

Design and Fabrication of “Cavitation Water Heater”

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Abstract - Hot water plays a major role in domestic as well as in industries. At present time fossil fuels are widely used for heating water. They yields excessive pollution in the environment as well as leads to depletion of natural resources. To deal with this issue a prototype of liquid cavitation water heater system is designed and fabricated. Also our aim is to develop new way that can overcome problems of conventional heater and provide heated water at much less cost as compare to conventional water heater techniques. Our phenomenon is based on the principle of hydrodynamics and liquid nucleation. There is use of no heat transfer medium i.e. heat is directly transferred to water. Furthermore, there is no scale build up in liquids. The main advantage of this kind of heater is high efficiency, instantaneous & direct heat to liquids and homogenous heating. Also it can be used in industries of food, beverage and dairy for mixing, dispersion & homogenization, emulsification, hydration and aeration.

Key Words: Water Heating, Liquid Cavitation, Liquid-Nucleation, Hydrodynamics, Pressure Reduction

1. INTRODUCTION

Heating of water is done either by use of electricity or by the burning of fossil fuels. The burning of fossil fuels leads to pollution and its depletion for future generation. On the other hand consumption of electricity for heating water is high due to low efficiency of heating system. To overcome these problem electrically operated water heater based on the principle of cavitation can be used. This water heater is having higher efficiency as compared to conventional one because the heat is transferred directly to the water thus eliminating the need of heat transfer medium.

Cavitation is defined as the process of formation of vapor phase of a liquid when it is subjected to reduced pressure at a constant ambient temperature. Thus it is a process of boiling in a liquid as a result of pressure reduction rather than heat addition. However, the basic physical and thermodynamic processes are the same in both cases. [5]

Cavitation as a source of concentrated energy input for the chemical processes is increasingly being studied owing to its ability to generate local high temperatures and pressures at nearly ambient bulk processing conditions. Hydrodynamic cavitation have already been applied to several chemical engineering applications (physical and chemical) like water disinfection, waste treatment,

oxidation of alkaline and emulsification and homogenization.

2. LITERATURE SURVEY

This paper emphasis on design and fabrication details of the externally driven liquid cavitation heating system. The work has been done to assemble the heater units like storage tanks, hose, pipes, valves etc. and to obtain the heat characteristics of the designed heater with respect to water intake temperature and speed of motor and to determine the efficiency of heater and to correlate the results with the convectional heater and determine the cost analysis.[1]

In this paper, cavitation heat pump system is developed to heat water. The four experimental setups and modifications were presented to illustrate the efficiency enhancement potential of the cavitation heat pump system. Throughout the four experimental setups and modifications, the total cost of heating the water by using the cavitation heat pump came out to \$0.92, \$0.40, \$0.42, \$0.39, which is quite close to current energy cost. [6]

The design of pilot-based industrial sample of a rotary-impulse-device for use in a decentralized heating system of buildings and facilities for residential and industrial purpose was proposed. To implement the effective control over the cavitation process during operation of the heat generator, a method was devised based on the measurement of oscillatory energy of the apparatus using a vibration compensation device. The method of control over efficiency of the cavitation process by the measurement of vibrations of the apparatus at various temperatures of the liquid at the outlet was tested in the operating system. Results of the approbation confirm the possibility of using the given control method to evaluate the efficiency of the cavitation process in thermal systems. [2]

On the basis of information on impact of ultrasonic and hydrodynamic cavitation on water in various engineering and agrochemical applications parameters of the frequencies favoring to an intensification of growth of some grades of tomatoes, shanks of decorative roses and saplings of a pine ordinary are defined. The example of the engineering application of operated hydrodynamic cavitation on the basis of the independent generator of warmth for heating is presented. This example was patented and successfully used further for water

structuring in some agrochemical applications. Results of researches of influence of acoustic radiations in the range of frequencies of 20 Hz - 50 kHz and operated hydrodynamic cavitation on growth of some types of plants and data on influence of the specified private range on some physical and chemical properties of irrigation water are presented. It is shown that for a productive drop irrigation of skilled plants the range of ultrasonic radiation in a range close to 20 kHz which leads to increase of concentration of microcells of the metals dissolved in irrigation water is most effective and also influences favorable change of pH of irrigation water. Experimentally an established fact of increase of productivity of tomatoes for 15 % at rather short-term period of watering by the structured water and considerable effect of increase in growth of root system at saplings of decorative roses. Also established an experimentally fact of decrease in an electric conductivity of irrigation water after hydrodynamic cavitation impact on 18-23 %, along with favorable change of pH of water. Some factors influencing an intensification of growth of saplings and development of root system with considerable decrease in pathogenic micro flora are analyzed and revealed. [7]

2.1 Conclusion drawn from literature review

From references of journals it is observed that making use of hydrodynamic principle, process of cavitation can be used to heat water and further to convert into steam with some more arrangements. It increases temperature much quicker with respect to time after few minutes. It make use of less electricity to heat water which may act as a crucial factor in lowering cost of production.

3. GAP OBSERVED

To attain more volume for cavitation design is modified and fabricated.

