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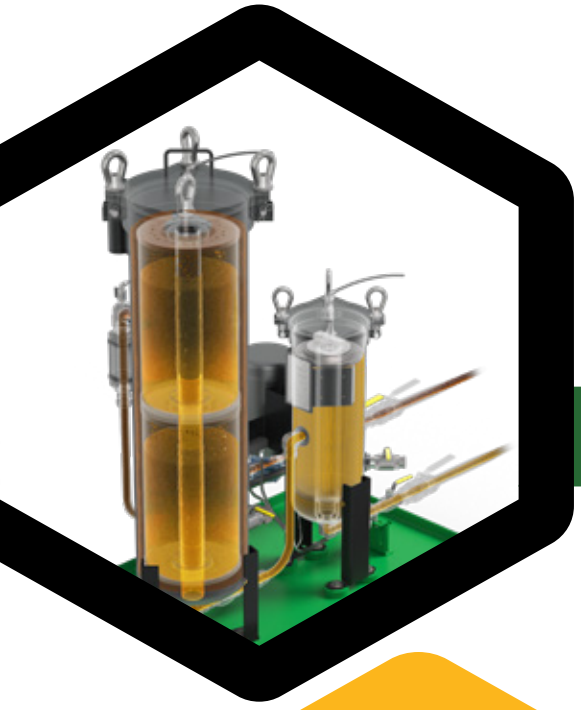
LUBRICANT CHEMISTRY MANAGEMENT



Case Studies

Turbine Lubricant Varnish Removal

Studies using SVR®

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There are 1000's of SVR installations on turbine lubricant reservoirs operating throughout the world. These systems have gained an industry leading reputation for reducing and maintaining low varnish potential including many sites where competing systems have failed.

Each SVR installation is supported by a team of experts who will ensure that results are achieved and documented at your facility. This support is included with the purchase of each SVR.

Attached are case studies that demonstrate typical results. Once an SVR is installed, the lubricant enters a "Restoration phase" that lasts 3-4 months on average. During this phase, previously deposited varnish dissolves back into the purified lubricant where it is removed by SVR. During this clean-up period, the MPC values fluctuate as the varnish content of the fluid varies. Once varnish deposits are removed, varnish is continually removed as it forms and the lubricant enters a "Stability phase" where MPC values are maintained at <15 (ASTM 7843). Because varnish is continually removed as it forms during the stability phase, varnish does not accumulate in the lubricant reducing the risk of varnish formation to nil. For privacy, all customer specific information has been removed.

