

Summer Project

The Effect of Drag Reducing Agent on Intake Valve Deposit

Prepared
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INTRODUCTION:

My summer training was in Aramco Company, in the research and development center (R&D C).

Research & Development Center:

The Research and Development Center reflects the Aramco's continuing and expanding commitment to the future of petroleum research, to development in the Kingdom, and to achievement in research. This new facility will enable scientists and engineers to effect a shift in focus from service orientation to a blend of specialized services and applied research.

Saudi Aramco President and CEO Abdallah S. Jum'ah said "Research and development work is not new to us at Saudi Aramco. What's new about this project is that it provides a better work environment for the scientists of our company to help unleash their innovation and creativity. The nature and size of our oil fields and the huge magnitude of our operations as the largest integrated petroleum company in the world, and the operational challenges that we face during the execution of our activities, pose unique challenges and require solutions that cannot be brought in from somewhere else in the world."

Research-capaplties

With completion of the new, state-of-the-art Research and Development Center, Saudi Aramco has made a strong commitment to expand applied R&D by developing innovative techniques and acquiring advanced technologies. Research within the R&D Center is focused upon both upstream and downstream corporate operations. In addition, emphasis is placed upon providing research in the material and analytical sciences.

Upstream research provides integral support to all phases of petroleum and gas recovery. Applied research encompasses the application of geochemistry, petrophysics, hydrocarbon phase behavior, formation damage-stimulation and drilling fluid analysis. The utilization of geochemistry has helped to reduce exploration risk, thereby enhancing the development of existing fields.

Research in gas recovery, refining and oil transportation is providing improved support to downstream customers. Hydrocracker and Reformer Pilot Plants allow scientists to optimize catalyst selection and to evaluate new fuel products. Also, research will focus on new technologies for cleaner fuels and fuel additives designed to improve quality and performance.

Summer project:

My summer training was in Aramco Company, in the research and development center (R&D C) in the crude evaluation unit.

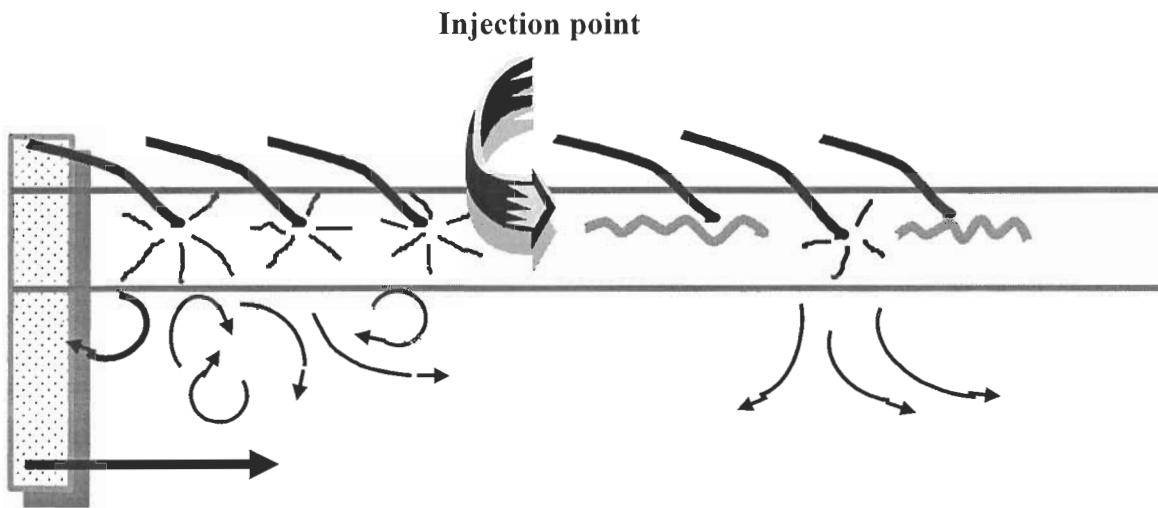
The idea of my summer project was based on a real problem they faced in the R&D center. They wanted to increase the production rate of crude in north Riyadh coming from Dhahran. So, they thought about increasing the size of the pipeline, but it was expensive and time-consuming. Then, they thought about the drag reducing agent and it did work. After few years, large car companies like BMW and Mercedes started to complain about the gasoline because it affects the performance of the car and other mechanical problems. So, the R&D center started to do tests on a laboratory engines and they found that the drag reducing agent actually increase the deposits on the engine parts especially the intake valve. So, they came up with a detergent that takes away the deposits formed by the drag reducing agent.

