Automation of process of manufacturing products from a mixture of fluids fast polymerized in air using the jet centrifugal method

F G Karikh and L N Shafigullin
Naberezhnye Chelny Institute (branch), Kazan Federal University
Sjujumbike street 10a, Naberezhnye Chelny, 423800 Tatarstan, Russia
misharin_82@mail.ru

Abstract. The developed method provides the extraction of each component from the transported agents into flexible vessels followed by blending in a dosing unit, mixing in a static mixer, spraying the mixture on the surface of ellipsoidal drums, while ensuring the required thickness of the gel coating transported to the line of formation.

1. Introduction
Among the resins polymerized in air, dicyclopentadiene (DCPD) has the widest range of uses. Today, it is polymerized using barrels [1 - 5] by combining two premade mixtures. Typically, the first mixture includes DCPD, and the second one – other components, such as plasticizer, modifier, dye, etc. These mixtures are premade due to a rapid rate of DCPD polymerization and difficulties in providing small amounts of hardener (1-2% wt.). The drawbacks of this method are highly labour intensive preparation of a two-component mixture and a low-speed usage of this mixture.

2. Body text
The following installation has been designed to correct these drawbacks. The units of the installation.

1. Jet centrifugal device. It helps to eliminate the drawback of the method [1] by using the jet centrifugal method to form a stream of droplets with controllable mixture jet velocity and path [6]. The schematic view of the jet centrifugal device is shown in Figure 1 where the fluid (2) is supplied from the flexible vessel (1) through the connection tube (3) to the gland (4) used to seal the connection with a system of the rotation unit (5). The silicone tube (6) provides a leak-tight connection between the rotation unit and the glass atomizer (7). It ensures the fluid outflow through the nozzle (8) which defines the jet (9) diameter.

The path of the resulting droplet stream (10) is determined by an inclination of the nozzle (8) in relation to the axis of rotation (11). The flow rate of fluid depends on two parameters: nozzle (6) diameter (typically 50-200 μm) and distance between the nozzle and the axis of rotation (11) (usually 2-50 mm). The silicon tube (6) has a 30-μm mesh filter to prevent the nozzle (8) from clogging (omitted in Figure 1). It is mounted in the silicon tube (6) at a sharp angle to its axis.

2. Dosing unit. It has been proposed to use a dosing unit for continuous preparation of a mixture of fluids which are not polymerized in air [7]. It controls the flow rate ratio for each component and ensures that no mixture component has a contact with air. Each component is added through the flow passage into the respective dosing chamber on the mounting plate, with the adjustable size of a dosing opening separately for each chamber. No compressor is needed thanks to the flexible vessels that are...
sealed to the inlet fittings of the dosing chambers. The quantity of a prepared mixture in unit time depends on the performance parameters of the jet centrifugal device: its rotational speed and section of the atomizer nozzle.

Figure 1. Device for manufacturing products from a mixture of fluids fast polymerized in air using the jet centrifugal method

The components are dosed with a required ratio based on resin consumption per a specified period, sizes of the ring dosing openings are set for each chamber according to pre-compiled tables on the relationship between the component flow rate and the ambient temperature.

3. Static mixer [8]. Figure 2 shows the schematic longitudinal section of the mixer which includes the housing (1) with the tangential inlet (2) for a mixture from the dosing unit. This mixture is added to the mixing cylinder (3) with the cylindrical insert (4) and filler (5), which press tightly against the metal mesh (6) in the annular space (7). It mates with the threaded portion of the cap (8) which presses tightly against the cutoff (9). The cutoff is basically a twisted wedge with the blade (10), and it is used to form a circular vortex in the chamber (11), which is limited by the tapered surface (12) extended to the cylinder (3). As the fluid spirals in the mixing cylinder (3) and contacts the mesh (6) the components are mixed, and the mixture is transferred to the jet centrifugal device through the openings in the profile ring (13) that connects with the fairing (14) with the outlet duct (15) and outlet orifice (16).

A different variant of the static mixer [9] has a conical mixing chamber. It is intersected with a metal cylinder-shaped mesh to provide a higher degree of sealing with linking of the joint in the region of its generator.
4. System of mechanically interconnected rotating drums. In order to extend the application of the method [10] for production of a wider range of products, the method and apparatus [11] have been proposed to apply coatings on the surface of rotating drums with a toroid-shaped surface, which have various diameter ends. The number of drums depends on a product range. For example, Figure 3 shows the three-drum installation where the jet centrifugal device (1) includes two atomizers (2) with opposite jets that are atomized into droplets (4) onto the toroid-shaped surface (5) of the drums (6). These drums are rigidly secured to the rods (7) which are connected via identical bevel gears (8) with the motor (9) to ensure the same rotational speed for all the drums. As the duration of contact between droplets (4) and atmosphere is constant due to the stable distance between the atomizers (2) and wetting area (5), the degree of polymerization of a gel layer formed on the drums (6) is constant. All the drums (6) are positioned in such a way that their ends (10) with a larger diameter are overlapped by the ends (11) with a smaller diameter. The gap between the adjoined pair of drums is minimal, so the surface (12) of each drum remains unwetted. It addresses the following needs: prevention of leakages of polymerized droplets (4) through the gap between the adjoined pair of drums; prevention of environmental pollution; facilitation of throwing the gel polymerized layer off the drums (6); stability of the size and cleanness of the edges (14); facilitation of layer (13) removal from the transporter line (15) during its delivery to the process line with suitable forming equipment.

Figure 2. The mixer

Figure 3. The three-drum installation
3. Conclusions
1. The installation can operate automatically when its components follow the program which takes into account a change in such variable parameters as ambient temperature, composition of a used fast polymerizing mixture of fluids, rotational speed of drums and atomizer.
2. The number of drums can be increased if it is necessary to expand a range of products.

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