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# On-Line Analysis of Fuel Products for Particulate, Color, Water and Haze

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# Introduction

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- Vision technology, when applied correctly, can provide insight to a process that cannot be gained otherwise.
- Vision systems measure process or particle features directly as opposed to indirectly as with other methods.
- Vision can provide shape, color analysis as well as visual confirmation.
- Well suited for fuel contamination analysis.

# Sources of Contamination

- Residuals from the refining process (water) can reduce fuel BTU capacity, cause corrosion and freeze.
- Microbes can grow in water fuel mixtures creating sludges and causing corrosion of metal parts.
- Transport systems can contaminate fuels due to insufficient cleaning between handling of different types which can introduce water, cleaning agents and surfactants into the fuel.
- Solid particulate due to wear of containment systems or poor methods of handling.

# Vision System Fundamentals

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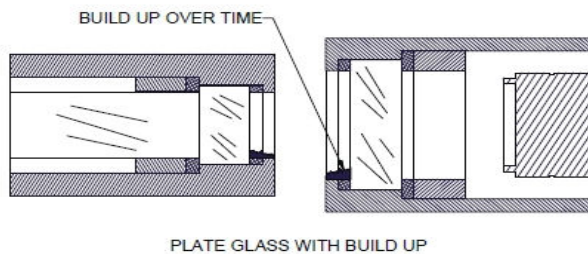
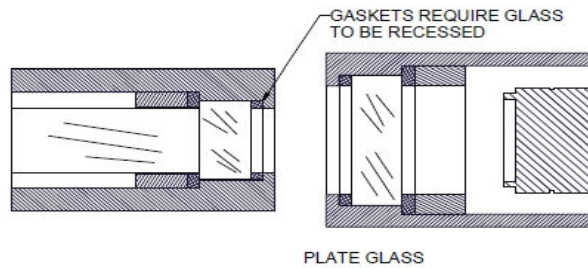
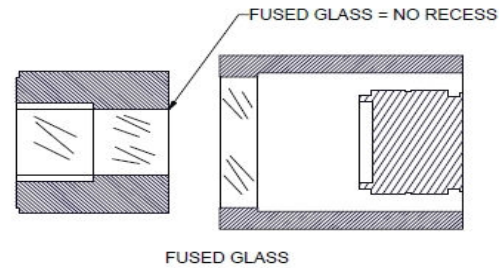
- Operating Principle - Mimic Human Eye-Brain interaction. Objects are discerned in free space by how they reflect light differently from their background.
- Intense and controlled illumination – to discern objects the same way each time they are detected requires a controlled illumination system.
- Rugged, clean and clear process connection.

# Vision Technology Features

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- Fused glass to metal process connection.
- Controlled flow cell configuration
- Properly designed camera/optical package.
- Ethernet connectivity for system control and manipulation.
- Robust software analysis package.

# Fused Glass Benefits



# Illumination and Cell Gap

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- Adjustable light intensity with regulation.
- Multiple lighting configurations:
  - Back / Front / Side
  - Dark Field
  - Polarized / Phase Contrast
- Adjustable flow gap for best and consistent presentation of particles to the camera.

