
Kind Of A Drag - Boosting Crude And Products Pipeline Capacity With Drag Reducing Agents

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The capacity of a pipeline built to transport crude oil or refined products is often thought to be tied only to the pipe's diameter and pumps, as well as the viscosity of the hydrocarbon flowing through it. Increasingly, though, midstream companies are injecting flow improvers—special, long-chain polymers known as “drag reducing agents” —into their pipelines to reduce turbulence, thereby increasing the pipes' capacity, trimming pumping costs or a combination of the two. The role of these agents has evolved to the point that they aren't simply being considered to boost existing pipelines, their planned use is being factored into the design of new pipes from the start. Today we begin a series on DRAs and their still-growing influence on the midstream sector.

The Shale Revolution has had as big effect on pipeline companies and other midstream players as it has on producers. As new production areas have emerged and some older ones have faded, a number of the crude oil, natural gas, natural gas liquids (NGL) and refined-product pipelines built decades ago have been reversed and/or expanded—and new pipelines have been built—to meet the needs of the *new* order. Growth in Western Canadian oil sands production has spurred the need for new pipeline capacity too. We've blogged extensively about the build-out of crude oil pipeline infrastructure, which continues to this day, despite the overall decline in crude production since the collapse of oil prices in late 2014 and 2015 (see [This Pony Knows More Than One Trick](#), [Tighten Up](#) and [Let Your Crude Flow](#) for some recent examples). We've also discussed the capacity challenges facing the nation's refined-products delivery networks, the Colonial Pipeline from the Gulf Coast to the Northeast chief among them (see [Move It On Over](#) and [Looks Like We Made It](#)). And, in our [Hey Crude](#) series, we took a nearly comprehensive look at crude pipeline economics; the only thing we didn't get to in that series was drag reducing agents (DRAs), which we take up today.

While it might seem reasonable to think that refined-products like motor gasoline and diesel and all but the heaviest, thickest crudes flow through pipelines with relative ease, that's not the case. In fact, flows through crude and refined-products pipelines operate within what's referred to as a “turbulent flow regime” can be anything but efficient. Within a turbulent flow regime, fluid molecules move in a random manner, and much of the energy applied to them (by pumps and/or downhill gradients) is wasted as eddy currents and other haphazard swirling as the crude or refined product sloshes toward its destination. As the throughput is ramped up, the turbulence increases significantly, causing higher operating pressures and limiting further increases in the throughput. Reducing that turbulence—and the “frictional pressure drop” or “drag” that it creates—is the aim of DRAs. It's worth noting up front that DRAs are used almost exclusively on *transmission* pipelines, which either transport hydrocarbon liquids from the central collection points of gathering systems to refineries or storage facilities, or transport refined products (motor gasoline and diesel, but not—as we'll get to—jet fuel) from refineries to storage, distributors or end users. It typically does not make economic sense to use DRAs in oil gathering systems, however there are exceptions where significant production increase from a given multi-well pad or a field through the existing infrastructure can be achieved by the use of DRAs. We also should point out that while DRAs are not (to say the least!) a common topic of discussion, we understand that roughly three-quarters of the crude oil and refined products barrels flowing through U.S. pipelines as you read this have been DRA-treated.

We will try our best not to cause flashbacks to a painful and confusing physics course you may have taken, but to understand how flow improvers reduce pipeline turbulence, we need to briefly explain the three parts of turbulent flow. The “turbulent core” (light blue section of pipe in Figure 1) takes up most of the pipe's internal diameter and accounts for the vast majority of the fluid flowing through the

pipeline; the flow of the turbulent core (to left of “flow improver injection site” at top-center) is random and raucous, but moving forward at a frenetic pace (like the I-610 around Houston when the traffic’s light). Along the pipeline wall, the “laminar sub-layer” (grey sections) where the fluid moves laterally in sheets, and between it and the turbulent core is the “buffer zone” (green sections).

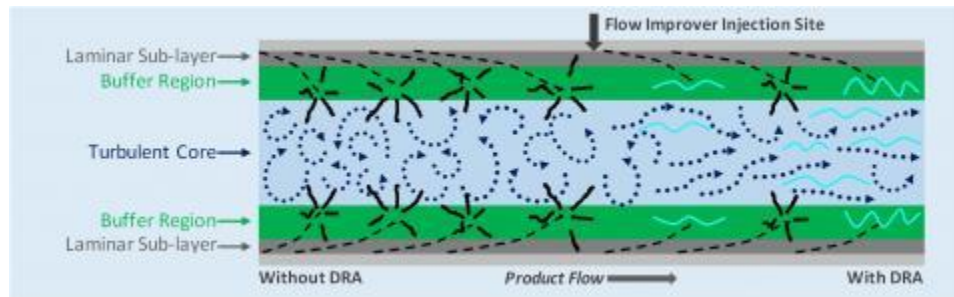


Figure 1; Source: LiquidPower Specialty Products Inc.