My summer training was about doing the tests that relate the affect of the drag reducing agent and the intake valve deposition. Also, I did the specification tests of the gasoline that used in these tests. Moreover, I attended a lot of meeting and presentations about different subjects.

DRAG REDUCING AGENT:

Drag reducers are high-molecular-weight polymers that improve the fluid flow characteristics of low-viscosity petroleum products. As energy costs have increased, pipelines have sought more efficient ways to ship products. Drag reducers lower pumping costs by reducing friction between the flowing gasoline and the walls of the pipe.

When they are injected into pipeline these long chain polymers interact with small scale flow disturbances that develop into large scale turbulent structures. These interactions interfere with the development of large scale turbulent flow structures resulting in a reduction in the amount of turbulent flow in the pipe. This reduction in turbulence results in a reduction in the frictional pressure loss for a given flow rate.



The long chain polymer are broken up in regions of flow where high shear is present such as pumps or through pipe sections with numerous elbows. Once broken up these types of DRA no longer exhibit any significant drag reduction. There are also other types that are able to reform after passing through regions of high shear. I did not know which type I was working on, because it is confidential information and the policy of the R&D Center does not permit that.

Advantages of DRA:

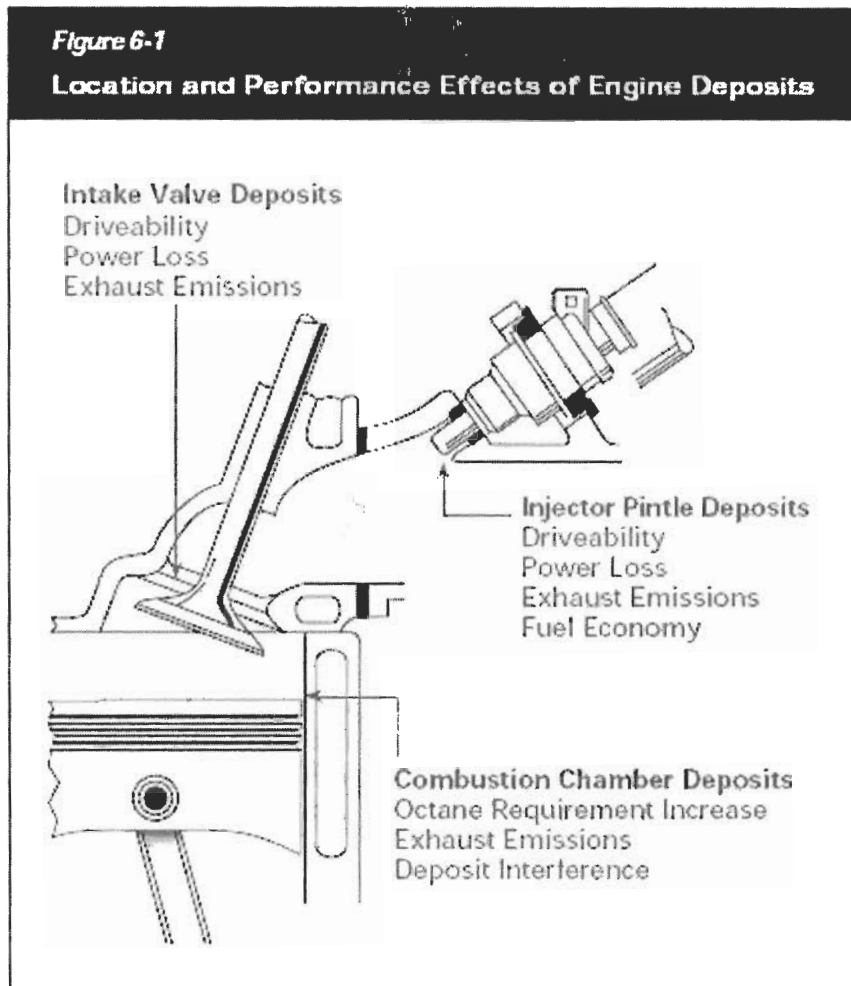
Capacity may be increased by installing more pumping power on the pipeline system, by installing parallel pipe sections or by increasing the diameter of the mainline pipe. The installation of new pumping facilities or additional pipe is a big investment and is a time consuming process. A DRA injection installation, in its simplest form, consists of an injection tap, and injection pump, and a DRA storage tank as in this picture taken from Aramco field.



