

The multilayer and wide-deck vibrating screen based on the innovative long-span vibration exciter

Ming Zeng¹, Zonglin Xu², Jinnan Zhang¹, Minghong Zhang²

¹ School of Mechatronic Engineering, Southwest Petroleum University, Sichuan, Chengdu 610500, China

² Chengdu Green Innovation and Technical Service Co., Ltd

Abstract: The multilayer and wide-deck innovative single plasmid vibration screen is applicable to the petroleum drilling and the other relevant industries. The structural features and advantages of the components are illustrated, and the innovative long-span vibration exciter together with the steel rope saddle block flexible coupling is emphatically analyzed. Two engineering examples are provided to make the explanation.

1 Introduction

With the developing of the modern manufacturing technology, the vibrating machines are widely used in various departments. For the purpose of raising productivity and screening volume, the vibrating machines with large screen deck and wide body are the overall trend at present. The broadening of the screen deck is benefit for increasing the feed rate, and the extending of the screen deck can expand the processes so as to enhance the effect of screening and separating. However, with the promotion and application of the wide vibrating machines, the mass of vibration for the machine must be increase. Besides, the span of vibration exciter should be enlarged because of the extending of vibration plasmid.

2 The innovative long-span vibration exciter

2.1 Status analysis

At present, the long-span vibration motor products all use the same structure: employ the short vibration motor, and then add casings at both sides in order to transfer the bearing point of the whole vibration motor to the both ends of the casings, as shown in Figure 1.

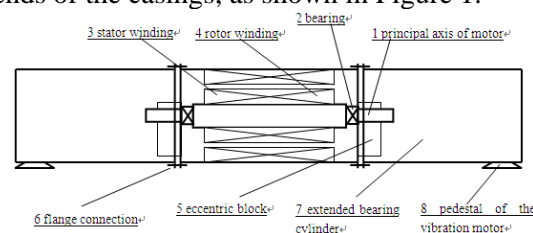


Fig.1 Structural diagram of the present long-span vibration motor

Although, the span of the vibration exciter is enlarged, the force conditions of the vibration motor have no improvement. Meanwhile, the casings simultaneously bear the bending load and the lateral load. However, the best load conditions of the cylindrical components are anti-torsion but not anti-bending or anti-shearing, so this structural will lead to some serious consequences.

Moreover, it can be seen from the axial bending moment of the motor, which is presented in Figure



2. The dynamic cyclic bending moment it bears is:

$$M_{\max 1} = 160\text{KN} \times 660\text{mm} = 105600\text{KN-mm} \quad (1)$$

The dynamic cyclic shear force is 160KN, which exclude the bending moment and shear force caused by the static loads of the middle vibration drive motor itself. And the maximum bending moment caused by the static load of motor is:

$$3.4\text{KN}/2 \times 950\text{mm} = 1615\text{KN-mm} \quad (2)$$

$$M_{\max} = 105600 + 1615 = 107215\text{KN-cm} \quad (3)$$

The side plates of screen box bear the alternating compound resistance such as: tension, pressure, bending etc, so the stress states are extremely negative. To ensure the safety and service life, the thickness of the plates is increased, which also bring into a vicious cycle.

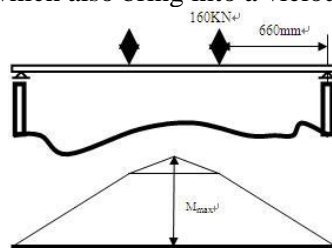


Fig.2 The axial bending moment of the motor

2.2 The principle of innovative long-span vibration exciter

The structure of our innovative integrated long-span vibration motor is shown in Figure 3, which inner span is 1900mm. Meanwhile, the span of this motor can be adjusted according to the demand. If the span increases to more than 3000mm, another separated long-span vibration exciter we designed is competent. The quality is greatly reduced by using the structure of our long-span vibration motor. For example, the self-weight of 320KN exciting force motor is only 340kg. The motor shaft barely bears the dynamic cyclic bending moment, it just suffer the bending moment caused by its static state:

$$M_{\max} = 1.7\text{KN} \times 290\text{mm} = 493\text{KN-mm} \quad (4)$$

The ratio of equation (3) and (4) is 217. Thus, the force conditions of side plates are much improved, and the strength as well as reliability is sufficiently guaranteed.

