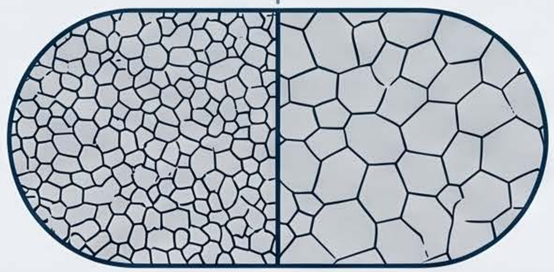
Green Quenching: Optimising 1020 Steel with CMC Polymer

Evaluating Carboxymethyl Cellulose (CMC) as a sustainable, water-soluble alternative to traditional quenching media for enhancing low-carbon steel properties, balancing microstructure, strength, and wear resistance.

Traditional Quenching

Conventional Quenching Media



Water Quenching: Fine but Distorted Grain

Oil Quenching: Coarse Grain

High distortion or safety risks with less uniform results.

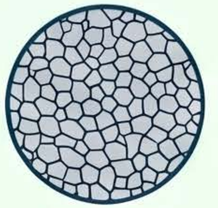
CMC Optimized

CMC POLYMER
(Controlled Cooling)

0.1% wt CMC

Optimal Balance

Superior balance of hardness, wear resistance, and tensile strength.



0.1% CMC + Tempering: Grain Size **44µm**, Hardness **177 HV**

0.1% CMC: Uniform, Fine Grain

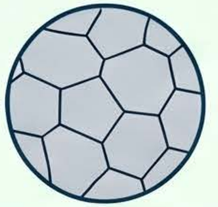
CMC Concentration

0.1% wt — **0.4% wt**

127% Increase in Grain Size

Higher Viscosity Slows Cooling

Concentrations above 0.4% wt increase viscosity, slowing heat extraction and causing undesirable grain growth.



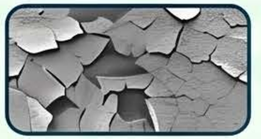
0.4% CMC + Tempering: Grain Size **59µm**, Hardness **172 HV**

0.4% CMC: Larger Grain due to Slow Cooling

Performance & Sustainability

Wear Resistance vs. Hardness

Improved performance is driven by microstructural homogeneity rather than surface hardness alone.



AS-RECEIVED STEEL: Severe delamination & fragmentation

vs.

CMC QUENCHING: Adhesive Wear Dominance. Reduces severe delamination.

Sustainable Alternative to Oil

Eliminates fire hazards associated with oil quenching while reducing the distortion common in water quenching.

CMC Polymer offers a greener, safer pathway to achieving uniform microstructure and enhanced mechanical properties in 1020 steel.