

Method for compensating leakage losses and conveyor system for conveying a defined
volume of a liquid

The invention discloses a method for compensating leakage losses in a line system for liquids having at least one positive displacement pump and at least one shut-off member, in particular in the isobaric metering of liquid plastic components. The invention also relates to a conveyor system for in particular isobaric conveying of a defined volume of a liquid per unit of time, in particular for metering of a liquid plastic component.

During the processing of the components of two-component or multi-component plastic systems it is important that the components are mixed together as precisely as possible in a defined mixing ratio in order to be able to react completely. The mixing of the components takes place for example in a mixer head with a rotatably driven stirrer, wherein the two or more components are delivered to the mixer head via inlet valves and are mixed together in the interior of the mixer head, before the mixture is then discharged via a closable outlet of the mixer head, for example, in order to apply the mixture produced in this way to a structural part in a material strand which then, after the reaction of the mixture, forms an affixed seal on the structural part.

The components are conveyed by the conveyor system to the mixer head by means of positive displacement pumps, in particular geared pumps, through the line system, wherein in low pressure systems, that is to say systems in which the pressure of the components upon entry into the mixer head is only a little greater than the ambient pressure, the respective volumes conveyed can be readily handled by regulation of the rotational speed of the positive displacement pumps.

In systems in which the liquids to be conveyed are at higher pressures, however, leakage losses occur in particular in the region of the pumps because of the pressure gradient by comparison with the inlet of the pump, wherein these leakage losses can be increased or decreased not only with changing pressure conditions, but become greater with the increasing service life of the pump due to wear. The exact metering which is required during the processing of multi-component plastic systems is then difficult, since the material losses due to the leakages are quantitatively difficult to estimate. This applies in particular if between individual metering operations there are shutdown or

waiting times of different durations, during which the shut-off member shuts off the line system, as the material losses are variable with the changing shutdown periods.

The object of the invention is to provide a method and a conveyor system by which leakage losses during metering of the liquid can be taken into account in a particularly simple manner with great precision.

For this purpose according to the method according to the invention the actual liquid pressure in the line system is ascertained by means of a pressure measuring device and is brought to a pressure target value by actuation of the positive displacement pump with the shut-off member closed. In a particularly advantageous further embodiment of the invention it is then possible for the conveying loss rate of the positive displacement pump, which ensues to maintain the pressure target value when the shut-off member is closed, to be added to a target delivery rate in order to compensate for the leakage loss occurring at the relevant pressure target value. In order to carry out this method according to the invention, the conveyor system according to the invention has a line system with at least one positive displacement pump and at least one shut-off member, as well as a pressure measuring device which ascertains the actual liquid pressure in the line system and a control system which acts on the positive displacement pump as a function of the ascertained actual liquid pressure, including means for determining a conveying loss rate of the positive displacement pump with the shut-off member closed to maintain a target liquid pressure in the line system and preferably means for adding the conveying loss rate to a target delivery rate of the positive displacement pump with the shut-off member open.

The invention is based on the knowledge that, during the conveying of liquids such as for example liquid plastics or plastic components under constant pressure, the leakage losses occurring in the line system depend substantially (only) upon the pressure level in the system and the viscosity of the liquid and thus are at least largely independent of the currently conveyed volume flow. Thus they also occur in a pressurised line system when the shut-off member in the line system is closed, that is to say at times when no material is conveyed. In the operational state in which conveying of material does not take place, that is to say with the shut-off member closed, the extent of the leakage losses can be ascertained comparatively simply by regulating the pressure in the line system constantly to a target pressure. This target pressure may be in particular the conveying pressure which should prevail during a metering operation.

The target pressure in the line system is obtained when the positive displacement pump is operated further at a correspondingly reduced conveying (loss) rate, so that the losses due to leakages are compensated. Through this measure it is ensured that, when the shut-off member is opened at the start of a new metering operation, the liquid is delivered immediately at the required pressure and thus also at the correct conveying rate to the subsequent assembly, for example a mixer head. In a particularly preferred further development of the method according to the invention, the resulting conveying loss rate, that is to say the material volume flow per unit of time which is conveyed in the system by the pump with the shut-off member closed and leaves the system as leakage loss at points which possibly cannot even be checked, can be added as a compensation variable to the target conveying rate with the shut-off member open, that is to say for example an open inlet valve on a mixer head, since it can be assumed that the leakage loss per unit of time also remains constant during the conveying of the material through the line system if the pressure in the system during the conveying operation does not change or does not change significantly with respect to the pressure in the system with the shut-off valve closed. Thus the values of actually occurring leakage losses to be ascertained in the stationary state of the system with the shut-off member closed can also be taken into account according to the invention during the conveying of material, whereby particularly precise conveying of a volume flow is possible.

According to the invention a rotary displacement machine, in particular a geared pump, is preferably used as the positive displacement pump. The line system preferably has an at least largely constant volume at least between the positive displacement pump and the shut-off member.

The method according to the invention can be used advantageously in the conveying of thixotropic liquids, that is to say liquids of which the viscosity in the moving state (under shear stress) is lower than in the rest state. For example, some polyol components exhibit such a thixotropic material behaviour, as their viscosity falls significantly under shearing and - as a function of the length of the shutdown or waiting times - again increases clearly. In the case of different waiting times this possibly leads to different initial viscosities of the liquid at the start of a metering operation and thus to deviations at the start of metering.

In order to be able to compensate for this effect as a function of the length of the standstill time, in an advantageous further embodiment of the regulation according to the invention the pressure target value can be broken down into two parts. In this case the pressure target value consists of a basic pressure (for example the target pressure during a metering operation) plus a time-dependent offset. This offset can be designed as a conventional PT1 element used in regulating technology, whereby the increase in viscosity can be described very well as a function of the duration of the shutdown time between the metering operations.

