Development of Dryer for Anodized Aluminium Section

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Abstract— In a world of fully automation in every sector, time conscious research activities have become relevant for all industrial applications. Drying as an energy intensive process, is one example when conventional air drying is replaced by superheated steam (SHS) drying with the help of boiler. This work represents novel arrangement which reduces the time taken for manual drying process, by the use of automatic drying system. The analysis is applied to a aluminium anodizing industry which currently uses manual drying process. The drying of the sections is done in an isolated tank, which is given two inlets from opposite side of the tank. The part of steam is passed through the pipes, which are connected to the inlet of tank. The door of the tank opens and the sections are placed in the tank, with the help of cranes. After placing of the sections, the door is closed and the supply of the steam is given to the tank with the help of boiler. After the sections are dried the door gets opened and the sections are lifted by the cranes. To obtain effective output, we have performed trial and error method for various pipe designs. At first we decided to design the pipe in series, but the results obtained were: the velocity obtained was negative at the outlet and the pressure was below atmospheric pressure. This pressure and velocity obtained were not effective. So we decided to design the pipes in parallel. As compared to the series combination of pipes, the result for the pipes connected in parallel was much more effective. The pressure and velocity obtained in the parallel design were sufficient to dry the sections. In this way we will be saving the time and there will be automation in the industry.

Key words: Dryer, Anodized Aluminium Section

I. Introduction

Anodizing is a process in which the part to be treated forms the anode electrode of an electrical circuit. Anodizing increases resistance to corrosion and wear and provides better adhesion for paint primers and glues than bare metal does. Anodic films can also be used for a number of cosmetic effects, either with thick porous coatings that can absorb dyes or with thin transparent coatings that add interference effects to reflected light.

Anodizing is also used to prevent galling of threaded components and to make dielectric films for electrolytic capacitors. Anodic films are most commonly applied to protect aluminium alloys, although processes also exist for titanium, zinc, magnesium, niobium, zirconium, hafnium, and tantalum. Iron or carbon steel metal exfoliates when oxidized under neutral or alkaline micro electrolytic conditions; i.e., the iron oxide (actually ferric hydroxide or hydrated iron oxide, also known as rust) forms by anoxic anodic pits and large cathodic surface, these pits concentrate anions such as sulphate and chloride accelerating the underlying metal to corrosion. Carbon flakes or nodules in iron or steel with high carbon content (high-carbon steel, cast iron) may cause an electrolytic potential and interfere with coating or plating. Ferrous metals are commonly anodized electrolytically in nitric acid or by treatment with red fuming nitric acid to form hard black ferric oxide. This oxide remains conformal even when plated on wire and the wire is bent.

The anodizing is an electrochemical process that converts the metal surface onto a decorative, durable, corrosion-resistant, anodic oxide finish. Although other nonferrous metals, such as magnesium and titanium can be anodized, but aluminium is ideally suited to anodizing. Hence, it's clear that the aluminium sections must be anodized to give it a glossy finish, durability, and corrosion resistance. The various process involved in the aluminium anodizing are- degreasing, rinsing etching (in brine solution), rinsing (for neutralisation), rinsing (to avoid contamination of the previous processes and to get clean surface), anodizing (the oxygen develops at anode and aluminium trioxide layer is formed), rinsing (to remove acids from surface), colouring (if required), rinsing, de-ionised water rinsing, hydration impregnation, drying. These processes take more time to finish, as they are processed in the cuboidal tank. The last process in the anodizing involves drying, which is done manually nowadays in almost all industries. So, our project mostly focuses on atomising the manual drying process, which will in return reduce the time taken for drying as taken earlier and increase the production rate of the sections. This will obviously lead to the profit of the industry.

