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This invention concerns an improved metering and mixing process and installation, particularly for products of widely different viscosities and densities.

Pumps already exist to circulate products of widely different viscosities, but for products with very high viscosities and densities, the circulating pressure, and consequently their flow rate, vary considerably, so that the products to be mixed together cannot be metered correctly.

If the products being prepared are to retain their characteristics throughout, as is generally the case when synthesizing organic or inorganic substances, existing pumps are unsatisfactory.

This invention offers a way of overcoming the drawbacks of existing processes and installations.

The invention concerns a process for metering and mixing products, particularly those with widely different viscosities and densities, in which metering is done at different selected respective constant pressures and volumes, and each product is circulated by means of a pneumatically driven hydraulic pump, and mixing is done by any existing means.

In one embodiment of the invention, the system comprising said pneumatically driven hydraulic pumps exerts a thrust, the amplitude of which can be adjusted.
as desired, by regulating the pneumatic pressure, i.e. the pressure of the low-pressure side of said pumps.

The invention in one embodiment concerns an installation for metering and mixing products, particularly with widely different viscosities and densities, in which the products are circulated by means of pneumatically driven hydraulic pumps, and a metering device consisting of a cylinder containing a free (or floating) piston is placed between this circulating system and the mixing tank.

In one embodiment of the invention, the metering device consists of a cylinder with a floating piston and a fixed piston which is adjustable for instance by a micrometric screw.

In another embodiment, the circulating system comprises hydraulic piston pumps, the output pressure of which can be adjusted by regulating the pneumatic pressure of the pneumatic actuating devices driving said pumps.

In another embodiment, the temperature of the products is kept constant, and is regulated by means of pyrometric probes which are arranged on the metering device and the injection-forcing head, and are connected to reading devices.

In another embodiment, these devices regulate the temperature by means of impulses.

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in which high-pressure pneumatically driven hydraulic pumps inject a plastic material dispatched by a distributor valve to a cylindrical metering device, and then to a tank where it is mixed with a catalyst which is injected simultaneously by another pump and conveyed by a suitable distributor valve to another metering device and then to the mixing tank.

In one embodiment of the installation, the temperature of the ingredients being conveyed can be altered during their conveyance by means of heat-regulated rings, or cooling pipes, which are mounted on the metering devices or injection head, and inside which a cooling fluid circulates.

The distributor valves dispatch the raw material from the pumps to the metering devices and then from the metering devices to the mixing tank; there are at least two such distributor valves, so that the metering devices and the mixing tank can be fed simultaneously.

This installation is particularly suitable for the preparation of a new industrial product consisting of a conglomerate, bound by a polycondensable resin such as a phenol-formaldehyde resin, of one or more substances or fillers such as TiO₂, mica, asbestos, and synthetic or inorganic fibres, such as organic resins, polyamide or glass fibre.
The conglomerate as defined in this embodiment is obtained by mixing one or more of these substances or fillers, in a resin such as a phenol-formaldehyde resin and at a temperature of between 20 and 80°C, and preferably at about 50°C, after one or more agents such as blowing agents, e.g. sodium bicarbonate, have been added, by polycondensation caused by adding 8 to 10% weight of catalyst in relation to the weight of resin.

The catalyst used for polycondensation may consist of one or more acids belonging to the group made up of HCl, \( H_2SO_4 \), \( H_3PO_4 \), benzene sulphonic acid, etc..

In one embodiment, the conglomerate contains between 40 and 80% of these fillers, and preferably between 55 and 75%.

The speed of mixing varies, depending on the mixer, from 1,500 rpm at the start to 750 rpm as viscosity drops with the addition of acid.

The product obtained is extremely useful as a heat and sound insulating material, and it is flame-resistant, being able to withstand temperatures of 3,000°C or more without ever catching fire or producing smoke or toxic vapours.

Other aims and advantages of the invention will appear from the following description, with the accompanying figure. The invention is in no way confined to the embodiment.
shown here.

