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Energeia Labs liquid cooling solution for EV battery pack

Present technology background

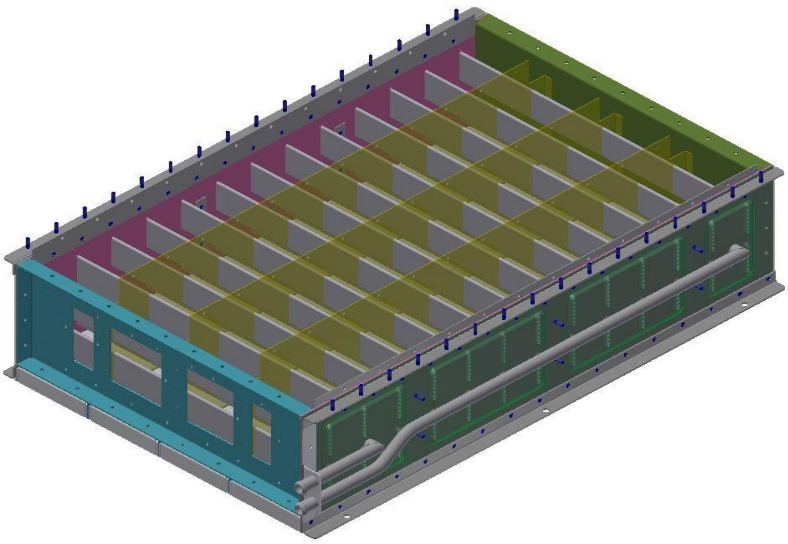
Present liquid cooling solutions for EV battery pack are complex and costly, like GM Volt; or less effective and inefficient, such as solution with heat sinks plate attached below battery module.

Our technology

Energeia Labs has developed a novel liquid-cooling / heating battery pack, which coolant loops are 3-D integrated into enclosure grid structure.

With a simple and an innovative flow connection, it ensures each battery cell's large surface is cooled or heated quickly, uniformly and effectively, additionally ensuring greater temperature uniformity.

The enclosure grid structure is shown in the following figure:



The whole enclosure is made of aluminium alloy and brazing together totally, means the yellow colour partition plates with the grey colour micro port tubes (MPT) and the grey colour bottom plates, the MPT with the pink colour end plates, the green colour side plates with the bottom plate are all welded together simultaneously by continuous atmospheric brazing (CAB) process.

These MPT are not only serves as cooling duct plates to provide coolant to each battery cell's large surface, they also support cells and constitute a grid structure for the battery pack.

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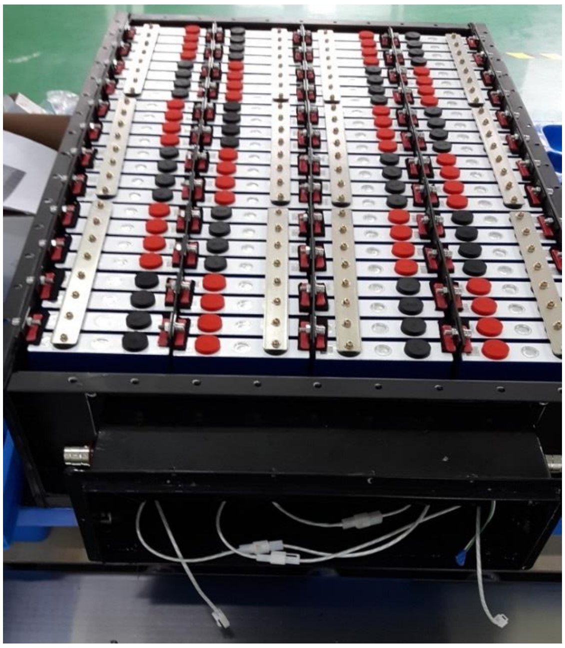
Compared to a sheet metal box（same size 1060 x 630 x 250 mm), the weight of this box is reduced from 38 kg to 28 kg, the strength and structural integrity is significantly better. Stress and deformation of the battery box also meet design requirements (Random vibration in the direction of battery box Z & Y, 3G gravity in Z direction, pressure of MPT).

