Design of High performance liquid cold plate for IGBT cooling

Currently in electronics industry liquid cooling is widely used to meet the thermal requirement of high power density modules and the desire for compact packaging. There are several advantages of using liquid cooling over air cooling for thermal management of high power devices. First in applications where power densities exceed the limit of air cooling, liquid cooling is the only practical option. Liquid cooling facilitates a compact design to accommodate in lesser space requirement and serves better control for heat load changes and higher reliability.

The objectives in the design of liquid cooling systems are to create a sufficient amount of total flow and to appropriately distribute the flow so as to maintain the electronic component temperatures at the desired level.

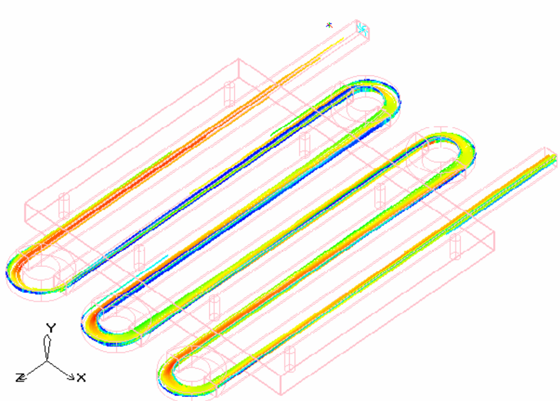

Fig 1: Pathlines through tube

Applied thermal technologies India and its parent company Aavid thermalloy, USA in their joint program designed liquid cold plates to serve the electronics market and aim at IGBT cooling. In Applied thermal technologies India, the CFD models to study the cold plate were developed while the prototyping and testing was performed at Aavid thermalloy USA. To achieve the current needs of compact packaging and to meet the cooling requirement, cold plate design was aimed to achieve the thermal resistance of 0.007 °C/W.

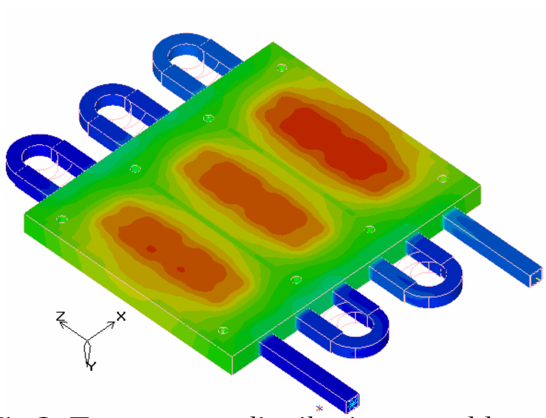

Fig 2: Temperature distribution on cold plate base

Conventional liquid cold plates available in the market are based on the simple geometry like tube embedded in base which may be two pass, four pass or six pass. The disadvantage of these cold plates is that to get the uniform flow over the entire base surface we need to increase the flow passes which increases the pressure drop significantly. Applied thermal technologies and Aavid thermalloy identified innovative cold plate geometries which have better thermal performances and much lesser pressure drop for specified flow over conventional cold plates.

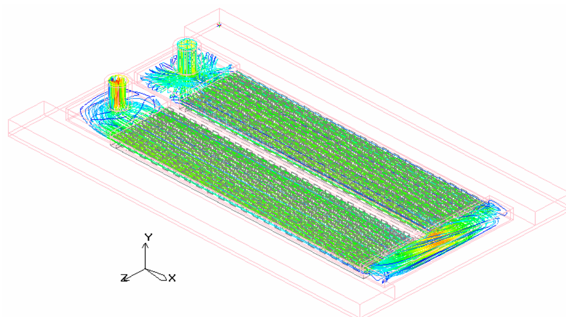

Fig 3: Pathlines through channels

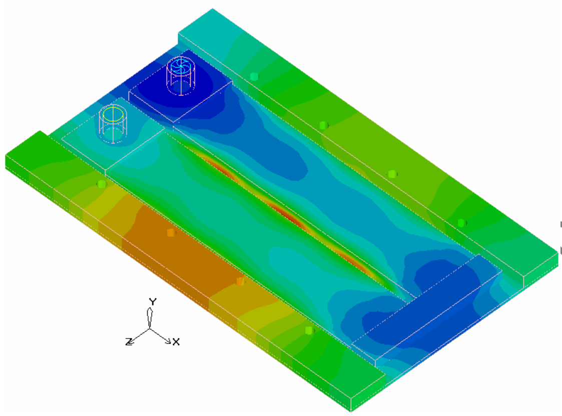

Fig 4: Temperature distribution on cold plate base

To design a liquid cold plate, first challenge is to decide on the required flow rate and to fix the pump characteristic. Based on the thermal calculation the required flow rate and the pump characteristic were defined. With the defined pump characteristics several cold plate geometries were created and simulated to meet the required cold plate performance. Different geometries were studied to enhance the heat transfer coefficient and to uniformly spread the flow over base to get minimum pressure drop. Performance of several cold plates was found to be better than the aimed thermal performance and incomparable in the market for same category.

For comparison, the tested values of cold plate thermal resistance and pressure drop between conventional six pass cold plate and Applied-Aavid designed cold plate for equal liquid flow rate are,

	R_{SA} (°C/W)	ΔP (psi)
Conventional Six pass tube cold plate	0.01	7
Applied-Aavid cold plate design	0.0054	1.2