New Products

Practical Application of the World's Lowest-Profiled Heatsink

1. INTRODUCTION

As computers improve in speed and performance in recent years, MPU (Micro Processing Unit) that constitutes the core component increases in heat generation, rendering thermal countermeasures indispensable. Thus it can be said that heat-dissipation has become a key technology particularly for electronic equipment with limited case volumes such as notebook PCs, DVD players, digital cameras, mobile phones, game machines of the next generation and digital home appliances. Accordingly, Furukawa Electric has been offering to the market comprehensive heat-dissipating technologies that make efficient use of heatpipes.

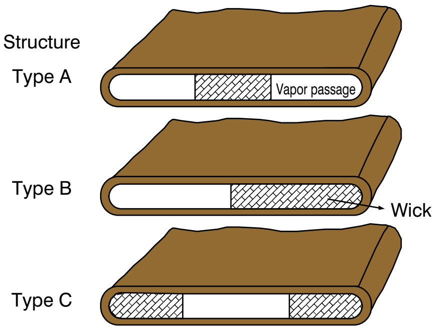
More specifically, from the standpoint of heat generation, whereas high-end MPUs continue to increase in the heat generated, power-saving MPUs are also being developed, whereby the generated heat tends to be suppressed while the performance carries on to improve. Recently electronic equipment with these MPUs with small heat generation onboard acquire a good reputation from the marketplace.

Meanwhile, these electronic equipment with power-saving MPUs onboard are required to have such features as portability, space saving, lightweight and low noise as well as small power consumption. In order to satisfy all these requirements, we have developed the world's lowest-profiled heatsink (as of March 1, 2005; to the best of our knowledge) that employs an improved version of the 1-mm thick heatpipe we have already developed.

2. STRUCTURE

Heatpipes designed for room temperature operation normally consist of a copper container and a working fluid of water, and the inside is depressurized virtually to a vacuum. When heat is applied to the one end (evaporator section) of the heatpipe, the working fluid nearby vaporizes to deprive the region of a vaporization heat while simultaneously raising the pressure rapidly, and subsequently the vaporized working fluid moves to the other end (condenser section) that is low in pressure. Upon reaching the condenser section, the vapor condenses and liquefies to release as a latent heat the thermal energy it has carried, and then the liquefied working fluid is refluxed to the evaporator section through a wick which is provided with capillary mechanism. That is to say, because the working fluid circulates within the heatpipe taking advantage of phase change, a large quantity of heat can be transferred between the points of quite a small temperature difference.

Figure 1 shows the structure of the 1-mm thick heatpipe. The mesh is arranged at the center or the end of the cross section of the flat copper container, thereby separating the passage for the refluxing working fluid and that for the vapor, which constitutes the central feature of this heatpipe. Using such a structure, the vapor passage is obtained to result in sufficient circulation of the water and vapor even when the heatpipe is flattened to have a total thickness of 1 mm, making it possible to have an ample heatpipe function.



Specifications
- ■ Container: Pure copper
- ■ Wick: Pure copper mesh
- ■ Working fluid: Deionized water
- ■ Standard size: 1.0 mm in thickness

Figure 1 Structure of 1-mm heatpipe.

Recently, we have reviewed the design and material of such heatpipes for optimization, and succeeded in improving the maximum heat transfer rate and reducing the thermal resistance —both parameters are the most important performance indices for heatpipe— while maintaining conventional production costs. Due to these improvements it became possible to apply the upgraded heatpipes to the heatsinks for MPUs where heatpipes were not applicable before, so that the world's lowest-profiled heatpipe-based heatsink —including heatpipe, fin and fan— has been successfully developed. See Figure 2 for comparison of the heatsinks.

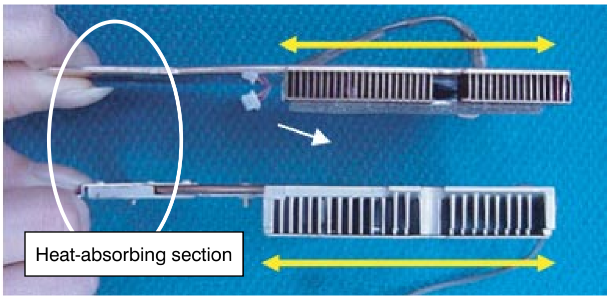


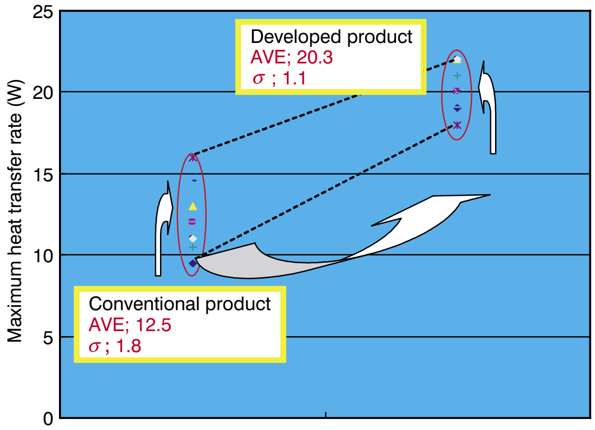
Figure 2 **Comparison of the profiles of heatsinks with equivalent thermal performance. Above: Developed heatsink, 1.7 mm and 9 mm for the heat-absorbing section and fins, respectively. Below: Conventional heatsink, 4.5 mm and 13 mm, respectively. The widths of the fin assemblies are the same.**