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Case Study 1

Turbine Lubricant Varnish Removal Using SVR®

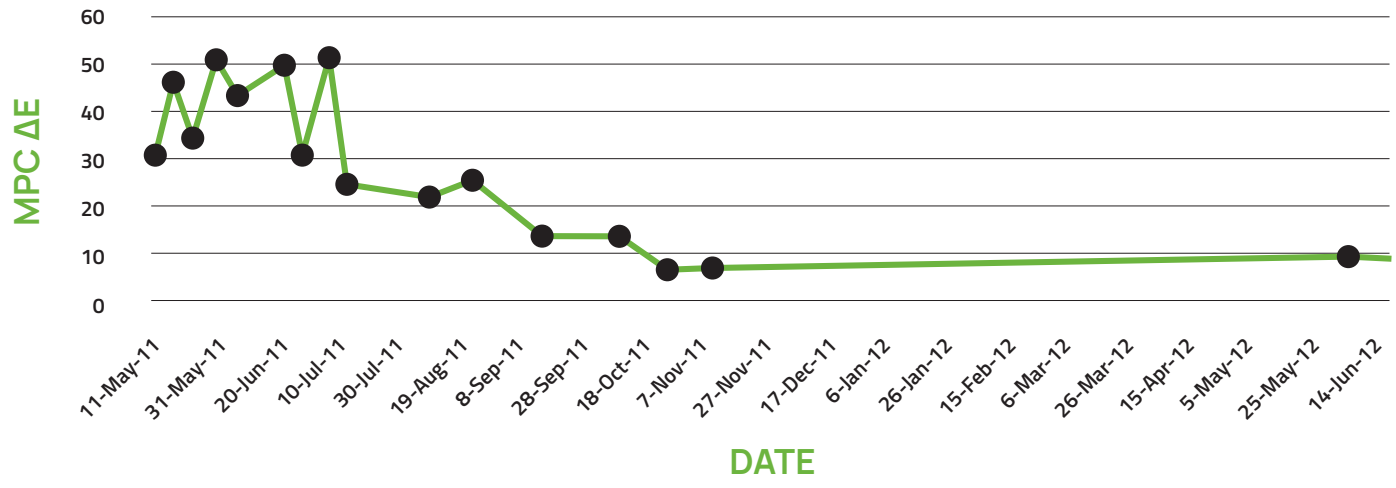
CASE STUDY #1

Location: *MD, USA*
MW: *350 MW*
Turbine Type: *ST, GE*
Oil Type: *Mobil DTE 732*
Volume: *8,000 Gallons/ 30,283 Litres*

BACKGROUND

This site was experiencing a build-up of varnish on mechanical components. An SVR was installed and initial results described a three-month stabilization period as varnish deposits were adsorbed back into the lubricant. A significant decreasing trend began after four months of operation, which means that varnished mechanical components had been completely cleaned. SVR treatment reduced the fluid varnish potential value to below 10 over the subsequent three months. Varnish potential values are now stable and at historically low values.

MPC ΔE REDUCTION USING SVR / MOBIL DTE 732



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Case Study 2

Turbine Lubricant Varnish Removal Using SVR®

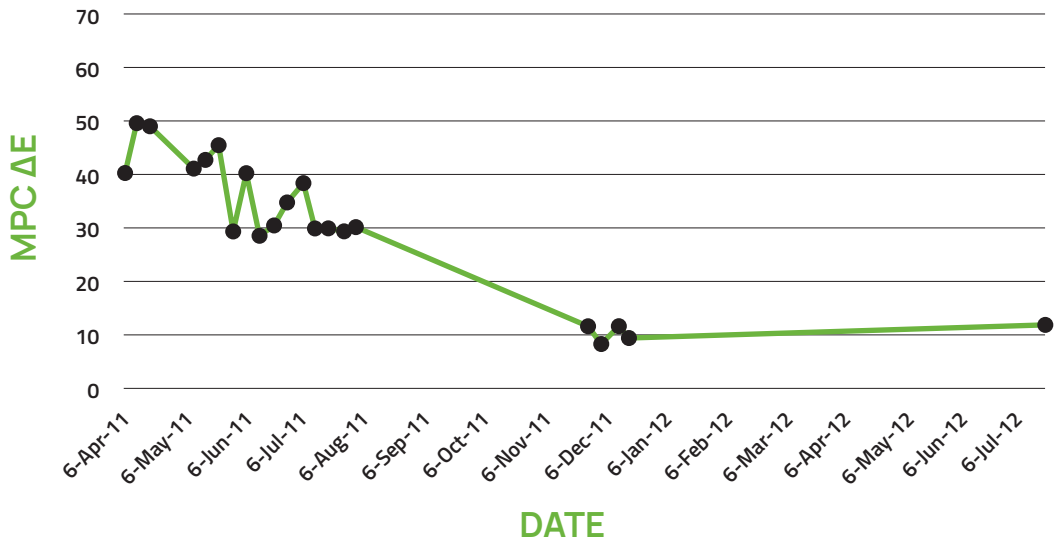
CASE STUDY #2

Location: *MD, USA*
MW: *685 MW*
Turbine Type: *ST, GE*
Oil Type: *Mobil DTE 732*
Volume: *7,450 Gallons/ 28,201 Litres*

BACKGROUND

This site had a history of varnish problems; the customer consistently experienced build-up of varnish on mechanical components. Once SVR was installed, varnish potential numbers fluctuated over a two month period while varnish deposits were adsorbed into the lubricant. Notable reductions were achieved by month three. Consistent reductions continued over the next six months. Permanent use of SVR has been able to reduce varnish potential values by another 60% and to be maintained at 15 or below. Varnish potential values are now stable and at historical low values.

