

TECHNICAL BULLETIN

The Challenges of Cold Diesel

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Summary:

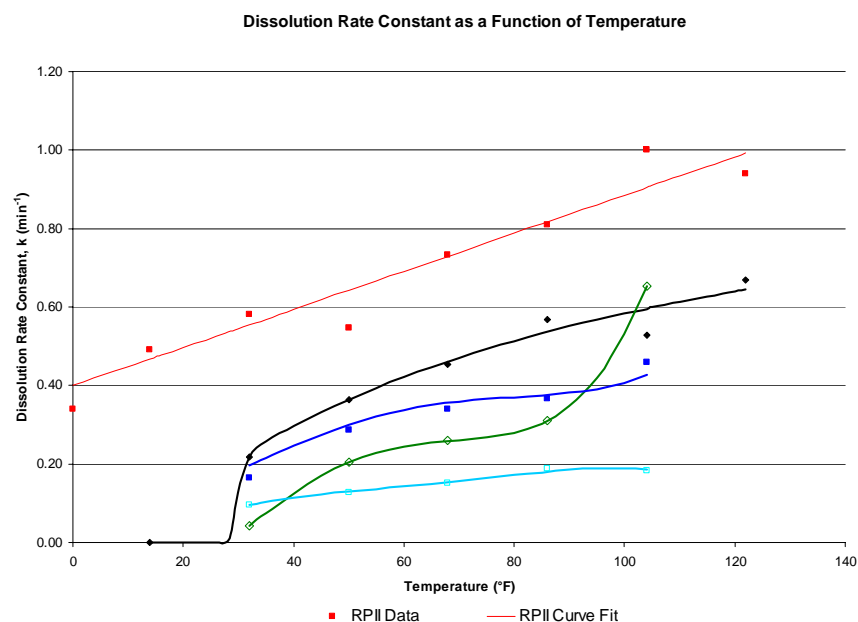
Dissolution of DRA polymers into cold diesel ($\leq 45^{\circ}\text{F}$) can be challenging. For example, some DRA polymers have poor dissolution properties while others may contain a small fraction of polymer that remains *undissolved* (reluctant fraction). This *reluctant fraction* can result in ***accelerating the pressure drop across filters at pipeline terminals and service stations***. CSPI identified and understands both of the phenomenons and through the use of the patented technology of RP™ II Flow Improver, dissolution can be maximized while eliminating reluctant fraction.

Background Information:

Under normal circumstances, when DRA is injected into a pipeline, the polymer will *dissolve* (become active and provide drag reduction); then *shear* as it is subjected to forces present in the pipeline. As stated above, injecting drag reducer into cold diesel can result in the DRA polymer having difficulty dissolving appropriately.

The patented technology used in RP™ II Flow Improver maximizes the *bulk dissolution rate*. A good bulk dissolution rate is necessary for all expected temperature ranges of refined products to assure the DRA polymer properly dissolves and shears in the refined product.

The adjacent graph represents the relationship between the bulk dissolution rate and diesel temperature. RP™ II Flow Improver is illustrated in red while other active DRA products are represented by the remaining traces.



As shown, RPT™ II Flow Improver not only has a faster rate of dissolution, but it also has an added benefit of dissolving in colder diesel temperatures.

Another common issue associated with injecting DRA polymer into cold diesel is the presence of *reluctant fraction*. This phenomena is defined by a small fraction (<1%) of the polymer *failing to dissolve* within normal DRA usage timelines. The reluctant fraction will travel down the pipeline in a molecular form similar to a tangled ball of yarn. When the polymer remains tangled and *undissolved*, it fails to provide drag reduction and also fails to shear degrade. The *undissolved / unsheared* polymer may eventually dissolve in filters which can accelerate the pressure drop in the system. *Reluctant fraction* and its impact on filter life correlate with DRA type, amount of DRA injected (ppm), and diesel temperature. The end result of reluctant fraction is substantially reduced filter life and frequent filter changes to prevent filter collapse – resulting in a winter maintenance aggravation.