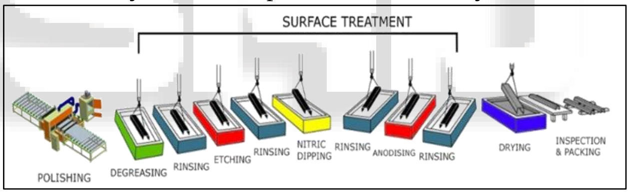


Fig. 1: Anodizing process

The Anodizing process begins by immersing the work in a series of solutions where various operations are performed (described below). The solutions are held in open top tanks and the work passes through each unit. The work usually consists of distinct items that are placed on special racks and carried through the process in batches.

Overhead cranes move the racks from one tank to the next. Superior's facilities have multiple overhead cranes to increase productivity and minimize "down-time." The work is rinsed thoroughly after each operation to avoid contamination and interference in the next solution.

II. Literature review

Sunil Jayant Kulkarni et al. [1] From this research paper he get to know that the type of drying or drying technique adopted depends on the product properties such as heat stability and chemical properties. The sun drying in open space is cheapest but has disadvantages like product contamination, non-uniform product quality and dependence on atmospheric conditions. The transparent enclosure can solve the problem of contamination of product. Fluidized bed drying can be used for granular solids. This has advantage of more uniform contact of air and more uniform temperature distribution. The microwave assisted fluidized bed dryer was very useful for vegetables and fruits. The removal of moisture increases the life of the product and reduces its weight. This aspect reduces the transportation cost. It can be concluded that proper drying of product can reduce transportation cost and makes it more durable.

Ratchaphon Suntivarakorn et al. [2] Improvement of boiler efficiency, the research performed by him, was using the recovery heat for fuel drying and by installing a 5hp blower to recover flue gas from a stack to blow directly on the fuel screw conveyor. The heat recovery for preheating air before entering combustion chamber used a 90-kW heat exchanger and a combustion air control system was installed based on the theory of fuzzy logic control algorithm to control FD fan revolutions. Experiment on heat recovery for fuel drying shows that an average of 3% moisture content was removed, increasing the temperature of fuel at 16 - 18°C higher. However, as he had a blower to recover flue gas heat, the average cost of electricity was 1.73 kWh or the cost of fuel loss instead of electric energy use in a blower of 0.346 kg/hr. In preheating air with flue gas heat before entering combustion chamber, he found the temperature could be raised at 35°C. The average temperature of flue gas leaving the heat exchanger was in the range of 140 - 155°C, which did not result in any condensation from SO2 that can cause damage to the machine. In automatic combustion control by setting the O2 in flue gas at 10%, it was found that the two experiments in 48 hours were able to control flue gas O2 at 10.86% and 11.33% or control errors of 8.6% and13.3%, respectively. After improvement of the boiler with our approach, the fuel drying system, preheating system, and automatic combustion control system were able to increase the boiler efficiency at 0.41, 0.72, and 4.34%, respectively. If the three systems are operated together the boiler efficiency will be increased at 5.15%, an equivalent of fuel saving of 246.88 tons per year.

King Abdulaziz University, Jeddah [3] In this paper he has presented an energy efficient drying system and it is applied to a milk powder producing plant. The system includes feed preheater, feed concentrator, and a SHS dryer with a bottoming MED unit. Energy conservation and mass conservation for various parts of the system are solved over a dryer inlet temperature range of 150±2758C. MVC is used for both the concentration process and for the drying process as well. The dryer operates in an SHS recycle mode with purging of the excess vapour results from the drying process. The purged SHS is compressed in a two-stage compressor with an inter-desuperheater and after- desuperheater. The system is driven by a gas turbine where heat is recovered from the exhaust gases, with the balance of energy being used to drive a conventional MED to produce fresh water. The results of SHS drying are compared with air drying. The feed preheater and concentration evaporator are the same for SHS and air cases with a specific surface area for the preheater and power consumption for the concentration process of 30.4 m2 and 34.5 kW/TP h respectively.

