

Design and Fabrication of Multipurpose Steam Jet Washer

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Abstract: The multi cleaning system uses steam to clean the machine component surfaces, automobile bodies and industrial storage vessels. The commercial detergent washers are compared with the system and it is found that the washing is very convenient and soapy forms are not produced that make the washing very clumsy. The removal of bacteria's formed on the surface of any material would be totally eradicated. The surfaces to be cleaned are given sponge down with a pressurized steam varying from 3 bars to 7 bars by which removal of dirt and stain particles were washed off very effectively. High pressure steam would be generated using the boiler which is in built within the system. The reason behind use of steam for washing purpose is to minimize the quantity of water required and also its availability. The development of steam based cleaning system has revolutionized the process of washing. One can choose an appropriate type of high power steam cleaners for challenging cleaning applications in domestic, office, commercial and industrial applications. The steam does the cleaning that other commercial washing system cannot do. A steam can remove grease and stain without the expensive detergents. Thus the aim of the project is design of multipurpose cleaning machine with a focus on saving the water, eco-friendly and cost reduction.

Key words – Steam, Multipurpose cleaning.

I. INTRODUCTION

Steam can be used for the purpose of cleaning as it is very efficient and effectively helps in cleaning the surfaces. It can be used to clean different type of surfaces such as metallic, non-metallic and even fabric. This cleaning system uses a process that uses high pressurized steam to clean the surface of different materials from stains, dirt and grease. Steam can be used for the primary purpose of cleaning as it has many applications in various different industries for the purpose of cleaning of different components and equipment. It can also be used in health care industry to disinfect and sterilize the equipment by killing all the germs and bacteria. It is more efficient than other methods of cleaning (Chemical wash, Dry wash, Water wash and Detergent cleaning) and has many advantages and applications when compared to these methods of cleaning. It has many benefits it is eco-friendly, Reduces the usage and gives a better surface finish and removes all the dirt easily which is why steam is chosen. The pressurized steam that is generated can be used to clean surfaces that are not reachable and it cleans these surfaces effectively. It has many applications in different industries as well as for day to day life. Vapor Steam Cleaners is a preferred cleaning tool for people with allergies, asthma, and chemical sensitivities to disinfect and sterilize the objects they use. By comparing steam cleaning with the traditional methods of cleaning (Chemical wash, Dry wash, Water wash and Detergent cleaning) it is an easier method as it is simpler, healthier and in the long run the more cost effective choice.

1.2 OBJECTIVES

The objective the project work is to

- Design and fabricate the steam jet washer
- Conduct the performance study of the steam jet washer.
- Save the electricity along with to achieve very efficient cleaning with a better surface finishing.

1.3 STEAM AS CLEANING MEDIA

Steam is the gas formed when water passes from the liquid to the gaseous state. At the molecular level, this is when H₂O molecules manage to break free from the bonds (i.e. hydrogen bonds) keeping them together. In liquid water, H₂O molecules are constantly being joined together and separated. As the water molecules are heated, however, the bonds connecting the molecules start breaking more rapidly than they can form. Eventually, when enough heat is supplied, some molecules will break free. These 'free' molecules form the transparent gas we know as steam, or more specifically dry steam.

Steam is used in a wide range of industries. Common applications for steam are, for example, steam heated processes in plants and factories and steam driven turbines in electric power plants, but the uses of steam in industry extend far beyond this. Also steam jet cleaners are free from the requirement of detergent.

1.3 WHY STEAM IS PREFERRED

The advantages of steam as a cleaning media are discussed as follows

1. Chemical-Free Cleaning

The only ingredient needed to use a steam jet washer is water and heat, cleaning and sanitizing the home has never been more environmentally friendly. It eliminates chemical residues in the house, making it a safer place (especially for children and pets who practically live on the floor), but also helps the environment by reducing the amount of chemicals that get washed down the drain and recycled back into our water supply.

2. Disinfecting the Surfaces

Bacteria, viruses, and mold may not be detectable, but they are potentially some of the most hazardous pathogens that can result in irritations, allergies, and infections. When steam jet washer is used, the tiny hot vapor molecules penetrate the pores of a surface, and as they come in contact with the cool surface of the pores, they expand and force all dirt, debris, and bacteria to the surface. Vapor molecules are so hot that they are not only able to extract pathogens like E. coli and Salmonella from surface pores, but also kill them.

