Recommended Dosing Calculation Method for SMAS in Circulating Water

1. Introduction

Sodium Methallyl Sulfonate (SMAS) is widely used in circulating cooling water systems as a monomer for polycarboxylic acid scale inhibitors due to its excellent calcium tolerance and thermal stability. Accurate dosing is crucial: insufficient dosing fails to prevent scaling, while overdosing increases costs and may lead to secondary water quality issues. This guide provides a calculation method based on key water quality parameters.

2. Key Water Quality Parameters Affecting Dosing

The required dosage of SMAS is not fixed; it must be adjusted dynamically based on the following parameters:

- **Hardness (as $CaCO_3$):** High calcium and magnesium ion concentrations increase scaling potential, requiring higher inhibitor dosages.
- **Alkalinity (M-Alkalinity):** High alkalinity indicates a higher buffering capacity and scaling tendency (especially $CaCO_3$), increasing the demand for dispersants.
- **Cycles of Concentration (N):** As water evaporates, ions concentrate. Higher cycles mean higher ion concentrations in the circulating water, significantly increasing the scaling risk.
- **pH Value:** High pH environments favor the precipitation of calcium carbonate and calcium phosphate, requiring stronger inhibition.
- **Temperature:** Higher temperatures (e.g., in heat exchangers) accelerate crystal growth and may degrade some polymers, requiring higher dosages.
- **Total Dissolved Solids (TDS):** High salinity can affect the solubility limits of scale-forming salts.

3. Recommended Dosing Calculation Method

We recommend a “Base Dosage + Correction Factor” approach.

3.1 Base Dosage (D_0) Reference Table

Select the base dosage based on the **Make-up Water Hardness** (or the hardness limit the system is designed to handle):

Water Quality Type	Total Hardness (ppm as $CaCO_3$)	Recommended Base Dosage (D_0) [ppm]
Soft Water	< 150	2 - 4
Medium Hard Water	150 - 300	4 - 6
Hard Water	300 - 500	6 - 10
Very Hard Water	> 500	10 - 15

3.2 Multi-Factor Correction Formula

To ensure precision, apply correction factors to the base dosage:

$$\mathbf{D = D_0 \times F_1 \times F_2 \times F_3 \times F_4}$$

Where:

- **D:** Final recommended active concentration in circulating water (ppm).
- **D_0:** Base dosage selected from the table above.
- **F_1 (Hardness Factor):**
  - Hardness < 300 ppm: 1.0
  - Hardness 300–600 ppm: 1.2
  - Hardness > 600 ppm: 1.4
- **F_2 (Alkalinity Factor):**
  - Alkalinity < 200 ppm: 1.0
  - Alkalinity 200–400 ppm: 1.1
  - Alkalinity > 400 ppm: 1.25
- **F_3 (Temperature Factor):**
  - Temp < 50°C: 1.0
  - Temp 50–80°C: 1.1
  - Temp > 80°C: 1.2
- **F_4 (pH Factor):**
  - pH < 8.0: 1.0
  - pH 8.0–9.0: 1.1
  - pH > 9.0: 1.2

3.3 Calculation Example

- **Scenario:** A circulating system with make-up water hardness of 400 ppm, alkalinity of 250 ppm, operating at 65°C, and pH 8.5.
- **Step 1:** Determine Base Dosage (D_0). For 400 ppm hardness (Hard Water), select **D_0 = 8 ppm**.
- **Step 2:** Determine Factors.
  - F_1 (Hardness 400): 1.2
  - F_2 (Alkalinity 250): 1.1
  - F_3 (Temp 65°C): 1.1
  - F_4 (pH 8.5): 1.1
- **Step 3:** Calculate.
  - **$D = 8 \times 1.2 \times 1.1 \times 1.1 \times 1.1 \approx 12.78$ ppm**
- **Result:** The recommended SMAS concentration in the circulating water is approximately **13 ppm**.

4. Dosing Method Optimization Suggestions

- **Continuous vs. Shock Dosing:** SMAS is typically used as a scale inhibitor and should be added **continuously** to maintain a stable concentration. Shock dosing is generally reserved for biocides or specific cleaning agents.
- **Dosing Point:** Add the chemical to a location with turbulent flow (e.g., the suction side of the circulating pump or before the cooling tower basin outlet) to ensure rapid mixing. Avoid points where the chemical might short-circuit directly to the blowdown.
- **Synergistic Blending:** SMAS is often used in combination with other monomers (like HPMA or Acrylic Acid) and organophosphates (like HEDP or ATMP). A typical copolymer formulation might contain 5–15% SMAS.

5. Dynamic Adjustment and Monitoring

- **Online Monitoring:** Monitor conductivity (to control cycles of concentration) and pH in real-time. Link the dosing pump to the makeup water flow or conductivity controller for automatic dosing.
- **Regular Testing:**
  - **Frequency:** Test Calcium Hardness, M-Alkalinity, and Total Phosphorus (if using phosphate blends) at least once a week.
  - **Action:** If the Calcium Hardness difference between makeup and circulating water decreases (indicating precipitation), increase the SMAS dosage by 10–20%.
- **Seasonal Adjustment:** In summer (high evaporation) or high-load production periods, increase the dosage proactively as the scaling tendency rises.

6. Precautions

- **Compatibility with Biocides:** If using oxidizing biocides (like chlorine), ensure they are dosed at a different point than the organic scale inhibitor to prevent oxidative degradation of the SMAS polymer.
- **Low-Temperature Solubility:** While SMAS has good solubility, if using a solid polymer containing SMAS in winter, ensure the preparation tank is kept above 5°C to prevent viscosity issues.
- **Accumulation Effect:** If the system has low blowdown, organic matter may accumulate. Monitor COD levels periodically.
- **Coagulant Interaction:** If the makeup water is treated with coagulants (e.g., polyaluminum chloride), ensure the coagulant is fully settled/filtered before the water enters the circulating system to avoid sludge deposition interacting with the SMAS polymer.

7. Summary

The accurate dosing of SMAS requires a combination of theoretical calculation and operational experience. Follow the core principle: **"Water Analysis First → Calculation Determines Base → Operation Fine-Tunes."** Regular monitoring of water quality trends is the only way to achieve the most cost-effective and safe operation.