

TAKING THE MYSTERY OUT OF POLYMER ACTIVATION

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The most common question asked of us as dry polymer makedown equipment suppliers is "how do we know when the polymer is fully activated or hydrated?" The response is based on 25 years of experience making down all types of polymers from all of the different manufacturers. Today with so many equipment manufacturer's promoting different wetting technologies, now more than ever the answer is ultimately dependant on the selected equipment manufacturer. Different wetting technologies require more or less mixing, more or less aging, and are limited to a maximum stock polymer concentration. The need for an automated measurement device to help the operator know when the polymer solution has reached full activation has never been more necessary.

This article attempts to explain to the reader the principle behind dry polymer wetting, the parameter selected to indicate polymer activation, and whether we can measure this parameter in real time. Graphs from preliminary laboratory testing are also presented for discussion purposes.

Polymer Wetting

The single most important step in the preparation of dry polymer is polymer wetting or polymer dispersion. At the moment of initial wetting where the polymer and the dilution water first come together, it is critical to disperse the polymer into the dilution water effectively, wetting each individual polymer particle. High shear mixing energy is required at this step in the polymer preparation process. By doing so, the formation of polymer agglomerations and fish eyes is prevented. Furthermore, the rate of hydration of the polymer molecule is proportional to the square of the radius of the polymer particle. In other words, the smaller the polymer particle, the faster it hydrates, requiring much less mixing time (reduces chance of polymer fracturing). Often times the "aging" step (which follows mixing) can be eliminated all together. Other benefits may include the ability to prepare stock polymer at much higher concentrations, reducing system footprint and power requirements. As all dry polymer makedown systems utilize basically the same polymer mixing, the polymer wetting is what differentiates one system from another and, therefore, it is important that the wetting technology being considered be thoroughly evaluated.



In-Line Viscometer

Following the polymer wetting or dispersion step, the polymer solution must be mixed in a properly designed mix tank utilizing a low shear, low speed mixer. For how long depends upon numerous factors including the type of polymer, dilution water temperature, pH, hardness, TSS concentration, and chlorine content, and of course how efficiently the polymer was wetted. All of the above affects the rate of polymer hydration, how long it takes to become fully activated. If we can measure a parameter that indicates the degree to which the polymer is activated, then we can evaluate the performance of the polymer makedown system in real time. Yong H. Kim (*Coagulants and Flocculants, Theory and Practice, pg. 42, Tall Oaks Publishing Inc., 1995*) and others proved the validity of using viscosity as a measure of polymer activation. Today there is technology available to continuously measure viscosity of a given solution. The in-line viscosity measurement system is a highly sensitive, versatile instrument that measures process fluid viscosity in a fully flooded product stream. The viscometer is unaffected by changes in pressure or laminar flow. The viscosity sensor is a vibratory style sensor that generates a digital signal that is proportional to viscosity. A process sample is circulated through a sample chamber and presented to the vibrating probe. Electronics convert the response from the probe into



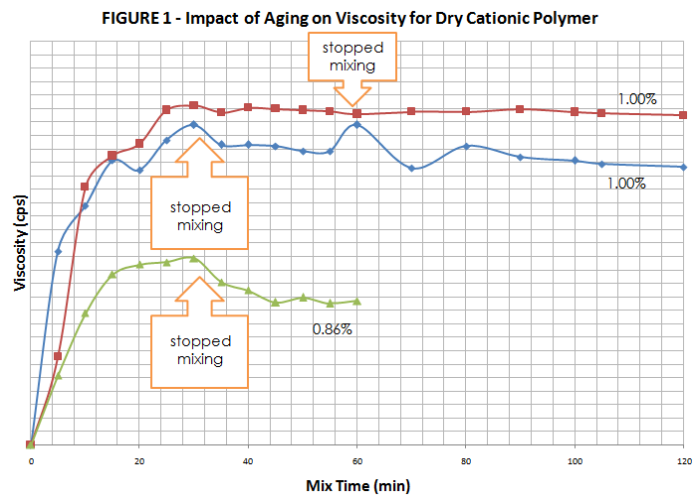
a 4-20 mA signal and a display controller is used to scale the viscosity response to the desired engineering units, read the temperature of the probe, and chart the viscosity.

An in-line viscometer was evaluated for its applicability for measuring the degree of dry polymer activation in real time. For the laboratory testing conducted, the in-line viscometer used drew a sample from the bottom of square mix tank containing a low shear, low speed mixer. The polymer mixing took place immediately following the polymer wetting, which occurred in a high shear mechanical wetting disperser unit. After the mix tank reached high level, a sample was continuously sent to the viscometer where it recorded the viscosity of the product solution over time. The in-line viscometer had no trouble reading the viscosity of the polymer solution.

Several scenarios were simulated in order to evaluate common polymer makedown system theories.

