

Auto Washing Mechanism of Heat Treated Blanks

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Abstract— Heat treatment and surface modification techniques are utilized to optimize physical, chemical and mechanical properties of metals. Heat treatment involves use of heating and cooling to achieve desired result such as hardening, softening etc. After heat treatment black quenching oil deposits, thin layer of scale, discoloration were observed on surface that need to be removed. These heat treated parts needs to be cleaned thoroughly. After scale removal the part can be polished back to its original surface finish. Part cleaning is necessary to many industrial processes, as important to Surface finishing or to protect sensitive components. Cleaning is defined as the application of time, temperature, chemistry and energy to remove contamination from the surface of a part to a level appropriate for the intended application. In other words, cleaning is simply moving contaminants from where they are not wanted (on the parts) to where they should be (in the waste disposal system). The cleaning process is embedded into the production chain and needs to be carefully balanced for an optimum result with respect to overall process cost as well as environmental, safety and health aspects. This paper presents the concept of heat treatment and formation of scale after heat treatment, the various principals to remove that scale effectively and concentrates on formation of scale on different types of metals and ways to avoid it or remove it.

Key words: Heat Treated Blanks, hardening, chemistry

I. INTRODUCTION

The demand for heat treated goods to have the highest quality continues to increase; not only optimum mechanical and dimensional properties, but also meeting increasingly stringent visual appearance specifications. Thus parts cleaners are used in nearly all industrial plants that perform metal working operations, because almost all “soils” left of processed parts need to be removed to some been used for decades to meet cleaning needs in the manufacturing environment, and they are extent. Parts washing can be performed by detergency, solvency, chemical reaction, or mechanical action, and typically uses large quantities of water and one or more of the following:

Organic solvents, the most widely used type of cleaners, are used primarily for removing organic or oil-based contaminants.

Acid cleaners such as sulfuric, nitric, and hydrochloric acids are used to remove oxidation scale and rust from metal surfaces [1].

Alkaline cleaners are aqueous solutions of inorganic salts often used in heated soak tanks to remove heavy, oily scales and some solid scales.

Caustic solutions are often employed as a paint-stripping agent.

Abrasives are designed to remove rust, oxides, and burrs to create a smooth surface. Common abrasives are sand,

aluminum oxide, or silicon carbide mixed with an oil-or water-based binder.

II. LITERATURE SURVEY

A. Evaluation of Automatic Aqueous Parts Washers by Michelle J. Hanson, et.al (1997):

Authors said that solvents have been used to clean oil, sand, greases, soils, inorganic salts and foreign particles from manufactured materials or parts. However, increased awareness of the health, safety and environmental issues surrounding the use and disposal of solvents has enriched the research for alternatives. Many parts cleaning methods using petroleum based solvents can be done easily with aqueous cleaning. This research evaluated automatic aqueous parts washers, sometimes called “jet washers”. The study found that users are generally satisfied with the performance of the washers and that the washers are relatively low maintenance. Recommendations were made to optimize the use of automatic aqueous parts washers. When combined with spray nozzles and hot water, aqueous cleaning solutions provide more efficiency. It is found that most users were satisfied with the automatic parts washer cleaning capability. Some pre-cleaning may be required if the parts are extremely dirty. According to his survey users must consider the types of parts to be cleaned in any application before deciding on a solvent substitution.

Automatic aqueous parts washers produce little corrosion and seldom damage parts, but if the parts to be clean have sensitive seals or are made of metals that will etch or pit easily, another alternative should be chosen. Author concluded his review with proficiency of automatic part washing system along with aqueous cleaning [1].

B. Cleaning of Fasteners Before & After Heat Treating by Daniel H. Herring, Richard D. Sisson, Jr. George F. Fuller (2010):

Mr. Herring et.al investigated about aqueous and solvent cleaning processes which can be made to clean almost any parts requiring subsequent heat treatment, so the choice between them will most often be made by factors that expected part cleanliness. The focus is on improving physical action (force and volume) in combination with a chemistry choice balanced for the type of cleaning required. They also stated that cleaning time depends to a large extent on the system and the parts for tools there is an additional need for tumbling i.e. movement of the parts to help the cleaning solution breakdown any coating residue soap or oily films or dirt present on the tools. Forced air convection drying is also considered necessary for most tools products to ensure that all surfaces are clean [2].

They also stated, about various cleaning tips and safety measures taken during cleaning of metal parts. He also included briefly in his research about number of tests to measure whether the parts are cleaned effectively or not.

These tests may include visual inspection, macroscopic (5X to 50X) inspection, "white glove" inspection, observation under ultraviolet (black) light, tape sampling, "water break" tests, surface tension test fluids, the Nord test method and gravimetric methods.

C. Cleaning for Heat Treatment by D. Scott MacKenzie, Mark Fretz, Don Schuster (2009):

Authors stated that part surface cleanliness is becoming a critical consideration for heat treatment as design requirements and service applications become more demanding. The automotive, aerospace, and consumer products industries are leading in requirements for the highest quality in terms of surface cleanliness.

