Material Serial number		Steel slag	Red mud	Bauxite	Anthracite	Aluminum dissolution rate	Iron reduction rate
Quality ratio	1	30	24	15	2	71.1	Basically above 80%
	2	88	40	33	6	65.4	
	3	25	12	15	2	73.5	
	4	53	48	32	4	69.8	

Figure 2 – Relationship between the mass ratio of materials and the reduction rate of aluminum and iron

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WTHERMOTUBE – NEW HIGH EFFICIENCY AND ENERGY SAVING HEAT DISSIPATION SYSTEM FOR DATA CENTER

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Summary. *Our passive refrigeration technology has been continuously studied, and a number of core technologies using gravity heat pipes for heat dissipation have been put forward. Through the phase change of working medium, efficient heat dissipation can be realized with very little energy consumption, and the working efficiency is extremely high.*

Nowadays, the heating density of data center is increasing rapidly, and the equipment used to solve the heat dissipation problem also consumes huge energy. Therefore, we designed a data center refrigeration and heat dissipation optimization system, which greatly improved the heat dissipation capacity and energy utilization efficiency of the data center. We build this system through eight high-level papers, four patents and six soft works.

The heat dissipation envelope designed by us embeds gravity heat pipe array into the wall, the evaporation section of the heat pipe is located at the lower part of the inner surface of the wall, and the condensation section is located at the upper part of the outer surface of the wall. The working medium in the heat pipe can evaporate under the drive of temperature difference and return under the action of gravity, which can transfer heat efficiently without additional power input. The structural unit is shown in fig. 1.

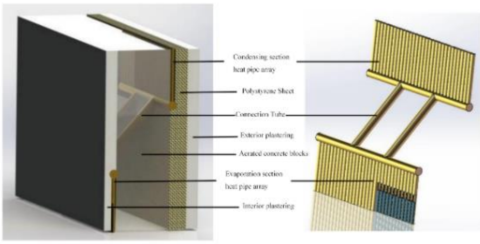

Figure 1 – Control diagram of heat pipe embedded

The structure of the device comprises a chassis containing double capillary short tubes embedded with chips and gravity heat pipes, wherein the evaporation section and condensation section of the gravity heat pipe are respectively connected to the capillary short tubes and the shell of the chassis, the chip is provided with a swing structure, and a direct evaporative cooler is arranged between the chassis and the wall. The physical diagram and structure diagram are shown in fig. 2, and the heat energy flow direction is shown in fig. 3.

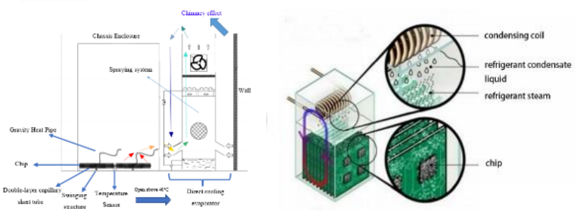

Figure 2 – Structure of chip liquid

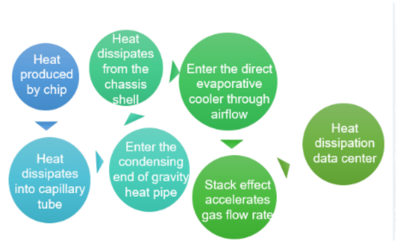

Figure 3 – Heat transfer process of chip liquid cooling heat sink embedded

We combine Tesla valves with liquid-cooled cabinets. Several ear-shaped sub-pipes are arranged on the main pipe of the liquid-cooled cabinet, as shown in fig. 4, so that the whole pipe presents a birdcage structure, as shown in fig. 5. Place the server chip in the birdcage and fill the Tesla valve with coolant. Due to the unique structure of Tesla valve, it can push the liquid in the main pipe to realize self-acceleration without external force assistance, thus improving the heat exchange efficiency. Calculated by comsol, the optimum aspect ratio of Tesla valve is 0.35, and the internal angle is 52°, which is the optimum structure.

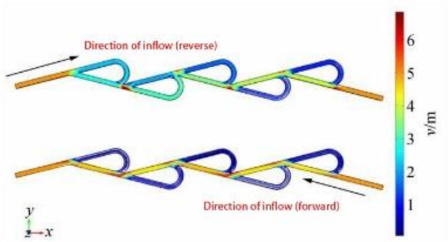

Figure 4 – Schematic diagram of Tesla valve flow field

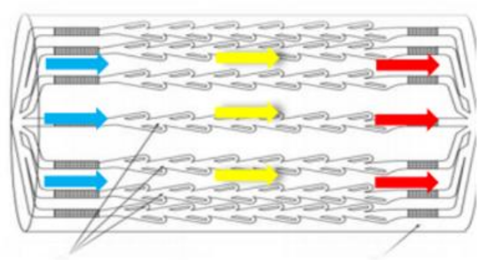

Figure 5 – Birdcace Tesla valve server

The new high-efficiency compound air conditioner consists of a temperature detection device, a unit temperature control device and a new evaporative condenser. We use a variety of refrigeration forms to optimize the three processes of cold capacity preparation, transport and supply, and realize efficient refrigeration on the premise of low energy consumption.

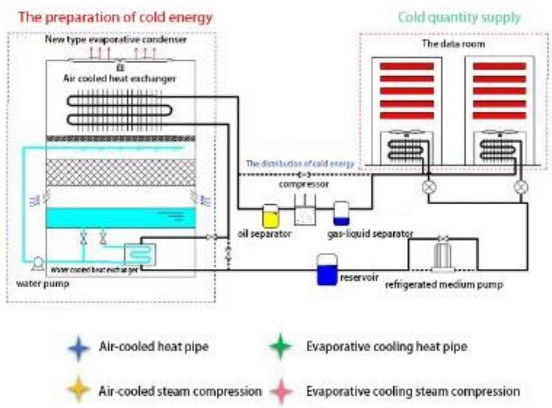

Figure 6 – Functional diagram of new high-efficiency composite air conditioning system

This system is a data center cooling system for multi-energy supply, which takes photovoltaic power generation as the main power source during the day, and use night electric to power the system at night. At the same time, the heat storage device is used to store the heat from waste heat boiler, water source heat pump and biomass particle burner to reduce the use of electricity. Different energy allocation is carried out under different use conditions to realize green energy saving in refrigeration process.

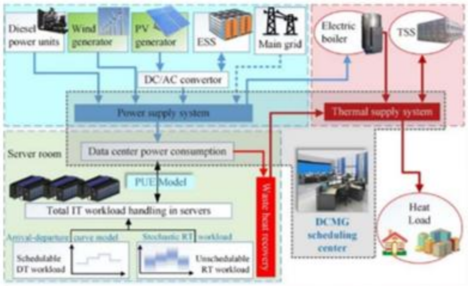

Figure 7 – Microgrid structure diargram of data center

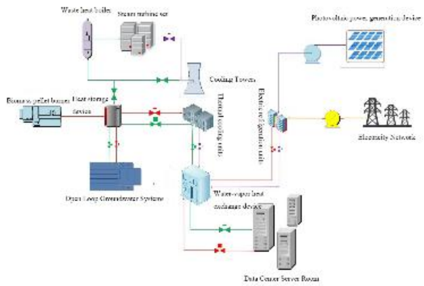

Figure 8 – chematic diagram of multi-energy cooling system