Sami Ajeel et al. [4] For achieving efficient anodizing process on stainless steel type 304, he proposed that electropolishing process should be applied before anodizing and it was observed that the best electropolishing conditions are current density of (0.55 A/cm) 2 at temperature of (95ºC) for time (10min.) which give the best brightness, smoothness. Anodizing process has been achieved successfully for first time locally on 304 stainless steel using an asymmetric power supply under conditions of current densities in positive cycle of (0.1 A/cm2), and negative cycle of (0.03 A/cm2), at temperature of(10ºC), and time of (10 mins.). For anodizing 304 stainless steel, two current density cycles are applied. During the positive cycle, substrate material beneath the oxide film converts to oxide film and sulfides in the film are oxidized to a soluble species. During the negative cycle, trivalent iron is reduced to divalent iron and hydrogen gas is evolved. The negative cycle is specially designed to help remove ferrous oxide in the film since ferrous oxide is much more soluble than ferric oxide in aqueous solutions.

III. Problem Definition

The process carried out in the factory is aluminium anodizing, it includes various processes such as jigging, clamping, anodizing, rinsing and hence drying. After the drying process the material is to be packed and dispatched to the respective customers. The process of drying which is after rinsing the anodized sections is one of the main problem in the industry. The process of drying which is carried out right now is manual i.e. hand dryer is used or at certain times natural drying process is used.

In natural drying process the main disadvantage is that after drying the sections by natural air, some spots of water droplets remain on the section, which affects the look of the section. Hence in natural drying, a labour is to be involved to clean the section by cotton cloth. As the aluminium anodized sections after rinsing comes in direct contact with air, it may get affected by the dirt and dust. After rinsing, the sections contain high amount of moisture content. This may allow direct contact with the chemicals present in the surrounding air, and hence reduces productivity. Climatic conditions affect a lot on the finishing of the product.

IV. Proposed Work

In this project we are going to change the existing drying process, which is involved in the aluminium anodizing process. The existing drying process is done manually, which is mainly time consuming. In order to save the time and efforts of the labours, there is a need to automize the current drying process.

We will also be focusing on the proper surface finish of the anodized aluminium sections. Along with the saving of the time in drying process, it will also lead to the increase in production rate of the industry. Hence forth we are going to manufacture the automatic dryer for the anodizing process.

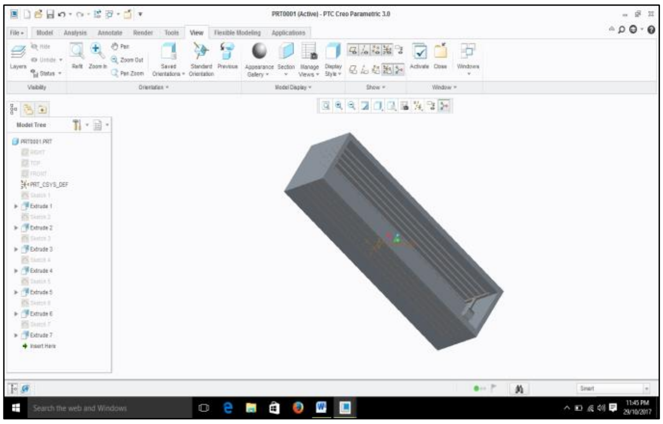


Fig 3.1: Prototype Model of Dryer Tank

A. Why to use fluoride salt cooled high temperature reactor (FHR)? Its typical thermal, pressure and flow conditions

- Fluoride salts are low-volatility fluids
- FHR have high volumetric heat capacity
- They have high melting and boiling temperatures as compared to other reactor coolants
- The high boiling point reduces concerns about coolant boiling
- Atmospheric pressure operation
- High solubility of most fission products in liquid fluoride salts
- Operation temperature (in degree Celsius): 700

B. Different materials being considered for fluoride salt cooled high temparature reactor (FHR)-

- 316L stainless steel (reactor vessel)
- Nuclear graphite (internals)
- SiC-SiC composites (core barrels and internals, control rods)
- C-C composites (core barrels and internals, control rods)
- Mo-Hg-C alloy (Mo very resistant to fluoride corrosion)
- New alloys being developed specifically for high temperature molten fluoride salts corrosion resistance with high creep strength
- These system elements are operated at different temperatures (in degree Celsius) i.e. at 700, 850 and 1000
- From the results it's found that, 316L stainless steel is the most suitable material for the tank.