Furthermore, the steel rope saddle block flexible coupling creatively used in the innovative long-span vibration exciter. So the plastic, rubber, and belt band are completely replaced by the steel rope connecting band. Hence, the operational environment, temperature, torque capacity and the service life are greatly improved. Due to the employment of steel rope saddle block flexible coupling, the structure and the force conditions of innovative long-span vibration exciter have a significant breakthrough, as shown in Figure 4 to Figure 6. In respect of the connection between the both ends of motor and the side plates of screen box, the innovative seat plug-in mounting method which uses both the tensile bolts and shear bolts is applied. This method not only adequately develops the complementary action of tensile bolts and shear bolts, but also raises the installation reliability of long-span vibration exciter, and prevents the looseness.

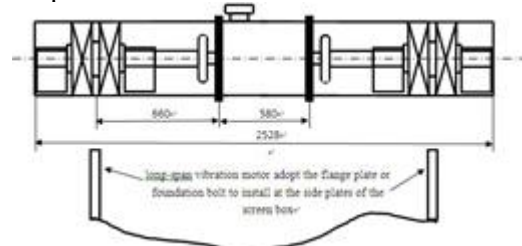


Fig. 3 The structural diagram of innovative integrated long-span vibration motor

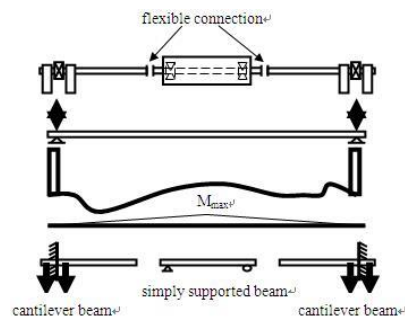


Fig. 4 The mechanical analysis of steel rope saddle block flexible coupling

a) Determinate structure

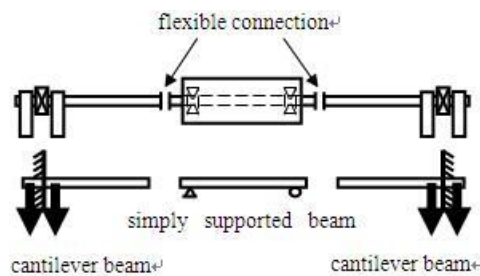


Fig. 5 The structural mechanics model

b) The force condition of eccentric block vibration component

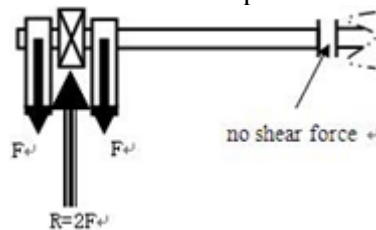


Fig. 6 The force analysis of eccentric block vibration components

2.3 The engineering implementation example

The separated innovative long-span vibration exciter is shown in Figure 6. The transmission shaft of anti-vibration driving motor is flexibly connected by the steel rope saddle block flexible coupling and the eccentric block vibration component, and the foundation tensile bolts seat mounting method is adopted by the anti-vibration driving motor together with the eccentric block vibration component to install on the bearing plate. The length of transmission shaft is allocated according to the distance between the side plates of the screen box so as to implement the various demand of long-span vibration machine.

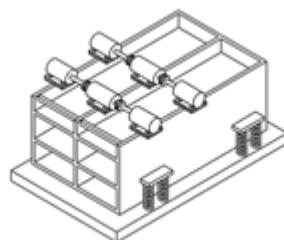


Fig.7 Separated long-span vibration exciter

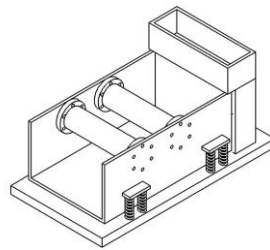


Fig. 8 integrated long-span vibration exciter

As presented in figure 7, the integrated long-span vibration exciter employs the flange plate shear bolts plug-in mounting method to install the vibration exciter into the side plates of the solid-liquid separator. The anti-vibration driving motor in the long-span vibration exciter is connected by the retaining cylinder of eccentric block vibration component as a whole, and directly installed on the carrier box of the solid-liquid separator.

