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Study Of Planetary Concrete Mixers

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ABSTRACT: The mixing is certainly the most critical phase of the concrete production process and the quality of the concrete depends heavily on the quality of the mixer. Due to the efficiency of the compulsory mixing action, the planetary mixers meet the requirements of various production processes. The mixing flow is highly efficient due to integrated action of central stars combined with different peripheral scrapers. This research paper aims to study the various types of concrete mixers, discuss the advantages of the planetary concrete mixer over all the other type of mixers, and study the various components of the planetary mixer in detail.

KEYWORDS: Concrete, Mixers, Mixing Arms,Planetary, Scrapper Arm

1. INTRODUCTION

A concrete mixer (also commonly called a cement mixer) is a device that homogeneously combines cement, aggregate such as sand or gravel, and water to form concrete. A typical concrete mixer uses a revolving drum to mix the components. For smaller volume works portable concrete mixers are often used so that the concrete can be made at the construction site, giving the workers ample time to use the concrete before it hardens. An alternative to a machine is mixing concrete by hand. This is usually done in a wheelbarrow; however, several companies have recently begun to sell modified tarps for this purpose. [1] The concrete mixer was invented by Columbus industrialist Gebhardt Jaeger.

2. TYPES OF CONCRETE MIXERS

Concrete mixers can be divided in two main groups: a batch mixers and continuous mixers. [2]

2.1 Batch Mixers:

A batch mixer can produce one batch at the time and has to be emptied completely after each mix.There are two main types of batch mixers:

2.1.1.Drum Mixers:

All the drum mixers have a container with a cross section similar to that shown in Fig. 1. The blades are attached to the inside of the movable drum. Their main purpose is to lift the materials as the drum rotates. In each rotation, the lifted material drops back into the mixer at the bottom of the drum and the cycle starts again. Parameters that can be controlled are the rotation speed of the drum and, in certain mixers, the angle of inclination of the rotation axis. There are three main types of drum mixers:

- Non-tilting drum;
- Reversing drum;
- Tilting drum.[1]

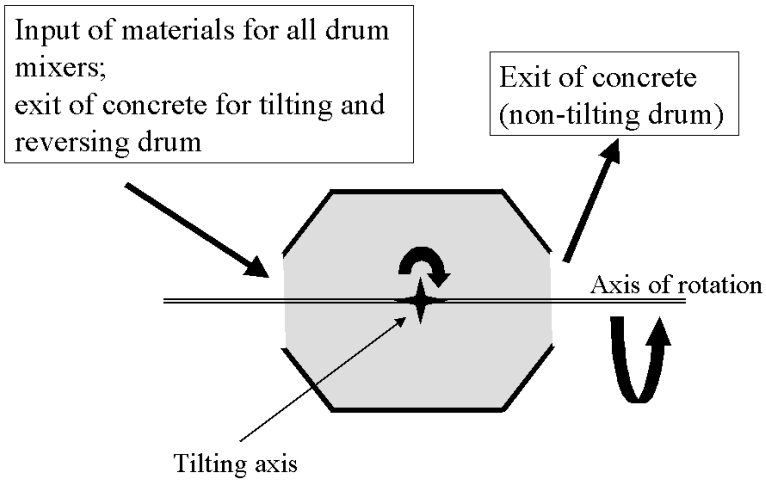

Figure 1: Drum Mixers

2.1.2 Pan Mixers:

All pan mixers work on basically the same principle: a cylindrical pan (fixed or rotating) contains the concrete to be mixed, while one or two sets of blades rotate inside the pan to mix the materials and a bladescrapes the wall of the pan. The shape s of the blades and the axes of rotation vary. Fig. 2 shows the differentcombinations of blade configurations and pan. The otherelement of the mixer is the scraper. This is a blade that is suspended at an angle near the inner wall of the pan. Its role is to scrape theconcrete that tends to stagnate near the wall of the panfrom the wall and to push it inward so that it encountersthe rotating blades. To discharge the mixer, the pan is usually emptied through a trap on the bottom. For small mixers (less than 20 L or 0.02 m3), the blades are lifted and the pan can be removed to empty the mixer. [1]

Figure 2: Pan Mixers

2.2 Continuous Mixers

As the name indicates, the materials are continuously fed into the mixer at the same rate as the concrete is discharged. They are usually non-tilting drums with screw-type blades rotating in the middle of the drum. The drum is tilted downward toward the discharge opening. The mixing time is determined by the slope of the drum. [1]

