DRAG REDUCTION

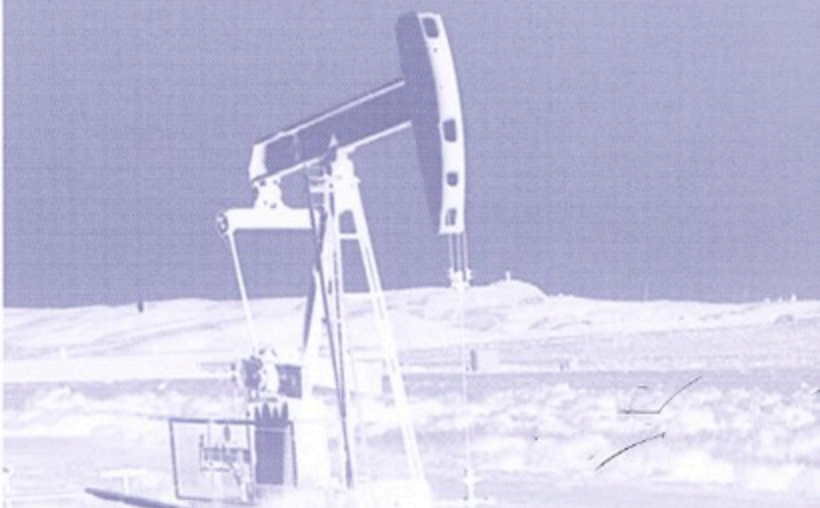
DR 7000 range of polymers to increase water injection capabilities

SNF FLOERGER®

Why use a Drag Reducer ?

Within any given oil field, the amount of water injected into a reservoir for sweep efficiency, pressure maintenance and voidage replacement can be severely limited by existing water injection facilities. Once this limitation is reached, injection facilities must be upgraded to increase injection capacity, if not, ultimate oil recovery could be reduced. In most cases, facilities upgrades of this type require significant capital investment and may not be feasible due to logistics or platform loading.

SNF's DR range of polymers increases injection capacity and flowline performance by reducing the turbulence at high Reynolds numbers, thus reducing the amount of turbulent flow friction. Typical drag reduction effect is 25-50%. DR polymer is added to the injection system continuously at low concentration and requires minimum capital costs to initiate.



Oil Field Applications

- *Increase water flowrate into injection wells*
- *Increase bottom hole pressure*
- *Reduce operating costs in water injection facilities*
- *Operate injection pumps at lower speed to increase operating life*
- *Reduce the level of corrosion*
- *Temporarily use to increase the injection rate in parts or whole fields to make up voidage ratio lost during downtime or high production rates*
- *Used from the beginning of injection to minimise capital expenses by allowing design of smaller pipelines or tubing*
- *Production wells with high water cut*
- *Water pipelines*
- *Oil pipelines having more than 10% water cut*

Drag Reduction

DR 7000 range of polymers to increase water injection capabilities

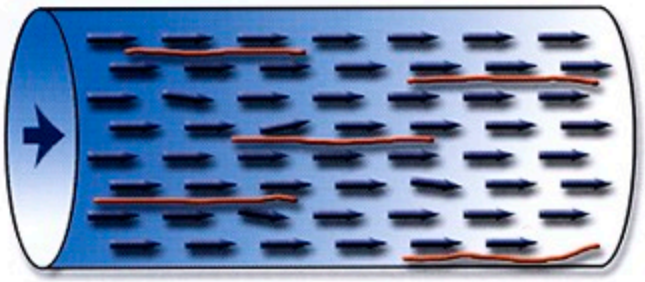
Technical details

SNF's Drag Reduction (DR) range of polymers are partially hydrolyzed, high molecular weight polyacrylamide emulsions, specifically developed for drag reduction applications.

They are environmentally safe, contain no alkylphenols and have a category C toxicity classification. The polymers are easy to handle and can be used in sea water, produced water or fresh water injection. Typical use concentration is around 50 ppm (0.018 lb/bbl).

The DR range of polymers are EOR grade and do not cause wellbore plugging or loss of injectivity. They can be added to the low pressure (suction) side of the injection pump or to the high pressure (discharge) side.

