Journal of Basic and Applied Engineering Research
p-ISSN: 2350-0077; e-ISSN: 2350-0255; Volume 4, Issue 7; October-December, 2017, pp. 551-554

http://www.krishisanskriti.org/Publication.html

A Literature review on the Development of Tube's Inner Surface Polishing

Mohammadabrar Shaikh[1], Patel Utkarsh K[2], Manan Singh Patial[3], Sumant Mandar M.[4] and Patel Anshul M[5]

[1,2,3,5]Student, Babaria Institute of Technology
[4]Babaria Institute of Technology
E-mail: [1]sabrar160@gmail.com, [2]utkarshpatel1234@gmail.com, [3]manan.oct10@gmail.com, [4]mandarsumant.me@bitseducampus.ac.in, [5]anshul29patel@gmail.com

Abstract—*The required finish/texture is one of the prime requirements in various, finished components after conventional machining, processes like grinding, lapping, polishing and super finishing processes. Industries are spending very huge amount of money to get the required finish and surface roughness after the components being machined. This will calls for advanced non-conventional finishing processes. Abrasive Flow Machining (AFM) is one of the non-conventional finishing processes in which a semi-solid medium consisting of an elastic polymer and abrasive particles mixed in a definite proportion. This media is extruded under pressure through the surface to get the required finish. In this article an attempt has been made to review various published technical papers on AFM and the power for the experimental setup which is given by the hydraulic fluid. The review paper is about the abrasive flow finishing process and its advantages from the different research papers.*

1. INTRODUCTION

In this section presently used technology is mentioned which is hugely used in the industries for surface finishing purpose. Finished surface does not require in some industries but the surface finish component also improved the lifetime of the component in some extends. Sand blasting process is the widely used process for the surface finishing in the industries. In the sand blasting process sand particles are used for the surface finishing, In many cases the sand particles after striking the component surface break down and turnout into dust and pollute the surrounding by dust. It is harmful for the workers. And the surface finish achieved by the sand blasting machine is not that level so we can call it polished surface because the polish surface roughness value is around 0.02 micron but the surface roughness achieve by the sand blasting process is around 2.5 microns. Abrasives are ability to give the polish surface with roughness value of the 0.02 micron. So, the abrasive flow finishing process is able to give the wide range of the roughness value compare to sand blasting machine. Below is the technology used in industry is mention in detailed,In the field of finishing process many types of operation included like a grinding, honing, polishing, cleaning etc. For the all above operation different kinds of machines are developed. For tube inner wall polishing purpose sand blasting machines are widely used in industries. Sand blasting machines are passes through many design changes in time of interval by changing its components and the arrangement of components. In sand blasting machine mainly sand are used as an abrasive medium for polishing process. But many time rather than sand materials are also use for sand blasting process such as sand, glass, slag, metallic shot or grit, synthetic materials, or other. In sand blasting machine when sand is used as an abrasive blasting where reclaiming is not feasible, like in unconfined sand blasting operations. Sand has a rather high breakdown rate, which can result in substantial dust generation. Worker exposure to free crystalline silica is of concern when silica sand is used for abrasive blasting. This method typically include three basic components an abrasive container, a propelling device, and an abrasive blasting nozzle or nozzles. There are much auxiliary equipment for this machine which is used depends on the application. For the sand blasting operation three propelling methods are used in sand blasting system centrifugal wheel, air pressure and water pressure. Centrifugal wheel system use centrifugal and inertial forces to mechanically propel the abrasive media. Air blast method use compressed air to propel the abrasive to the surface which is to be finished. And lastly, the water blast method uses either compressed air or high pressure water for finishing of the surface.

In compressed air suction systems, two rubber hoses are connected to a blasting gun. One hose is connected to the compressed-air supply and the other is connected to the bottom of the abrasive supply tank or "pot." The gun (Figure 1) consists of an air nozzle that discharges into a larger nozzle. The high velocity air jet (expanding into the larger nozzle) creates a partial vacuum in the chamber. This vacuum draws the abrasive into the outer nozzle and expels it through the discharge opening.

