Kinematic analysis of a planetary mixer mechanism

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Abstract. The production of dry building mixtures is currently one of the most promising areas of the building materials industry due to the widespread use of its products. The mixers with a planetary movement of working bodies are best suited among the wide variety of designs of mixers for the production of these products. One of the drawbacks of planetary mixers is the contamination of the planetary gear and the ingress of lubricants into finished products. To eliminate this disadvantage, a protective diaphragm was installed to separate the tank and the drive part. The motion simulation of the rotator was created using the CAD / CAM / CAE system NX.

1. Introduction
Mixers are an important element in the production of dry building mixtures, as the characteristics of this equipment affect the quality of the finished product. Planetary mixers are one of the most promising areas for the development of mixing equipment. This type of mixers have high performance, are distinguished by the best quality of mixing and the ability to mix materials with different properties.

The disadvantages of this type of mixer are presented by huge energy costs, a long time of unloading, the planetary gear has a complex structure, which must often be maintained.

2. Schematic diagram of a planetary mixer.
Planetary mixers are forced-action mixers. This mixer (figure 1) consists of a tank and working bodies arranged vertically. The working bodies are represented by the blades 2, rotating around its axis and around the axis 1 of the housing 3.

One of the features of planetary mixers is that the mixing part has various design options. In one embodiment, at the end of the drive rack installed working body in the form of a asterisk.

The rack is made with a cavity, which is located inside the drive sprocket. In the course of the mixer operation, the sprocket rotates around its axis and moves in a circle inside the container.

Existing mixer (figure 2), consisting of the device boot 1, cover 2, the electric motor 3 connected by the output shaft 4, on which the leash 5 is fixed. Gear 6 is fixed movably with the help of the bearing on the axis fixed on the leash and is in engagement with the gear crown 8 which is installed by welding in the housing 9. On the other side of the gear is the counterweight 7. The gear is rigidly fixed agitators 11. The finished material unloads from the tank 10 through the discharge device 12.
Figure 1. Planetary mixer

Figure 2. Design of a planetary mixer: 1 - loading device; 2 - case cover; 3 - engine; 4 - output shaft; 5 - leash; 6 - gear; 7 - counterweight; 8 - ring gear; 9 - case; 10 - capacity; 11 - stirrer; 12 - unloading device

The material for mixing enters the tank 10 through the loading device 1. Together with the supply of material, the electric motor 3 is turned on. Rotation from the electric motor 3 through the output shaft 4 is transmitted to the leash 5. At the same time gear 6 rolls along the gear ring 8, which is fixed to the
housing 9. Due to this mixer 11 makes a complex cycloidal movement that ensures the circulation of the mixture inside the tank. At the end of the mixer is unloaded material through the device 12.

The use of computer-aided design allowed us significantly speeding up and simplifying the design process of the design under development using tools for gap analysis and geometry intersection [1], calculating the mass of equipment items, etc.

The design of the planetary mixer was carried out using CAD / CAM / CAE computer-aided design system NX [2]. After the initial design sketches were developed, an electronic-digital model of the mixer was created on their basis in the “Modeling” [3] and “Assembly” applications of the NX system (figure 3).

Figure 3. Electronic-digital model of the mixer.

Further, the design of the mixing mechanism of the planetary mixer was developed, due to which one of the problems of this machine is solved - the pollution of the planetary gear and the ingress of lubricants into the finished product (figure 4).
Figure 4. Electronic-digital model of the modernized mechanism of a planetary mixer: 1 – a leash; 2 – protective disk; 3 – counterweight.

3. Kinematic analysis of the planetary mixer mechanism in the CAD / CAM / CAE system NX

In order to determine the rational configuration of the location of the working bodies of the mixer, a kinematic analysis of the electronic-digital model of the mixer mechanism was carried out (figure 5) in the NX Motion Simulation system module [4, 5]. Using the PLM system (product lifecycle management system) Teamcenter [6], a variable structure [7] of the planetary mixer was created, which made it possible to carry out a kinematic analysis of various performances of the mixer working body in a single data set.

Using variant design, it is possible to obtain several variants of the planetary mixer by configuring the composition of its electronic-digital model [8, 9]. In accordance with the developed mounting disk designs, the variants of the planetary mixer for the calculation were configured. At the end of the calculation of the mechanism, it will make a movement corresponding to 5 seconds of work of a real device with identical parameters. Since tracing was included in the animation parameters, in the process of solving the markers (figure 6) were copied in space at each step.
Figure 5. Electronic-digital model of the mechanism of a planetary mixer

Figure 6. Mixing Bar Markers

Thus, using the trajectory of kinematic analysis, the configurations of mixing organs (figure 7) are calculated.
Figure 7. Fingerprint markers of mixing rods located in the spiral cut of the disk.

The resulting image allows concluding that the selected location and movement of the mixing rods allows mixing of the mixture components throughout the capacity of the planetary mixer with the minimum presence of stagnant zones.

Such a characteristic suggests the production of mixtures with a high coefficient of heterogeneity, which is one of the main quality criteria [10].

4. Conclusion
As a result of the kinematic analysis of the planetary mixer mechanism in the CAD / CAM / CAE system NX, a variant of the most efficient arrangement of mixing rods for obtaining dry building mixtures with a high heterogeneity coefficient was found.

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