Below is an example of a standard C pack（1060 x 630 x 250 mm) for an electric bus designed for a Chinese customer.



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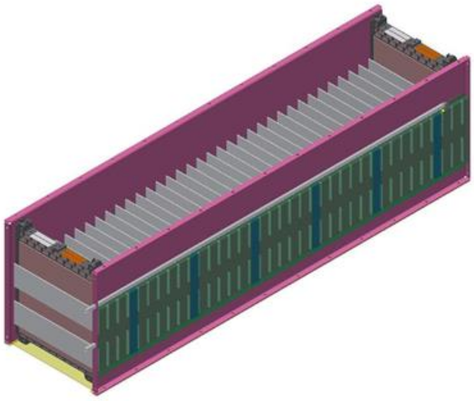
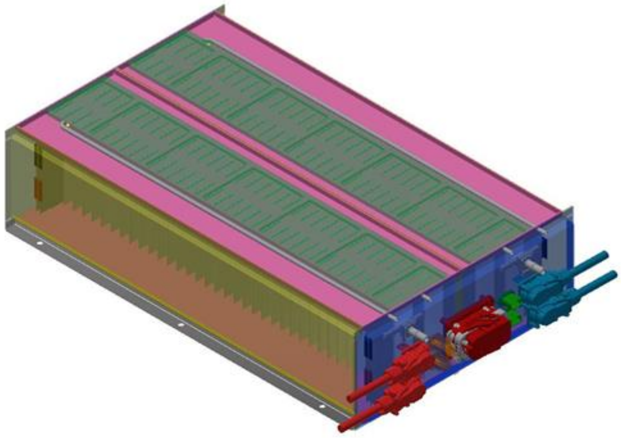
The following is a design of a standard C battery pack of liquid-cooling / heating for fast charging for electric buses.





The design of the liquid cooling module adopts 72 pcs of 68Ah pouch cells, two modules constitute a standard C box, 36kWh, the weight of the enclosure is less than 29kg, and the system energy density is larger than 150Wh/kg, while the system volume energy density is kept same.

The trend now is to reduce weight and save costs by increasing the module size.

The overall battery packs above are compact and solid owing to no wastage of space. For same volume, our weight energy density is higher than its original natural air cool pack design.

Two cells as a group are installed in a cooling grid, the foam between the two cells is used for absorbing the expansion of the cell, and assisting the fixing of the cell to keep the cell pressed uniformly. In case thermal runaway happening for one cell, the cooling grid will also block and insulate heat transfer, slow down or prevent the thermal runaway from spreading, improve the safety of the battery pack.

Fixing method of cell is simple and reliable. The module level is now unnecessary. The module frame and support are no longer required, thereby reducing the number of parts, reducing the cost, allowing for greater convenience for assembly、maintenance and replacement of a single cell rather than whole module.

Compared to cooling the bottom or the sides of each battery modules in the battery pack, this solution allows each individual cell to have a large surface to come in contact with MPT. The MPT bears no cell weight and vertical vibration load, and no stress from cell expansion (stress offset on the two sides). The contact area is large, the heat conduction distance is short, so the heat transfer efficiency is 50~80% higher than the cooling of bottom or side edge of the cell/ module.

This design is flexible for both liquid cool and air cool solution. We can easily remove the green coolant chamber cover, let the air flow through MPT to cool down battery cell evenly.