This typically requires a much smaller investment and can be quickly installed at almost any existing facility. The DRA injection equipment can also be easily relocated to other locations should operational needs change in the future. Since DRA injection equipment can be deployed quickly, it can be used to provide short term increases in capacity if required. So, it can be injected into specific commodities and at specific rates to meet the required goals of increased capacity and improved operating costs.

INTAKE VALVE DEPOSIT:

The schematic in the Figure shows the critical areas of deposit formation and the associated performance impacts. My work was focused on intake valve deposits only.

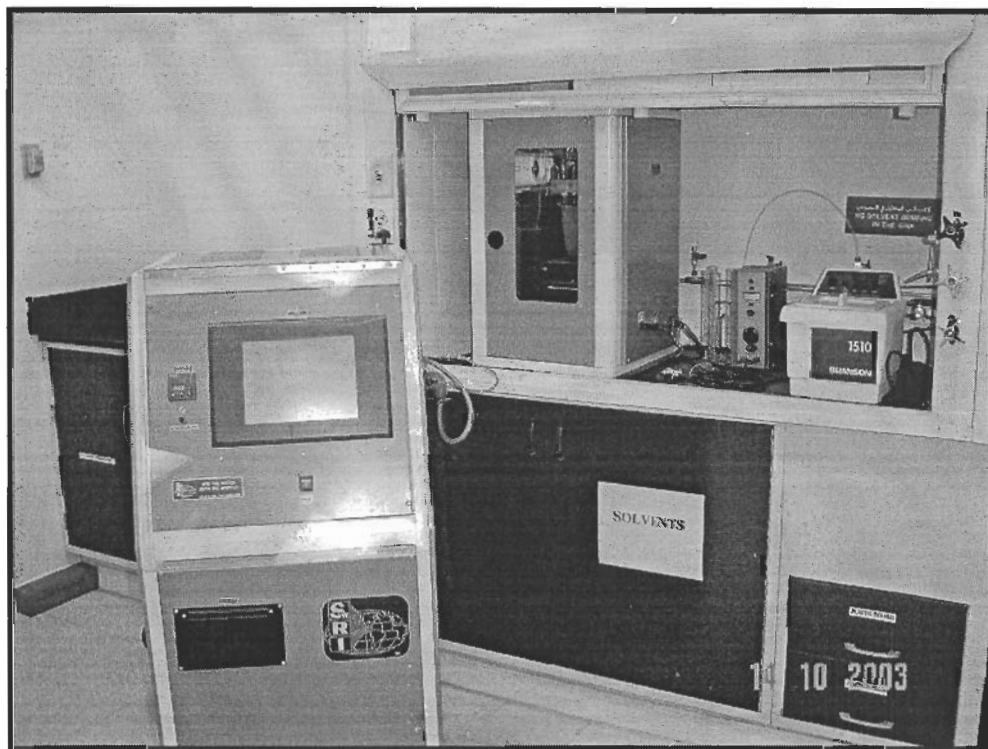


Intake valves are subject to more deposit build up because they operate at higher temperatures. Heavy valve deposits reduce maximum engine power because they restrict air flow and also reduce fuel economy. Intake valve deposits also have been shown to affect exhaust emissions by increasing them, particularly VOCs and NOx. In some very sensitive modern fuel-injected engines, low levels of intake valve deposits can degrade cold start and warm-up driveability. Other valve deposit problems include valve sticking in very cold weather, because deposits interfere with the valve stem sliding in its guide. Also, severe deposits prevent the valve from seating properly.