MPC ΔE REDUCTION USING SVR / MOBIL DTE 732



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Case Study 3

Turbine Lubricant Varnish Removal Using SVR®

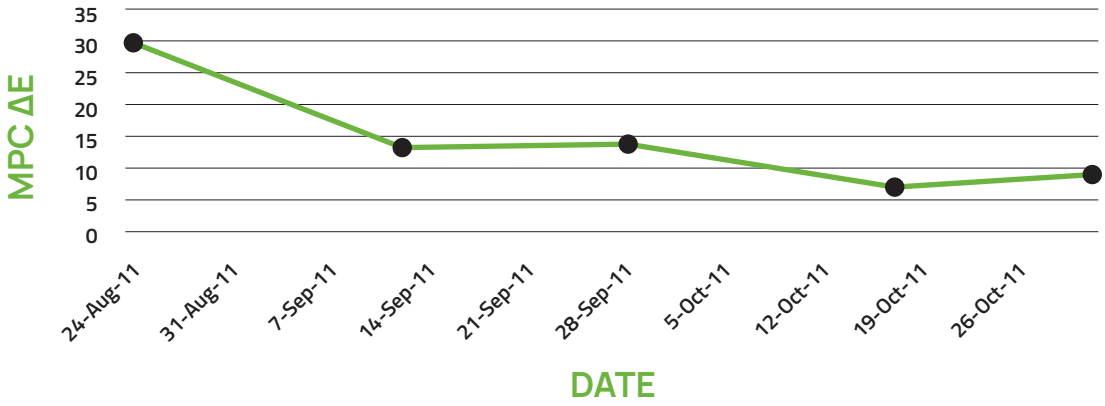
CASE STUDY #3

Location: *PA, USA*
MW: *190MW*
Turbine Type: *GE 7FA*
Oil Type: *Shell Turbo CC 32*
Volume: *6,200 Gallons/ 23,470 Litres*

BACKGROUND

This site had a history of varnish problems with QSA® varnish potential values at 75 or higher. Previous efforts on the part of maintenance staff were unable to control varnish potential values, which was a significant concern for the turbine owner. Upon installation of SVR, varnish potential values were quickly reduced. MPC varnish potential values are now at 10 or lower.

MPC ΔE REDUCTION USING SVR / SHELL TURBO CC 32



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Case Study 4

Turbine Lubricant Varnish Removal Using SVR®

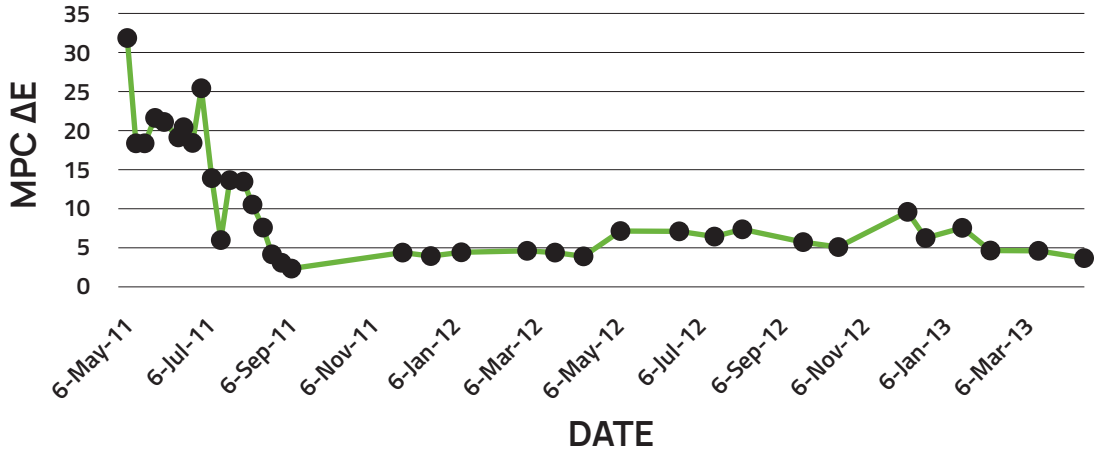
CASE STUDY #4

Location: *CA, USA*
MW: *40MW*
Turbine Type: *GT, GE 6FB*
Oil Type: *Shell Turbo TX 32*
Volume: *1,700 Gallons/ 6,435 Litres*

BACKGROUND

This turbine is used as the primary generator at an oil and gas production facility. High varnish potential values were of concern due to the critical nature of the turbine and the potential loss in production associated with any turbine outage. SVR was installed and quickly reduced varnish potential values by >50%. Further decreases were observed with continued SVR use. Varnish potential values are now less than 5.0 and stable.

