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PERFORMANCE ANALYSIS OF THERMOSYPHON FOR COOLING INTEL I7 MICROPROCESSOR

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Abstract: ***Microprocessor cooling is mandatory for its operation. The intel Intel® Core™ i7-990X Processor Extreme Edition (12M Cache, 3.46 GHz, 6.40 GT/s Intel® QPI) dissipates 140 W when operating at Base Frequency with all cores active under an Intel-defined, high-complexity workload. The cooling method adapted is forced air flow with fan attached to the processor. The performance of fan and thermosyphon for cooling the microprocessor is carried out indicating the use of later is more effective.***

Keywords: ***Microprocessor Cooling, Thermosyphon***

I. INTRODUCTION

Microprocessors are currently air cooled using a fan to dissipate heat by forced convection. As the power density is increasing there is a demand for more effective and efficient cooling method for a compact system to dissipate 140W/cm2 maintaining CPU Case temperature below 70◦C. In the current paper the performance of fan and thermosyphon for cooling the microprocessor is carried out. Thermosyphons are heat exchanging devices that circulate fluid through natural convection. The movement of the coolant occurs due to change in the density of the coolant, without an external source. The change in density of the coolant occurs in thermosyphon applications because of rise in the coolant temperature or phase transition. The portion of the coolant which is less dense rises and the denser portion falls. This phenomenon creates a force which drives the coolant to movement. As the circulation of the coolant occurs naturally, the thermosyphons do not use external surface forces, such as pumps. As the difference in the coolant densities is the driving force for the movement, the thermosyphon is dependent on the gravitational field and thus requires to be placed in such orientation as it is designed.

1.2 Thermal Resistance calculations with fan as cooling system

$$R_{ca} = (\Delta T)/Q = (T_c - T_a)/Q \ldots\ldots(1)$$

Where,

R_{ca} =Thermal Resistance (°C/W)

T_a: ambient air temperature in (°C)

T_c: Average core Temperature T_C in (°C) is related to processor temperature for desktop and mobile systems based on Intel® Processors. To allow optimal system operation and long-term reliability, the processor must not exceed the maximum case temperature specifications. *Calculated using core temp1.0 RC6

Q = Thermal Design Power (TDP) The average power, in watts, the processor dissipates when operating at Base Frequency with all cores active under an Intel-defined, high-complexity workload.

S.no	(Tc) (?C)	Ta (?C)	? T (?C)	Rca (?C/W)
1	60	35	25	0.29
2	61	35	26	0.29
3	62.3	35	27.3	0.29
4	63.8	35	28.8	0.29
5	64.1	35	29.1	0.26
6	65.7	35	30.7	0.27
7	66.2	35	31.2	0.26
8	67.9	35	32.9	0.26
9	69.5	35	34.5	0.27
10	70	35	35	0.26

Table 1, Thermal Resistance table without thermosyphon showing variation of Rca (◦C/W)

1.3. Thermal Resistance calculations with using thermosyphon as cooling system

$$Rth = R1\ (L/KA) + R2\ (1/hA) \ldots.(2)$$

Rth= Thermal resistance using thermosyphon

A= Available Area for Thermosyphon Evaporator (40.5 mm x 36.74 mm)

K = Thermal conductivity of copper, (385 W/m K)

h = convective heat transfer coefficient for methanol with copper transmission surface (3000 w/m^{2}K)

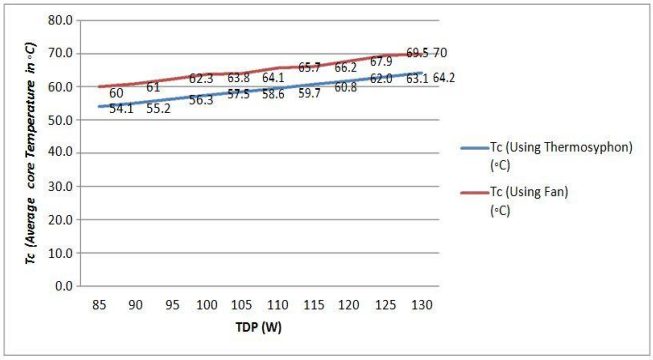
S. No	R1	R2	R Total	(Tc) (?C)
1	0.000573	0.22	0.22	54.1
2	0.000573	0.22	0.22	55.2
3	0.000573	0.22	0.22	56.3
4	0.000573	0.22	0.22	57.5
5	0.000573	0.22	0.22	58.6
6	0.000573	0.22	0.22	59.7
7	0.000573	0.22	0.22	60.8
8	0.000573	0.22	0.22	62
9	0.000573	0.22	0.22	63.1
10	0.000573	0.22	0.22	64.2

Table 2, Thermal Resistance table with thermosyphon showing Core temp (◦C)

**The above table is calculated using TDP corresponding to variation in table 1 using core temp1.0 RC6

II. COMPARISON OF AVERAGE CORE TEMPERATURE USING FAN AND THERMOSYPHON

The above tables indicate the core temperature varies with TDP, In fan cooling system the maximum average temperature achieved by the core is 70◦ C and in case of thermosyphon cooling system which incorporate liquid cooling having methanol as fluid, maximum average core temperature achieved is 64.2 ◦C which indicate that using thermosyphon maximum average core temp is way below the maximum core temperature specifications to allow optimal system operation and long-term reliability which the processor must not exceed.



Graph 1 Comparing F

III. CONCLUSIONS

In this paper a performance evaluation of fan and thermosyphon for cooling the microprocessor is carried out for cooling the intel Intel® Core™ i7-990X Processor Extreme Edition (12M Cache, 3.46 GHz, 6.40 GT/s Intel® QPI). This study identifies that thermosyphon cooling system is better with respect to fan cooling system. The presented numerical results represent a preliminary study on the performance of thermosyphon as a cooling system over fan. Further detailed numerical and experimental studies are needed to accurately predict the behavior of the thermosyphon..

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