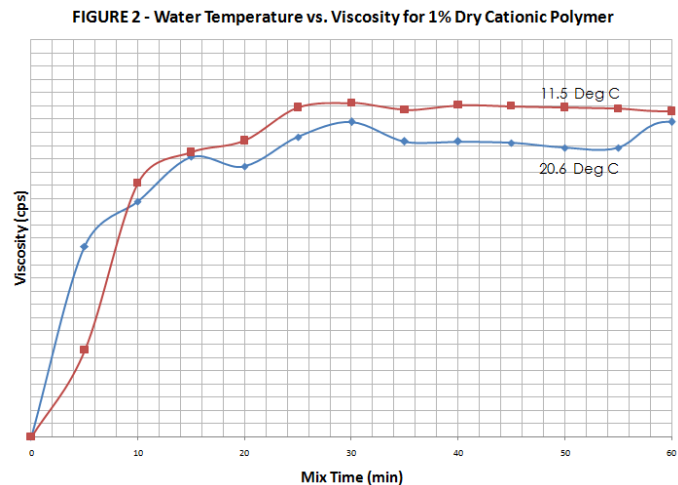
Polymer Solution Aging

Aging is the concept of allowing the polymer solution time to sit undisturbed after mixing and prior to feed to the process. The idea is that the polymer is allowed to finish the hydration process. Aging was common place at one time due to the fact that the polymer wetting stage was ineffective or even non-existent resulting in much larger polymer particles after wetting. As described earlier, larger polymer particles require much longer hydration times. During laboratory testing, none of the tests conducted showed any improvement in viscosity after the mixing stage was terminated. Furthermore, extended mixing provided no benefit to the polymer activation. Once the maximum viscosity was reached no further mixing or aging is required.



Dilution Water Temperature

Another common question asked is what is the benefit of using tempered dilution water when preparing polymer solution? Preliminary testing of two dilution water temperatures showed no benefit to using warmer water. More than likely, the negative impact on the polymer activation process will occur with really cold water in the 4 °C range. Due to the fact that our testing occurred in the middle of summer, we found it difficult to produce water at that temperature. Further testing in this area is required. However, it is presumed that the sole disadvantage of using lower temperature dilution water is that the required mix time to reach full hydration may be a little longer. Consideration for this likelihood should be incorporated into any polymer makedown system design.

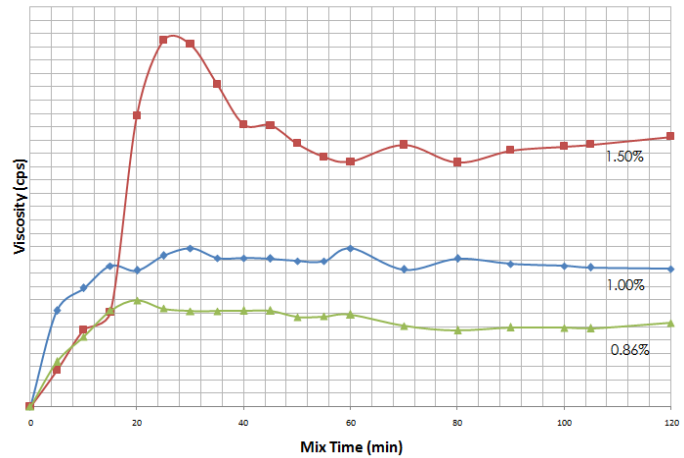


Stock Concentration vs. Mix Time

When designing a dry polymer makedown system it is beneficial to look at preparing the stock polymer solution as concentrated as possible, up to 1% for cationic polymer and 0.5% for anionic polymer, assuming proper polymer wetting. The advantages of such a design are: less potable water required (in a wastewater treatment plant we can use effluent water to post dilute to the final feed concentration), smaller mix tanks/day tanks, smaller mixers, smaller footprint, and more concentrated solutions have a longer shelf life. It has been expressed that higher polymer concentrations require much longer mix times to reach full hydration. This did not appear to be the case or at least the times were not significantly different. One interesting find was that concentrations greater than 1% may be possible and this idea will be investigated in future testing.

Keep in mind that the polymer solution must be ultimately pumped to the process and so performing pressure drop calculations (considering the polymer solution viscosity) when designing the feed pumps is crucial.

FIGURE 3- Concentration vs. Viscosity for Dry Cationic Polymer



Design Note: The polymer solution was re-circulated through the viscometer using clear vinyl tubing. Clear tubing allowed visual inspection of the polymer solution over time. The time at which the polymer particles were fully dissolved into a homogeneous solution corresponded to the peak or plateau on the viscosity versus time curve.

Although minimal testing was completed and the above results would need to be verified with further laboratory and field testing, the in-line viscometer appears to be a promising tool to evaluate a dry polymer makedown systems performance in real time. The viscosity can indicate the degree of polymer activation for every batch of polymer solution prepared. This can allow operators to better evaluate and understand their polymer makedown system and get a better handle on operating costs. Furthermore, designers now have a tool to use to evaluate one or more polymers during the design phase of a project to ensure a successful polymer makedown system project every time.

Full batches were not prepared due to time constraints. This may have caused excessive mixing energy in the mix tank that may help to explain viscosity deterioration during a few of the tests. A special thanks to Dan Veneruzzo of BASF for supplying us the dry polymer for our testing.