RESEARCH ARTICLE OPEN ACCESS

Analysis Approach to Improve Star Rating Of Water Heater

Sujata Dabhade[1], Prof B.R. Kharade[2]
1(Department of CAD/CAM Production Engg, Pune University, Pune)
2 (Department of CAD/CAM Production Engg, Pune University, Sangamner)

ABSTRACT
Electric Water Heaters are widely used all over the world that can be categorized in two types i.e. Instant Water Heaters & Storage type Water Heaters. The energy consumption for 6 liter water heaters is much higher in the storage type of water heater. As energy is an important factor for economic development of country, therefore there is need to save the energy which implies the focus to use Storage type Water Heaters. In 6 Liter water heater, Existing model converting from 4 star rating to 5 star rating by thermal analysis & insulation. After the theoretical calculation of thickness of glass wool is the practical testing of product with BEE norms & got results for 5 Star Calculation. Finally we are doing the thermal analysis for theoretical & practical verification of the product
***Keywords* –**Energy Saving, Standing Loss, 5 Star Rating, Thermal Insulations, Thermal Analysis

I. INTRODUCTION

As we all know the water heaters are domestic equipment which is used for heating cold water forth purpose of bathing. Our aim is to investigate technical & economical potential of raising the energy efficiency of domestic water heater.

There are two principal systems in water heaters which differ by their approach given below

1) Decentralized systems: - This is the approach by which a number of small instant water heaters poisoned at each point of load/demand.
For e.g., shower/bath & each sinks.
These systems are also known as instant type water heaters.
2) Centralized systems: - This is the approach wherein a single large storage water heater is used for whole house-hold.

These systems are also known as Storage type water heaters.

Storage water heaters draw less power as compare to instant water heater & the timing of power demand can be distributed to periods other than

There is the relation between volume of hot water stored & rated power of resistance of heater and the ability of water heater to satisfy the user demand for hot water, according to it electric storage water heater efficiency is defined in the analysis as standing heat losses (in kwh) for 24 hours as a function of storage volume capacity. The most important aspect of design influencing standing losses is the thickness of insulation.

The distribution of the insulation around the tank can also be important as thermal stratification means it is better to position the thickness insulation around the top of the tank which contains the hottest water..

II. EXISTING 6L PRODUCT DETAILS

2.1 Product Specification of 4 stars 6L Water Heater

By reducing the excess loss of heat energy, we can increase the energy efficiency of the existing model by some modification. We are going to adopt the various methods and testing procedure as per BEE. In existing product energy saving 40%, To improve it from 40% to 50% as by analysis method & by some modifications in product.

TABLE2. Existing Product Specification

Model Name	PR-6L(6Liters capacity) 4 Star Rating
Rated Pressure	6.5 bar
Class	Class-I
Heating Element	3.2 kW
Inner Tank	SS 304
Thermostat /Cutout	Stem Type
Insulation	PUF
Outer Body	Polypropylene

2.2 Material

2.1 Inner Tank (6 L) Material: SS304

Type 304L is an extra low-carbon variation of Type 304 with a 0.03% maximum carbon content that eliminates carbide Precipitation due to welding. As a result, this alloy can be used in the “as-welded

"Condition, even in severe corrosive conditions. It often eliminates the necessity of annealing weldments except for applications specifying stress relief. It has slightly lower mechanical properties than Type 304.

TABLE 2.1: SS304L Material composition

	Chemical Analysis (%)				PRE_N	Mechanical Properties		
	C	Cr	Ni	Mo		Proof Stress	Tensile	Elongation
304	.08	18.5	9	-	19	235	530-730	40
304L	.03	18.5	9	-	19	200	500-700	40

2.2 Insulating Material (6 L) 4Star : PUF

Rigid polyurethane foam (PUR/PIR) is a closed-cell plastic. It is used as factory-made thermal insulation material in the form of insulation boards or block foam, and in combination with various rigid facings as a constructional material or sandwich panel. Polyurethane in-situ foams are manufactured directly on the building site.

