Particle Analysis in Lube Oil

Determining Sources of Contamination by Vision

Current Methods

- ASTM specifies several methods of determining contamination of lubricating oils. All are lab based tests which count particles or otherwise assess the oil as a whole.

- Vision allows for on line, real time analysis and the capability to distinguish particles based on shape.

Vision Basics

- Particles – are detected when they stand out from their background due to lighting effects.

- Software detects them the same way the human eye-brain mechanism does. The determination of boundaries between particles and their background is done in an objective manner.

- Once detected the particle features are measured; length, width, area, perimeter, color, and from these measurements secondary filters can be derived to classify particles such as aspect ratio, circularity, volume etc…
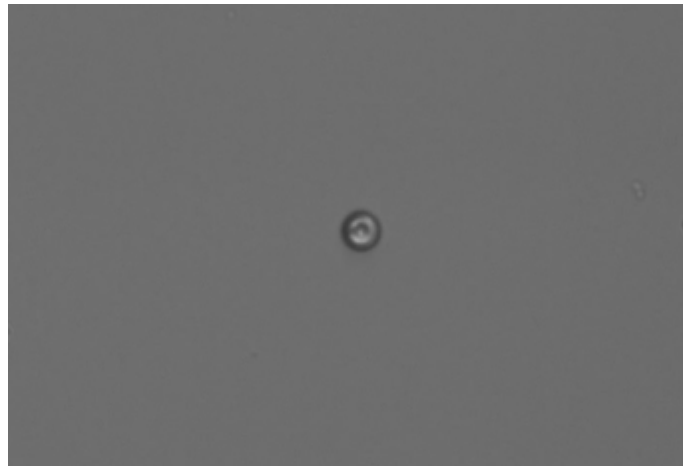
Particles Present in Lube Oils

- Oils can be contaminated from several sources:

  - Soot – from combustion

  - Water – from coolants

  - Air – trapped in the system

  - Metals – from mechanical wear

  - Non Metals – from wear and aging
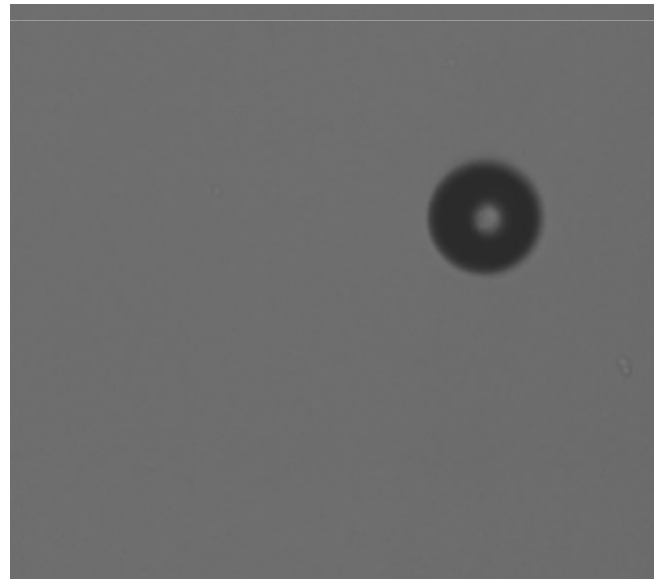
Soot in Oil   vs. Clean Oil
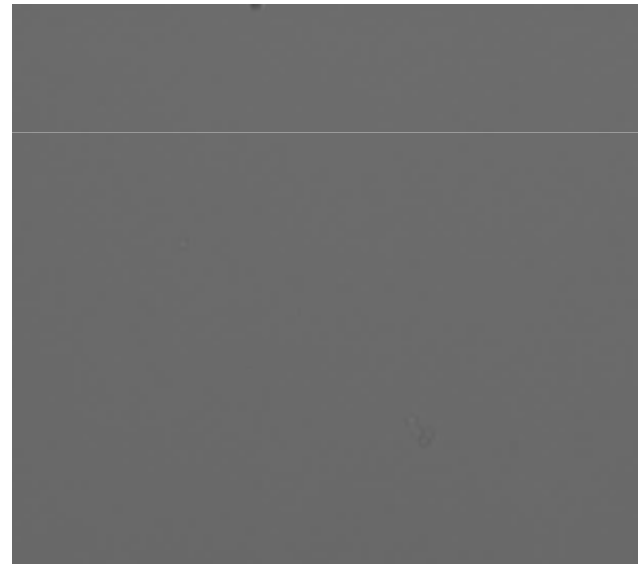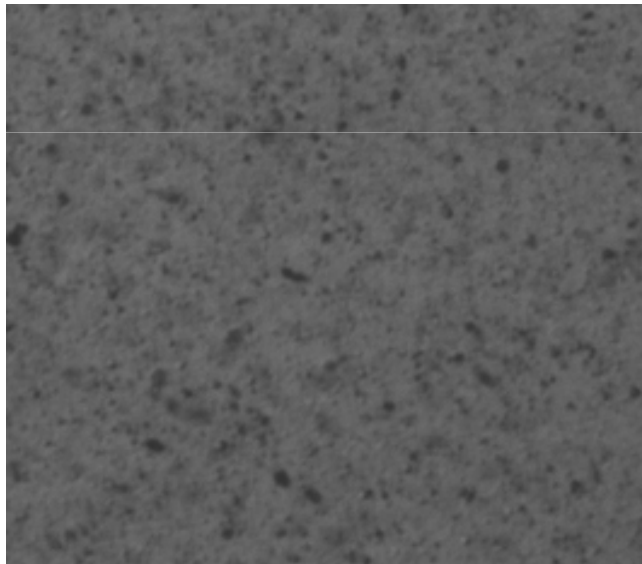
Water in Oil