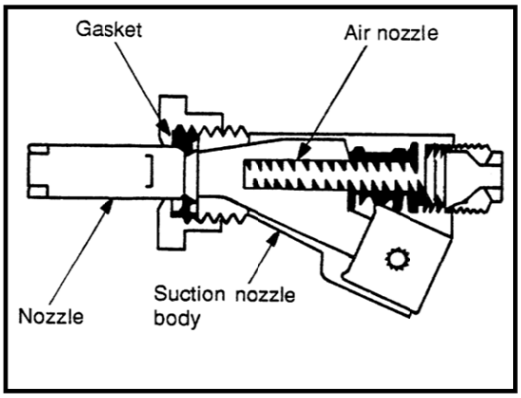

Figure 1 Sand blasting machine nozzle

The compressed air pressure system consists of a pressure tank (pot) in which the abrasive is contained. The use of a pressure tank forces abrasive through the blast hose rather than siphoning it as described above. The compressed air line is connected to both the top and bottom of the pressure tank. This allows the abrasive to flow by gravity into the discharge hose without loss of pressure (see Figure 3).Below Fig is for the compressed sand blasting machine

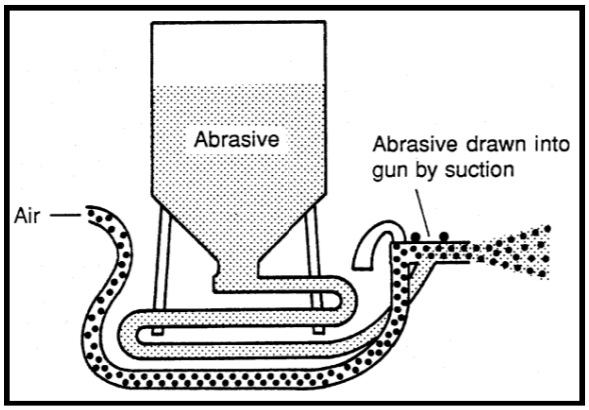

Figure 2 Compressed sand blasting machine

Below figure for the compressed air pressure sand blasting machine

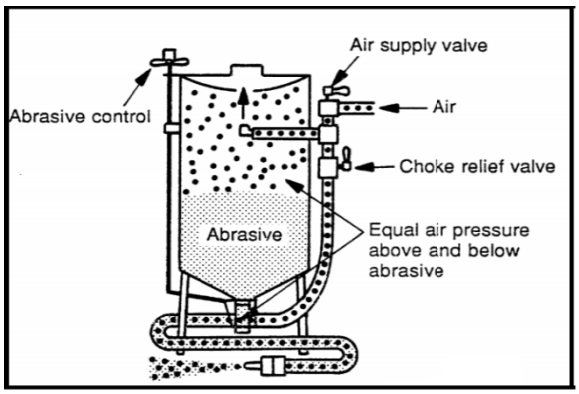

Figure 3 Compressed air sand blasting machine

At last, wet abrasive blasting systems (Figure 4) use a specially designed pressure tank. The mixture of abrasive and water is propelled by compressed air. An alternate method uses a pressure tank and a modified abrasive blasting nozzle.

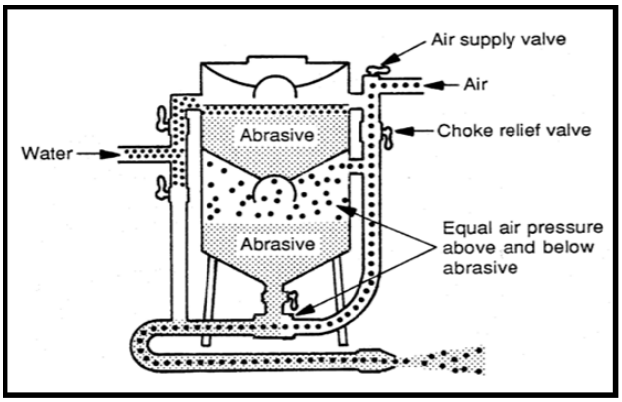

Figure 4 Wet sand blasting machine

1.1 Recent Trend

In recent manufacturing is use this sand blasting for finishing the surface, as we know it does not offer best surface finish for that many industries use the abrasive flow finishing process which is able to give up to 0.1 micron roughness value which is not possible in the sand blasting machine. Presently in India small size abrasive finishing machines are imported but it does not offer the wide range for size of the work pieces. They are very compact in the size consider as a box.

