

Overview of Spray Testing Capability at En'Urga



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Background

- En'Urga provides spray characterization services for all types of fuel injectors, urea dosers, and nozzles using real world fluids.
- En'Urga Inc. has over 25 years of experience in developing spray characterization products
- En'Urga Inc. has over 20 years of experience in providing spray characterization services
- Our test capabilities are highlighted in the following slides



Spray Injection Capability

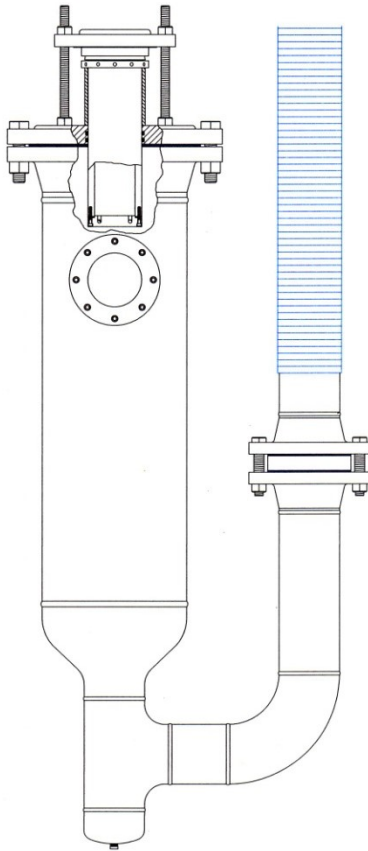
- Steady state and pulsed injectors for pressures up to 30 MPa – typically using pressure vessels and accumulators
- Pressure up to 60 MPa – accumulator with intensifier
- Fuel flow rate up to 500 kg/hr and air up to 100 kg/hr
- Real world or synthetic fuels –gasoline, diesel, JP-8, kerosene, heptane, furnace oil, Mil C-3024, API solvents
- Different liquids – water, polymers, solids containing fluids, pharmaceuticals, etc.
- Short duration consumer sprays such as fragrances, cleaners, etc. with automatic dispensing



Diagnostics Capability

- Spray patternation (SETScan optical patternator, En'Urga Inc.)
- Drop sizing – laser diffraction (PODscan, Malvern)
- Drop sizing & velocity – PDA (Dantec)
- High speed spray imaging – 10,000 Hz (Quantum Tech.)
- Infrared spectrometry – 1,320 Hz (Spectraline Inc.)
- Visible spectrometry – 60 KHz (Spectraline Inc.)
- Mass flow measurements –gravimetric
- X-Ray tomography (dense sprays, windowless combustors, particulate filters, pharmaceutical powders, etc.)
- Correlation velocimetry (SPiVel – En'Urga Inc.)

Spray Environment Capability



- Pressure rating –20 PSI to 400 PSI
- 10 inch nominal ID
- 5 inch fused silica window on 2 sides
- Switched to sapphire for infrared diagnostics
- 34 inch tall vessel reduces spray bounce back
- Fully indexable injector mount
- Fitted with AP400 patternator
- Temperature controlled injection to 90°C
- Temperature controlled ambient up to 440 F

Hazardous Material Testing



- Pharmaceutical APIs
- Hydrocarbon solvents
- Volatile fuels
- Chiller for condensing sprayed material
- Fully contained nitrogen purge
- Safe disposal of waste
- Walk-in fume hood for mixture preparation

