The Effect of Different Rapidly-Composed, Biodegradable Hydrogel Formulations on Adhesion, Fire Retardation, and Viscosity

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Today, wildfires are increasing in prevalence and size. Biodegradable fire retardants are the solution to protect human property facing wildfire, because they eliminate environmental threats from fluorinated "forever" chemicals in traditional foams. Demonstrations last year showed that particle-polymer hydrogels are a promising biodegradable retardant solution. After water evaporation, they form aerogels to extend fire protection duration to >10x water alone. The principal drawback of these gels is the multi-hour formulation time that prevents creation with local water supply at the point of immediate need. This science fair project evaluates hydrogels after a single minute of curing, marking a 200x decrease over other hydrogel formulations. This speed ensures fabrication is consistent with using fire hydrants or natural water supplies close to the fire's edge. The aim of this paper is to identify the most functional, rapid, biodegradable hydrogel formulation in terms of adhesion, viscosity, and fire retardation. To test adhesion, a vertical lift test is used. Viscosity is tested with a dip-type viscosity cup. Fire retardation is tested using a butane torch and popsicle sticks as fuel. Hydrogel formulations include polymer at 1% to 3% by weight, colloidal silica particles (CSP) at 5% by weight, and water. Biodegradable polymers under test include: Methyl 2-hydroxyethyl cellulose (MHEC), chitosan, kappa-carrageenan, and konjac glucomannan. Water alone serves as control. A formulation of 0.75% kappa-carrageenan, 0.25% konjac glucomannan, and 1% MHEC with 5% CSP demonstrates the most compelling balance of performance attributes with a flame retardation of 20x water alone.

Awards Won:
Chemistry and the Law: Second Award of $3,000
YM American Academy: First Award of $3,000
American Chemical Society: Diploma of Recognition and $100 gift card
NC State College of Engineering: Alternates (not read aloud)