed in claim 3, wherein the hoses are high-pressure flexible hoses.

5. The calibration device for a weighing system as claimed in claim 3 or 4, wherein the hydraulic cylinder is a pull-type hydraulic cylinder.

6. The calibration device for a weighing system as claimed in one of the claims 3 to 5, wherein the pump is a manual pump or an electric pump.

7. The calibration device for a weighing system as claimed in one of the claims 1 to 6, wherein the calibration module comprises a plurality of U-clevises, a plurality of rod ends, a coupling nut, a threaded rod, a calibration load cell and a pull-type hydraulic cylinder;

wherein the lower end of the calibration load cell is connected to the rod of the pull-type hydraulic cylinder, the U-clevis and the rod end in succession; and

wherein the upper end of the calibration load cell is connected to the threaded rod, the coupling nut, the rod end and the U-clevis in succession.

8. The calibration device for a weighing system as claimed in claim 7, wherein lifting lugs are arranged at the top of the support legs or support brackets, and the U-clevises are fixedly connected to the corresponding lifting lugs.

9. The calibration device for a weighing system as claimed in one of the claims 1 to 8, wherein the bottom ends of the support legs or support brackets are supported by a solid foundation, a mezzanine floor or steel structure via anchor plates, and the rod ends are fixed to the anchor plates.

10. The calibration device for a weighing system as claimed in one of the claims 1 to 9, wherein one, two, three or four calibration modules are provided.

11. The calibration device for a weighing system as claimed in one of the claims 1 to 10, wherein a pull-type calibration load cell is connected in series with a pull-type hydraulic cylinder, and is used to display, in real time, a tension load value generated by the pull-type hydraulic cylinder, via the calibration terminal.

~~12~~1. A calibration device for a weighing system, the weighing system comprising

a tank (10), with a plurality of support legs (11) or support brackets being provided to mount the tank on a solid foundation, a mezzanine floor or a steel structure; wherein the calibration device comprising

at least one calibration module (20) for applying a force to the tank (10) fixedly connected at the upper end of the calibration module (20) to one of each support leg (11) or support bracket, and fixedly connected at the lower end of the calibration module (20) to ~~a~~ the solid foundation, mezzanine floor or steel structure, the calibration module (20) comprising

a calibration load cell (25) for converting the applied force from the calibration module (20) into an analogue signal;

the calibration device further comprising

a calibration terminal (40) for processing the analogue signal of the calibration load cell (25) and displaying, in real time, the applied force from the calibration module (20); ~~and~~

~~at least one A/D-converter for converting the analogue signal from the calibration load cell into a digital signal~~

characterized in that

the calibration device further comprising at least one A/D-converter (42) for converting the analogue signal from the calibration load cell (25) into a digital signal; wherein

for each calibration load cell (25), an A/D-converter (42) is located at the calibration terminal (40) for converting the analogue signal and providing a digital output signal for processing at the calibration terminal (40), or in that

for each calibration load cell (25), an A/D-converter (42) is located at the calibration load cell (25) for converting the analogue signal and providing a

digital output signal for processing at the calibration terminal (40), or in that

the calibration device further comprises a smart junction box (43) having an A/D-converter (42) for each calibration load cell (25) and providing a digital output signal per calibration load cell (25) for processing at the calibration terminal (40).