TABLE2.2:
PUF Insulation Material Properties

Density	40+/-kgs/ m3
Tensile Strength	4kgs/cm2
Bending Strengths	4.2kgs/cm3
Temperature Range	-180 to 140 ºC
Temperature conductivity at 0 ºC(Design value.020k cal/m-h/ ºC)	0.018 kcal/m-hm/ ºC

2.2 Insulating (6 L) Material 5 Star Product: Glass wool

Glass wool is an insulating substance which is made from fiberglass. It has a texture resembling wool. Glass wool can be in the form of rolls or slabs with varying thermal and mechanical properties. We are known for our premium class Glass Wool. The Glass Wool supplied by us is widely being used in Pharmaceutical industries, chemical plants, Hospitals, Malls etc.

Fig: 2.1 Glass Wool: Thermal Insulator

III. EXISTING 6L MODEL ANALYSIS

3.1Test Procedure 6L Storage Water Heater Standing Loss Test :As per IS 2082 Standerd

The energy consumption of water filled water heater, after the steady state conditions have been reached, when connected to electrical supply during 24 h when no water is withdrawn.

The water heater is filled with cold water. The electrical supply is then switched on for a few cycles of operations of the thermostat until steady state conditions have been reached.

Starting and ending at a cut-out of thermostat, the energy E1 consumed during time t1 (hours) is measured over a period of not less than 48h.The water temperatures □EI at each thermostat cut-in and □AI at each thermostat cut out are measured by means of the thermocouple positioned as in clause 10. The energy consumption E per 24 h is calculated according to the following formula:

$$E = ((E1 * 24))/t1 \quad (1)$$

The mean water temperature □M is calculated by the formula:-

$$E = (A + E)/2 \quad (2)$$

□A and □ E being calculated as indicated in clause 10.Standing loss per 24 h Qpr is calculated according to the formula:-

$$Qpr = 45/(m - amb) * E \quad (3)$$

Qpr is expressed in kilowatt-hours per 24 h related to a temperature rise of 45K and expressed to the nearest 0.1 kWh.

IV. EXPERIMENTAL SETUP CONDITION

4. Test Setup as per IS2082 EWH

Visualization of all water Heater with inlet temp, ambient Temp & Humidity on screen

In this software we can see status of water heater on the screen mean water heater is in ON condition or OFF Condition .Temperature, KWH, Voltage, Current of water heater recording. After Completion of Test we get Automatic generation Of Standing

Loss Report in Standard Format

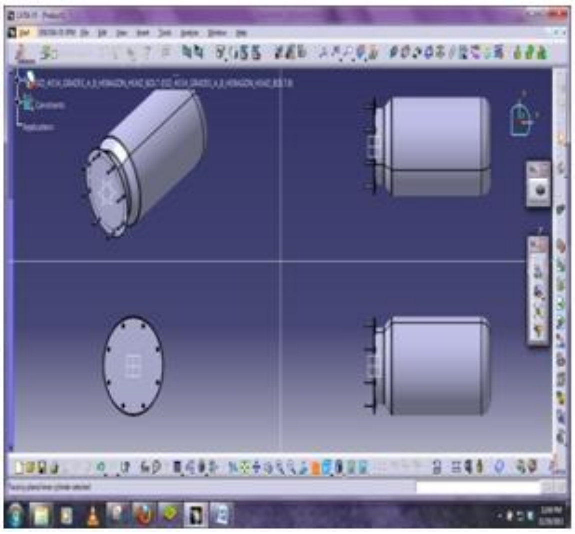
Water heater mounting: On panel situated at least 150mm from any structural wall 2)Water heater Position : Clear space 250 mm above& below &250 mm at side & front

