

## MODULE – 5

### Vapor Corrosion Inhibitors (VCIs) in Protecting Computer Circuit Boards

Vapor Corrosion Inhibitors (VCIs) are an effective solution for protecting computer circuit boards from corrosion caused by environmental factors such as humidity, air, salt, and pollutants.

**Vapor Corrosion Inhibitors :** VCIs are chemicals that release corrosion-inhibiting vapors, which form a protective molecular layer on metal surfaces. This layer prevents the metal from undergoing electrochemical reactions that lead to corrosion.

#### Types of VCIs Used for Circuit Boards

##### Anodic Inhibitors:

- These inhibitors work by forming a protective oxide layer on the **anode** of the metal, preventing further oxidation and corrosion.

Examples: Calcium nitrite, sodium nitrite, sodium benzoate, and sodium chromate

##### Cathodic Inhibitors:

These work by reducing the rate of the **cathodic reaction** (e.g., oxygen reduction or hydrogen evolution). They often work by either:

- Precipitating protective compounds (e.g., calcium, magnesium) on the cathode surface to block the reaction.
- Reduce the cathodic reaction by blocking oxygen or precipitating protective compounds.

Examples: Carbonates, Phosphonates, Polyphosphates

##### Mixed Inhibitors:

- These inhibitors provide protection by acting on both the anodic and cathodic reactions simultaneously. They form a uniform protective film over the entire metal surface.

Examples: Amine-based inhibitors, silicates, benzotriazole (for copper).

#### How VCI work?

- VCIs are embedded in various carriers such as sealed pack/ enclosed pack.
- Vapor Corrosion Inhibitors (VCIs) work by releasing corrosion-inhibiting molecules into the enclosed environment

3. Once the VCI molecules come into contact with a metal surface, they adsorb onto it, forming a **molecular protective layer**.
4. This layer prevents corrosion by blocking the interactions of the metal with moisture, oxygen, and other corrosive agents.

## Example of VCI Application in Circuit Boards

For sensitive electronics like circuit boards:

1. The board is placed in a **VCI-infused bag** or box.
2. The VCI molecules diffuse and adsorb onto the metal contacts and traces, forming a protective layer against corrosion.
3. The protection remains active as long as the environment is enclosed.
4. Upon opening, the VCIs evaporate, leaving the board ready for immediate use.

## Benefits of VCI Technology:

1. **Non-Invasive:** Protects even hard-to-reach areas without direct application.
2. **Clean Protection:** Leaves no residue, unlike oils or coatings.
3. **Ease of Use:** Integrated into packaging materials or small capsules.
4. **Cost-Effective:** Reduces the need for additional protective coatings or maintenance.

## Thermal Management in CPUs Using Liquid Cooling Systems

Liquid cooling is a thermal management strategy that uses a liquid coolant to transfer heat away from a CPU and other computer components.

Liquid cooling systems use a circulating liquid (usually water or a water-based coolant) to transfer heat away from the CPU to a radiator or a heat exchanger, where it is dissipated into the surrounding environment.

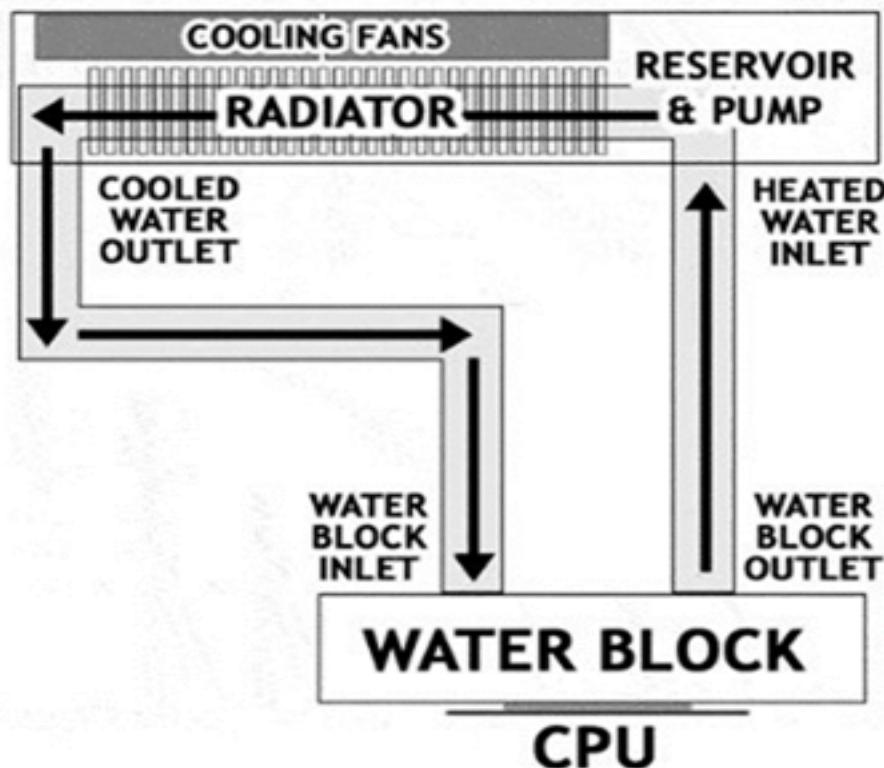
During normal operation, the transistors inside a CPU convert electrical energy into thermal energy (heat). This heat increases the temperature of the CPU. If an efficient path for that heat doesn't exist, then the CPU will exceed its safe operating temperature.”

Hence, CPUs need to be properly cooled to achieve maximum performance.

## Components and Working:

- **Coolant:** The medium that absorbs and transports heat. Often water-based with additives that absorbs heat from the CPU's.
- **Water Block:** It is a component mounted on the CPU to absorb heat through direct contact.
- **Pump:** Circulates the coolant through the system.
- **Radiator:** Transfers heat from the coolant to the air, often using fans to increase airflow.

- **Tubing:** Connects the components and facilitates coolant flow.



The working of a liquid cooling system for thermal management in CPUs can be explained in four key steps:

1. **Heat Absorption:**
  - A water block is mounted on the CPU. This block absorbs heat generated by the CPU through a layer of thermal paste that improves thermal conductivity.
2. **Heat Transfer:**
  - A pump circulates the liquid coolant through the tubing, transporting the absorbed heat away from the CPU to the radiator.
3. **Heat Dissipation:**
  - In the radiator, the heated coolant releases its heat to the surrounding air. Fans attached to the radiator help to enhance this heat dissipation process by improving airflow.
4. **Coolant Recirculation:**
  - The cooled liquid is then recirculated back to the water block on the CPU, and the cycle repeats.

## Applications

- **High-Performance Computing (HPC):**
  - For tasks like video editing, 3D rendering, and scientific simulations.
- **Gaming:**
  - Overclocked gaming rigs often use liquid cooling to sustain performance.
- **Data Centers:**
  - Large-scale systems utilize liquid cooling to efficiently manage heat in densely packed servers.