

A NEW AUTOMATED SYSTEM APPROACH AND IMPROVEMENTS IN VIBRATORY MASS FINISHING PROCESS

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Abstract- Vibratory mass finishing is a manufacturing process used widely for surface finishing of industrial products. Vibratory mass finishing as same as other manufacturing methods primarily is constructed to consider the safety and health of workers and environmental pollution. This consideration is the key of sustainable manufacturing in which production engineers increasingly focused on. In addition there are too many factors affect sustainable manufacturing and they mostly focus on time, energy and material efficiency. The state of the art of the paper is developing new controllable vibratory mass finishing method which allow to increased sustainability and productivity of the system.

Keywords- Vibratory mass Finishing, Automation, Occupational Health, Environment, Production Efficiency.

I. INTRODUCTION

Mechanical surface finishing, also known as mass finishing or vibratory finishing, is a surface finishing technology has been widely used for more than six decades for surface finishing of materials, because of the capability of finishing consistency with considerably lower manufacturing cost [1]. Vibratory mass finishing involves the use of a cyclic action to create grinding contact between workpieces and medium surfaces [2]. Mass finishing can be performed dry or wet, however it is common to wet the media with water-based lubricant. Cycle times can be as short as 10 minutes for nonferrous workpieces or as long as 2 hours for hardened steel [3]. Vibratory mass finishing is a versatile process that can be used for deburring, edge preparation, surface smoothing, polishing, degreasing or cleaning. Besides being a low cost method an important advantage of this process is the high surface quality and hardness. The selection of the process parameters are important for product quality and based on the operator's experience or trial and error [4]. These parameters include the frequency and amplitude of the vibration, the amount of water or lubricant, and the size, shape and properties of the media [5]. However, the sustainability of vibratory finishing is of high importance for production costs. There are many sustainability indicators available, but these indicators mostly focus on energy and material efficiency [6]. For product quality these indicators are adequate, but they are not enough for sustainability. The production system also must be environmentally friendly, do not have any risk on occupational health and safety and precision controllable.

The mass finishing is considered a "low-tech" technology that is noisy, dirty, contaminant and uncontrollable. And many manufacturer do not pay enough attention to decrease these unfavourable effects of vibratory mass finishing to optimize their

Finishing operation. The results of such negligence are usually high finishing cost and a high environmental pollution. In order to make the vibratory mass finishing system as resource efficient as possible, the interactions between input and output factors need to be considered and optimized. The worker, the machine and the environment affect and enable the process in addition to the resource streams.

There is very little scientific literature published on the vibratory finishing process and the most of them are based on process parameters effect on the product quality [7], [8]. A very small part of them are based on improvement in production efficiency and system improvement. Linke et al. (2014) were investigated more appropriate efficiency indicators for finishing operations which were calculated as ratio of change in process performance or part quality divided by the needed resources. Three efficiency indicators based on average roughness, average peak-to-valley height and subjective part quality are then used in a case study on vibratory grinding [6].

The objective of the present study was to improve the vibratory mass finishing system and increase sustainability with process efficiency. The principal changes were made on product loading and transport with new conveyor system, automation addition, sound isolation, air cleaning system addition and reduction of harmful waste.

II. CURRENT STATE OF VIBRATORY MASS FINISHING PROCESS

Nowadays many manufacturer perform the vibratory mass finishing process where parts are mixed in a bulk with abrasive media causing rubbing actions in an open environment. Although technology is rapidly developing and human is getting replaced by robots and machines, in vibratory mass finishing process the operations is often carried out by workers. These

operations start with the installation of parts, control and ends by discharging. Some of the negative effects of the process on human health at this time are noise induced hearing loss, hand vibration syndrome (white finger disease), carpal tunnel syndrome (CTS), waist disorders, lung and skin diseases. Because of these serious problems the improving and optimization in existing technology has become inevitable.

In vibratory mass finishing process the number of parts at one time is about 2000. The total weight of these components may range from 200 kg to 400 kg. The installation and transportation of these parts from the vibratory bench is mostly done by workers. This is a rather troublesome and time-consuming job.