MPC ΔE REDUCTION USING SVR / SHELL TURBO TX 32



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Case Study 5

Turbine Lubricant Varnish Removal Using SVR®

CASE STUDY #5

Location: *CA, USA*
MW: *40MW*
Turbine Type: *GT, GE 6FB*
Oil Type: *Shell Turbo TX 32*
Volume: *1,700 Gallons/ 6,435 Litres*

BACKGROUND

This unit had a history of varnish problems with multiple unit trips and fail-to-start conditions. SVR systems were installed on all turbines and quickly reduced varnish potential by over 50% with no further turbine failures occurring. Continued long term use of SVR has been able to reduce varnish potential values by another 40% with values now at <15. Varnish potential values are now stable and at historical low values.

MPC ΔE REDUCTION USING SVR / MOBIL DTE 832/ SHELL TURBO CC 32 MIX

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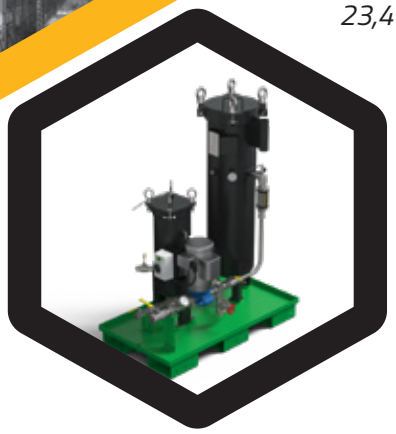
Case Study 6

Turbine Lubricant Varnish Removal Using SVR®



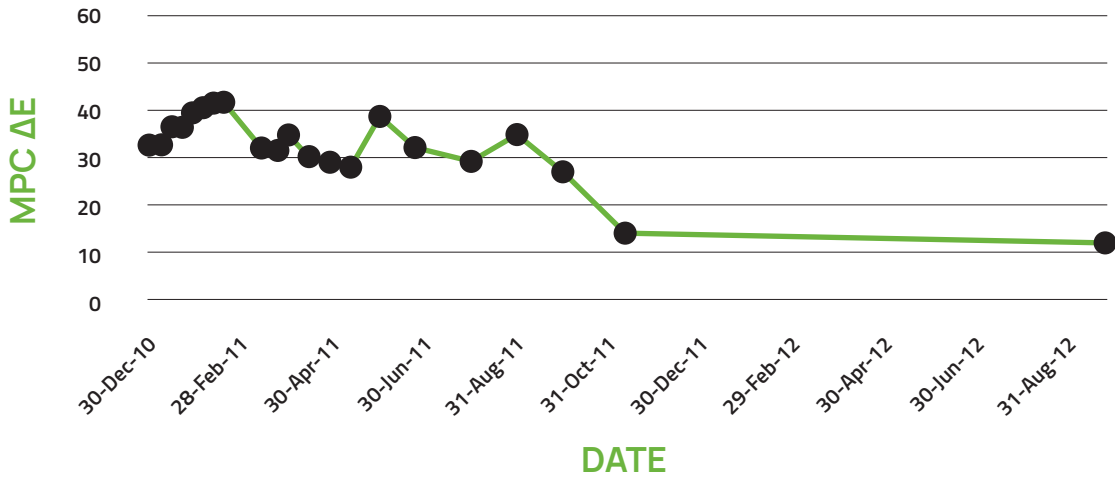
CASE STUDY #6

Location: *PA, USA*
MW: *185MW*
Turbine Type: *GT, GE 7FA CC*
Oil Type: *Mixture Mobile DTE 832/Shell Turbo CC 32*
Volume: *6,200 Gallons/ 23,470 Litres*

BACKGROUND

Unit had a history with multiple trips and fail-to-start conditions. SVR system was installed on this unit and within six months had produced downward trending MPC results. No turbine failures occurred after the SVR system was installed. The length of time prior to decreasing MPC is based on the amount of varnish on system components. The varnish potential is now below 15 and continues to decrease.