It is important that the washer system be properly monitored to achieve the desired cleaning. A disciplined approach to washer and cleaner maintenance is critical if quality cleaning is to be achieved. This can include daily, by shift and weekly. This is in addition to the routine preventative maintenance done on the quenching system and quench oil. If a plan uses coolants, drawing compounds, rust preventatives or heat treating oils, then it will likely have a strong requirement for cleaning [3].

This part addresses the methods of cleaning. Washer capability and capacity should be understood in terms of the types of scales it is capable of removing. He also described briefly about various cleaners like Detergent Cleaners, Synthetic Cleaners, Acid Cleaners, Solvent Emulsion Cleaners, tumble-type washer for small part, spray washer with parts conveyor and fume hood, soak tank type washer with vertical motion of parts for agitation.

Investigators briefs about the factors which need to consider while selecting cleaning method for particular application, they may include concentration, temperature required for cleaning, agitation, water hardness etc.

D. Gajen P. Dubal, Heatbath / Park Metallurgical Corp., "Salt Bath Quenching", Advanced Material and Processes, (1999):

Researcher gives an overview about salt quenching system including its safety and environmental consideration. In quenching, part is cooled from austenitic temperature fast enough to avoid pearlite nose of TTT diagram and to transform austenite into martensite to maximum extent possible. In conventional quenching, water, brine, polymer solution is used as quenching media. Generally steel with low hardenability can be quenched by conventional quenching. But this method causes distortion, non uniform hardness, cracking etc.

Quenching temp will be much higher in range of 170-400C (350-700F). Water, brine and other quenching media cannot be used at this temperature. Meanwhile the molten salt can be the choice for high temperature quenching. Salt having many advantages as compared to other quenching media. These may include Quench severity to greater degree, higher productivity, excellent thermal and chemical stability, and non-flammability, easy washing, and reduced operating cost. Though quenching salt is non flammable and nontoxic, concern for personnel safety arises due to the temperature at which it is used. After quenching parts are immersed in agitated hot water bath where most of salt is dissolved and then rinsed in hot water spray [4].

Mr. Dubal concluded his paper with different merits and demerits of salt bath quenching and its future scope along with various materials.

E. Gordon Turner-Walker, "Nature of cleaning physical and chemical aspect of removing dirt, stain and corrosion", National Yunlin University of Science and Technology, (2012):

According to Mr. Gordon, Dirt is a part of earth's surface consisting of disintegrated rock. "Dirt" may be classified into three broad categories – soiling; staining and corrosion. The cleaning method is usually determined by the type of dirt but can be again roughly divided into four categories–mechanical cleaning, wet cleaning, chemical cleaning and chemical modification of the altered (corroded) surface. In this paper the different kinds of dirt and various alternative cleaning strategies are described and illustrated by case histories involving ceramics, metals artifacts and historic bones [5]. Gordon explains briefly about various cleaning methods like mechanical cleaning, solvent cleaning ammonia cleaning, sand blasting, and air abrasion. Mechanical cleaning includes several processes like air movement, brushing, peeling, polishing, scraping, cutting, abrading, thermal shock, impact etc.

Author illustrated three different case studies involving three very different classes of materials, metals, ceramics and bone and all three are drawn from the author's personal professional experience. He concluded his paper that, to be considered a successful method any cleaning regime must satisfy several requirements – it must be cheap, simple, not damage the future integrity of the object, require the minimum of expensive equipment, and pose minimal hazard to the environment and to the health of the conservators using it.

F. John Sparks, "The basics of Alkaline in Process Cleaning for metal substrate", Oakite Products Inc.:

Author mainly explained about alkaline cleaners, but includes solvents and acids also. Iron phosphate products, which make up the bulk of the acid cleaners, will not be covered. The objective is to acquaint us with metal cleaners, the differences between them, what to look for, and how to choose a cleaner.

Mr. Sparks stated the various principles of cleaning. In his words, regardless of the type or category, all cleaners remove soils by one or more of the following principles:

Solvent Action - This enables the cleaner to dissolve the oils present on the metal surface.

Saponification - In this highly alkaline process, drawing compounds (lard oils, fatty acids) are chemically converted into soap and rendered water-soluble.

Detergency - Surface active wetting agents reduce the interfacial tension of surface oils, enabling cleaning solutions to better penetrate and displace soils from the metal surface being cleaned.

Emulsification - The suspension of oil particles in an aqueous phase permits them to be rinsed away easily.

Deflocculation - In this process, the soil is converted into very fine particles and is suspended in the cleaning [6].

