

Design of Cleaning Machine for Passenger Car Bogie

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Abstract. The thesis mainly of equipment overall design scheme, the cleaning process, equipment performance, structural characteristics, use effect were detailed, and main technical parameters of the equipment are calculated and checked, in order to provide a theoretical basis for the whole design process.

Introduction

Bogie frame design of cleaning machine main purpose is cleaning the steering frame of dirt and paint. For the next working procedure to frame is disassembled, the parts by shot peening and play sand provide prerequisites. At present, the main ways of cleaning such parts are: ultrasonic cleaning, high pressure water flow and alkali, water cleaning, etc. [1]The apparatus is high and alkali wash combined, the reason why the use of the cleaning method is due to the frame size is larger, the pollution is heavy, the two kinds of cleaning methods combined, the water impact force is greater than the dirt and surface adhesion, high pressure water will be dirt stripping, washed away, at the same time hot alkaline cleaning on the stubborn dirt, had little effect on the corrosion of the workpiece, is economical and practical way of cleaning. In addition, according to the whole process of the passenger car repair needs, fully utilize the energy, the small and medium-sized parts of the car washing can also be carried out in the steering frame cleaning room. [2,3]

Cleaning Machine Plan

The device according to the factory switched bus repair projects in the overall process arranged within the existing 48 meters long, wide 9 meters span workshop, in the design, the cleaning indoor storage of two steering frame and a cook wash tank design, one bogie in cleaning table, a in parking position. The cleaning room can realize the simultaneous cleaning of the bogie and the cooking and cleaning, and simultaneously, the water washing and the washing table of the steering frame and the small fittings are arranged at the same time. [4]To ensure that one pair of Passenger Car Bogies after the disintegration simultaneously into the washing step. Set the stack portal at the ends of cleaning the chamber, in order to achieve the bogie and cleaning tank respectively from both ends (along track) import. Control systems are manual control.

When the truck wash and cook tankers in and out of the cleaning chamber share a traction device, the device is also used in truck washing traction bogie reciprocate.

Injection pipeline system in the clear, alkaline each with a pump, and a common set of injection pipe, two rows ring nozzle in the cleaning chamber cleaning station position, the nozzle on the nozzle direction can be adjusted using the form. Cook and truck parts washed up washed separately using a water pump and setting up a pipeline system.[5]

Alkaline wall of steel and then poured concrete, and arranged in the ground position shown in Fig. 1. At the same time provided with a reflux system alkaline, alkaline to achieve recycling.

The clear water tank is a steel structure, which is arranged on the ground in Fig. 1.

An effective ventilation system is set up in the cleaning room.