V. OBJECTIVES

- To reduce the operational time required for the manual drying process which is accomplished by replacing it with automatic drying process.
- Increase the production rate of the industry.
- The reduction in labour work.
- To obtain smooth surface finish and glossy appearance.
- Reutilization of the waste hot steam of boiler, (which is already installed in the industry). It will reduce the expenditure to manufacture dryer to some extent.

VI. METHODOLOGY

Hydration impregnation, the process involved before the drying process has the liquid left over on the aluminium sections. The sections need to be dried before being packed for the sell. Before manufacturing of the dryer, the industry was using more labours for drying of the anodized parts and this process consumed more labour and time, for saving manual work and time we are manufacturing this dryer. It will increase the productivity of the industry. The process involves the re-use of the waste hot steam of the boiler (which is already present in the industry). The supply of the waste steam is given through the pipeline to the tank. The aluminium sections will be inserted into the tank through the electrical crane. The support will be provided in the tank for the sections to be placed. After the sections are placed in the tank, then the tank will be isolated with the help of pneumatic/hydraulic operated doors. As the tank is isolated, then for a particular duration of time, the hot steam will be passed in the isolated tank. After the sections are dried then the pneumatic/hydraulic operated doors will open, and then through the electrically operated crane the sections will be lifted, and further towards the packing of the section.

Fig 6.1: Curved section

Fig 6.2: Square type section

Fig 6.3: Rectangular Section

VII. RESULTS AND DISCUSSION

To obtain effective output, we have performed trial and error method for various pipe designs. At first we decided to design the pipe in series, but the results obtained were: the velocity obtained was negative at the outlet and the pressure was below atmospheric pressure. This pressure and velocity obtained were not effective. So we decided to design the pipes in parallel. As compared to the series combination of pipes, the result for the pipes connected in parallel was much more effective. The pressure and velocity obtained in the parallel design were sufficient to dry the sections.

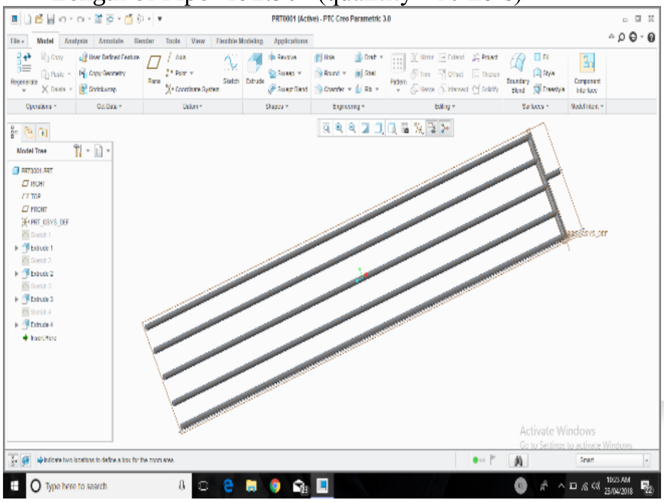
Specification of Pipe:

Material: Copper

Significance: Low frictional losses, excellent heat conductivity, good corrosion resistance, low cost.

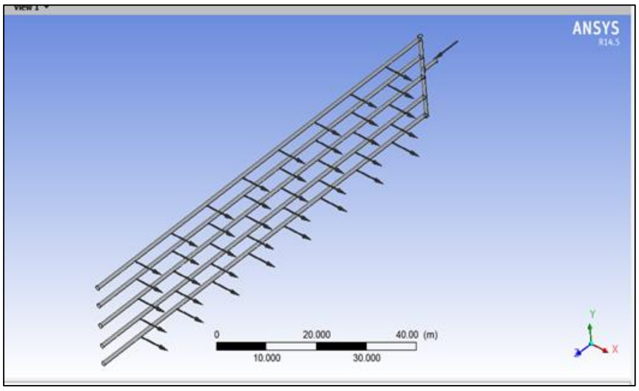
Pipe Dimensions:

- Outside diameter- 1.75”
- Inside diameter -1.5”
- Hole Diameter- 0.236”
- Length of Pipe -152.36” (quantity= 10 no’s)

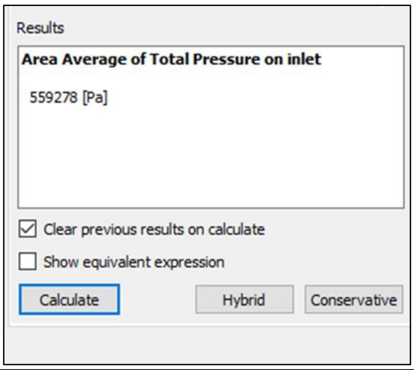


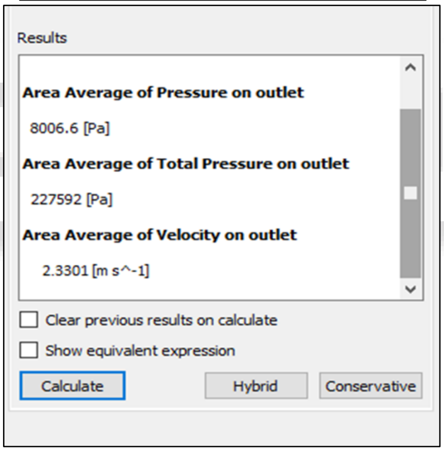
A. *Specification of Steam*

STEAM CHARACTERISTIC	16 Bar, 204.3 C, 12TPH
Molar Mass (kg-k/mol)	18.02
Density (Kg/m3)	8.0044
Specific Heat Capacity (J/KgK)	2903.6
Dynamic Viscosity (Kg/ms)	1.589e-5
Kinetic Viscosity (m^2/s)	1.9857e-6
Thermal Conductivity (W/mK)	0.040404
Inlet Pressure Condition (Pa)	559278

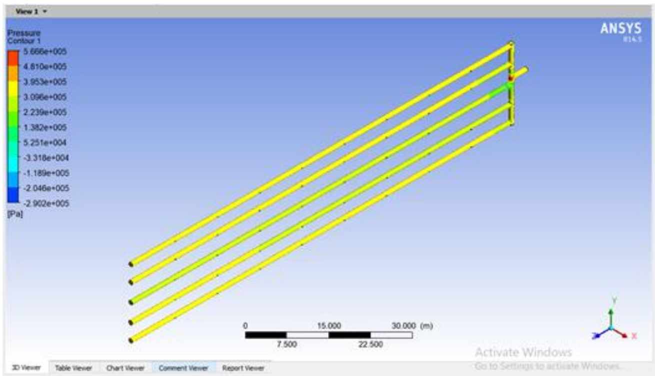


B. *Different parameters at inlet and outlet conditions*





C. *Pressure Contour*



The main objectives were: To atomize the existing manual drying process, time saving, reduction of labour work, drying of complex section. From the above results we have concluded that all the objectives were achieved.

VIII. FUTURE SCOPE

As the current manual drying process is going to be replaced by the automatic drying process, hence it will be useful in various ways, which are listed below:

- Faster production rate of the anodized aluminium sections.
- Smooth surface finish of the anodized sections will be obtained from the automatic drying process.
- Labour work will be reduced.
- Reduction in time consumed by the natural or manual drying process.

Using this new technology, there will be increase in demand of such dryers as these automatic dryers requires very less time to dry the anodized aluminium section. Finish produced after anodizing will be maintained on a high scale, required microns will be achieved. Reduction in labour work enhances the use of technology. Here, as a boiler is also used in the factory, the waste heat can also be used as a working medium for dryer. Hence energy requirement for running these types of dryers will be less. Low maintainece will be required, and hence cost reduction in working of dryer.

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