The buffer zone, while small, is critically important, because it’s where slivers of the laminar sub layer (called “streaks”; the arc-like black-dashed lines in grey section) occasionally slough off into. There, these streaks swirl, then break up and splash into the outer edge of the turbulent core in what are called “bursts” (star-shaped icons in green sections). This is where DRAs come in. DRAs are ultra-high molecular-weight, long-chain polymers (wavy blue lines in Figure 1 within buffer zones and turbulent core to right of flow improver injection site) that are injected into pipelines just downstream of pumping stations. Once there, these long polymers (think wet, flexible strands of spaghetti) act like shock absorbers, “catching” the streaks as they slough off the pipe wall and thereby minimizing the turbulence the streaks would otherwise have created. Long story short, by reducing the turbulence within the pipe, DRAs ease the flow of crude or refined products through the pipeline, which increases the volume of fluid that can move through the pipe within any given period of time with the same amount of energy applied to the system.



DRA injection site on crude oil pipeline; Source: LSPI

There are four ways that a midstream company might apply the benefits of DRAs. The first (and the one that typically provides the biggest bang for the buck) is the one we just mentioned—namely, increasing the capacity or throughput of a pipeline from end to end (say, from 200 Mb/d to 300 Mb/d)

and earning the incremental revenue as a result. (Tomorrow—Thursday, January 19—Enbridge Energy Partners will end a binding open season for a proposed capacity expansion on its Enbridge Ozark Pipeline that will be achieved by a combination of adding DRAs and increasing the horsepower at pump stations. The 433-mile pipeline transports crude from Cushing, OK hub to Wood River, IL.) As we'll get to, DRAs have the potential to double pipeline throughput, often at a cost of only a few nickels per incremental barrel.

The second use of DRAs is removing constraints or bottlenecks within a specific portion (or portions) of a pipeline. Third, by reducing the drag within a pipeline, DRAs can be used to reduce the operational pressure (or need for pumping), thereby saving energy costs with no reduction in throughput. And fourth (and this is a variation of #3), if an operator is directed to reduce the pressure in a pipeline (maybe because it's old or has been damaged), the addition of DRAs can allow throughput to be maintained at existing levels when the pressure is cut. Another variant of #3 is when the pipeline shuts down intermediate pump stations to save on the operating costs or for temporary maintenance purposes.

Before we go any further, we should interject a few important facts regarding DRAs. For one, the volume of DRAs injected into pipelines is minimal compared to the volume of crude or refined products, typically measured in parts per million, or PPM. For another, DRAs do not change the chemical composition, density or viscosity of the fluids—crude, motor gasoline or diesel at the end of the pipe is virtually identical to the crude, gasoline or diesel that was fed into the pipe. (Nor do DRAs “coat” pipeline walls—a common misconception.) And one more fact: the long, spaghetti-like strands of DRA take a beating and gradually break apart as they flow downstream, and whatever is left of them is torn to bits when they reach pumping stations (where the churning resembles the innards of a kitchen blender stuck on “high”). That explains why another injection of DRAs is typically made just downstream of each pumping station.

As we'll get to in more detail in the next episode in this series, DRAs are generally most effective in reducing turbulence—and increasing capacity—in pipelines that transport either refined products or lighter crudes such as condensate, West Texas Intermediate (WTI) or Louisiana Light Sweet (LLS). This is true largely (and ironically, in a sense) because these fluids, with their lower viscosity and easier flow, create more turbulence as they move through pipes than do higher viscosity crudes and blends such as “diluted bitumen” (dilbit; see [Heat It](#) for more on dilbit), or Mexican Maya, whose flows more closely resemble thick maple syrup or even molasses than water or tomato juice. However, new DRA technology has been developed and commercialized specific to “heavy” crudes such as dilbit. Next time, we'll also summarize the development of DRAs over the past 40 years, examine the mechanics and the costs associated with adding DRAs, and provide some specific examples of how DRAs are helping to improve the flow of crude and refined products to their destinations.

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“Kind of a Drag” was a 1967 hit for The Buckingham and the title of the Chicago-based pop group's debut album.

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