Technology Introduction

Production Transfer of MSG Swing Motor to KHIZ on Installation of High-quality Assembly Line

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1 Introduction

Traveling motor MAG-33 Note 1) and turning motor MSG-27, 44 Note 2) for mini/compact hydraulic excavator are currently manufactured in KYB Sagami plant and shipped to the international destinations, including China. Japanese manufacturers of mother machines have already shifted their productions to emerging countries such as China and many of them requested the local production/supply.

For traveling motor, the MAGassembly line, which used to be located in Sagami plant was transfered to KHIZ Note 3) (KYB Hydraulics Industry Zhenjiang Ltd.)last year in response to our customer requests. For turning motor, the new assembly line has just been established in KHIZ.

In new assembly line, there will two different setups, one is for MSG-27 (Photo 1) and the other is for MSG-44 (Photo 2). This may cause a wrong-assembly and requires the precision of quality assurance better than that of Sagami plant. The low-cost washer was developed and the in-house production was increased to reduce the equipment cost. Furthermore, the hazardous work has been eliminated aimed at avoiding work-related injury.

As a consequence of considering those measures, the assembly line of superior quality and safety was successfully developed.

Note 1) Type of Motor Axial piston with a gear reducer
Motor Axial piston Gearbox-33cc/rev

Note 2) Type of Motor Swashplate with a gear reducer
Motor Swashplate Gearbox-27, 44cc/rev

Note 3) KHIZ has been integrated with KIMZ(KYB Industrial Machinery (Zhenjiang) Ltd.)in April 2016.

Photo 1 MSG–27

Photo 2 MSG–44

2 Outline of Plan for Assembly Line

The assembly line processes flow is designed to be Large component Cleaning→Assembly→Inspection→All paint. Small components are cleaned in sub-assembly process and later charged in an assembly line (Fig. 1).

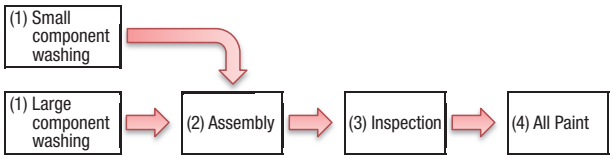

Fig. 1 Outline of Plan for MSG Assembly Line in KHIZ

3 Purpose

Establish the high quality MSG assembly line in KHIZ.

4 Objectives

(1) Production line claim 0 case (as of December 2015)
(2) Work-related injury 0 case (as of December 2015)
(3) Start of Production December 2014

5 Requirements

(1) MSG-Establishment of high quality assembly line that enables set-up of 27 and 44.
(2) Reduction of equipment cost in order to achieve the budgetary objectives in investment.
(3) Securing the safety by elimination of hazardous work.

6 Descriptions

6.1 Improved precision of quality assurance through error-proofing system

6.1.1 Establishment of Picking System for Selection of Shim Note 4)

From multiple shims available in various sizes, one should be selected for assembling based on the amount of the clearance created between components during the bearing

assembly process. At this point, there is a potential risk of wrong assembly caused by misselection of shim. Once the wrong part is assembled, the play of roller inside bearing may become excessive and cause vibration, resulting in shorter life time of bearing.

When the clearance determined by a measuring apparatus, was wirelessly transmitted (Photo 3), the indication lamp of a part box, in which appropriate shim is stored, illuminates (Photo 4). The system is designed to prevent a product from proceeding to the next step until an operator presses a picking sensor after picking out the specified shim.

The technique which allows the correct picking regardless of the operator's skill was established in this improvement.

Note 4) Spacer used in adjusting the height of component and extra clearance

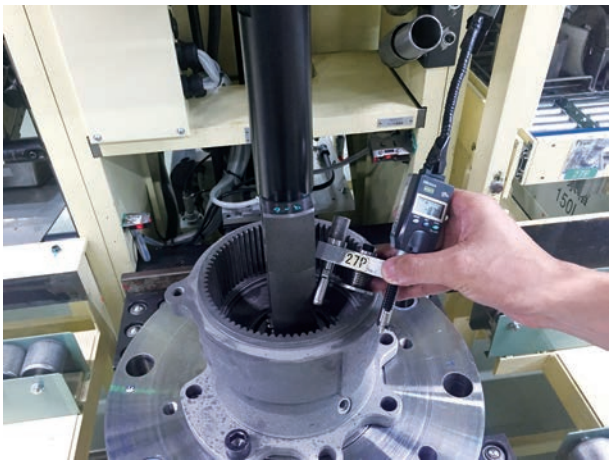

Photo 3 Clearance Measuring Apparatus

Photo 4 Shim Storage Rack

6.1.2 Establishment of Grease Quantification System

Since the grease application to bearing is a manually performed process, the amount of grease applied to each machine may vary. Also, a product may proceed to the next process, skipping grease process. Insufficient grease application may cause the shorter lifetime of a bearing.