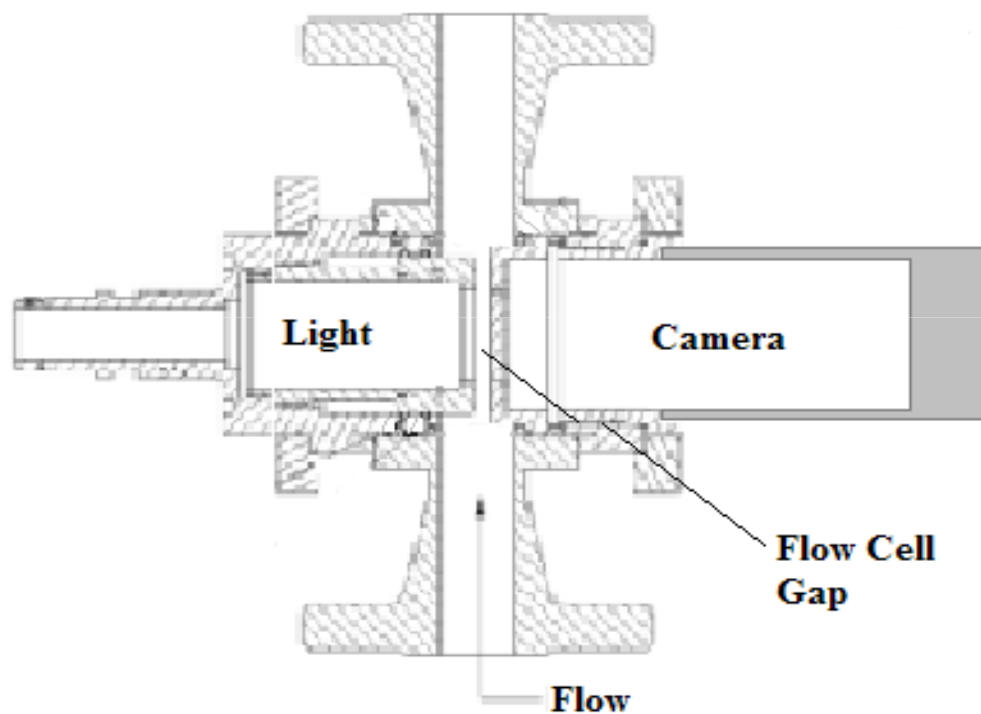
# Optical System

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- High quality, precision optics combined with rugged, fused glass to metal process entry optimizes system effectiveness.
- High resolution, low light sensitivity CCD.
- Ethernet connectivity is essential in creating an effective tool for monitoring, analyzing and controlling the process from the real time video.



# Typical In-Line Instrument



# Software Analysis

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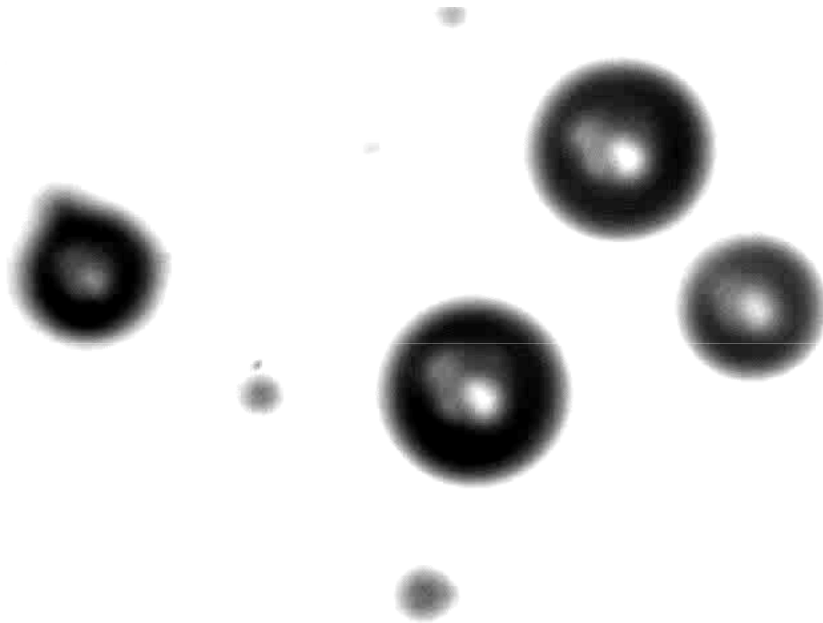
- Process images can be analyzed to yield important particle information including:
  - Size
  - Aspect Ratio
  - Perimeter
  - Circularity
  - Appearance: Color or Translucence
- These factors help identify process contaminants and possible sources.

# Current ASTM Fuel Test Methods

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- There are three primary lab methods of fuel testing described by ASTM standards:
  - Titration (Karl Fischer method ASTM D6304)
  - Separation (Centrifuge method ASTM D1796)
  - Distillation (ASTM D95)
- All are off line, lab based tests.