The installation contains two pneumatically driven hydraulic high-pressure pumps (1 and 1'), with an electro-valve to control the air-intake at a pressure of 1 bar. The hydraulic high-pressure pump portion is submerged in a tank (not shown here), containing the raw material. The high-pressure outlet is connected by pipes (2 and 2'), controlled by pressure-detectors (not shown here), to distributor devices (3\(_1\), 3\(_2\), acting in parallel and 3'\(_1\) and 3'\(_2\)) acting in parallel, which dispatch the ingredients towards the metering device (4), along pipes (5 and 5'), and then towards the mixing tank (6), along other pipes (7 and 7' and then 8\(_1\), 8\(_2\), 8'\(_1\) or 8'\(_2\)).

Similarly, a pump (9), pipe (10), distributor valve (11) and pipe (12) supply another metering device (13) with catalyst, which is conveyed to the mixing tank (6) by a pipe (14), distributor valve (11) and another pipe (15).

There is a stirring device in the mixing tank, such as a turbine (16), driven by a motor (not shown here).

The mixed products are discharged through an extrusion head (17), by opening a tap (not shown here), which acts in liaison with the order of selection of the distributor valves. When one pair of these valves (e.g., 3\(_1\) and 3'\(_1\)) dispatches raw material to the
metering device (4), the other (e.g. 3 and 3') dispatches it to the tank (6).

Selection of these devices is controlled by a pressure detector (not shown here), which detects the pressure in the metering device. When the metering device is full, this detector selects the appropriate distributor devices, so that fresh material is fed to the metering device and the preceding batch is dispatched towards the mixing tank. Naturally, one metering device is provided for each ingredient; two pumps as shown in this figure (1 and 1') may however be provided instead of one pump, in case the required flow-rate is too great for a single pump, each pump 1 and 1' having a pair of valves 3 operating in parallel associated with it.

The temperature of the products being conveyed through the installation can be changed, by means of high-precision heat-regulated rings, or pipes mounted on the metering devices or on the injection head with heating or cooling fluid circulating inside them.

The temperature of the metering devices is preferably regulated by a fluid having the appropriate temperature and circulating about said metering devices.

The temperature of the products is preferably kept constant, being regulated by means of pyrometric probes on the metering device and injection head, linked to reading devices which regulate temperature by emitting impulses.

Dispersion of all the ingredients is carried out in the mixing tank, and expansion begins as soon as the
catalyst is injected into the mixture, continuing as it is dispersed therein; the reaction is isothermal, with extra heat contributed by the heating system, regulated by pyrometers on the mixing tank.

The installation as shown here is particularly suitable for the preparation of a new industrial product consisting of a conglomerate, bound by a polycondensable resin such as a phenol-formaldehyde resin, of one or more substances or fillers such as TiO₂, mica, asbestos and synthetic or inorganic fibres, such as organic resins, polyamide or glass fibre.

Each of the high-pressure pumps (1 and 1') forces the substances for the conglomerate towards the metering device (4), through the distributor devices (3₁, 3₂, 3'₁ and 3'₂) and pipes (5 and 5').

The batches of raw material thus obtained are conveyed to the mixing tank (6) along pipes (7 and 7'), through the distributor devices, and along other pipes (8₁, 8₂, 8'₁ and 8'₂).

Meanwhile, the catalyst, consisting of 8% weight of H₃PO₄ N/3, is simultaneously injected by the pump (9), pipe (10) distributor device (11), pipe (12), metering device (13) and pipes (14 and 15).

The various substances needed for the conglomerate are fed simultaneously into the mixing tank, with the
carbon-dioxide-generating substances which cause limited expansion of the extruded product such as NaHCO₃ or other blowing agents. Extrusion then takes place, usually, at a temperature of about 45°C.

The conglomerate as defined in this invention can be obtained as follows.

Approximately 50 parts phenol-formaldehyde resin, 10 parts TiO₂, 20 parts mica, some in perlite form and the rest in powder form, 15 parts asbestos in fine fibre and powder form, and 5 parts magnesium silicate or CaCO₃ are fed into the metering device 4. The catalyst component comprising 3.5 parts N/3 phosphoric acid and approximately 2 parts of a blowing agent such as NaHCO₃ is passed to metering device 13 and added to the resin mix. The temperature of the metering device mixing tank is kept at 45°C.

The inlet flow-rate is 50 to 100 kg a minute, and the extrusion rate is 200 to 500 litres an hour, expanded at 485 bars.