Grease gun, which provides grease amount control, was adopted (Photo 5) in order to quantitatively provide the one-push amount of grease. The system is designed to prevent a product from proceeding to the next step when the amount of applied grease is insufficient.

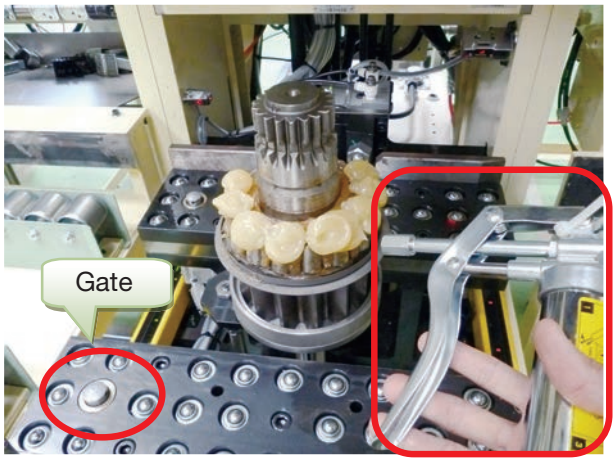

Photo 5 Quantitative Grease Filling Gun

The technique which enables an application of grease quantitatively on each machine regardless of the operator's skill was established in this improvement.

6.2 Mechanical Efficiency (Torque Efficiency) Stability Measurement

The variation of mechanical efficiency (torque efficiency) may occurs in a performance test equipment due to unstable torque measurement. Since the rotational shaft of the performance test equipment is equipped with contact type torque-meter, the zero point drift easily occurs due to wear of the contact portion which can cause the unstable torque measurement. In addition, since the torque is controlled by a hydraulic motor (Fig. 2), its rotational speed is destabilize due to the oil pressure pulsation, leading to unstable torque.

Non-contact type torque-meter is currently equipped on rotational shift of the performance test equipment as a substitution. Also, the inverter controlled motor is used for torque control. Consequently, the rotational speed, and then torque speed were stabilized.

The technique which enables the stable measurement of mechanical efficiency regardless of the operator's skill was established in this improvement.

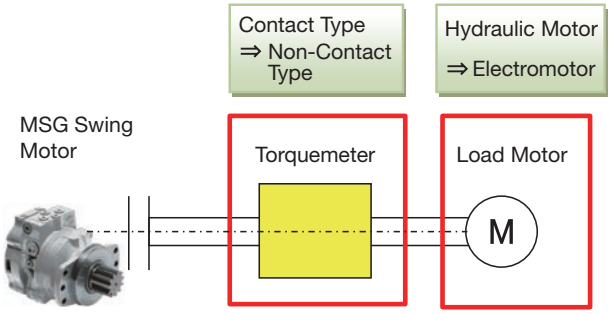

Fig. 2 Performance Test Equipment rotational shift

6.3 Development of Filter Selection Simulator

For MSG performance test, the hydraulic fluid is supplied to MSG by the hydraulic pump installed on performance test equipment to rotate the motor. This causes the initial wear particles over the contact surface, which lower the fluid cleanliness level.