2. LITERATURE REVIEW

A Review on Abrasive Flow Machining, Author: - Santosh Kumar S & Somashekhar Hiremath, Year: - 2016, Problem identification: - Requirement of high surface finish/texture, Method used: - Abrasive flow machining, Result: - With the help of semi-solid medium consisting of viscous-elastic polymer reinforced with abrasive particles are extruded under high pressure through the surface which is to be polished/finished. The slurry helps attain the required finish via AFM [1]

Development of Cleaning Device for In-pipe Robot Application, Author: - Ana Sakura, Muhammad Farhan Amin, Mohamad Muaz Sadini, Year: - 2015, Problem identification: - Cleaning/maintenance of pipe's inner surface, Method used: - Pipe crawler robot, Hydro jetting, Power rodding, Result: - With the help pipe crawler robot pipes with larger lengths can also be cleaned without the need of rods with the same length as the pipe. The crawler crawls into the pipe in which hydro jetting action takes place at high pressure which removes all the clogging & dirt from the inner surface of the pipes. For removing grease and oily material power rodding will be used [2]

A pragmatic modelling approach in Abrasive Flow Machining for complex shaped automotive components,Author: - E. Uhlmann, V .Mihtovic, S. Robkamp, Year: - 2016, Problem identification: - Inner surface finishing using AFM for complex automotive parts., Method used: - Abrasive flow machining, Result: - The complex parts of automobiles, which require inner polishing can't be polished with existing processes as the components are too small or they have a complex shape which is harder to deal with. In this case Abrasive flow machining is used for inner surface polishing of automobile parts of any shape and size [3].

Technical Advances in Super Fine Finishing, Author: - Anthony Beaucamp & Chubu Namba, Year: - 2014, Problem identification: - Ultra-precise/super fine finishing (Review), Method used: -Super-stiff Ultra-precision Grinding, Electrolytic In-Process Dressing, Shape Adaptive Grinding, Float Polishing, Fluid Jet Polishing, Elastic Emission Machining, Continuously Pressed Polishing, Magneto-Rheological Fluid Finishing, Magnetic field assisted finishing., Result: - With the help of above mentioned process ultra-fine surface finish of the following order is achieved (RMS values): -i) Super-stiff Ultra-precision Grinding<0.1mm, ii) Fluid Jet Polishing <0.1mm, iii) Electrolytic In-Process Dressing<0.5mm, iv) Elastic Emission Machining<0.2mm, v) Shape Adaptive Grinding<0.5mm, vi) Continuously Pressed Polishing<0.3mm, vii) Float Polishing<0.5mm, viii) Magneto-Rheological Fluid Finishing<0.5mm [4]

Enhancement of the Performance of Hydraulic Power Pack by Increasing Heat dissipation, Author: - M.L.R Chaitanya Lahari, Dr B. Srinivasa Reddy, Year: - 2014, Problem identification: - Cooling of hydraulic system., Method used: - Changing the material, Result: - The total heat transfer rate has been improved by changing the material of the tank from Mild steel to Aluminum for the power pack and the simulation can be done even when the power pack of greater capacity is used. The limitation of the work is that the pressure bearing capacity is more for Mild Steel where the same is less for Aluminum [5]

Design and Performance Evaluation of Abrasive Flow Finishing, Process during Finishing of Stainless Steel Tubes, Author: - Sachin Singh, M.Ravi Sankar, Year: - 2015, Problem identification: - To measure surface roughness of the tube after abrasive flow finishing Method used: - Abrasive flow machining for stainless steel, Result: - Here finishing of stainless steel is done with the help of AFM. Stainless steel is used as these pipes are less prone to rusting and corrosion. Hence they require less maintenance [6]

Design of a Miniature Hydraulic Power Unit, Author: - Ryan D. Bruneau, Year: - 2015, Problem identification: - Requirement of Compact/Miniature hydraulic system., Method used: - N/A, Result: - The proposed miniature hydraulic power unit design meets all of the stated requirements of Parker-Hannifin as well as those of hydraulic systems in general. Finite element analysis has been used to verify that the design will maintain its structural stability over the products life, and stress relaxation calculations confirm that the unit will be leak-proof. The proposed design is 20% shorter and should provide a significant cost savings over the PVTM series. The lower production costs, reduced length, and the use of a transparent reservoir should enhance the overall marketability of the design [7]

Polishing of mould steel, Author: - Jake Paul, Year: - 2014, Problem identification: - Polishing of steel. Method used: - i)Conventional Process, ii)Electro slag Remitting Process, iii)Powder Metallurgy Process, Result: - Material removal in hardened steels is more consistent and repeatable. when diamond products are used. Precision hand tools incorporating linear movement of the working tools, grinding files and polishing stones, give a less troublesome preparation process. A good practice is to work perpendicular to the grooves in all preparation steps and to verify with optical examination that all scratches from the previous step have been completely removed. Note, that heavy cold worked material beneath the surface needs to be removed for a perfect end result [8]