# Water Detection by Vision - Direct on line Method

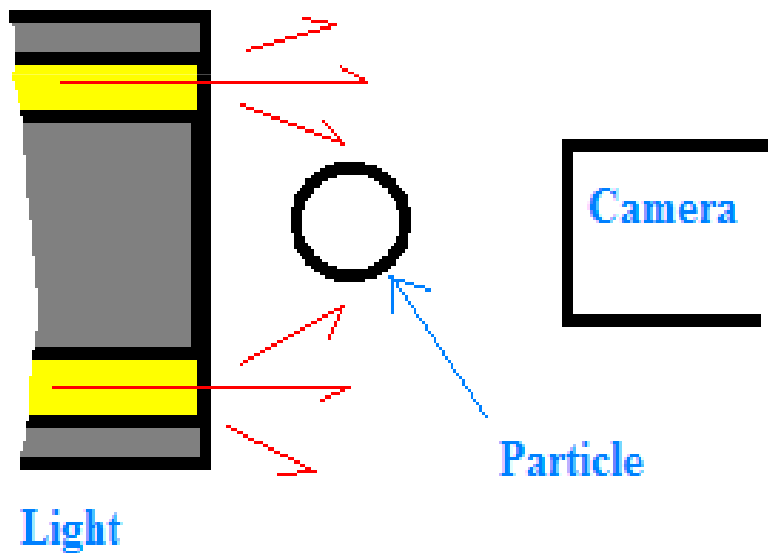


## Water Droplets in Propane

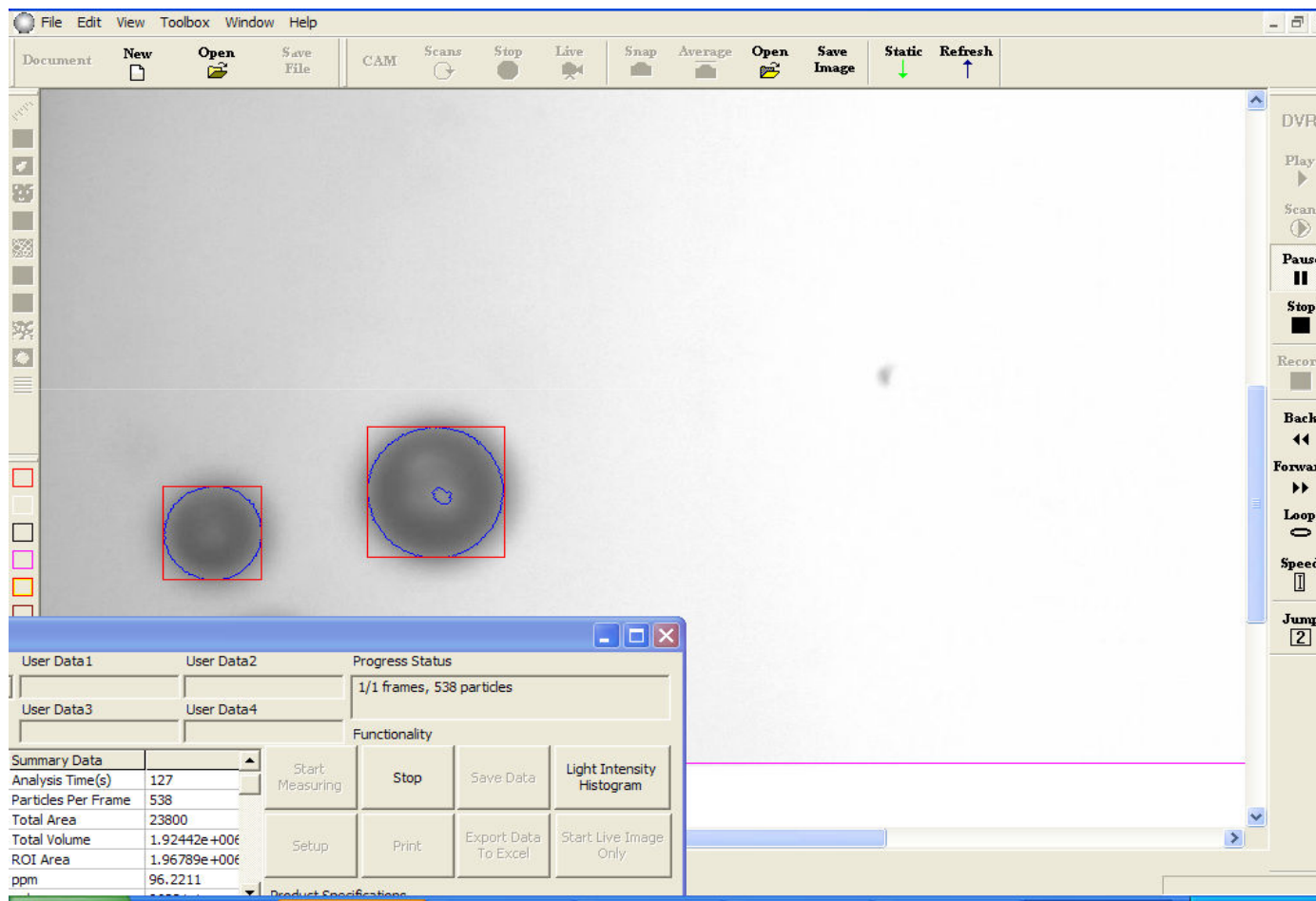