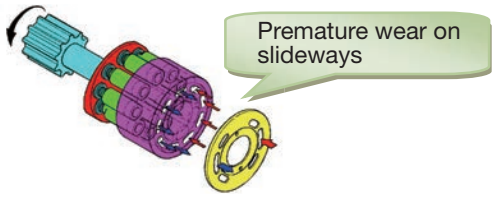

Fig. 3 Rotary Parts of MSG turning motor

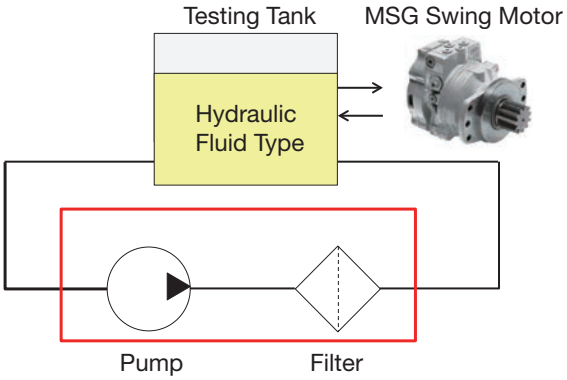

Fig. 4 Offline Filter Circuit

The fluid cleanness levels were set out in our internal standards. The low fluid cleanness level results in the risk of premature wear or failure on MSG (Fig. 3). In order to prevent decrease in fluid cleanness, a filter was installed (Fig. 4). However, the determinations of filtration accuracy (filter mesh) and pump flow rate were only based on engineer's experience in production, who had decided the specifications of the performance test equipment, and the selection criteria were not clearly defined.

A simulator which outputs the particle count inside the performance test tank upon entry of the required data, including filtration accuracy and pump flow rate, was internally developed this time (Fig. 5). The filtration accuracy and pump flow rate were determined by using this simulator in order to maintain the fluid cleanness level of the performance test equipment to be within our internal standard.

The technique which enables the determination of appropriate filter regardless of the operator's skill was newly established in this improvement.

6.4 Development of Low-cost Bubbling Washer

The machine time of the washer preciously used in Sagami plant was too short in regard to the target cycle time and over-specified (requires a high equipment cost) . Meanwhile, the cleaning accuracy was set out in our internal standard and thus must be complied with.

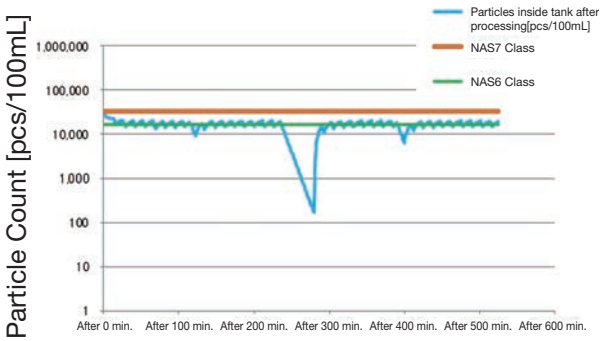

Fig. 5 Simulator Output for Particle Count

The low-cost bubbling washer was newly developed in order to keep expenses within investment budget (Photo 6). The previous bubbling washer requires two pumps, one for the circulation and the other for bubbling. This time, one pump can provide both the circulation and bubbling functions and successfully contribute to reduce the cost of equipment (Fig. 6). For further reduction of equipment cost, a local manufacturer in China was selected as a source of this washer.

The specification of the equipment was developed in Sagami plant. Then, the subsequent process from the acquisition of estimation through equipment installation, test-run, and check for cleaning accuracy were conducted mainly by KHIZ local staffs.

Photo 6 Bubbling Washer Appearance

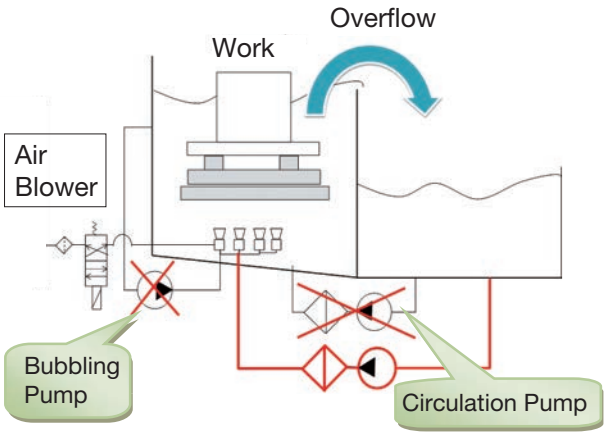

Fig. 6 Circuit Diagram of Washer

6.5 Internally Developed Control Software for Performance Test Equipment

The control software for the performance test equipment was previously outsourced.