In vibratory mass finishing process the abrasive media and the parts interact in different contact modes: free impact, rolling of media on part, and part-media contact with adjacent media rolling over it. The effect of this interactions and the bench engine noise level are measured as the average of 110 dB during system operation. Another effect of this interaction is the formation of the high amount of dust collision. Even if the workers on the bench use

personal protector equipment as requirement of safety regulations, these negative operating conditions are spread over a wide working zone.

Despite its broad application in machine and automotive components manufacturing, medical and aerospace engineering, vibratory mass finishing process is not completely modeled or understood as a system. This situation can be generate great potential for fundamental research and process improvements.

III. IMPROVEMENT OF SYSTEM OF VIBRATORY MASS FINISHING PROCESS

In this study our improvements on the vibratory mass finishing process including the product loading with lift and transportation, automation addition, sound insulation, air indication system addition and reduction of harmful waste were summarized. Our study was carried out to improve the sustainability and efficiency by increasing the production rate of vibratory mass finishing system. In this system optimization three bench were used. The schematic of the improved process was given in Fig. 1.

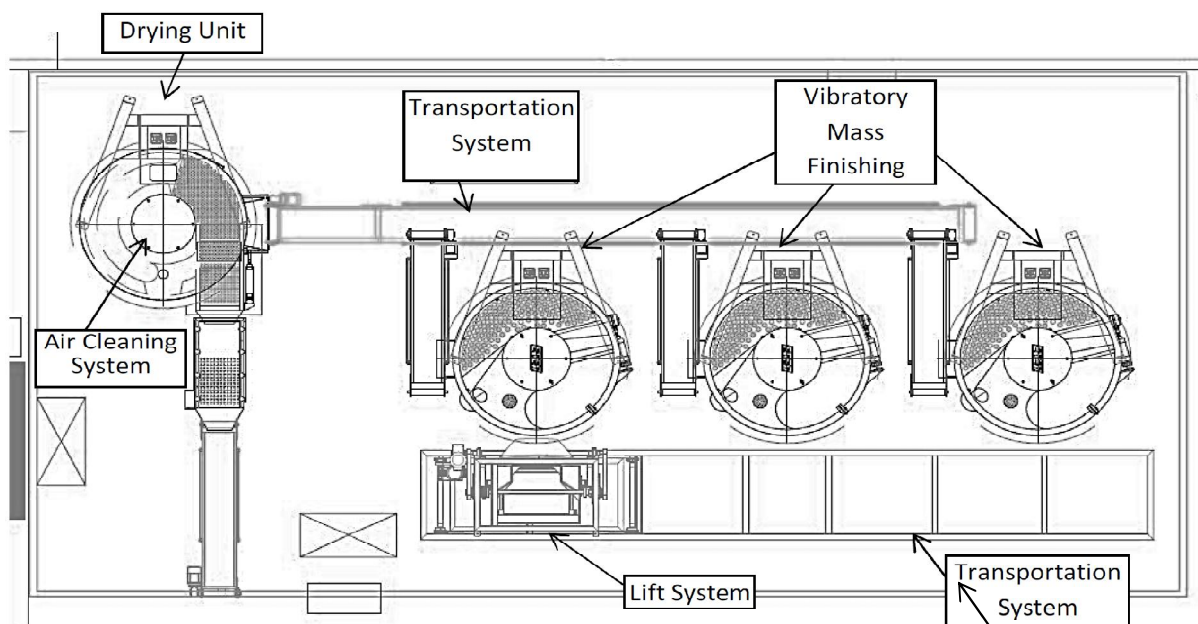


Fig. 1. The schematic of the improved vibratory mass finishing system.

3.1. Improvement in Product Loading and Transportation

Our first goal is to minimize the human effect in order to ensure occupational health and increase the production rate in vibratory mass finishing process. For this purpose an elevator system that allows loading the parts and a conveyor system that allows transporting the parts were designed (Fig. 1). In this way the system realizes a more controlled manner and quickly transportation. The photograph of the designed and installed system of elevators and conveyors were shown in Fig. 2.



Fig. 2. Lift system.

3.2. Material Flow Automation

To increase the controllability and permanence an industrial automation system were installed to the system (Fig. 3). Automation systems are the traditional way to get information about the production and system. Production is monitored installation until the end and production time can be measured. So that daily, weekly or monthly production planning can be done and data control can be easily achieved and recorded. In our study the process parameters of every different product were defined to the automation system.