# Droplet Analysis

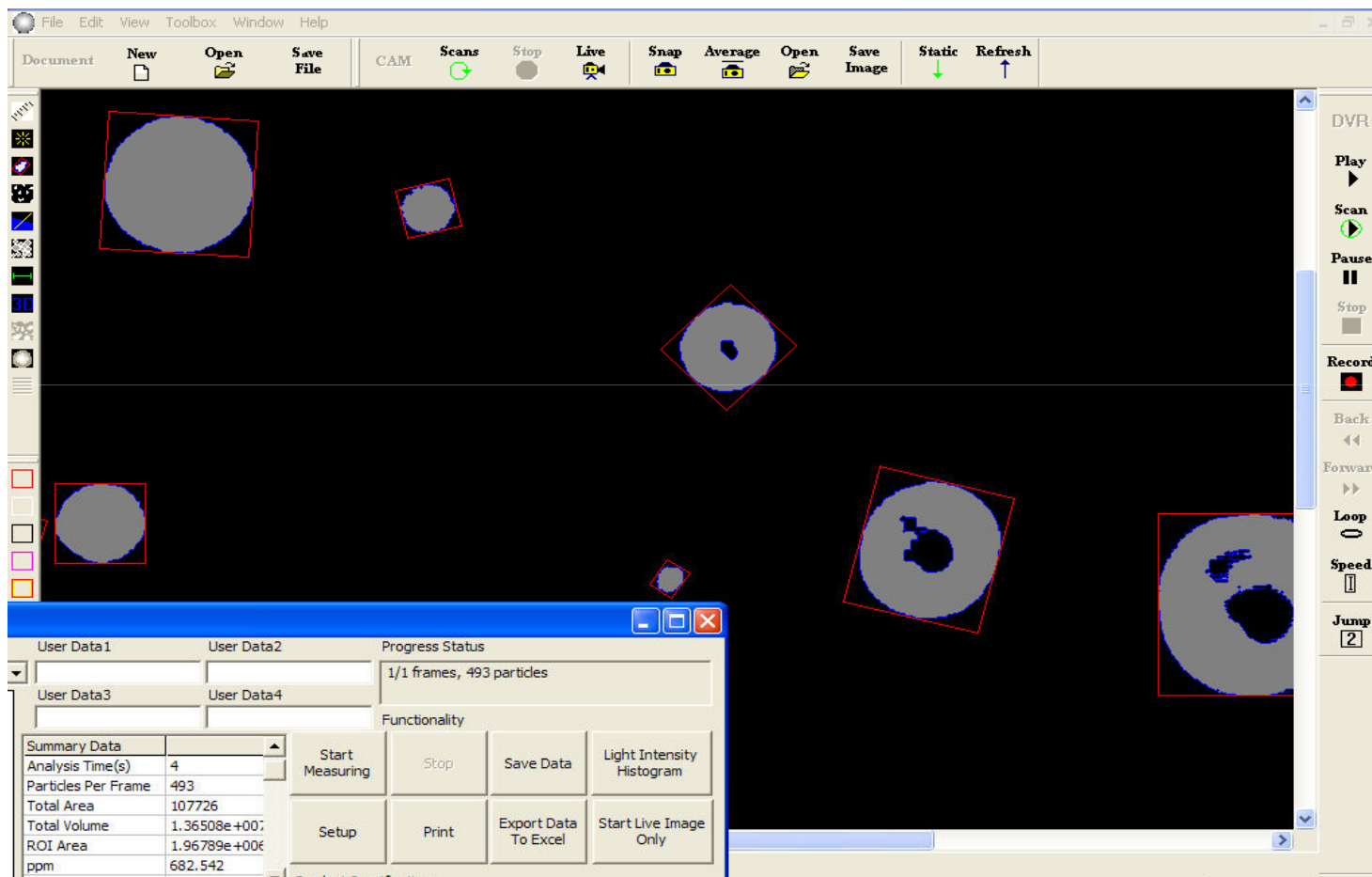
- Illumination methods enhance image contrast;  
i.e. Dark Field