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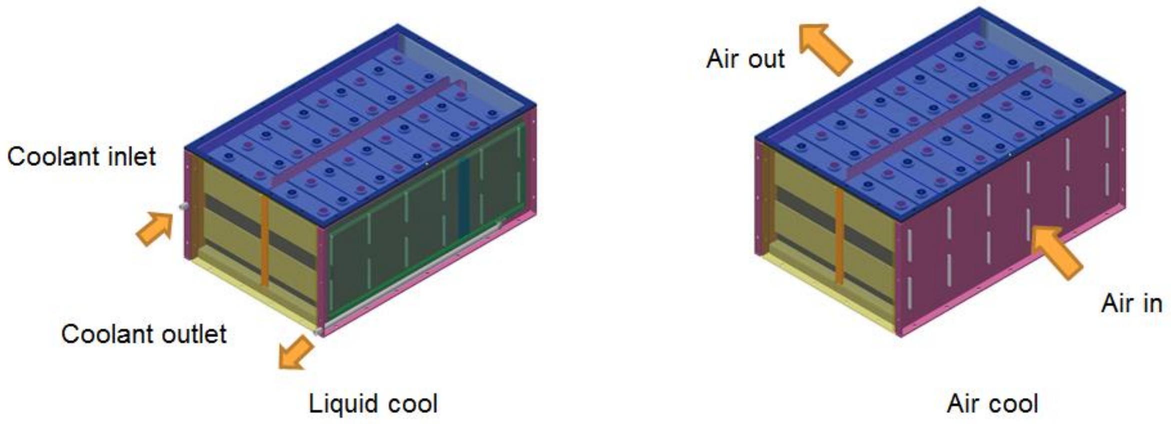
Both two options are IP67 water prove for cells, which prevent moisture to corrode cell tab where in most air cool solution faced (e.g. in ESS).



The existing "cell - module - battery pack" assembly production model is simplified now as the "cell - battery package" model, with greater suitability for automation.

Due to using continuous atmospheric brazing process, this enclosure can be manufactured with consistent quality at low costs for mass production.

Conclusion and advantages

This product is easy serialization and extended to other application areas.

For EV applications, we have designed 2 configurations.

Type A goes in the boot, and type B resides on the car bed. It is flexible enough to allow for different applications.

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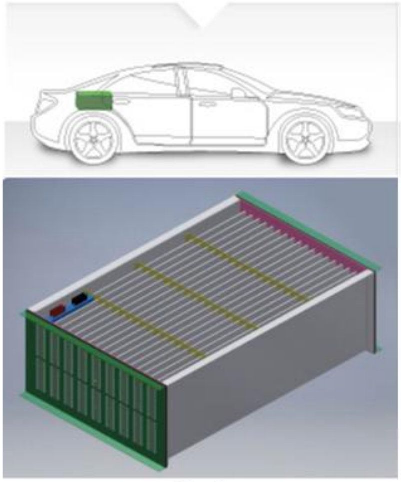
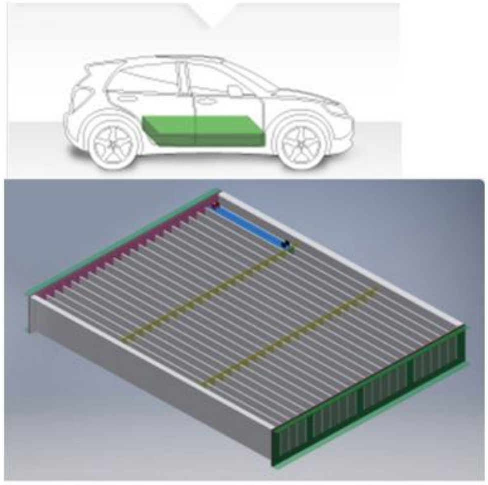


Type A



Type B

		Cell	Pack							
		Cell Ah	Cells (quantity)	kWh	Box length (mm)	Box width (mm)	Box height (mm)	Total weight (kg)*	Wh/kg	Wh/L
Type A	EL-10-A	31.5	90	10.5	623	455	270	88.6	118.4	137.1
	EL-16-A	31.5	136	15.9	808	505	270	**131.4**	**120.6**	**143.9**
	EL-22-A	31.5	190	22.1	993	555	270	180.3	122.8	148.8
Type B	EL-24-B	65	100	23.7	832	1080	160	148.4	159.9	165.0
	EL-30-B	65	126	29.9	1214	920	160	**185.3**	**161.3**	**167.3**
	EL-46-B	65	200	47.5	1596	1080	160	290.5	163.3	172.1

**Total weight includes cells, enclosure, coolant, and battery management system (BMS)*

Existing problems	Our solution	Benefits
Poor cooling effectiveness and efficiency	Even, effective, and efficient cooling at cell level	Enhance safety Doubled battery longevity
Heavy, large volume	Lightweight, compact	Standard and series possible Plug-and-play capability for quick swaps
Complex, high cost	Simple, low-cost	Eliminate the need for modules Easy maintenance Cost reductions