MPC ΔE REDUCTION USING SVR / MOBIL DTE 832/ SHELL TURBO CC 32 MIX



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Case Study 7

Turbine Lubricant Varnish Removal Using SVR®

CASE STUDY #7

Location: *AB, Canada*
MW: *100MW*
Turbine Type: *GT, GE 7EA*
Oil Type: *Teresso GTC 32*
Volume: *5,000 Gallons/ 19,000 Litres*

BACKGROUND

An electrostatic oil cleaner was operational on this system full-time since turbine commissioning in 2009. Within 18 months of initial operation, varnish potential values had increased above 40 to critical levels. SVR was installed February 2011 and reduced varnish potential, which then increased as system deposits were adsorbed back into the lubricant. Subsequent element changes performed annually have achieved stable and historically low varnish potential values.

MPC ΔE REDUCTION USING SVR / TERESSO GTC 32

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Case Study 8

Turbine Lubricant Varnish Removal Using SVR®

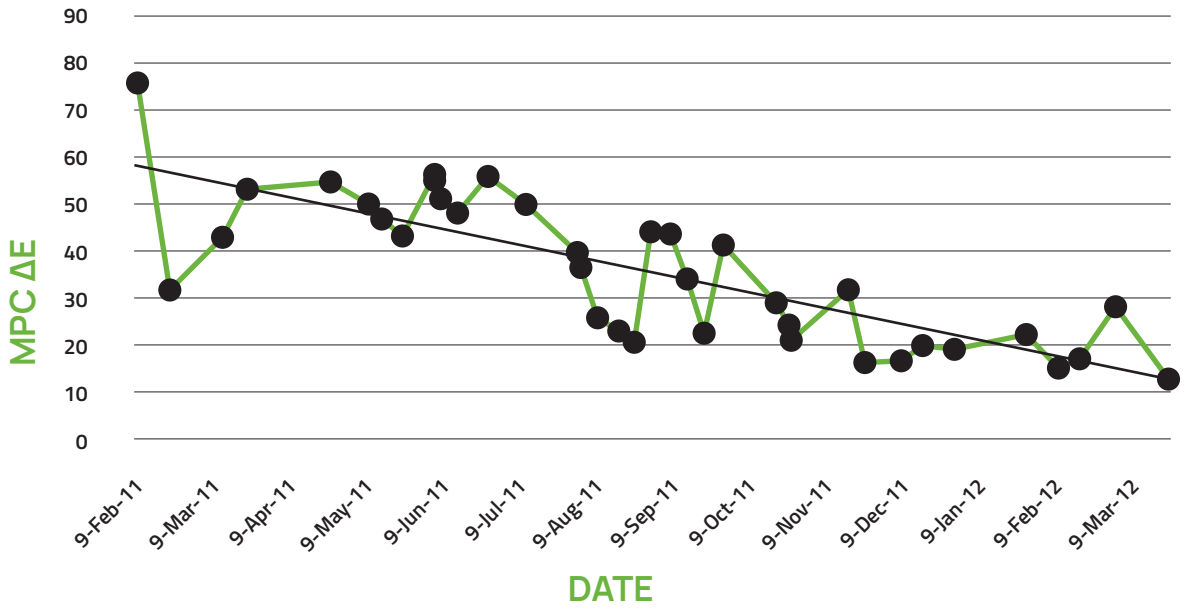
CASE STUDY #8

Location: *CA, USA*
MW: *520MW*
Turbine Type: *ST*
Oil Type: *Shell Turbo CC 32*
Volume: *3,000 Gallons/ 11,356 Litres*

BACKGROUND

When initially contacted, this site had extreme varnish potential values. SVR was installed and immediately reduced varnish potential values by >60%. Existing system deposits were then adsorbed back into the lubricant which increased varnish potential values. Based on the level of increase, the results suggest that existing system varnish deposits were above average. Secondary decreases followed by increases also suggest above average levels of varnish deposits were present. The system stabilized after eight months of SVR treatment. No additional operational problems have been experienced and varnish potential values remain at historically low levels.