# Water in Propane; 96 PPM



# Water in Propane; 662 PPM



# Data Output

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- Droplet count
- Droplet volume
- PPM concentration
- Size (diameter)
- Circularity – can distinguish spherical droplets from non spherical, solid particulate.



# Color and Haze

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- Color and haze relate to the quality of jet fuel.
- Current ASTM standards are subjective, optical comparisons.
- Vision technology can objectify these standards and bring them on line for analysis on a continuous basis.

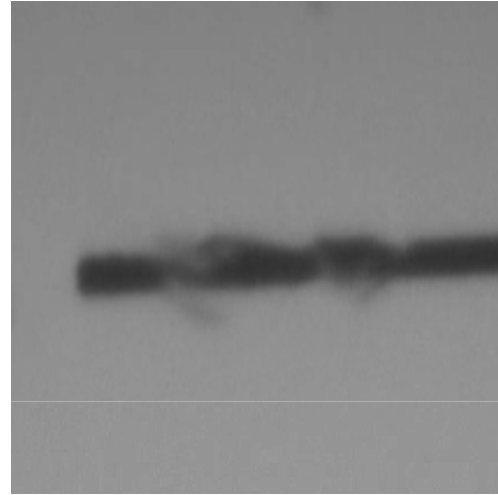
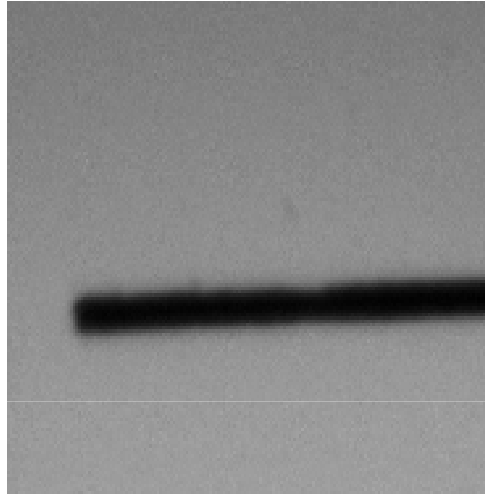


# Haze Analysis

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- Haze testing measures the water content in fuel. Presence of water alters the transmission of light through the fuel and renders an image or object viewed through the fuel hazy or blurry. This test can be conducted in the field or the lab.
- Current standard is based on subjective, comparison techniques (see ASTM 4176).
- Vision technology can eliminate the subjective aspect of the measurement and bring it on line.

# Clean Gas Vs Watered Gas



A target is fixed into the view of the vision system in the above images. As the fuel becomes hazy due to water, the crispness of the target changes as well as the shape in some instances. The software easily detects these changes.

# Conclusion

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Vision technology can:

- Advance process and quality control functions by providing on line, real time analysis of fuel products.
- Enhance vehicle performance and integrity due to improved inspection capabilities.
- Provide a visual record of product quality