If for example during the conveying of a thixotropic liquid under the influence of the shear effect a (target) pressure of 50 bars prevails in the flowing liquid, after a relatively long waiting time, during which the liquid does not flow and increases its viscosity, it is necessary to temporarily increase the initial pressure at the start of a new conveying or metering operation for compensation for the higher viscosity, for example to an (initial) pressure of 52 bars. If in fact the shut-off member were to open at a preload pressure of merely 50 bars, this would lead to a slight delay of the start of metering. In order to avoid this the target value of the shutdown pressure regulation is increased as a function of time to an increased initial target pressure, for example 52 bars. In this case the initial target pressure preferably approaches a maximum value logarithmically as the shutdown or waiting time increases.

The invention is explained in greater detail below with reference to the preferred embodiment which is illustrated in the drawings. The single **figure** shows a conveyor system according to the invention on a dynamic mixer head for mixing polyurethane or silicone plastic components for the production of a foaming sealing material in a flow diagram.

The conveyor system 10 depicted in the drawing serves for metering of two liquid plastic components A, B to a mixer head 11, in which the two components A, B are mixed together by means of a driven stirrer 12 in a precisely fixed quantitative ratio and are then discharged with an overpressure prevailing in the system by comparison with the ambient pressure as a reactive mixture via an outlet 13. Only as the mixture exits from the outlet is it subjected to the ambient pressure, i.e. the pressure in the interior of the mixer head is at least somewhat higher than ambient pressure. With such systems, for example, foaming seals are produced which are formed directly on a structural part.

A line system 14 of substantially the same construction is provided for each of the two components A, B. This system has a motor-driven geared pump 15 and a shut-off member 16 arranged on the mixer head 11 in the form of an electromagnetically switchable valve, by which the inlet for the respective component A, B into the interior of the mixer head can be opened or closed.

For starting of a metering operation the two valves 16 are opened, so that by means of the geared pumps 15 the components A, B are conveyed out of their respective storage containers 17 in the required mixing ratio and into the mixer head 11, where they are mixed together by the stirrer 12, whilst maintaining the pressure prevailing in the line system 14, and are then discharged via the outlet 13 as a reactive plastic mixture.

In order to compensate for leakage losses which occur in the line system 14 due to unexpected leaks, for example in the region of the pump 15, and which are represented in the schematic drawing by the arrows on the broken lines as Q_v , the line systems 14 are in each case provided with a pressure measuring device 17 which ascertains the system pressure in the line system 14 with the valve 16 closed. This actual liquid pressure 18 is compared with a pressure target value 20 in a comparator 19. As soon as a pressure drop is detected, and thus the actual liquid pressure drops relative to the pressure target value, the geared pump 15 is actuated, even with the valve 16 closed, at a correspondingly lower conveying (loss) rate, in order to deliver to the line system 14 precisely the quantity lost from the system due to the leakage Q_v .

This conveying loss rate which is produced by the pump 15 with a few revolutions per unit of time is also taken into consideration during the process of conveying to the mixer head with the shut-off member open, i.e. in order to compensate for the leakage losses Q_v the geared pump is operated at such a speed that it withdraws from the storage container for the component concerned a mass flow which corresponds to the sum of the leakage loss Q_v ascertained with the valve closed and the target delivery rate Q_s of the component concerned. In this way the leakage loss is also taken into account during the metering of the components to the mixer head.

CLAIMS

1. Method for compensating leakage losses in a line system for liquids having at least one positive displacement pump and at least one shut-off member, in particular in the at least largely isobaric metering of liquid plastic components, wherein the actual liquid pressure (18) in the line system (14) is ascertained by means of a pressure measuring device (17) and is regulated to a pressure target value (20) by actuation of the positive displacement pump (15) with the shut-off member (16) closed.
2. Method according to claim 1, **characterised in that** the conveying loss rate (Q_v) of the positive displacement pump (15) which ensues to maintain the pressure target value (20) when the shut-off member (16) is closed is added to a target delivery rate (Q_s) in order to compensate for the leakage loss occurring at the corresponding pressure target value (20).
3. Method according to claim 1 or 2, **characterised in that** a rotary displacement machine, in particular a geared pump, is used as the positive displacement pump (15).
4. Method according to one of claims 1 to 3, **characterised in that** the line system (14) preferably has an at least largely constant volume at least between the positive displacement pump (15) and the shut-off member (16).
5. Method according to one of claims 1 to 4, **characterised in that** in order to compensate for a thixotropic flow behaviour of the liquid the pressure target value (20) with the shut-off member (16) closed is increased by comparison with the pressure target value during a conveying operation with the shut-off member open.
6. Method according to claim 5, **characterised in that** the regulation for raising and/or lowering the pressure target value (20) takes place as a function of time in the manner of a PT1 element.

7. Conveyor system in particular for isobaric conveying of a definitive volume of a liquid per unit of time, in particular for metering a liquid plastic component, comprising a line system (14) having at least one positive displacement pump (15) and at least one shut-off member (16), as well as a pressure measuring device (17) which ascertains the actual liquid pressure (18) in the line system (14) and a control system which acts on the positive displacement pump (15) as a function of the ascertained actual liquid pressure, including means for determining a conveying loss rate (Q_v) of the positive displacement pump (15) with the shut-off member (16) closed to maintain a target liquid pressure (20) in the line system (14) and means for adding the conveying loss rate (Q_v) to a target delivery rate (Q_s) with the shut-off member open.