G. Article: AICHELIN cleaning equipment:

This plant is used for cleaning a wide spectrum of parts both before and after heat treatment. The essential components include an isolated container for two cleaning agents, a

spraying chamber with a rotating spraying system positioned above, sink/swinging platform, heating for submerged and spraying agents, level control and an oil separation unit. The charge to be cleaned is dipped into the cleaning fluid (medium 1). The oscillating movement serves to intensify the cleaning process after the programmable oscillating time has elapsed; the charge is lifted into the spraying chamber and the cleaning residues that are stuck to it are removed by means of rotating spraying jets containing the second cleaning agent. A separation system serves to effectively prevent mixing of the agents.

After spraying and draining, the charge is dried by means of a vapour vent condenser [7]. The warm, moist air is sucked out of the chamber and the water dissipated. The air is subsequently reheated and blows non to the charge by means of a diffuser. The container filling levels are monitored by means of Level sensors and, where necessary, refilled with fresh water. These patented units are used especially where highest level so if purity is required and/ or geometrically complex components are to be cleaned. The essential components include a vacuum tight cleaning chamber, isolated tanks. For two (optionally three) cleaning agents, vacuum pump, spray pump and heating for each agent and an oil separation unit [7].

H. A Designer's Handbook Series-9001, "Cleaning and Descaling Stainless steel", By American Iron And Steel Institute:

This handbook includes descaling of stainless steel, acid pickling, caustic descaling, and sand blasting. Also the various cleaning processes and their effective working. This publication will describe various practices for cleaning stainless steel before, during and after fabrication. This includes methods for removing oxides scale resulting from hot forming or machining operations.

This handbook identifies several commercially available cleaning products from plain water to more effective detergents and solvents.

Future investigations to improve the present methods of cleaning and descaling stainless steel will be directed towards minimizing acid consumption and disposal problems. This can be accomplished by increased use of electrical energy to cleaning system. Electrolyte acid pickling can also reduce the concentration of acids required and metal attack [8].

I. Dr-Ing. N. V. Mandich, CEF, AESF Fellow, "Surface Preparation of Metals Prior to Plating", HBM Electrochemical & Engineering Co. (2002), pp761-828:

Author investigates about definition of the clean surface, influence of base metal and the choice of cleaning methods. Soak, spray, electrolytic, acid, solvent and ultrasonic cleaning are elaborated as well as acid dip and pickling steps. Metal cleaning is usually accomplished by six general methods of handling the work in relation to the cleaning media, namely: (a) soak tank, (b) electro cleaning tank, (c) spray washer, (d) solvent vapor degreaser (e) steam gun, and (f) abrasion with grit, shot blast or tumbling.

According to Mr. Mandich, Cleaning is loosely defined as the process of removing unwanted contaminants or dirt from a surface. A practical definition of word clean is "containing no contaminants that would interfere with satisfactory deposition of one adhering finish" [9].

Mr. Mandich stated different cleaning schemes widely adopted in industries likely, soak cleaning, electrolytic cleaning, spray cleaning, ultrasonic cleaning, solvent cleaning, vapor degreasing, emulsion cleaning, acid cleaning, acid dipping, activation and pickling etc.

In actual practice, the cleaning process is in most cases, actually controlled by combination of visual water break and white glove tests plus solution analysis [9].

Author also briefs about troubleshooting of cleaning operations along with its portable cause and remedy to overcome that cause. With the objective of the cleaning operation clearly defined, one should be able to choose the system or variation thereof that best suits the requirement. He concluded his paper with, successfully operated cleaning process requires careful audit and selection of proper chemistry as well the proper equipment that facilitates and augment the effects of the chemistry.

J. Cleaning Concepts for Tools, Article by DURR, (2015):

Increasing cleanliness requirements and consistent cleaning results are common demands for the production of tools. Durr Eco clean and UCM offer optimized solutions ranging from cleaning during processing to final cleaning before PVD/CVD coating. With its wide range of cleaning equipment ranging from aqueous to solvent-based, single-stage to multi-stage systems, the Durr Eco clean Group always offers the best solution for all cleaning processes in the production chain [10].

They have stated various cleaning methods for different tooling types. The Durr Eco clean range of cleaning equipment provides systems for virtually all types of cleaning tasks in industrial production for parts made of metal, Plastic and glass; from pre-cleaning via intermediate cleaning to fine and ultra fine cleaning requirements, including clean room applications.

III. CONCLUSION

Washing of cutting tools is very important in industries. There are many machines available for washing in market but some of these have some disadvantages like high cost, high power, complex design and difficult to maintain. The details above illustrates how extremely complex this specific field is. Already small changes in the requirements can necessitate completely different processes. On the other hand, it becomes more and more important to receive the required degree of cleanliness as cost-effective as possible and with continuously minimized health and environmental risks, because cleaning has become of central importance for the supply chain in manufacturing. In industry, chemical solvents were typically used to remove oils; grease and dirt during the cleaning process, but recent environmental concerns and regulations have encouraged the innovation of natural, non-chemically based detergents. It is customary to discuss and confer the cleaning cycles in considerable detail [9]. This means describing the ideal, or near ideal cleaning cycle, which if followed studiously, will result in the production of excellent plated products, providing that the cleaning and plating baths are also in ideal conditions.

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