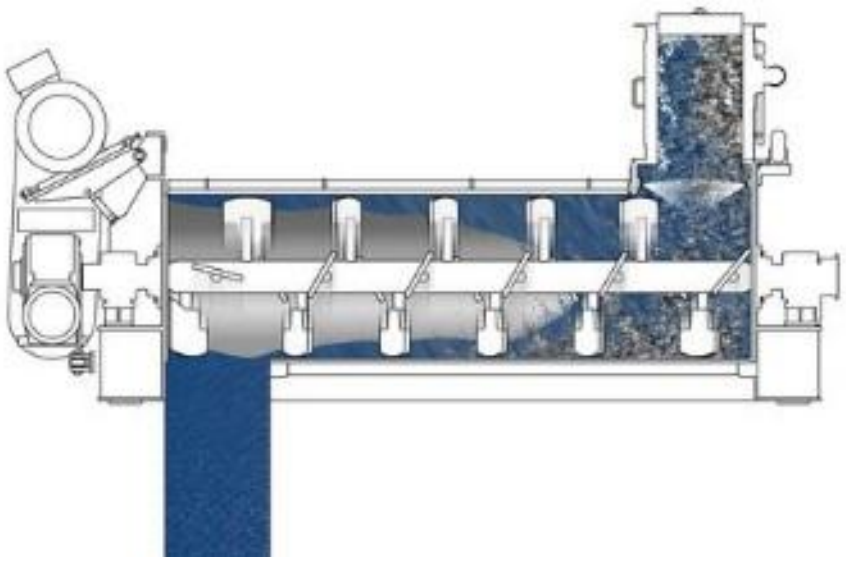

Figure 3: Continuous Mixers

3. PLANETARY CONCRETE MIXERS

Pan mixers that have their have the axis offset [planetary motion mixer and counter- current motion (Fig.4). In these cases, there are two rotations: the blades rotate\around their axes and around the axis of the pan (arrow 2 in Fig. 4) [1]

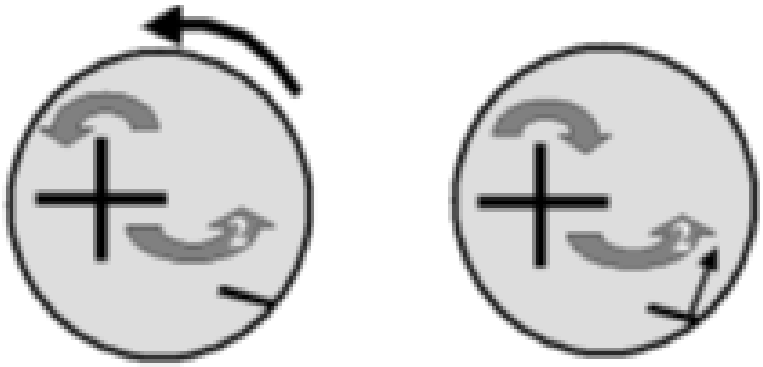

Figure 4: Planetary Mixer Configurations

[1] Components of Planetary Mixers

The main components of the Planetary Concrete Mixers have been described in this section.

3.1.1. Motors

Electric Motors arethe primary source of rotating power for mixers, since a rotating shaft with an impeller is common. In some cases, Pneumatic or hydraulic motors are used, where a combination of variable speed and non-explosive characteristics are needed. Diesel engines are used occasionally where electric power is unavailable or unreliable.Motors can be classified by size, power source, enclosure, and even application. An essential part of any electric motor is the nameplate. Without the information found on a nameplate, most motors look like a cylindrical or rectangular housing with wires leading in and a rotating shaft coming out. Understanding the information on a motor nameplate will help identify an existing motor or specify a new motor. Much of the information is essential for proper operation and application of a motor.

3.1.2 Speed Reducers

Except for some portable mixers, high-shear mixers, and a few special mixers, most mixers operate below standard motor speeds. Typical motor speeds of 1800 or 1200 rpm (30 or 20 rps) are reduced to between 350

and 30 rpm (5.8 and 0.5 rps) for most mixer applications. Gear reduction is used with most low-speed portable mixers, and belts are used with many side-entering mixers. Turbine mixers can use single-, double-, or triple-reduction enclosed gear drives. Sometimes a combination of gear and belt drives is used. Since most drives transmit essentially constant power, the reduced speed results in much higher torque. Torque is proportional to power divided by speed and represents the amount of turning force produced by a drive.Gear reducers use a small rapidly turning toothed "gear" called a *pinion* to turn a larger gear with more teeth. The amount of speed reduction depends on the relative diameter of the pinion and gear, measured by the number of teeth on each. Thus a 5:1 gear reduction has five times as many teeth on the gear as on the pinion.Most gear reducers for mixer applications are enclosed to prevent the same potential contamination problems as those mentioned for motors. Also, open gearing poses safety hazards for operators. For the speed ranges required in mixers, one, two, or three gear reductions may be needed. Each reduction results in a successively lower speed. All of the reductions can be inside the same housing, or one reduction can be attached to the motor, with the other reduction or reductions inside the reducer housing. [3]

3.1.2 Supporting Arms

The supporting arms form an integral part of the entire mechanism, as they hold the motor and the gearbox required for imparting motion to the scrapper as well as mixing arms. One end of the arms is boltedto the ring, whereas the other is bolted to a thin plate on the gearbox unit. They are formed by shearing and then joint by welding and they have a tapering rectangular cross section to improve stress handling capacity. They are made of EN8 steel.