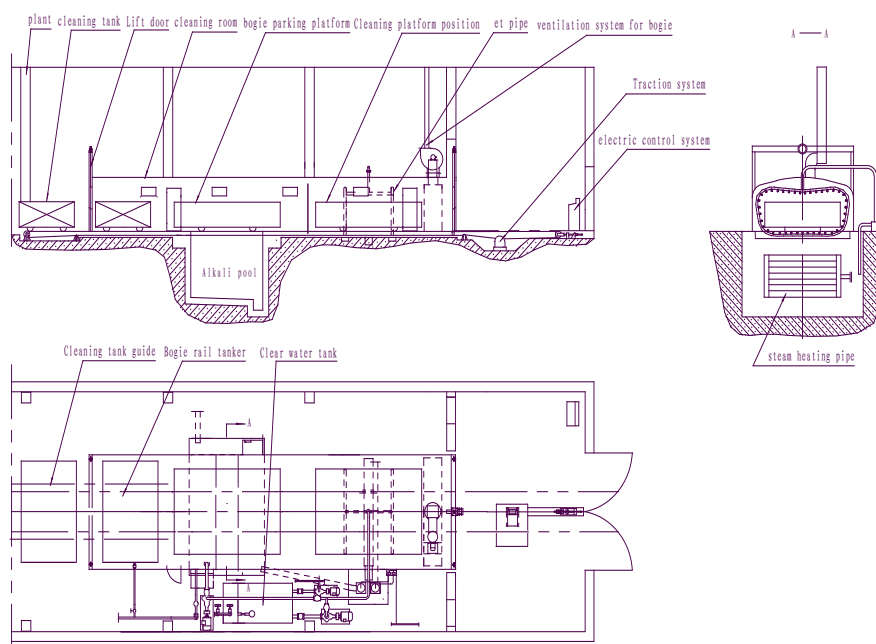


Figure 1. schematic diagram of the composition of the cleaning machine

Cleaning Process

Cleaning Process Flow of Bogie. The first steering frame to clean the indoor parking spaces→ Second sets of bogie to clean the table→ Second bogie in cleaning indoor reciprocating hot water flushing (salt water temperature of 80 °C) about half an hour→ Rinse water for 5 minutes→ Pull the outdoor artificial feeding water wash→ Using compressed air to blow the residual water→ The first bogie to enter the cleaning stage to complete the second sets of the same washing process.

Washing Process of the Accessories for Small or Medium Sized. Middle and small accessories into the washing basket→ Into the boiling wash tank of alkali water→ Will pull to the tanker parked indoors cleaning table→ Steam heating lye boil wash access 30 minutes→ Cook wash tank traction to the outside→ Hanging washing basket→ Manual repair→ Using compressed air to blow the residual water.

Main Technical Parameters of the Bogie Cleaning Machine

Workpiece maximum size(L×W ×H) 1100mm × 3200mm ×4500mm.

The size of cleaning room (L ×W × H) 2000mm × 4100mm ×15550mm.

The size of cook wash tank (L ×W ×H):3800mm × 2200mm×1100mm.

Reciprocating distance when the bogie flush : 1300 x 2mm.

The method of heating salt water : steam direct heating.

Main parameters of installation equipment:

Alkali pump: power 15 KW , head 80m , flow 50m³/h ;

Clear water pump: power 15 KW , head 50m , flow 50m³/h ;

Cleaning pump: power 7.5 KW , head 47m, flow 30m³/h ;

Fan: power 2.2 KW , air volume 5527m³/h ;

Traction device: power 3 KW ; traction speed 4m/min ; maximum traction force 10t ;

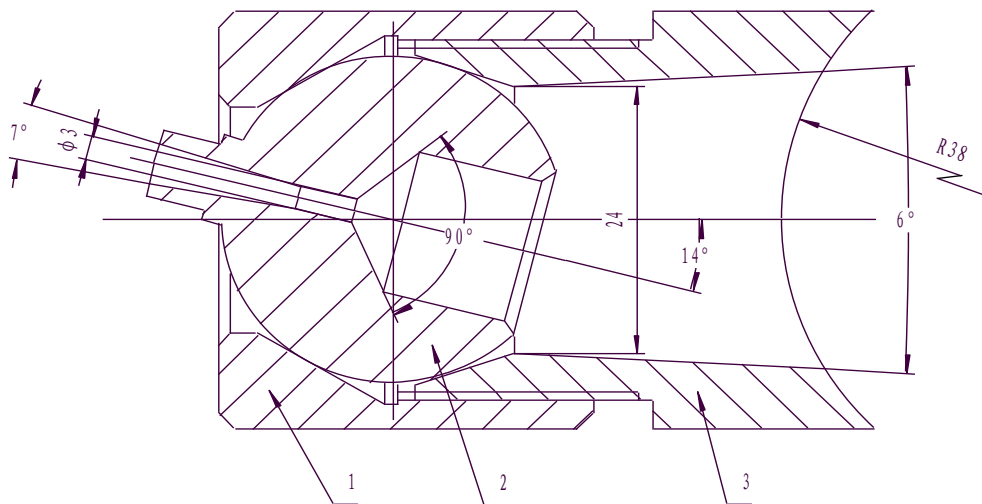
Door landing gear: power 2 x 0.8 KW , landing speed 30m/min .