3. PERFORMANCE

Figure 3 and Figure 4 compare the maximum heat transfer rate and thermal resistance of the conventional and developed 1-mm thick heatpipes, respectively. As can be seen from these Figures, the new heatpipe has achieved substantial improvements over the conventional one —about 70 % in the maximum heat transfer rate and about 60 % in the thermal resistance. The improvements made it possible to provide more latitude to the heatsink designs where greater multifunctionality is always required in a limited space. Below will be described some examples.

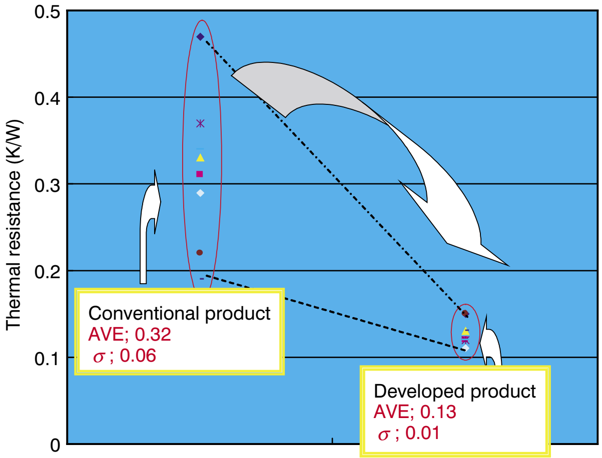
First, the use of 1-mm thick heatpipe allows reduction of the thickness of heatsinks. To provide thermal performance equivalent to that of a heatsink using the 1-mm thick heatpipe developed here, heatsinks using conventional heatpipes would have to be 2.5 to 4 times thicker than their counterpart. Specifically, while the heat-absorbing section of the developed heatsink is 1.7 mm thick —heat receiving plate: 0.5 mm, heatpipe: 1.0 mm, and heatpipe cover: 0.2 mm, that of the conventional one is approximately 4.5 mm.

Secondly, given a certain cubic measure, heatsinks using the 1-mm thick heatpipe are superior to those using conventional heatpipes in terms of thermal performance. In one example, the use of the heatsink developed here has achieved experimentally a temperature reduction of 10°C in an MPU with an input heat of 27 W. This is due to the fact that the surface area of the heat-dissipating fin assembly —a key factor component for heat dissipation— has been increased by as much as the heatpipe thickness has been reduced, because basically the heat-dissipating performance improves by increasing the heat-dissipating surface areas, although it is also subject to the influence of such factors as the pressure loss due to airflow and the airflow behavior. In addition, the improvement in the thermal performance has made it possible, even with a suppressed rotation speed of the fan, to obtain the thermal performance equivalent to that of conventional heatsinks. This eventually leads to the reduction of wind noise and fan motor noise.



Total length: 130 mm
Evaporator section length: 40 mm
Condenser section length: 70 mm

Figure 3 **Comparison of maximum heat transfer rate of 1-mm thick heatpipes.**



Total length: 130 mm
Evaporator section length: 40 mm
Condenser section length: 70 mm

Figure 4 **Comparison of thermal resistance of 1-mm thick heatpipes.**

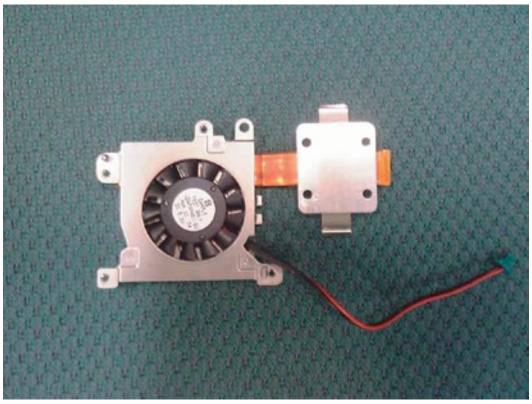


Figure 5 **Appearance of the world's lowest-profiled heatsink.**

To summarize, the significant improvements in the heatpipe has resulted in the performance upgrading of heatsinks overall, thereby succeeding in the development of a low-profiled, high-performance heatsink that is capable of solving various problems related with conventional heatsinks.

Figure 5 shows the appearance of the heatsink developed here.

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