3.1.3 Planetary Gearbox

This reduces the amount of power consumed by the mixer. In earlier designs, the power supplied to the mixing arms used to be driven by an auxiliary motor. In this design, the gearbox unit has a larger gear bolted to the fixed body. The pinion is connected to the mixing arms and is placed in the rotating body. The rotating body receives rpm from the motor. Due to the rotation of the rotating body, the pinion moves in a circular motion around the periphery of the rotating body. At the same time, due to being meshed with the gear, it rotates about its own axis as well. Thus, the pinion rotates about its own axis as well as around the gear, thereby giving the mixing arms the planetary motion required for more efficient mixing action. The gears are made of case hardened 50C4 and manufactured by hobbing, whereas the fixed and rotating body are made of EN8 steel and are manufactured by first rolling the side body, then welding it and press fitting the top and bottom plates to the rolled components.

3.1.4 Shafts

Shafts are the elements responsible for the rotation of the mixing arms and the scrapper arm around the periphery of the mixer vessel or shell. The shaft of the mixing arms will be connected to the pinion, which will provide it the necessary rotating action about its axis as well as the revolving motion, whereas the shaft of the scrapper will be bolted to the bottom of the rotating body, giving it the revolving motion around the periphery of the shell. They are also made of EN8 steel.

3.1.5 Shaft Seals

Shaft seals are necessary for tanks operating at elevated pressures, tanks containing hazardous, toxic, or noxious materials, and any mixer application where the shaft enters the tank below the liquid surface (i.e., side- and bottom-entering mixers). Several methods are available for sealing around the rotating mixer shaft. Although some methods are similar to seals used on pumps and other submerged equipment applications, the shaft deflection and run-out for mixers are larger because of long shafts and large hydraulic loads. Thus, although similar in some ways to other applications, shaft seals for mixers are also unique. [3]

3.1.6 Mixing Paddles

The mixing arms are components which rotate about their own axis as well as around the entire container, thereby providing planetary mixing action. They have an inclined angle of 145deg and mixing paddles, made of harder material such as Nicral, are attached to the end of the mixing arms so as to prevent the wear and tear and thus early failure of the arms. The mixing paddles are made of hardened material as they come in direct contact with the mixture, and if damaged they are easier to replace.

3.1.7 Scrapper Arm

This is a blade that is suspended at an angle near the inner wall of the pan. Its role is to scrape the concrete that tends to stagnate near the wall of the pan from the wall and to push it inward so that it encounters the rotating blades. Since the pan is fixed, the scraper must move to push concrete toward the blades.The scraper arm has an F-shaped section, and it is bolted to the revolving body directly for revolving motion. It is also protected with

liner plates, since this arm comes directly in contact with the mixture material and hence could fail much earlier than the other components.

3.1.8 Shell and Ring

The shell forms the base of the mixer. It is the container in which the cement, water and other aggregates are mixed to get the finished product. It is generally made of MS plate, rolled and welded together, with slots provided around its periphery to enable the fitting of liner plates so as to prevent the wear of the shell itself. It is designed based on the amount of concrete required from the mixer. It has a welded base plate, which forms the base of the mixer, and there is a cut-out for the gate, from which the concrete is discharged. A thin ring at the top forms the final part of the shell, which is to provide support for welding the supporting arms.

3.1.9 Liners

During the concrete mixing phase, the various contents of the mixture i.e. sand, stones, aggregates, cement etc. are thrown outwards due to the centrifugal force caused by the rotation motion of the mixing arms. After a certain period of time, due to the impact of these materials on the inner surface of the shell, the shell will get worn down and may get damaged. Hence to prevent the damage to the shell, internal liners are bolted along the inner periphery as well as the base plate of the shell. The main purpose of these liners is to protect the wear and tear of the internal surfaces of the shell. These are easily replaceable materials, hardened so as to prevent their early failure, and they are used to protect the shell since their replacement cost is much cheaper than manufacturing an entire new shell. The material currently used is Nicral, but we hope to find a suitable cheaper alternative to this material as well.