Structural Characteristics of Cleaning Machine

Cleaning Room. The main body of the cleaning room is carbon steel welded structure. [6]The indoor can realize the cleaning and storage of a pair of bogie, and the cooking and washing are

carried out at the same time. Tanker truck wash and cook were out from both ends of the cleaning chamber. The gate stack is arranged at the two ends. The two sides of the cleaning room are provided with an observation window, which can be observed at any time to clean the room. The cleaning chamber is provided with a quick steam pipeline interface and is provided with a movable steam rubber pipe.[7]

Injection Pipeline System. According to the overall dimensions of the bogie, the cleaning station bit is set in two rows fixed annular nozzle spacing of 2 m . Due to the fluid jet nozzles, under the action of air resistance, the flow rate decreases, the momentum theorem, the greater the distance of the nozzle from the workpiece, the jet force on the workpiece is smaller, so small from the cleaning effect. The distance is small washing area is also small, so the distance from the nozzle to the workpiece directly affect the cleaning quality of the workpiece. The analysis finds that taking the distance from the nozzle to the workpiece $300\text{ mm} \sim 350\text{ mm}$, with a row of 41 nozzles per nozzle spacing of about 215 mm . Nozzle made of stainless steel, cross-sectional shape of a fan, spray angle adjustable. Fig. 2:



1. nut 2. nozzle sphere 3. joint body

Figure 2. Nozzle structure

The Device of Traction . Traction device includes a winch means, guide wheels, fixed pulley, wire rope, tensioning device, traction fixtures, limit switches and the like. The electrical control of the bogie and the cleaning tank pull in pull. When the bogie is cleaned, the traction bogie does reciprocating motion, and the left and right travel of each 1300 mm . Traction speed 4 m/min .

Design Calculation

The design calculation of the cleaning machine mainly includes the design calculation of the steel structure of the cleaning room, the design calculation of the injection pipe, the design calculation of the traction system, the ventilation system and so on. The design and calculation of injection pipe and traction system are introduced here.[8]

Injection Line Calculation. Process requirements: Two rows of annular jet pipe, pipe diameter $d_1 = 50\text{ mm}$, a total length of 9 meters, a number of 41 single line nozzle, exit flow pressure $P_{out} = 1\text{ MPa}$, export diameter $d_2 = 3\text{ mm}$, the average height of exports from the ground is 500 mm . As shown in Fig. 3:

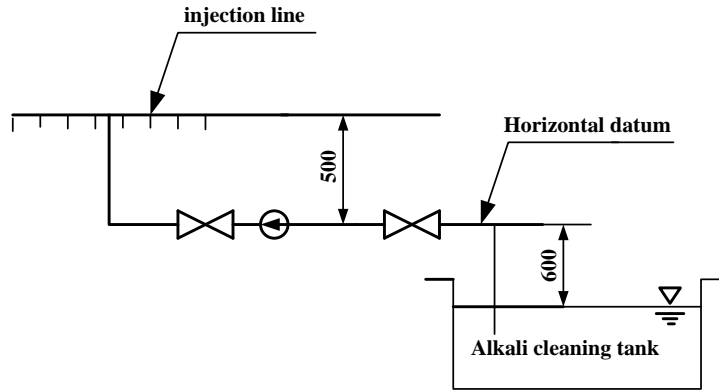


Figure 3. injection piping system

Resistance Calculation. Flow types: Circular: $Re = v_1 d_1 / \gamma$ (Average velocity of water pipeline $v_1 = 2.5 m/s$, Kinematic viscosity coefficient of water at normal temperature $\gamma = 1.007 \times 10^{-6} m^2/s$). Therefore, $Re = 124131 > 2300 m^2/s$, for turbulent flow.