The precise reaction mechanism responsible for fuel-related deposit formation has not been identified. Generally, it is clear that deposit formation is both time and temperature dependent and may be broadly categorized as follows:

- Auto oxidation, self catalyzed oxidation not directly involving the container surface, typically observed in long term storage environments.
- Thermal oxidation, fuel flowing over hot surfaces of 150 degree C and above, typically observed in operating equipment away from the combustion zone.
- Pyrolysis, decomposition of fuel and thermal oxidative deposits on very hot surfaces, typically close to the combustion zone.

This is a picture of the machine I was working on; this is a test apparatus that has the same conditions like an engine (laboratory engine).

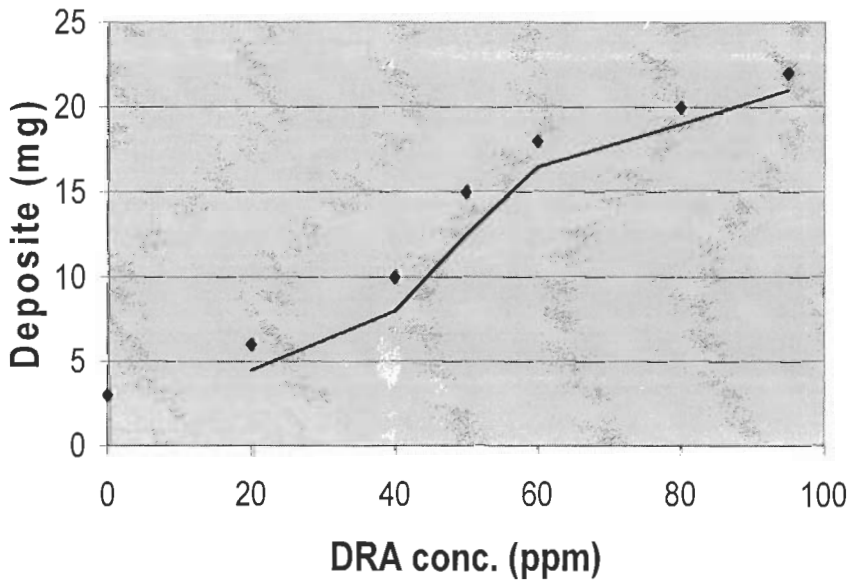


I focused my work on the deposits from the DRA by using the same gasoline (from the same batch) and changing the DRA concentration.

The data I got from this laboratory engine, after calculations:

DRA conc. (ppm)	Deposit (mg)
0	3
20	6
40	10
50	15
60	18
80	20
95	22

Intake Valve Deposition (IVD)



This graph shows clearly the effect of the drag reducing polymer on the deposits of the intake valve in the engine.

The specification of the gasoline used:

Analytical Test	Units	Test Results
Distillation		
IBP	°F	92
10%	°F	120
50%	°F	193
90%	°F	337
95%	°F	370
FBP	°F	411
Sulfur Content	ppm	1163
MTBE	wt%	9.36
Benzene Content	wt%	0.82
RON		95.0
FIA Test		
Aromatics	vol%	35.2
Olefins	vol%	23.3
Saturates	vol%	41.5
washed wt.	mg/100 mL	1.0
Potential Gum		
unwashed wt.	mg/100ml	19.3
washed wt.	mg/100ml	14.5
Oxidation Stability	1440 min.	No Break

Other contributors to intake valve deposits:

- Short driving cycles.
- State of tune up.
- Cylinder head temperature.
- Heat retention of valve.
- Angle of spray pattern to valve.

Engine control technology.

Fuel compositions – olefins, diolefins, sulfur contents.

Level and type of gasoline additive treatment.

CONCLUSION:

Drag reducing agent is used to increase the production rate of the crude oil that pass through pipelines. DRA reduce the friction between the crude oil and the pipelines which means with the same pump pressure used before we can get more crude production rate. DRA are high molecular weight polymers that decompose in the engines causing additional deposits and as the DRA concentration increase the deposits also increase. In order to get rid of the deposits caused by DRA, detergent should be used. A three dimensional graph relating DRA, detergent and intake valve deposit will give us the right amount needed of the detergent.

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