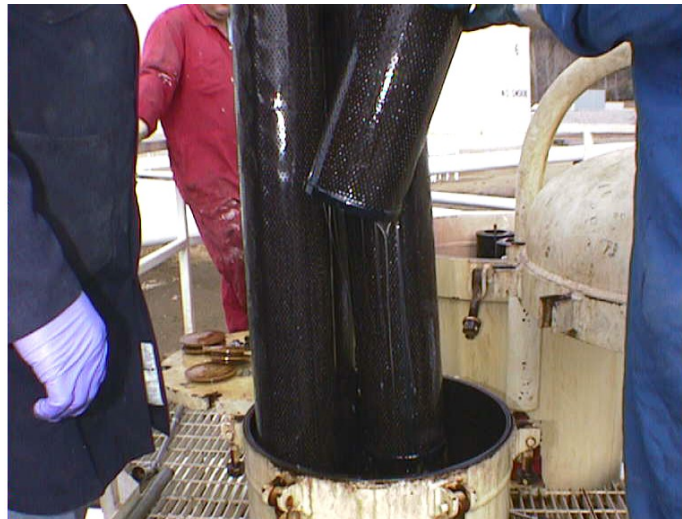
Although both reluctant fraction and decreases in dissolution rates are both cold diesel phenomenon, DRA polymers can exhibit good dissolution properties while still maintaining a portion of reluctant fraction. The patented technology used in RPT™ II Flow Improver exhibits maximum dissolution rates while eliminating reluctant fraction.

Identifying Reluctant Fraction:

DRA related filter issues are usually identified when filters are removed. The filters typically appear clean, but an elastic polymer strand will be observed when inspecting the filters.

Reluctant fraction is not the only phenomena that can cause accelerated pressure drop across filters. Other factors can cause similar problems that are unrelated to reluctant fraction. Anytime an *unsheared* active polymer reaches a filter there is an increase in *extensional viscosity* resulting in an increase in pressure drop over the filter.

If a pipeline is having filter problems related to DRA, three possibilities should be considered:



First, if a gel DRA is injected, it is likely related to injection dynamics resulting in a broken gel strand. The broken gel strand or clump of undissolved gel will likely accumulate on filters. While this is not considered reluctant fraction, the effect of this gel clump is identical to reluctant fraction – increased pressure drop over a filter due to increased extensional viscosity. The solution to this problem is to repair the injection dynamics or replace the product with a suspension DRA.

Second, if DRA is injected into a static line, the gel or suspension DRA can accumulate into a clump at the injection point and the DRA will not have adequate surface area exposed to the hydrocarbon to dissolve. The undissolved DRA will likely accumulate on filters. While this is not considered reluctant fraction, the effect of this DRA clump is identical to reluctant fraction – increased pressure drop over a filter due to increased extensional viscosity. The solution to this problem is to tie the injection skid into the station programmable logic controller to eliminate injecting into a static line.

Third, in rare cases, the DRA polymer can fully dissolve, but may be exposed to inadequate shear. The *dissolved* and active polymer will show extensional viscosity effects and likely concentrate on filters. The solution to this problem is to add a shear point upstream of the filter (i.e. orifice plate). The shear

point can shear the polymer enough to flow through the filter without significant extensional viscosity effects. Adding a shear point upstream of the filter will not solve problems associated with reluctant fraction because it only works in systems where the polymer is dissolved and reluctant fraction is based on conditions where the polymer does not dissolve.

Preventing Reluctant Fraction:

RP™ II Flow Improver was developed to solve the reluctant fraction problem by ensuring maximum polymer dissolution in fuels at all pipeline temperatures. This is achieved by maximizing the dissolution rate of the polymer in the pipeline so that it can adequately shear prior to filter contact. Ultimately this minimizes filter problems while increasing their life cycle.

CSPI uses two test methods for identifying reluctant fraction in cold diesel systems. The first is a polymer detection technique developed by our in-house analytical services group. The second, more practical, approach is the Cold-Shear Warm-Filtration Test™. This test can give an indication of whether a DRA polymer is likely to exhibit reluctant fraction by mimicking pipeline operations. For example, DRA is added to cold diesel (38°F). The mixture is then agitated to mimic pipeline conditions. The diesel sample with the DRA is then passed through a fine filter (~5 microns). The time required to pass through the filter is compared to the time a similarly processed diesel sample (without DRA) takes to pass through an identical filter. If the difference in filter times is minimal, reluctant fraction is likely not present.

Conclusion:

Cold diesel filtration problems due to DRA can be prevented. Tests are available to evaluate DRA polymers for reluctant fraction prior to injection into pipelines. CSPI manufactures RP™ II Flow Improver which uses patented technology to maximize dissolution and minimize reluctant fraction, filtration problems, and winter maintenance aggravation.

For further information or inquiries, please reference CSPI's website: www.LiquidPower.com