Resistance loss: $\Delta P_w = \Delta P_e + \Delta P_r$

Resistance loss along the path $\Delta P_e = \lambda l / d \times \rho v_1^2 / 2$, Drag coefficient $\lambda = 0.038 / (0.842 - \lg Re)^2 = 0.02$, so $\Delta P_e = 0.02 MPa$

Local resistance loss $\Delta P_r = \sum \xi \times \rho v_1^2 / 2$ (ξ is the local resistance coefficient, Which gate valve 2 $\xi_1 = 1.3$; Entrance $\xi_2 = 0.5$; Export 82, $\xi_3 = 0.3$; Shrink diameter 82, $\xi_4 = \xi' (1 - A_2 / A_1) = 0.41 [1 - (3/50)^2] = 0.4$; 82 pipeline expansion, $\xi_5 = 0.05$; Branch pipe $\xi_6 = 1.3$; Elbow $\xi_7 = 0.13$.two).

$$\text{So, } \Delta P_r = (2\xi_1 + \xi_2 + 82\xi_3 + 82\xi_4 + 82\xi_5 + \xi_6 + 2\xi_7) \times \rho v_1^2 / 2 = 0.1 MPa \quad (1)$$

$$\Delta P_w = 0.12 MPa \quad (2)$$

Pump Outlet Pressure Calculation. For pipeline and export $v_1 A_1 = 42 v_2 A_2$, so $v_2 = v_1 / 42 \times (d_1 / d_2)^2 = 16.5 m/s$, Flow $Q = 2 v_1 A_1 = 36 m^3/h$; taking the horizontal ground as the datum plane, the Bernoulli equation of the base water pool surface and the jet plane column is:

$$P_{pump} - Z_1 \rho g + 0 = P_{out} + \Delta P_w + Z_2 \rho g + \rho v_2^2 / 2 \quad (3)$$

$$P_{pump} = P_{out} + \Delta P_w + Z_2 \rho g + \rho v_2^2 / 2 + Z_1 \rho g \approx 1.22 MPa \quad (4)$$

$$\text{Motor power: } N = P_{pump} Q / \eta (\eta = 0.7) = 11.4 KW \quad (5)$$

According to the above calculation, the pump head 80 m, flow 50 m³/h, power 15 KW. Reference to the above calculation, take the water pump head 50 m, flow 50 m³/h, power 15 KW.

Traction System Calculation. Process requirements: Mainly consists of five parts: motor, reducer, drum, steel wire rope, pulley. Traction tonnage: cleaning equipment weight 10t; bogie weight: 7T, two do not work at the same time, namely the maximum traction tonnage is 10t. Traction speed: 4 m/min. [9]

The principle of design: Traction system working principle is mainly motor is reducer reducer, drives the drum to rotate at a speed, while driving wound on the reel wire rope straight reciprocating motion, in the steel wire rope is fixed with a clamp ring, [10] to clamp the boiling wash equipment and bogie, boiling washing equipment and steering frame in the reciprocating motion of the wire rope is pull in and pull-out cleaning room. By the above structure, the rotating motion of the motor

is changed into the linear motion of the bogie.

Parameter calculation:

Determination of motor power: rail maximum static friction coefficient: $\mu = 0.15$;

Maximum static tension: $S_{\max} = \mu N = 1500Kg = 14700(N)$;

Power: $p = 0.99^4 \times 0.95 \times 0.85^4 \times 0.95 = 0.45$

The total power of motor: $P = p/\eta = 2.2KW$ take $p = 3KW$

Select Y series motor Level 4 $n = 1450r/\min$; $p = 3KW$

Choice of model of reducer: reel output line speed: $v = 4m/\min$; reducer output speed:

$v = \pi dn/1000$, $n = 1000v/\pi D_1 = 5.3r/\min$; transmission ratio: $I = 1450/5.3 = 273$, selection:

Nominal transmission ratio: $I = 289$. Reducer model: XWEY3-84-289-B3

Conclusions

The equipment has been delivered, the equipment running in good condition. This device not only to achieve the desired effect, and create favorable conditions for the smooth conduct of bus repair, and manufacturing costs for the plant to save a hundred thousand dollars. Meanwhile, in the design fully consider the health effects of corrosion and alkali vapor generated during the cleaning of the plant for workers and improve the working environment for workers.

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