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A large scale deployment experience using immersion cooling in datacenter

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A large scale deployment experience using immersion cooling in datacenter

With the improvement of computing performance, the power consumption is significantly increased. Increasing power consumption of server components brings enormous challenges to heat dissipation and power optimization. Immersion cooling completely breaking the air-cooling power dissipation bottleneck and also achieving extremely low PUE.

This presentation introduces the problems encountered by Alibaba in the scale deployment of immersion cooling data center, solutions and considerations.
Key Points

1. Today’s Datacenter Challenges
2. Why immersion cooling?
3. Challenges of immersion cooling
4. Practice of Alibaba
Today’s Datacenter Challenges

1. high power density racks’ cooling

- Computing drives devices into higher power consumption. Rack power density is growing rapidly
- Air-Cooling cannot meet the heat dissipation demand any more
The energy consumption of the data center for cooling is quite large. How to achieve low PUE and optimized TCO? That has become a new challenge.
Key Points

1. Today’s Datacenter Challenges

2. Why immersion cooling?

3. Challenges of immersion cooling

4. Practice of Alibaba
Why is immersion cooling?

- liquid has greater heat transfer capacity than air.
- No Server Fans, No CRAC, High Density Servers, low PUE 1.05-1.07
Key Points

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The challenge of immersion cooling
Challenges of immersion cooling

Basic Level

Liquid Selection

Material Compatibility

Signal Integrity (PCB/CONN)
### Challenges of Immersion Cooling

Choosing the right heat transfer fluid for immersion cooling requires a multi-faceted evaluation of fluid candidates. The chart below shows the different parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Fluorocarbon</th>
<th>Mineral Oil</th>
<th>White Oil</th>
<th>Vegetable Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Transfer Effectiveness</td>
<td>Very Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Electrical insulator Characteristics</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Chemical stability</td>
<td>Very Good</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>Material Compatibility</td>
<td>Very Good</td>
<td>Good</td>
<td>Good</td>
<td>Fair</td>
</tr>
<tr>
<td>Oxidation Stability</td>
<td>Very Good</td>
<td>Good</td>
<td>Fair</td>
<td>Poor</td>
</tr>
<tr>
<td>Flammability</td>
<td>Very Good</td>
<td>Poor</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>Cost</td>
<td>$$$$$</td>
<td>$</td>
<td>$</td>
<td>$$</td>
</tr>
</tbody>
</table>
Challenges of immersion cooling

Material Compatibility

The weight decrease in mass is due to small molecules such as PVC dissolves in the liquid. Solutions: Replacing PVC with PTFE or other materials.

The Weight increase in mass is due to liquid leaks into the device. It shows that the sealing performance of this type of relay is poor. Solutions: Replace the relay with good sealing.
### Challenges of immersion cooling

#### Signal Integrity

<table>
<thead>
<tr>
<th>Type</th>
<th>Dielectric constant</th>
<th>6Gpbs (SAS/SATA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7.52</td>
<td>Not meet</td>
</tr>
<tr>
<td>B</td>
<td>7.35</td>
<td>Not meet</td>
</tr>
<tr>
<td>C</td>
<td>1.91</td>
<td>Meet</td>
</tr>
<tr>
<td>D</td>
<td>1.9</td>
<td>Meet</td>
</tr>
<tr>
<td>E</td>
<td>1.80</td>
<td>Meet</td>
</tr>
</tbody>
</table>
Challenges of immersion cooling

Component Level

CPU, Storage, Memory, HBA
Optical Devices
Performance, Stability, Energy efficiency
Challenges of immersion cooling

Purpose
To confirm if there is a issue or degradation unique for liquid cooling in High Temperature

Condition
Drive : SATA 8TB
Condition : Soaked in the coolant (55degC 1000hrs) with running test script

Conclusion : No fatal issue and degradation were observed in 1000hrs running in 55degC liquid
Challenges of immersion cooling

Unsealed

Sealed
Challenges of immersion cooling

System Level

- Server architecture, Tank sealing, Maintainability, Space utilization
- Data center architecture, pipe layout
- Monitoring and Management system
Challenges of immersion cooling

Unsealed

Tank sealing

cable-sealed

annual fluid loss ~10%

annual fluid loss ~1%
Challenges of immersion cooling

Maintainability

Special Maintenance Needed
1. Today's Datacenter Challenges
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As the number of servers increases, PUE gradually stabilized from 1.13 to about 1.07.
Liquid protects IT devices from harsh environment including high temperature, humidity, vibration, dust

The failure rate of storage HDD in liquid is 50% lower than that of air-cooled environment.
Higher Stability

Thermal Inertia of a liquid bath 1000 times higher than air

Liquid can safely absorb the heat pulses during heat exchanger units are in trouble

In case of a loss of cooling fluid

In air systems throttle and shut down in ~5 s

In immersion cooling system can run up to 30 min
In Alibaba air cooled data centers, noise levels reach up to 95dB; in immersion cooling data center, noise levels are around 50dB.
Summary & Key Takeaways

1. Immersion cooling is a better way to tackle the high power density challenges

2. Alibaba creatively bring the immersion cooling solution to its current data centers, and build out the world’s first immersion cooling server cluster in internet industry. We hope to work together with industry partners to promote ecological development.
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