Management system of shot peening process

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Introduction

The shot peening process is managed by various conditions such as injection pressure, injection amount, particle diameter of injected material, injection distance, etc. It is essential for the shot peening process to manage quality by managing these conditions and actual injection such as arc height, intensity and coverage. However, it is impossible to measure the arc height and other properties even if the injection conditions can be managed constantly by monitoring during blasting of the actual product. Therefore, since total inspection after shot peening is virtually impossible, it is necessary to periodically extract products and test them outside of processing.
When an abnormality is found in the inspection process, it is necessary to remove a set of products in a batch amount, and the loss is large. Also, it is necessary to arrange for personnel to conduct inspection outside of processing. Furthermore, when changing after the process changeover of products, initial product inspection is necessary, and the fact that production cannot be done until results are obtained is a problem. In addition, due to diversifying needs and shortening of the product life cycle in recent years, the introduction of cell production methods in various industries is advancing.
The cell production method described in this paper refers to a flexible production line aimed at achieving multivariate variable production for small-lot mass production through the conveyor production method using conventional conveyors. As the demand for multiple types of products increases, problems such as an increase in process changeover work and a decrease in production lead time cannot be disregarded. At this time, we will propose a peening management system in hopes of providing an opportunity to solve those problems.

Objectives

In this thesis, we aim to construct a system that passes on zero defects by achieving total inspection, which was impossible up till now. In addition, as an incidental effect of doing so, we aim to reduce production lead time through the integration of production and quality inspection, and further stabilize and improve productivity.

Methodology

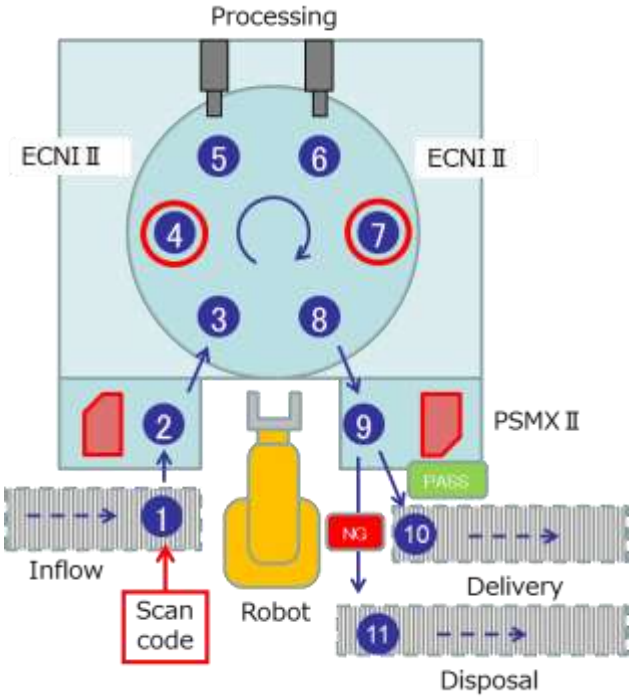
Sightia ™ [2] is indispensable for realizing these objectives. With *Sightia* ™, a peening device and a loading/unloading device are combined together to build up one system. As a result, for the fabrication of a single component, it is possible to complete the process through numerical control of processed information, and we believe that the problems mentioned above can also be solved.
This chapter introduces *Sightia* ™ and proposes concrete methods.

About Sightia ™

Sightia ™ is a non-destructive inspection device based on eddy current measurement and X-ray residual stress measurement, and our company has PSMX-II (X-ray residual stress measurement formula) and ECNI (eddy current formula) lined up. Before peening, evaluate using PSMX-II and ECNI, and evaluate using PSMX-II and ECNI after shot peening processing as well.
As a feature of both devices, measurements can be performed in about 10 seconds using our unique method of calculating measurement values, so it is possible to incorporate them inline. For each measurement point, PSMX-II can measure residual stress, but it is the result of only that

measurement point. On the other hand, unlike PSMX-II, ECNI does not measure actual physical quantities such as stress, but it can be used to judge whether the machining condition of the surface's entire circumference is good or bad.
Therefore, through evaluation of the surface's entire circumference with ECNI to determine whether the surface has been uniformly processed, combined with the measurement results from PSMX-II, it can be inferred that residual stress has been given to all the surfaces.
For the reasons mentioned above, we recommend inspection using both PSMX-II and ECNI.

Proposal of incorporating an inspection device into a peening device
Currently, one-piece manufacturing for the purpose of quality assurance and traceability in the shot peening process is becoming mainstream.(1) We think that it is necessary to ensure more stable quality not only by guaranteeing quality after peening but also by knowing the quality before peening when it is susceptible to the effects of peening. If there are variations in the product state (heat treatment or machining) before peening, even if the lot passes the sampling inspection after peening, there is a possibility that defective products outside the standard will actually be mixed in.
An illustration of incorporation into the peening device is described below (Fig.1). Place measuring instruments in front of and behind the device and perform total inspection. Remove non-standard products during the measurement before the peening device. Products meeting standards are subjected to peening treatment and then subjected to measurement. In the subsequent measurement, products within the standard move on to the next process, and products outside the standard are removed. With the introduction of the loading/unloading device, it is also possible to re-peen and reproduce products outside the standard depending on the state of the product.
This system enables total inspection, and the outflow of defective products becomes zero. By performing the preliminary measurement, unnecessary peening processing is eliminated and any irregularity in the previous process can be found at an early stage, enhancing the reliability of the entire line.