Turbulent flow without DR 7000

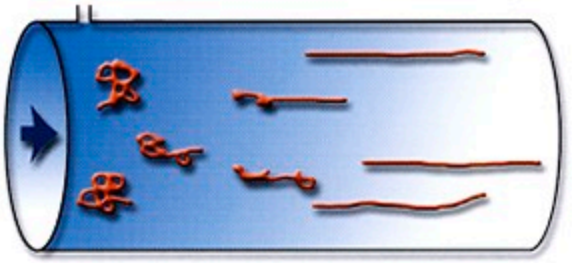


More laminar with DR 7000

Mechanism

DR Polymer can be effective where the Reynolds number is above 3000. In pipeflow, individual polymer molecules uncoil and become extended to create a more regular flow.

Polymer injection



These large molecules dampen some of the turbulent energy, suppressing the turbulent zone away from the pipe wall. This reduces the loss of radial kinetic energy and increases the intensity of the axial energy, creating resistance to the flow in the pipeline.

Reduction of frictional pressure can be utilised to increase the flowrate or decrease the pressure loss, which in turn can increase the bottom hole pressure in injection wells. In production wells or flowlines, this reduction of pressure loss can be used to increase the flowrate by reducing the back pressure on the well. In field applications, there is usually a combination of flowrate increase and friction pressure reduction.

Drag Reduction is the difference in frictional pressure drop along a segment of pipeline at a constant flow rate.

Drag Reduction

$$\% \text{ Drag Reduction} = \frac{(\Delta P_f)_{untreated} - (\Delta P_f)_{treated}}{(\Delta P_f)_{untreated}} \times 100$$

(ΔP_f) : Pressure drop due to friction

Pressure drop due to friction

$$\Delta P_f = \frac{fL\rho\, v^2}{28.5d}$$

L = length (ft)

f = Fanning friction factor

(ΔP_f) = pressure loss

v = velocity (ft/sec)

ρ = density (lb/gal)

The Fanning friction factor (f) is determined from a plot of Reynolds n° vs. f.

Reynolds N°

$$Re = \frac{928dv\rho}{\mu}$$

Re = Reynolds n°

d = diameter (inches)

μ = viscosity (cp)

Turbulent flow for Re > 3000

Field procedure, treatment and performance

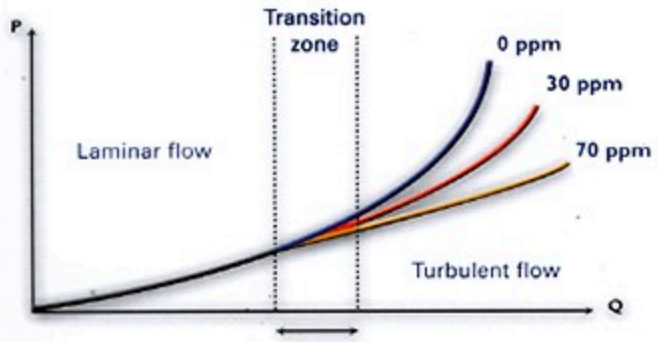
DR Polymer is injected on the fly directly into the flow line which allows quick and easy placement. The polymer is mixed by the turbulence in the pipeline. Injection is accomplished with a small chemical pump. In cases of multi-phase flow, the polymer may require pre-inverting in water before it is injected into the pipeline.

DR Polymer is added to the pipeline continuously at low concentration (25 to 100 ppm) and Drag Reduction begins to be measurable almost immediately following the start of DR injection and increases until all the fluids in the line contain drag reducer. This is normally reached in a matter of hours. Conversely, the benefits are diminished once the injection is halted.

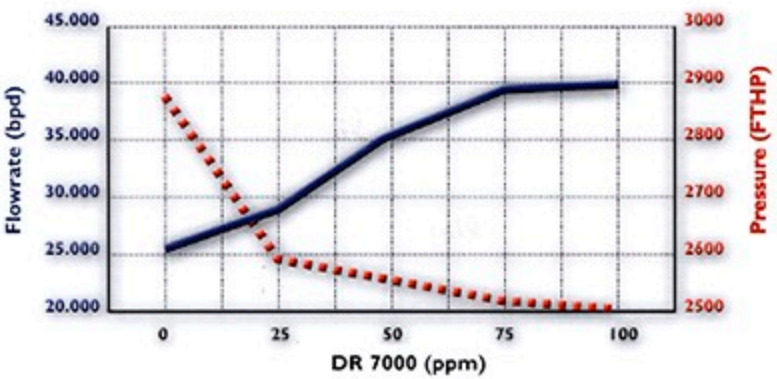
A typical field test consists of the following:

- *Establishing baseline conditions.*
- *Injecting the DR Polymer at dosages of 25 ppm increments from 25 ppm to 100 ppm and plotting the pressures and flowrates as a function of DR concentration.*
- *Analysing the test data to determine the optimum concentration of DR to add continuously.*

Pressure Loss versus Flow Rate



Example of Field Trial Data



A complete package for Drag Reducer applications

SNF engineers and chemists can assist in the design and operation of a field project or trial. The first step is to run a flow simulation to screen the candidate, followed by a field trial if conditions are favourable. A field trial is simple and easy to set up and it quickly shows the optimum drag reduction effect that will be expected from a full implementation.

Different grades of DR Polymer have been developed for various field conditions like water salinity, water temperature, storage temperature and multiphasic flow. A range of active content from 30% (DR 7000) to 50% (DR 7500) is available depending on field conditions.

Some of the services offered to support field projects are listed below:

- *Computer flow simulation to screen the project for DR application*
- *Complete laboratory services to support field projects*
- *Reservoir engineering and project design*
- *DR optimised to specific field conditions*
- *Chemical injection equipment specification, design and manufacture*
- *Field engineers and chemists for trial and project start-up*
- *Project monitoring*

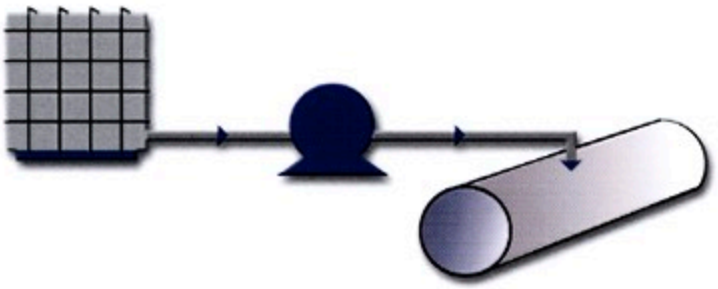
Equipment

Equipment can be designed and manufactured for specific field conditions.

Chemical pump (DR injection pump)

Small progressive cavity pumps are usually used for their easy maintenance and low shear. These pumps are optimized for injection pressure and flowrate.

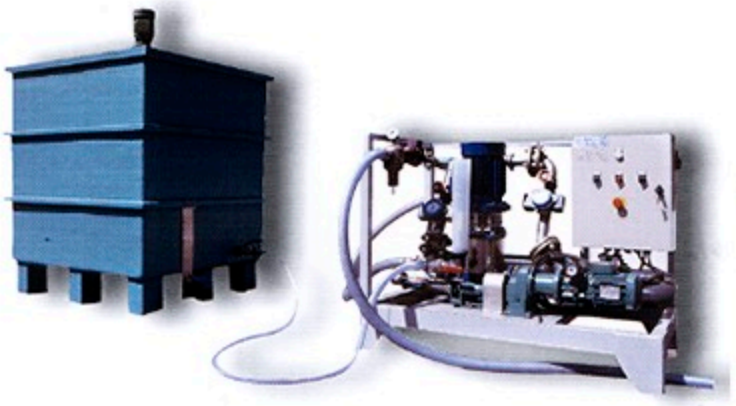
Direct injection into the flow line



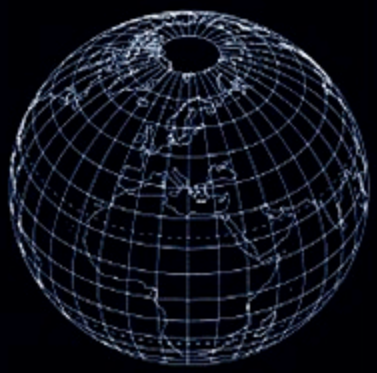
FLOQUIP®- DE

Floquip DE is a stand-alone polymer makedown system designed to dilute and activate emulsion polymers. It consists of a progressive cavity pump, a water flow regulation system, a dynamic and a static mixer and an electrical control panel.

The neat emulsion polymer is pumped from the container and injected into the suction side of a stainless steel dynamic mixer to initiate the inversion of the emulsion. A second water adjunction and a static mixer post-dilutes the polymer solution.



FLOQUIP®- DE



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