3. Cleaning Compact Surfaces

The steam can be used to clean any area that is out of reach of human hands. With the help of pressurized steam the unreachable surfaces can also be cleaned. When steam is forced onto a surface, the very small vapor molecules penetrate pores in the surface. The vapor molecules quickly and powerfully expand to force out all dirt, grease, detergents, bacteria, and basically any particles that don't naturally belong on the surface. The added bonus is the high temperature of vapor molecules, which kills bacteria and other pathogens like mold, fleas, flea eggs, and dust mites.

II LITERATURE REVIEW

2.1 Efficiency Improvement of Boiler

Sangeeth G.S et al [1] discussed that a boiler is an enclosed vessel that provides a means for combustion heat to be transferred into water until it becomes heated water or steam. The hot water or steam under pressure is then usable for transferring the heat to a process. Water is a useful and cheap medium for transferring heat to a process. When water is boiled into steam its volume increases about 1,600 times, producing a force that is almost as explosive as gunpowder. This causes the boiler to be extremely dangerous equipment that must be treated with utmost care. The overall efficiency and the thermodynamic analysis of boiler. There are many factors, which are influencing the efficiency of the boiler. The fuel used for combustion, type of boiler, varying load, power plant age, heat exchanger fouling they lose efficiency. Much of this loss in efficiency is due to mechanical wear.

2.2 Study on steam pressure characteristics in various types of nozzles

Firman et al [2] discussed that Nozzles are widely used in many industrial applications to provide high speed flow. Flow in a convergent-divergent nozzle is a fundamental fluid phenomenon which affects a lot of applications. Based on the results of experiments by simulations, it was found that various pressures occurred along the nozzles. The characteristic analysis on pressures in every type of nozzle showed different results and this was subject to the difference of geometry. An accurate analysis of steam flow through the nozzles is no easy matter. Often it becomes necessary to use steam tables, an h-s diagram, or a computer program for the properties of steam. A further complication in the expansion of steam through nozzles occurs as the steam expands into the saturation region. As the steam expands in the nozzle, its pressure and temperature drop, and ordinarily one would expect the steam to start condensing when it strikes the saturation line.

2.3 Experimental Study on Helical Coil Heat Exchanger

A. A. Ayare et al [3] discussed that an experimental investigation was carried out to review the overall heat transfer coefficients and effectiveness of shell and helically coiled tube heat exchangers. It is observed that, once cold water mass flow rate is constant and hot water mass flow rate is increased the overall heat transfer constant will increase. The helical tube permits the water to be in contact for larger period of time in order that there is an enhanced heat transfer compared to that of straight tube. It is also observed that hot water mass flow rate greatly affects effectiveness of heat exchanger. The effectiveness of helical coil heat exchanger gradually increases as flow rate of hot water increases. The overall heat transfer of heat exchangers depends on its LMTD.

2.4 Reduction in infection risk through treatment of microbial contaminated surfaces with a novel, portable, saturated steam vapour disinfection system

Benjamin D. Tanner et al [4] discussed that the saturated steam a vapour disinfection system tested for a study is the chemical-free, a broadly active, a rapidly efficacious, and therefore represents novel alternative to the liquid chemical disinfectants. A diverse assortment of pathogenic microorganisms was rapidly killed by the steam disinfection system; all of the pathogens tested were completely inactivated within 5 seconds. Risks of infection from the contaminated surfaces decreased rapidly with increasing periods of treatment by the saturated steam vapor disinfection system. The saturated steam vapor disinfection system tested for this study is chemical-free, broadly active, rapidly efficacious, and therefore represents a novel alternative to liquid chemical disinfectants.

2.5 Effects of physical interventions on house dust mite allergen levels in carpet, bed, and upholstery dust in low-income, urban homes.

Patrick J. Vojta et al [5] discussed that house dust mite allergen exposure is a postulated risk factor for allergic sensitization, asthma development, and asthma morbidity; however, practical and effective methods to mitigate these allergens from low-income, urban home environments remain elusive. The purpose of this study was to assess the feasibility and effectiveness of physical interventions to mitigate house dust mite allergens in this setting. Homes with high levels of house dust mite allergen ($\text{Der f 1} + \text{Der p 1} > \text{or} = 10 \text{ micro/g dust by enzyme-linked immunosorbent assay}$) in the bed, bedroom carpet, and/or upholstered furniture were enrolled in the study. Carpets and upholstered furniture were subjected to a single treatment of either dry steam cleaning plus vacuuming (carpet only) or intensive vacuuming alone. Bed interventions consisted of complete encasement of the mattress, box spring, and pillows plus either weekly professional or in-home laundering of non-encased bedding. Dust samples were collected at baseline and again at 3 days (carpet and upholstery only) and 2, 4, and 8 weeks post treatment. We compared pretreatment mean allergen concentrations and loads to post treatment values and performed between-group analyses after adjusting for differences in the pretreatment means. It was concluded that physical interventions offer practical, effective means of reducing house dust mite allergen levels in low-income, urban home environments.