Fig. 3. Control unit of the automation system

3.3. Improvement of Noise Isolation System

Vibratory system has the about 110 dB ambient noise during operation at full capacity. The noise not only affects the operator, also affect a wide area. For the solution system was separated from around and taken into a room which has the walls built with noise proof sandwich panels as given in Fig. 4. With noise insulation it is provided that ambient noise level was decreased to 80 dB as in standard. The control panel of automation system also was taken out of the noise insulated room and the operator was protected from noise.

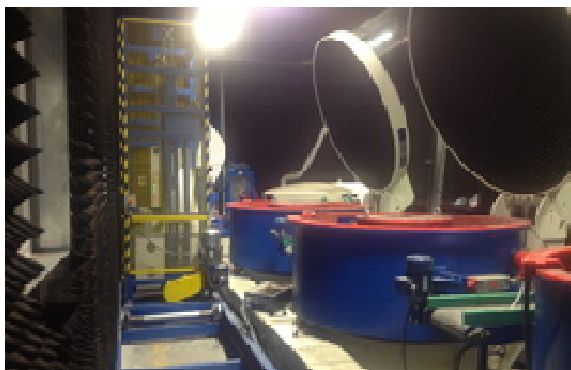


Fig. 4. Noise insulated room and noise proof sandwich panels.

3.4. Addition of Air Cleaning System

One of the most important problem in vibratory mass finishing process is the dust generation. Dust has risk on both of human health and environmental pollution.

Especially in the final stage of the drying process in vibratory mass finishing process large extent of dust is spread environment. Thus an air cleaning system was installed on the drying process in improved system as given in Fig. 5. So that powders were taken out with the vacuum effect and the the risk of pollution was reduced.

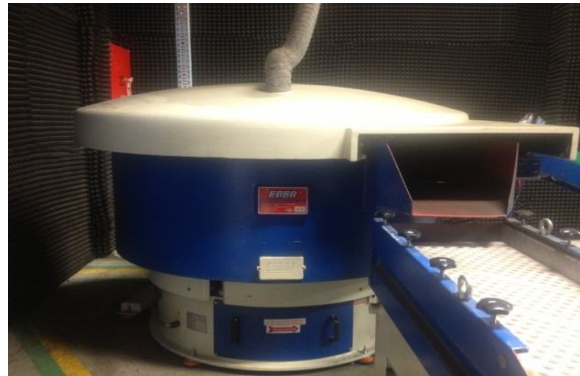


Fig. 5. Air cleaning system installed on the drying process.

3.5. Reduction of harmful waste

As a result of vibratory mass finishing process a waste like a mud was occurred consist of chemical oils, metal and stone particles. In the current system according to the waste regulations solid waste separates from the chemical liquid. And then water and chemical oil separate from each other and can be used again in the system. However, this is a very difficult process and it is not applied according with the regulations by many manufacturers. In particular, it is quite troublesome to separate very small dust particles from chemical oil and water. In our improved system the stones with small sizes which lost the ability to process were taken out from the system by the addition the pre-sieve system as given in Fig. 6. In this way, the amount of mud formed in a bench was reduced by 20%.

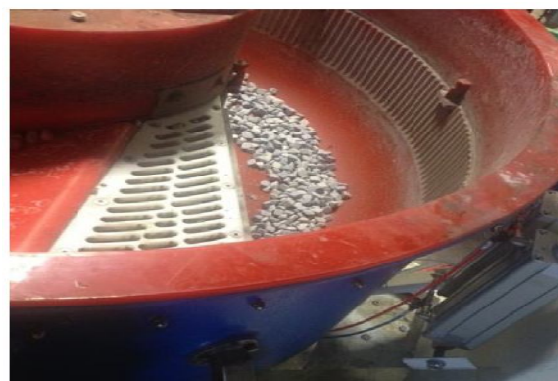


Fig. 6. The pre-sieve system.

IV. RESULTS AND DISCUSSION

In this study it is aimed to improve the production process of the vibratory mass finishing system used in the surface treatment of metal parts. Production efficiency, environmental pollution, occupational

health and safety are the basics of our performed improvements. Besides by providing the control of the system the production rate was increased. In this study the improvements done on vibratory mass finishing process system provide a base to apply more efficient production system for sustainability and quality product.

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