Evaluation of Diesel Injector & DPF Flush on Engine Torque, Power, and Exhaust Emissions in a Case IH Magnum 220 Tractor

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Abstract

Over standard operating hours, modern high pressure common rail diesel engines experience internal and external injector deposit formation. This fouling degrades fuel atomization, delays combustion, and leads to noticeable losses in engine torque and overall efficiency. This trial investigated the performance recovery of an agricultural diesel tractor following treatment with Diesel Injector & DPF Flush at a 1:500 treat ratio. Dynamometer measurements demonstrated a **+6.9% increase in maximum torque** (recovering +59 lb-ft) and a **+6.9% increase in maximum horsepower** (+12 HP) at the power take-off (PTO) within 20 operating hours. In addition, certified emissions analysis showed a **29.0% reduction in NO_x** and a **1.9% reduction in CO_2** over a 70-hour operational cycle. The findings confirm that chemical removal of injector deposits rapidly restores fuel spray geometry, maximizing combustion pressure and usable mechanical output.

Introduction

In modern diesel engines, fuel injectors mist fuel at pressures exceeding 30,000 psi through microscopic spray holes. Over time, heat and fuel breakdown create carbon and chemical deposits on nozzle tips (nozzle coking) and internal moving components (IDIDs).

When injectors become fouled, they deliver uneven, coarse fuel droplets rather than an engineered fine mist. Coarse droplets take longer to vaporize and burn, causing the combustion process to occur later in the power stroke. This delay lowers the amount of usable expansion pressure, resulting in sluggish throttle response, reduced pulling power (torque), and increased emissions. Diesel Injector & DPF Flush was designed to dissolve these stubborn deposits chemically, returning fuel spray patterns to factory condition without mechanical teardown.

Materials and Methods

1. TEST EQUIPMENT (MATERIALS)

- **Test Platform:** 2020 Case IH Magnum 220 tractor.
- **Engine:** 6.7L 6-cylinder turbocharged diesel engine.
- **Service History:** 4,400 accumulated operational field hours with real-world injector fouling.
- **Treatment Chemistry:** Diesel Injector & DPF Flush at a 1:500 treatment ratio
- **Dynamometer Instrumentation:** Calibrated eddy current PTO dynamometer installed in a climate-controlled test facility maintained between 70°F and 75°F. No power corrections were applied, relying on the stabilized cell temperature and pressure to ensure repeatability.

2. TESTING METHODOLOGY

- **Power and Torque Sweep Protocol:** Maximum torque and brake horsepower were evaluated before and after treatment using loaded dynamometer sweeps. Full-load sweeps were executed across the PTO speed range, pulling down from 1,100 PTO RPM to approximately 600 PTO RPM under stabilized engine operating temperatures.
- **Emissions Duty Cycle Protocol:** Exhaust streams were analyzed inside a certified emissions facility measuring continuous mass output of nitrogen oxides ($NO_{x)}$ and carbon dioxide (CO_2) in milligrams per second (mg/s). Emissions sampling was conducted with the PTO locked at standard rated speed (1,000 PTO RPM) across an alternating, stepped-torque loading sequence:
  - 250 lb-ft -60 seconds
  - 100 lb-ft -30 seconds
  - 500 lb-ft -60 seconds
  - 100 lb-ft -30 seconds
  - 750 lb-ft -60 seconds
  - 100 lb-ft -30 seconds
  - 1000 lb-ft -60 seconds
- **Operating Protocol:** Operational hours were accumulated on a closed 7.5-mile proving grounds track running without towed implements or trailers to eliminate variables such as ground drag. Torque and horsepower impacts were evaluated at 20 hours, with full emissions monitoring concluded at 70 hours after consuming 270 gallons of fuel treated with Diesel Injector & DPF Flush.

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Results

Chemical clean-up of the fuel injection system yielded rapid gains in mechanical work output and measurable decreases in criteria emissions.

Measured Parameter	Baseline (Fouled)	Post-Treatment	Net Difference	Percentage Impact	Evaluation Timeframe
Maximum Torque	852 lb-ft	911 lb-ft	+59 lb-ft	**+6.9%**	20 Hours
Maximum Power (PTO)	175 HP	187 HP	+12 HP	**+6.9%**	20 Hours
NO_x Mass Emissions	7.8 mg/s	5.5 mg/s	-2.3 mg/s	**-29.0%**	70 Hours
CO_2 Mass Emissions	6,129.6 mg/s	6,013.4 mg/s	-116.2 mg/s	**-1.9%**	70 Hours

- Peak torque climbed by 59 lb-ft within the initial 20-hour window.
- Shaft horsepower increased in direct proportion (+6.9%), matching the torque gains under identical test RPMs.
- NO_x emissions dropped by nearly a third (-29%) as fuel-air mixing normalized.

Discussion

The simultaneous +6.9% gain in torque and horsepower highlights the connection between injector spray quality and mechanical pulling power. When injector deposits dissolve:

1. **Faster Vaporization:** Fine fuel mist evaporates and ignites quicker, allowing peak cylinder pressure to push against the piston crown at a more optimal position. This produces direct torque gains at the crankshaft and PTO.
2. **Cooler, Balanced Combustion:** Fouled injectors create uneven pockets of wet, fuel-heavy mixtures that burn with intense, localized heat spikes. This is the primary cause of NO_x formation. Restoring an even spray pattern eliminates these hotspots, lowering NO_x emissions by 29%. Fewer NO_x emissions lowers the demand on the SCR/DEF system and reduces soot loading in the DPF.
3. **Optimized Fuel Use:** The 1.9% decrease in CO_2 demonstrates that more energy was extracted from each power stroke, reducing unburnt fuel and lowering overall exhaust carbon output.

Conclusion

Chemical deposit removal using Diesel Injector & DPF Flush delivers a validated, non-invasive method for recovering lost torque and horsepower in high-hour diesel engines. Equipment operators experiencing low power or sluggish response under load can restore factory-level performance.

1. **Add to Tank:** Introduce Diesel Injector & DPF Flush directly into the fuel tank prior to refueling to ensure thorough mixing at the recommended 1:500 treatment ratio.
2. **Clean-Up Cycles:** Operate equipment under standard duty cycles for an initial 20-hour window to establish proper injector spray patterns and recover lost torque.
3. **Performance Verification:** Validate recovery through increased pulling power, increased throttle response, and lowered emissions.

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ABOUT THE AUTHOR

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Jessica is the Director of Technical Services at Power Service Diesel Additives with 12 years of experience in fuel system performance and maintenance. By analyzing over 2,000 fuel samples annually, she provides unique, data-backed insights into real-world fuel quality and equipment longevity. An active member of ASTM Committee D02, she leverages her deep technical background to help fleet managers optimize fuel efficiency, reduce maintenance costs, and ensure reliability in varying regional fuel conditions.