- Water droplets appear as a dark ring with a transparent center due to the way light is refracted at the oil-water boundary.
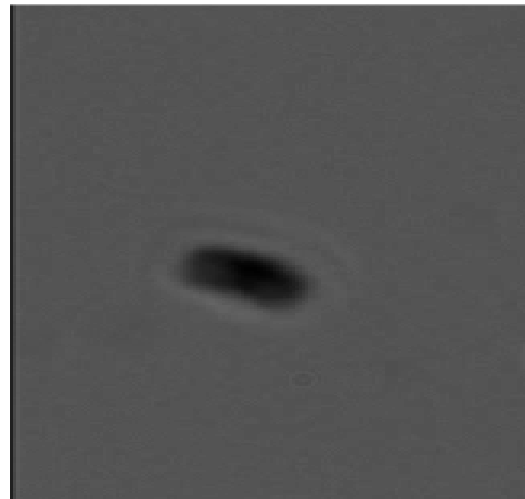
Air in Oil

- Refraction of light at the air-oil boundary produces a different appearance than water in oil.
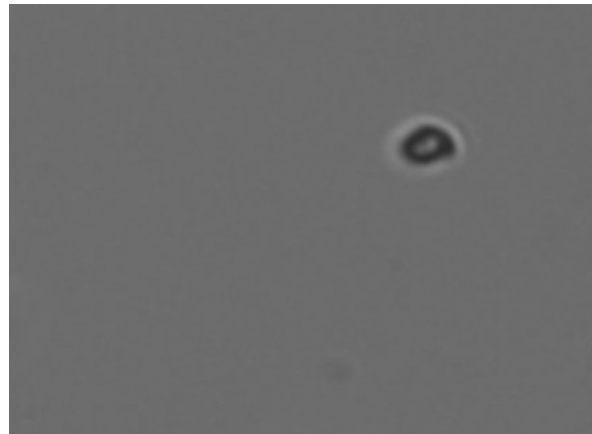
Metals in Oil

- Metals are classified by their likely shapes. As parts wear against each other long shavings are likely to be introduced into the oil.

Non Metals in Oil

- Non Metals are classified as transparent or of low aspect ratio with rough or jagged edges.

Identifying Particles

- Soot levels are identified by transmission of light through the fluid. The software makes an opacity measurement of the fluid to track soot level.

- Other particle detections are done after the particles are sized. Secondary features such as aspect ratio and circularity can be used to segregate the remaining particles.

Typical Filter Set

Particle	Aspect Ratio	Circularity
Air	< 1.1	< .85
Water	< 1.1	< .5
Metal	> 2	
Non Metal	1.1< > 2	

Circularity

- This number ratios the area vs. the perimeter of a particle:
- Air/Water – These particles, since they are clear in the center, have two perimeters which makes the ratio much different than a solid, spherical particle. The water droplet has a much larger inner perimeter which distinguishes it from an air bubble.

Conclusion

- Vision offers the best way to determine the condition of lube oil on line or in the lab.

- The ability to classify particles in real time provides clues to system wear in an objective, consistent way that other technologies can't provide.