3.1.10 Gate and Hydraulic Unit

As described in earlier section, there is a gate at the bottom portion of the shell, to discharge the finished product after the mixing has been completed. This gate is operated by a hydraulic unit, which actuates when a certain amount of time has been completed, and pushes the rod connected to the gate, which causes the gates to swivel along the rod axis and the concrete is discharged from the bottom of the mixer through the gate.

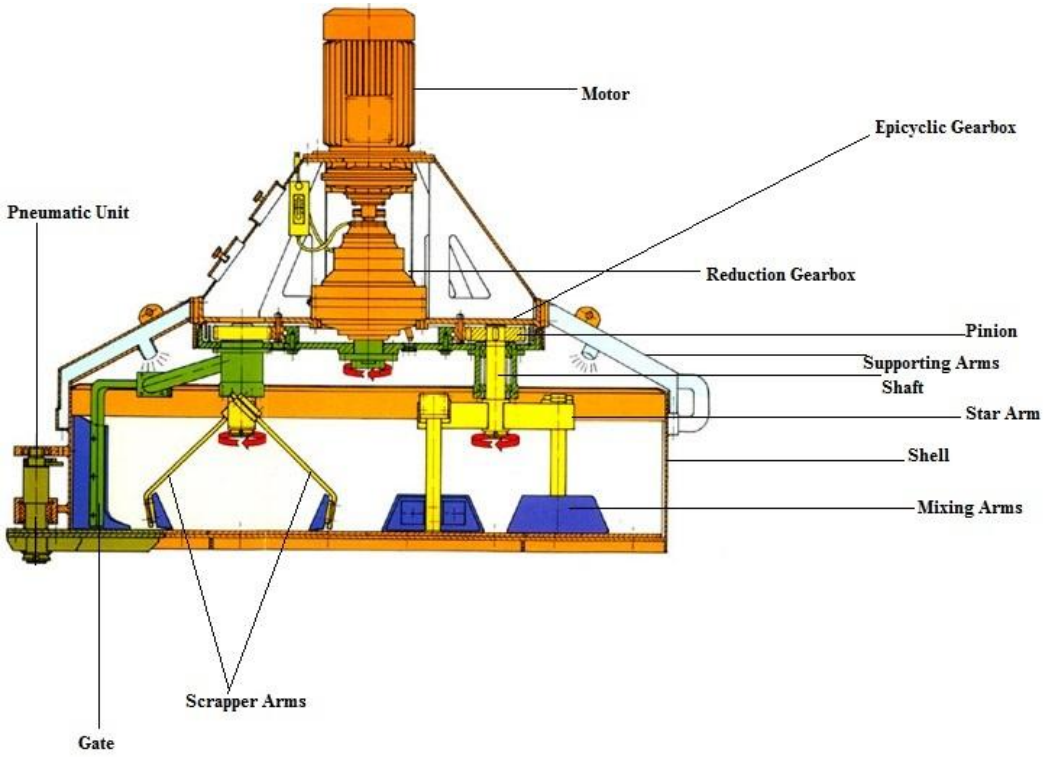

Figure 5: Layout of Planetary Concrete Mixer

4. EFFICIENCY OF MIXING

A mixer is efficient if it distributes all the constituents uniformly in the container without favoring one or the other. Therefore, in evaluating the mixer efficiency, properties such as segregation and aggregate grading throughout the mixture should be monitored. DIN EN 206-1 propose three classes: ordinary, performance or high performance mixers. Each class is defined by the obtained variability of four main parameters viz. water-to-fine ratio, fine content, coarse aggregate content and air content. Several samples are taken from the mixer and for each parameter the average and standard deviation is calculated. The coefficient of variation gives a measure of the homogeneity of the concrete produced.In determining mixer efficiency, the main focus has been determining the homogeneity and the quality of the concrete produced. [2]

5. ADVANTAGES OF PLANETARY MIXERS

5.1 Advantages

- Due to planetary mixing action, lesser mixing time is required
- More homogenous mixture is obtained due to compulsory mixing action
- Low wear and tear of parts due to liners present
- Highly efficient in terms of power consumption

5.2 Disadvantages

- Expensive to manufacture, since there are more components involved
- If there is wear and tear of any part inside the enclosed unit, entire assembly has to be dismantled to troubleshoot
- Due to presence of gear pair, lubrication cost increases

6. CONCLUSION

Thus, we have studied the different types of concrete mixers available in the world today. We have also studied about the construction and working of all components of the planetary mixer in detail, as well as the materials that are generally used in their manufacturing. We also discussed the concept of mixer efficiency, and provided advantages and disadvantages comparing the performance of planetary concrete mixers to those of the others.

7. ACKNOWLEDGEMENT

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