3 Related key technology

3.1 ultra-wide multilayer screen deck

The physical design of the inertia vibrating screen is in accordance with the ‘force center theory’ and ‘unequal mass-radius product follow self-synchronization and synchronous state stability theory’. The ultra-wide screen deck is constituted of sub-module decks, and the multilayer screen deck is superimposed by the single layer decks. Each layer of the screen decks are constructed by two sets of sub-module decks, and a sub-module deck is made up of several series screen meshes. One side of the sub-module deck is connected with the fixed hook board on the screen box, and another side is jointed to the active hook board. Meanwhile, the screen decks are tensioned by the bolts and nuts on the active hook board. From the top layer, there is a mud reflux deflector at the bottom of each screen deck. Therefore, the mud through the upper layer screen deck can be lead to the next layer to conduct the further solid-liquid separation until reach to the bottom.

3.2 excited system mounting technique

For the current two mounting methods of long vibration motor, the bolts are suffered the intense alternate tensile vibration load, or extremely inconvenient to dismounting during the field use. For this reason, our excited system is mounted through the clamp and flange plate, and both the tensile bolts and shear bolts are employed to fix the motor. From this, the original structural advantages of the tensile bolts and shear bolts are reserved, and the respective defects of them are overcome. Moreover, the connection lines of the motor rotation center are all at the same horizontal line, and coincide with the top edge of the side plate of screen box.

3.3 screen box mounting technique

The vibration mass of multilayer ultra-wide deck vibrating screen increase dramatically, the numerical value of exciting force is enlarged accordingly, and the vibration severity as well as the vibration intensity of the screen certainly will increase, so then the pedestal will suffer greater vibration shock. Therefore, the efficient vibration and noise reduction damping spring is employed to guarantee the safety of screen pedestal, non-vibration components, switch box, controller etc. The components of screen box are installed to the pedestal by using the spring damping system.

3.4 anti-vibration driving motor automatic control techniques

The high torque needed only when starting the vibration exciter, however when the operations become steady, the ratio between the break-out torque and steady running torque is from 3 to 7. Due to the low power factor of motor, mass of energy is wasted. Consequently, the variable frequency starting and energy conservation automatic control technology are utilized. When entering the steady operations, if the driving force of the live motor is satisfied to overcome friction moment and vibration resistance

moment on the two shafts, the vibration system can perform a stable operation under the conditions of self-synchronization and synchronous state stability. Therefore, electrify one of the motors is enough to insure the proper works when the operations are steady, and then to realize the energy-efficient.

3.5 mud back activation technique

The mud in the collection tank is pumped by the nozzle of the mini-sand pump to the top of decks again, and the mud with solid rock debris is then diluted. Meanwhile, the particles of solid rock debris which are difficult to go through the screen and easy to be conglomerated are shocked to be dispersed, so as to facilitate the pass of solid rock debris and raise the handling capacity of drilling fluid. Beyond, the blocking of screen mesh caused by the solid critical particles will be alleviated and implement the self-cleaning of the meshes. Furthermore, the parameters detected by the sensors can give guidance to the adjustment of mud ejection pressure, angle, position, volume etc. The back activation equipment can be mounted at the pedestal of the vibrating screen or at the screen box.

4 Conclusions

The combination of wide and multilayer screen deck increases the feed rate of mud, thus to benefit the separation of solids and liquids. The self-weight of innovative long-span vibration exciter is lightened, and the force condition of the side plate is greatly improved, so the strength and reliability are ensured. The steel ropes saddle block flexible coupling dramatically enhances the operational environment, temperature, torque capacity, and the service life, structure, force condition are obtain the breakthrough.

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