1 Feed location [scan code]
2 **PSMX-II measurement** (pre-processing)
3 Table loading site
4 **ECNI-II measurement** (pre-processing)
5 Processing site 1
6 Processing site 2
7 **ECNI-II measurement** (post-processing)
8 Table unloading site
9 **PSMX-II measurement** (post-processing)
10 [OK] Delivery to next process
OR
11 [NG] Disposal

Concrete example incorporating *Sightia* ™ (Fig.1)

Results and analysis

Effect of shot peening process incorporating Sightia ™

By incorporating ***Sightia***™ into the process, the following effects can be expected.

(1) Reduction of outflow of defects and quality assurance of all products

The shot peening process incorporating ***Sightia*** ™ is a shot peening process that integrates conventional shot peening condition management and quality control by installing ECNI and PSMX-II. Therefore, as described above, only quality guarantee through condition management of the conventional shot peening machine was performed, but by evaluating all the actual products before and after processing, it is possible to ensure the quality of all of the products.

From the above, it is possible to make the outflow of defective products as close to zero as possible.

(2) Accumulation of measurement data

Data of measured values and processing conditions of all products obtained by inline total evaluation are accumulated. Based on the accumulated data, it becomes possible to perform analysis by looking at problematic tendencies when defects occur, and appropriate countermeasures can be made.

(3) Proper handling of defective products by feed forward adjustments to processing conditions

As a concrete method, based on preprocessing measurement results, judgment is made with the three classifications of OK (pass), △ (requires adjustment), and NG (No Good). In the case of NG, injection is skipped and the product is discarded so that unnecessary processing is not performed. In the case of the △ judgment, adjustments to processing conditions are limited to the product in question to remedy it, thereby making it possible to turn it into a stable product of the same quality by correcting the processing conditions (feed forward).

However, it is necessary to continue with research to determine the extent to which shot peening conditions should be corrected for the properties of the product before processing.

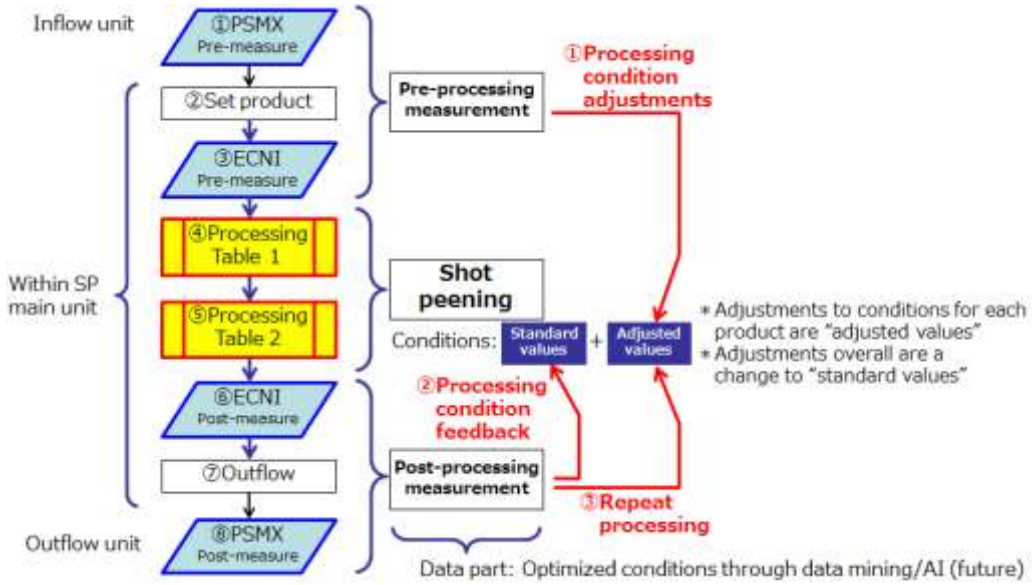
(4) Reduced probability of defective products through feedback on processing conditions

In the post-processing step, from data analysis of the accumulated post-processing evaluation results, the tendencies of the post-processing product are grasped. From these results, it is also possible to eliminate defective products through a warning or by resetting the processing conditions of the shot peening machine (feedback) (Fig.2).

(5) Securing traceability

In addition to the above-mentioned data accumulation, the identification number is marked on the product with a laser marker and they are linked. As a result, it becomes possible to track when and what kind of processing was done on the product, and product management becomes easy.

With the system described above, in a shot peening process incorporating *Sightia* ™, it is possible to establish a process capable of delivering many good products to customers by ensuring product quality and bringing the outflow of defective products as close to zero as possible.



Feedback operation

Maintain quality by utilizing peening data (Fig.2)

Conclusions

In this paper, we proposed a new shot peening process with *Sightia* ™ introduced before and after the shot peening process. Incorporating an inspection device inline makes it unnecessary to perform a sampling inspection by creating an integrated line of production and quality inspection, making it possible to reduce the lead time that comes with a quality inspection after the changeover. In addition, since it is possible to process a single product through the total evaluation of the product, buffers between processes are unnecessary, and it becomes possible to flexibly respond to the reduction of defective product outflow, variation of production amount and change in the type of product.

Even with labor saving, since digitization of machining values makes it easy to judge necessity after machining, we expect to be able to construct a production line without relying on skilled workers, including those involved in the inspection process. And because it can be expanded to various concepts that have been proposed in recent years such as Industry 4.0, IoT, and big data, by sharing data with front and rear processes from a customer's own analysis, it is possible to customize the process and strengthen the whole factory's production line process.

By continuing to propose a shot peening process that will be easy to use in the future, we will provide a system that can further increase trust and contribute to the construction of customers' production processes.

References

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