Since the performance test equipment is a core facility, the control design was developed in our machine tools center. As a result, the equipment cost was successfully

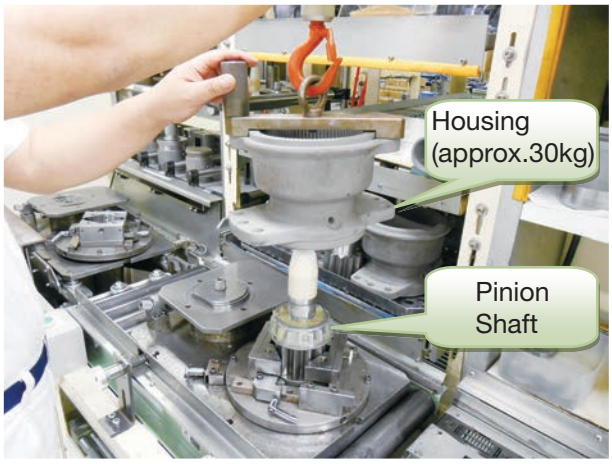

Photo 7 Crane Operation

reduced by internally developing the electrical circuit of the performance test equipment and control software.

6.6 Safety Measures

6.6.1 Craneless Preload Control Device Note 5)

The previous preload control method requires a crane, which lifts a housing of mass approx. 30 kg. and place it on pinion shaft for installation (Photo 7). Use of crane was considered as one of hazardous work, in which materials falling or caught-in may occur.

Note 5) Press equipment, which apply load on taper roller bearing.

The equipment has the structure for which the pinion shaft can be installed onto the bottom of housing in order to achieve the craneless operation (Photo 8).

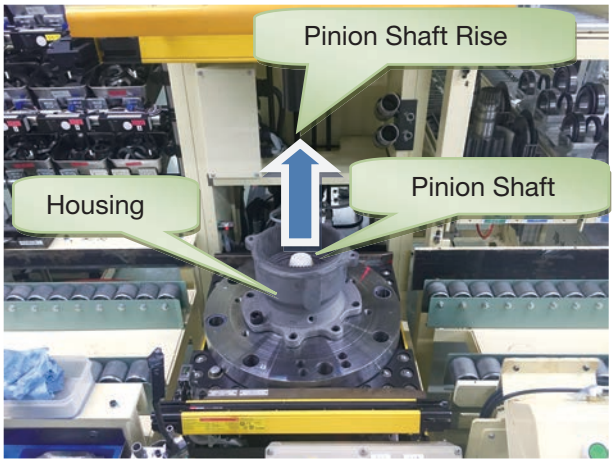

Photo 8 Preload control device

6.6.2 Craneless Performance Test Equipment

In the process using the previous performance test equipment, the material assembled in a longitudinal attitude was suspended by crane in a laying sideways condition to be install on the rotational shaft. Use of crane was considered as one of hazardous work, in which materials falling or caught-in may occur.

This time, the material was secured in a pallet, and gripped in a conveying loader. The work pallet was clamped, and tilted 90 degrees so as to be a horizontal attitude in order to achieve the first craneless operation for MSG (Photo 9).

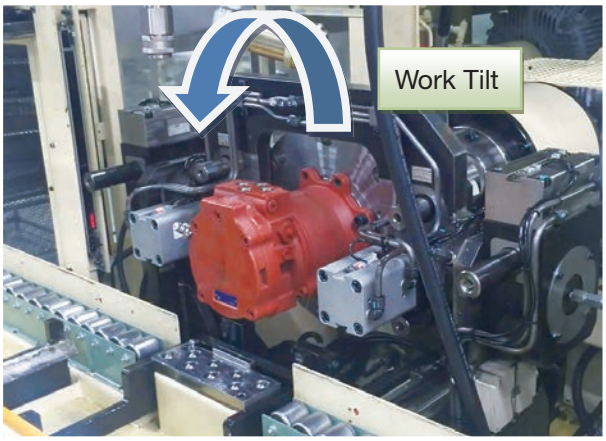

Photo 9 Performance Test Equipment

7 Results

All objectives were achieved.
(1) Production line claim 0 case (as of December 2015)
(2) Work-related injury 0 case (as of December 2015)
(3) Start of Production December 2014

8 Summary and future tasks

The assembly line was successfully developed not only for MSG assembly in KHIZ but also for achieving superior quality and safety.

We plan to share and improve this technology in other production lines.

9 In Closing

I would like to take this opportunity to express my deepest gratitude to everyone involved and provided support in the establishment of MSG assembly line.

Author

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Joined the company in 2007.
Production Engineering Sect.,
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