The conglomerate obtained has a density of between 180 and 200 g per litre, and excellent mechanical strength, particularly abrasive strength.

Its flameproof properties are such that it will not catch fire even when exposed to a flame at 3,000°C. Heat conductivity is low: when measured on a sample 25 cm thick, a factor of \( k_{25} \leq 0.8 \) is found.

The product also appears to be completely rotproof and impermeable.
Naturally, the invention is in no way confined to the embodiments described here: many alternative versions are possible for someone skilled in the art, without any departure from the spirit of the invention.
The claims defining the invention are as follows:-

1. A method of producing a conglomerate fireproof foam material of density between 180 and 200 grams per litre and not flammable below 3000°C containing a polycondensated phenol-formaldehyde resin binder and filling material, wherein fluid phenolformaldehyde resin containing said filling material and a blowing agent is mixed in metered amounts with metered amounts of a fluid polycondensation catalyst having a viscosity substantially different from that of said resin, said method comprising the steps; (a) of introducing under a first selected pressure by means of at least one first pneumatically driven hydraulic pump said resin into a first compartment defined within a first metering cylinder by a first floating piston, while connecting a second compartment defined by said first floating piston to a mixing chamber; simultaneously introducing under a second selected pressure said catalyst into a first compartment defined by a second floating piston within a second metering cylinder, while connecting a second compartment defined by said second floating piston in said second metering cylinder to said mixing chamber; (b) of introducing under said first selected pressure said resin into said second compartment of said first metering cylinder, while connecting said first compartment thereof to said second selected pressure into said second compartment of said second metering cylinder, while connecting said first compartment thereof to said mixing chamber; and (c) extruding the conglomerate from the mixing chamber.

2. An installation for carrying out the method of claim 1, comprising at least one first pneumatically driven hydraulic pump for circulating said resin, at least one second pneumatically driven hydraulic pump
viscosities and/or densities by the method of claim 1, comprising at least one first pneumatically driven hydraulic pump for circulating the first one of said substances, at least one second pneumatically driven hydraulic pump for circulating a second one of said substances, at least one first and one second metering cylinder having each two opposed compartments defined therein by a floating piston, a mixing container, and distributing valve means operated by actuating means in such a manner that in a first one of two alternating operating phases the outlet of said first pump is connected through said distributing means to one compartment of said first metering cylinder, and the outlet of said second pump is connected through said distributing means to one compartment of said second metering cylinder, while the other compartment of the latter is connected through said distributing means to the mixing container which is at the same time connected through said distributing means to the other compartment of the first metering cylinder, whereas in the second one of said alternating operating phases the outlet of said first pump is connected through said distributing means to said other compartment of said first metering cylinder, and the outlet of said second pump is connected through said distributing means to said other compartment of said second metering cylinder, while said one compartment of the latter is
connected through said distributing means to the mixing container which is at the same time connected through said distributing means to said one compartment of the first metering cylinder.

3.- The installation of claim 2, wherein said metering cylinders comprise each at least one adjustable fixed abutment piston cooperating with the floating piston for defining the length of the stroke of the latter.

4.- The installation of any one of claims 2 and 3, wherein the pneumatic actuating pressure of said pneumatically driven hydraulic pumps is adjustable, whereby the hydraulic pressure of the latter may be adjusted.

5.- The installation of any of claims 2-4, wherein said pneumatically driven hydraulic pumps are piston pumps.

6.- The installation of any one of claims 2-5, wherein pyrometric sensing devices are provided for controlling the temperature of said substances being metered and mixed, said sensing devices being connected in a manner known per se to heating and/or cooling means.

7.- The installation of any one of claims 2-6, wherein said mixing container is associated to an extruding device.

8.- The installation of any one of claims 2-7, wherein said distributing means comprise a plurality of four-way valves at least one of which controls the flow of one of said substances, while at least one other four-way valve
controls the flow of the other substance, between the pumps, metering cylinders and mixing container.

9.- Apparatus for metering and mixing at least two fluid substances, substantially as described hereinbefore, and as shown in the accompanying drawing.

H. Lievremon & A. Cominassi

By their Patent Attorneys,

G.R. Cullen & Company.