III DEVELOPMENT OF SYSTEM

3.1 Components of system

Main components used in multipurpose cleaning washer system are boiler drum, heating coil, pressure relief valve, water controlling knob, nipple valve, nozzle, nozzle pipe, control valve, pressure gauge and trolley. The boiler is cylindrical vessel made of mild steel used for producing the steam upon heating the water. The boiler is equipped with electrical coil. The flow of water into boiler drum will be controlled by water closing knob. Once the desired quantity of water is allow to flow in to drum the heating of water starts and once formation of steam begins there will be increase in the pressure. To monitor the rise of pressure the boiler equipped with pressure gauge and also boiler is equipped with pressure relief valve for safety concern. Once the desired pressure reached steam is allowed flow out of the boiler by operating control valve via nozzle pipe and through nozzle to accelerate the steam flow velocity. The whole assembly of system is mounted on a trolley for easy movement of the system. The boiler drum equipped with mountings, electric coil, pressure relief valve, control valve and nozzle are shown in Fig.1, Fig.2, Fig.3, Fig.4 and Fig.5 respectively.



Fig. 1 Boiler drum equipped with mountings



Fig. 2 Electric coil



Fig. 3 Pressure relief valve



Fig. 4 Control Valve



Fig 5 Nozzle

IV. FABRICATION AND OPERATION

A boiler acts as a reservoir for the storage of water and it is the primary component of the system. The cylinder will be used for storing the water that and it will be converted into steam. The boiler drum is made of mild-steel as it is strong enough to withstand the pressure generated by the steam. The heating coil of 2000 watts is made of copper coil of that is mounted at the bottom of the cylinder. The heat generated by the cooper coil is enough to convert the water into pressurized steam. A pressure relief valve is used to release the steam in atmosphere when pressure of steam exceed more than the rated value. A pressure gauge and temperature indicator are mounted at the top of the boiler to measure the pressure and temperature of steam continuously. The nozzle is connected to boiler through hose pipe for the supply of steam. The nozzle is employed for increasing the velocity of steam and sprays the steam on the required surfaced to be cleaned.

The boiler drum is filled with water for a specified level and heater is switched on. As soon the heater is switched on the water temperature stats increasing and water starts boiling leads to formation of steam. Since the 50 percentage of space of the boiler is filled with water and remaining 50 percentage of space will be occupied by steam. Upon heating the pressure of steam go on increasing and as soon the pressure of steam reaches 2 bar the steam is allowed flow out of boiler through nozzle by operating flow control valve. The dry steam with increased velocity coming out of the nozzle will used for cleaning the surface of machine, car, glass etc.

IV. CONCLUSION

By application of steam-based washing system we can save huge amount of water giving high return to environment. Thus, it is a very wide field still to be explored and can be pioneered in saving water and good condition of vehicles can be maintained. Stain free cleaning of the surface, since no cleaning agents are used here thus there won't be any water pollution from this steam car washer. Thus, by using steam for car washing following things can be achieved:

- Chemical free sanitation.
- Eliminate waste water
- Remove dirt, stains and grease.
- Deodorize and sterilize surfaces
- Remove stains from upholstery in less time.
- Clean interiors, exteriors, engine compartments, door jams, floor mate, tire.

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References

- [1] Sangeeth G.S and Praveen Marathur. (2015). Efficiency improvement of boilers. International Research Journal of Engineering and Technology. 2(5).
- [2] Firman and Muhammad Anshar. (2018). Study on steam pressure characteristics in various types of nozzles. The 2nd International Conference on Science. 979.
- [3] A. A. Ayare, S. D. Anjarleka, M. N. Tagare and S. S. Wamane. (2017). Experimental Study on Helical Coil Heat Exchanger. International Journal of Scientific and Research Publications. 7(5).
- [4] Benjamin D. Tanner. (2009). A Literature Review on Reduction in infection risk through treatment of microbially contaminated surfaces with a novel, portable, saturated steam vapour disinfection system. American Journal of Infection Control. 37 (1).
- [5] Patrick J. Vojta, Sandra P. Randels, James Stout, Michael Muilenberg, Harriet A. Burge, Henry Lynn, Herman Mitchell, George T. O'Connor, and Darryl C. Zeldin. (2001). Effects of Physical Interventions on House Dust Mite Allergen Levels in Carpet, Bed, and Upholstery Dust in Low-Income, Urban Homes. Environmental Health Perspectives. 109(8).