Latest Trends in Abrasive Flow Machining Process, Author: Karamjit Singh Dayal, Som Kumar, Balraj Singh Brar, Year: - 2017, Problem identification: - N/A., Method used: - i) One-way AFM ii) Two-way AFM iii) Orbital AFM, Result: - In AFM process, an abrasive laden media (semi solid) is used for brading the internal and external surfaces. Abrasive laden media extrudes under pre-define pressure across the surface, which is to be finished with help of hydraulic actuators. Due to mechanical impact of abrasive particles on the work-pieces surface, the material is abraded from the surface. The recent work represented here is an overview of developments of AFM and future research directions. AFM is mostly used to finish complex shapes for better surface finish and tight tolerances. But the main drawback of this process is low finishing rate. So the continuous efforts are being made to increase finishing rate and to improve MRR. Different researchers have proposed various types of AFM machines abbreviated as MAAFM, UFP, DBG-AFF, HLXAFM, ECA2FM and MRAFF etc. So, this process is successfully applied to finish the surface finish and MRR for externally as well as internally simultaneously. There is a further more scope of improvement in the field of AFM [9]

Magnetic Abrasive Finishing- A Review, Author: - Harish Kumar, Sehijpal Singh, Pardeep Kumar, Year: - 2013, Problem identification: - Surface finishing, Method used: - Magnetic Abrasive Finishing, Result: - (1)Magnetic abrasive finishing process can be used for surface finishing as well as surface modification of hard to finish surfaces such as brass, stainless steel, etc. (2) Magnetic abrasive finishing can be successfully used for finishing of internal as well as external

surfaces of complicated design (3) In magnetic abrasive finishing process, magnetic force is affected by the material, shape and size of work, and shape and size of magnetic pole, work-pole gap distance, and composition of magnetic abrasives Magnetic abrasive finishing with permanent magnetic has been proved as good finishing process for many engineering applications by decreasing surface roughness to a considerable extent. (4) Magnetic abrasive finishing with direct current has been used successfully for surface finishing as well as surface modification of external and internal surface and has given very good results. (5) Magnetic abrasive finishing with alternating current is not a common practice as it is difficult to maintain and control the alternating magnetic field to finish the surfaces. But still, it has been used for finishing and modification of surfaces [10].

2.1 Conclusion of Literature Review

After studying the journal and research papers we can conclude that the abrasive flow finishing process is the better option for the surface polishing over the sand blasting process presently use in industries. Abrasive particles are reused for the process but the sand is not used again and again because it breaks down during the process. So it is seen that the abrasive flow finishing process is quite cost effective in running cost. For a complicated interior components and the curve pipes it is complicated to give surface finishing with the help of sand blasting process, because as the sand is thrown from nozzle it strikes on the other side of the component and it losses the kinetic velocity and fall down. So, we design a setup which works on the abrasive flow finishing on small scale which is powered by the hydraulic system. The schematic diagram is as below,

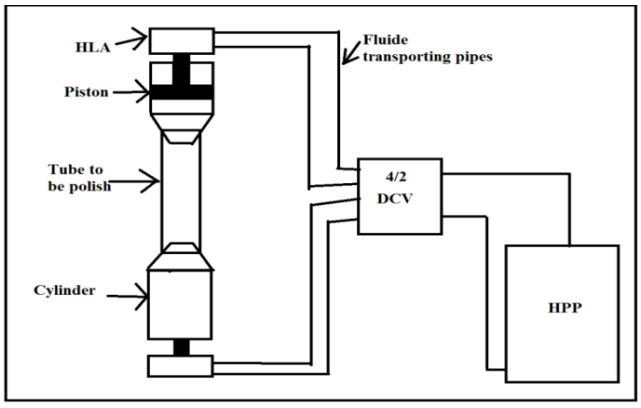

Figure 5 Schematicdiagrams for the experimental setup

3. FUTURE SCOPE

The designed setup by us is for the straight pipes. So if we want to give surface finish to some complicated materials than by some modification in the setup it is possible to give surface finish to that material. The setup we made is vertical because we are showing small length pipe for demonstration purpose for the large pipe vertical fixture is not possible so the fixture is turn out to horizontal with the support to pipe. For the development of the machine for the industries it is possible by enlarging the size of the setup.

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