Conditions for measurement	ISI Specifications (IS2082:1993)
Ambient Temperature	27+2°C
RelativeAir Humidity	not Exceeding 85 %
Cold Water Temperature	22 ± 2°C
Mean Temperature after thermostat cutout is average value of n temperatures(□ A)	□A=∑□ Ai/n
Mean Temperature after thermostat cut in is average value of n temperatures (□ E)	□E=∑□ Ei/n
Mean water Temperature(□ M)	72±5°C
Calculation Of Mean water Temperature(□ M)	θM= θA-θE/2
Electrical energy Consumed	Recorded in kWh to nearest 0.01 kWh
Calculationof Electrical energy Consumption per 24 h (E)	E=E1*24/t1
Standing Loss per 24 hrs(Qpr)	Qpr=[45/(θM-θamb)]*E
CalculationCyclic Temperature variation (Δ□)	Δ□= θA-θE
Cyclic Temperature variation (Δ□)	Shall not exceed 10°C

TABLE 4: SS304L Material composition

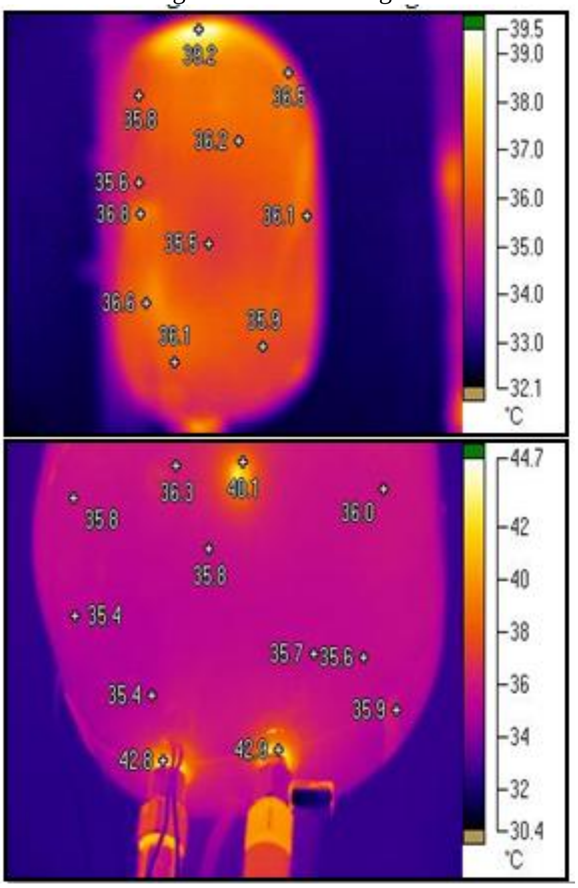
V. CAD MODEL&THERMAL IMAGES

Fig 5.1:SS304L Tank 3D Drawing



Below are thermal images are after thermal cutout for 4 star model. In below images it is analyzed that maximum heat loss it is in top Zone of tank

Fig 5.2: Thermal Images



Below are boundary conditions for thermal analysis

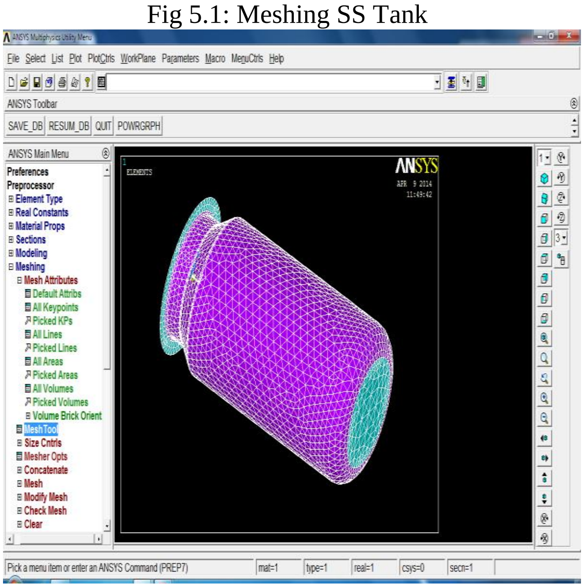
.Parameter	SS 304L	Glass Wool	PUF
Density(kg/m3)	8000	200	34
Thermal conductivity (W/MK)	16.2	0.04	0.03
Coefficient Of thermal expansion(/ K)	0.000016	0.0000046	0.0000003
Young's modulus(MPa)	193000	75000	90000
Shear Modulus (MPa)	79800	36000	40000
Poisson Ratio	0.3	0.24	0.25