Also to prevent pitting on the inner surface of casing polyurethane coating is done.

4. COMPONENTS USED AND SPECIFICATIONS

4.1 Induction Motor

For giving drive to rotor, 1-H.P. 2-phase Crompton Induction Motor is used. It can give drive upto 1200 RPM.

4.2 Jaw Type (Love Joy) Coupling

A jaw type coupling is a general purpose power transmission coupling that can also be used in motion control applications. It is designed to transmit torque (by connecting two shafts) while damping system vibrations and accommodating misalignment, which protects other components from damage.



Figure-1: Jaw Type Coupling

Specifications of coupling: -

Material: Cast iron

Max Bore: 50 mm

Max Torque: 256 Nm

4.3 Rotor (With Shaft)

It is the major component of this water heater as the phenomenon of cavitation (due to which temperature of water rises) occurs inside the holes perforated on its surface.

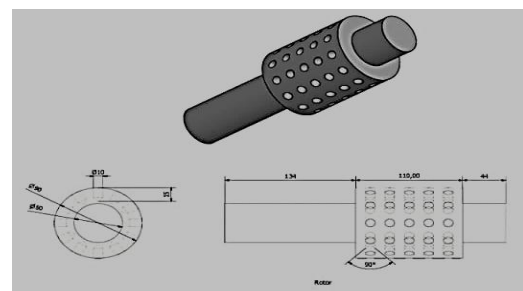


Fig-2: Rotor 3-D, side and front view

Specifications of Rotor: -

Material: Stainless Steel Grade-316

Outer diameter: 90 mm

Inner/Shaft diameter: 50 mm

Length: 110 mm

Length (with shaft): 288 mm

No. of holes: 60

Hole's Diameter: 10 mm

Hole's Depth: 15 mm

4.4 Casing

It is the part of water heater that is covering the rotor and in between the casing inner surface and rotor outer surface water is rotated.

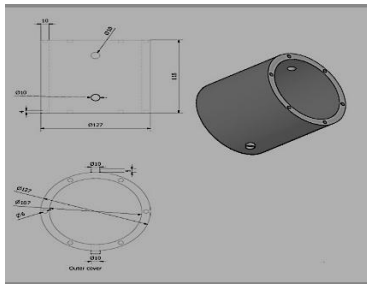


Fig-3: Casing 3-D, side and front view

There are two holes on the surface of casing, one for the supply of cold water and other for obtaining hot water respectively.

Specifications of Casing: -

Material: Stainless Steel Grade-300

Outer diameter: 127 mm

Inner diameter: 107 mm

Length: 118 mm

4.5 Cover Plates

Cover plate along with casing make a close chamber in which water is rotated via rotor. Two plates are used on either side of casing and fastened with help of Allen head screws. To make arrangement leak proof gasket sheet is used in between plate and casing.

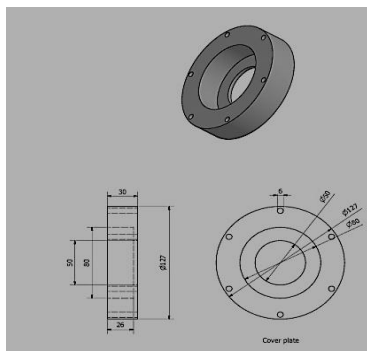


Fig-4: Cover Plates 3-D, side and front view

Specifications of Cover Plates: -

Material: Stainless Steel Grade-300

Outer diameter: 127 mm

Inner diameter: 50 mm

Thickness: 30 mm

4.6 Clamps

For clamping the casing with cover plates Allen head screw are used.

Specifications of screw:-

Nominal Diameter: 6 mm

Length: 34 mm

No. of screw used: 12

4.7 Bearing

SKF Deep Groove Ball Bearing with both side rubber seal is used to support the shaft which is mounted on rotor. Also friction is reduced and operation become smoother by application of bearing.

Shaft seal is used just before bearing for preventing any kind of leak that may affect bearing life.

Specifications of Bearing: -

Outer diameter: 80 mm

Inner diameter: 50 mm

Thickness: 16 mm

4.8 Pump

A Globus 18 watt submersible water pump is used for maintaining the circulation of hot or cold water from the water heater to the storage tank.

5. PRACTICAL SETUP AND METHODOLOGY



Fig-5: Fabricated Model of a Working Portable Cavitation Water Heater

- The electrical energy is supplied to motor which starts rotating and simultaneously shaft attached to motor with coupling starts rotating.
- The pump supplies water inside casing and the phenomenon of cavitation starts inside the holes perforated on the surface of rotor.
- The hot water comes out from the outlet pipe and filled in storage tank and again the same water is pumped inside the casing. This process goes continuously and heated water is obtained.

6. CONCLUSION

In this paper, Cavitation Water Heater is developed to heat water. This Water Heater directly converts electrical energy into thermal energy through cavitation induced by the rotation of the water. The Cavitation Water Heater decreases the pressure of the water, to a point below its saturation pressure, which consequently induces cavitation. Energy is released in the form of heat when the bubbles collapse, causes the water temperature to rise.

7. REFERENCES

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