MPC ΔE TRENDING USING SVR / SHELL TURBO CC 32



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Case Study 9

Turbine Lubricant Varnish Removal Using SVR®

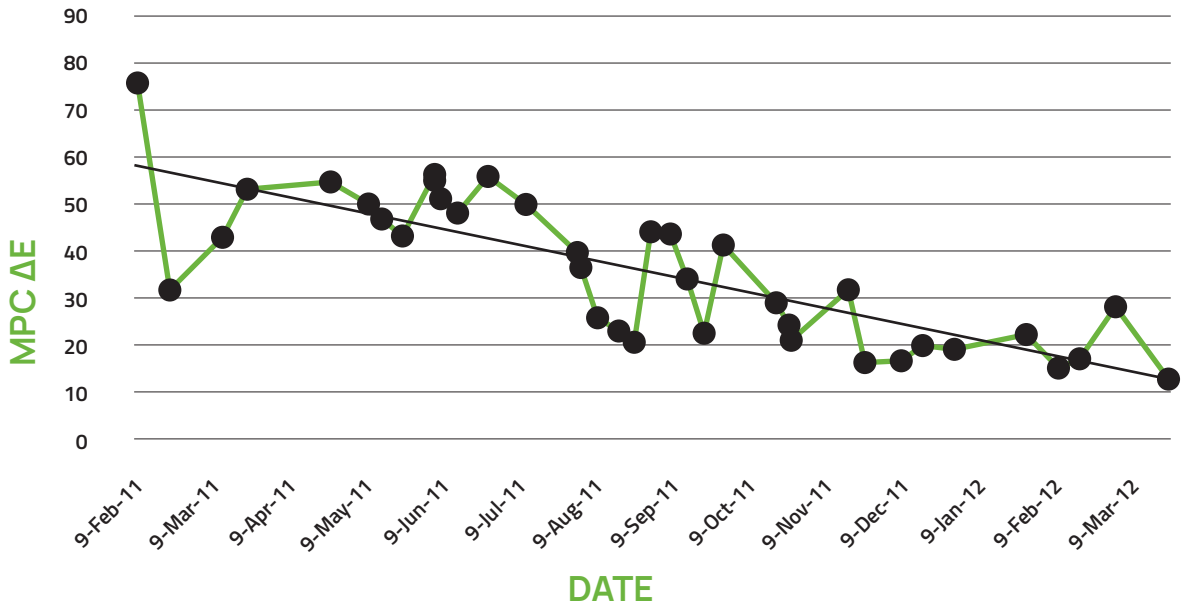
CASE STUDY #9

Location: *LA, USA*
MW: *Base load—185MW*
Turbine Type: *GT, GE 7FA*
Oil Type: *Mobil DTE 724*
Reservoir Size: *6,200 Gallons/23,470 Litres*

BACKGROUND

At this facility, three GE 7FA Gas turbines provide the primary power and steam for the chemical plant. Plant reliability was negatively impacted from elevated varnish potential numbers in the gas turbine. To reduce the risk of outage maintenance staff tried a number of varnish removal systems without success. SVR was installed and had an immediate impact, reducing varnish potential numbers and within three months, values had been reduced by 80% to a varnish potential value of <5. Based on these successful results, SVR has been installed on all three gas turbines at this site.

MPC ΔE TRENDING USING SVR / MOBIL DTE 724



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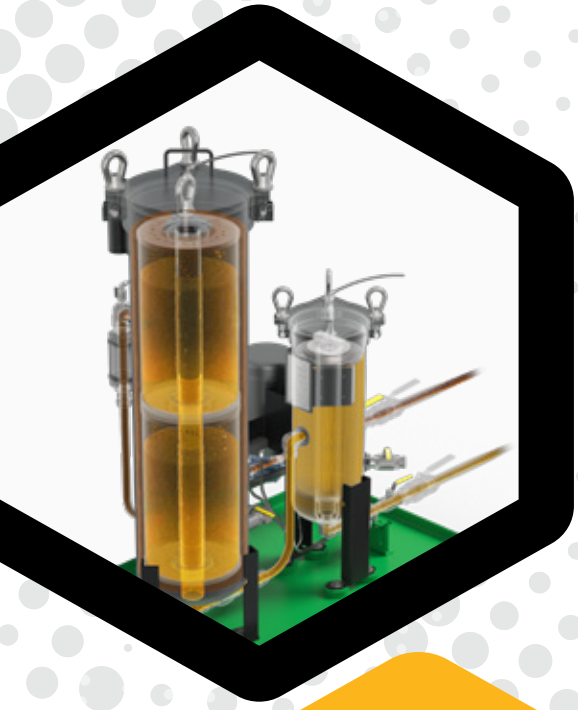

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