TABLE 5: Boundary Conditions

5.1 Meshing & Problem conversion into 1D

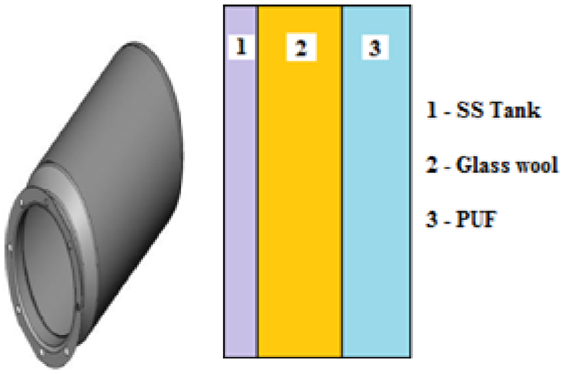
5.1.1 Meshing: - Meshing is the process of discrimination of component or part in smaller units in finite numbers .Import the 3D CAD model into ANSYS 14.0 & mesh it properly over entire geometry

Fig 5.1: Meshing SS Tank



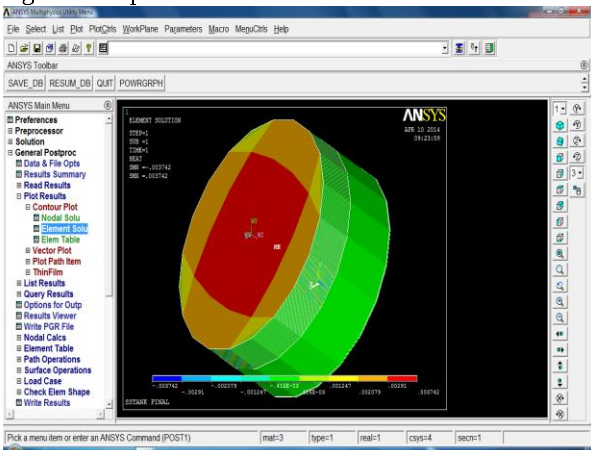
5.2 Conversion of model into 1D Problem

Fig 5.2: Conversion in 1D problem



VI. RESULTS BY ANASYS

Fig 6.1 Temperature at each node of Junction



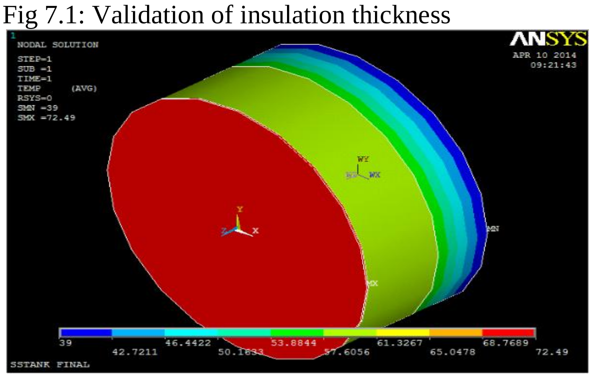
VII. RESULT & DISCUSSION

7.1Validation

7.1.1 Insulation Thickness validation

The theoretical values of temperature calculated at each node of the junction give us the required thickness of glass wool which is needed to avoid the heat loss value. This thickness of glass wool calculated is validated by ANSYS 14.0In ANSYS 14.0 we have input the value of thickness of glass wool & finally we got the same values of temperature which were calculated manually. This validates the thickness of glass wool calculated theoretically.

Fig 7.1: Validation of insulation thickness



Thickness of Glass Wool, L2 = 30 mm
T1 = 72.50 C
T2 = 72.49 C
T3 = 57.72 C
T4 = 39.00 C

VIII. CONCLUSION

We have calculated the theoretical thickness of Glass Wool & have analysed by software ANSYS 14.0.

This thickness of Glass Wool is fixed in assembly of product.

Then, we have carry out the practical standing heat loss test& after that we got the product results as 5 Star.

IX. ACKNOWLEDGEMENTS

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