Mixing capability



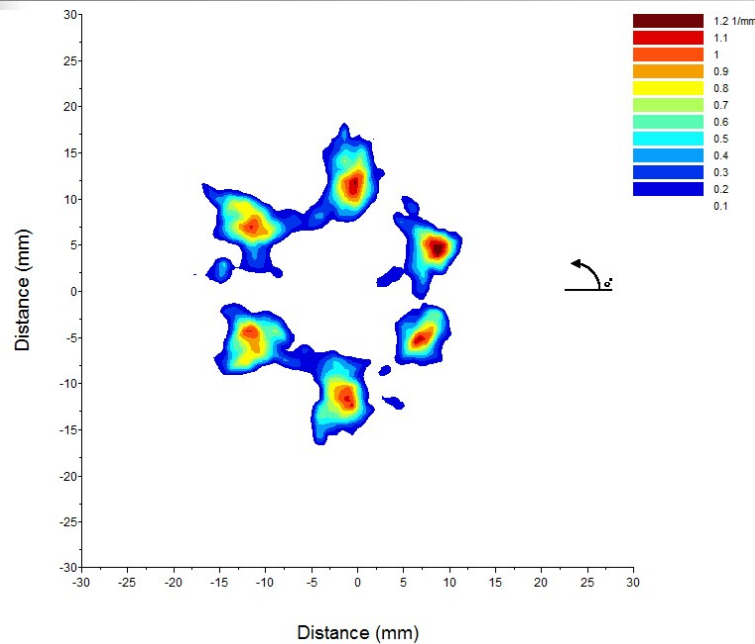
- Stainless steel tank
- 100 liter capacity
- 100 PSI working pressure
- Teflon O-rings
- Air driven mixer
- Stainless steel blade
- Direct feeding into high pressure tanks
- Inside fume hood



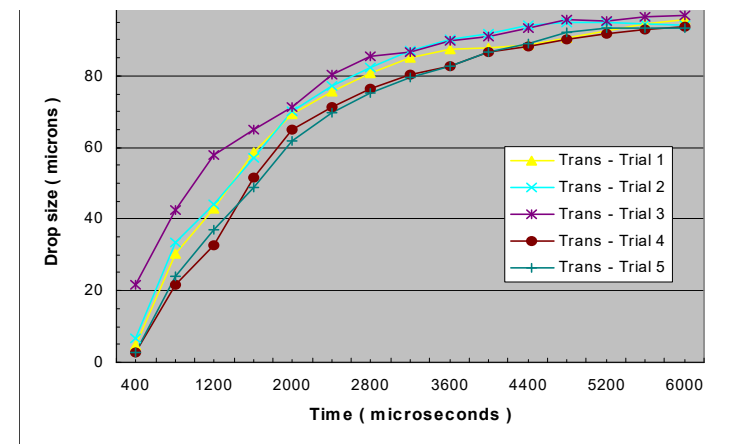
Resources

- Fully equipped combustion, optical diagnostics, and electronics laboratory
- Lead lined X-Ray room (12 x 12 x 8 feet)
- Design software for mechanical, optical, and electronic components
- Access to the extensive laboratory facilities at Purdue University
- Fully developed supply chain for out sourcing
- Highly skilled technical staff
- Full facility leasing option

Sample Results (GDI injector)



Injection pressure 10 MPa gage
Chamber pressure 80 Kpa absolute
Liquid temperature 30 °C
Plume analysis for angles, % flow,
and centroid locations





Quality Audit of Injectors

- SETscan patternator based quality audit of injectors
- 1000's of nozzle per day
- Currently used for 100% testing in the Aerospace and Automotive industry
- Complete turn key solution with spray stand and equipment
- Contract quality audit for statistical quality assurance
- Highly repeatable and accurate results
- Address production problems as soon as it occurs

Partial list of customers

Boeing	Rolls Royce	Bosch
General Electric	Siemens	Hitachi
Exxon-Mobil	Proctor & Gamble	Continental
Abbott	Cummins	G.W. Lisk
Tenneco	Caterpillar	ITW
Eaton	General Motors	Biogen
Colgate	Ricardo	Nordson
Boston Scientific	Vertex Pharmaceutical	Toyota
Biotronik, AG	Faurecia Emissions	Woodward
Danfoss	Pfizer	United Technology
FEV	Biogen	Spectrum Brands
Delphi	AVL	Agilent
S.C. Johnson & Son	Columbia Chemicals	Westinghouse