ViPA

HMA INSTRUMENTATION

- On-line
- Rugged & Compact
- Continuous Operation
- Size Distributions
- Concentration Measurements
- Automatic Differentiation Between Particle Types
- Size Oil Droplets and Solids Separately at the Same Time
- Differentiate Between Different Types of Solids
- User Definable Alarms for Size and Concentration for Each Type of Particle
- 4 - 20 mA Ouput & Digital Alarms
- Modbus via TCP/IP
- Trend Analysis - Identify Upsets Before They Occur
- Fully Automated Packages

WHAT PROCESS BENEFITS CAN A VIPA SYSTEM PROVIDE?

The ViPA uses on-line image analysis techniques to simultaneously provide information on the particle and droplet size distributions and the relative concentrations of both oil and solids in produced water.

The ability to monitor significant parameters throughout the oily water separation and disposal process allows previously unattainable levels of control, offering the opportunity to avoid many current process problems in the future.

What are the potential benefits of the some of the possible installation points for this technology within the oily water process train?

Having true oil droplet size distribution information (a size distribution without solids) after the first stage separator could improve the accuracy and control of the dosing of demulsifier chemicals, minimising their usage, environmental impact and cost. This information would also allow the confident specification of coalescers, where required, and give genuine information on separator efficiency.

Continuously monitoring the oil concentration in overboard water would allow operators to improve the quality of water discharged. Providing information on the trends in discharge levels would allow pre-emptive action to be taken to maintain a process within specification. Information on droplet sizes at this point in combination with oil concentration data provides a diagnostic tool to identify areas in the separation train that may be experiencing problems. Information on solids present in discharge water could be used to develop solids treatment regimes and to identify where and when solids loadings are being generated.

Where produced water is re-injected, determining the size and concentration of both oil droplets and solid particulates is a powerful tool to reduce injectivity losses, as the size and concentration of different materials affect the formation's porosity differently. Where the formation is soft and injection has to be maintained at less than fracture pressure this becomes increasingly more important.

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HOW DOES A VIPA WORK?

The ViPA, Visual Process Analyser, is an on-line instrument for the monitoring of particle and droplet sizes and concentrations. The ViPA can operate continuously on-line at high pressure and elevated temperatures.

The ViPA package consists of the ViPA software set and a compact and robust measuring head (with a built-in cleaning mechanism) that can be located up to 500 yards from the control computer. The analyser is installed on a bypass line close to a quill type sampler, this ensures the most representative possible sample is used.

Using image analysis techniques to differentiate between particles and droplets in real time, the ViPA monitors up to seventeen parameters about each particle and droplet continuously including size and concentration.

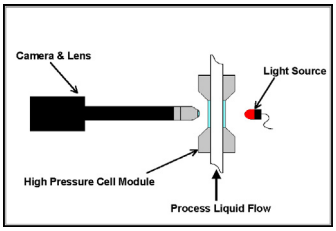
The ViPA software includes a set of trend algorithms that use statistical tests to determine if a process will exceed pre-determined specifications during a set period. This provides the opportunity to pre-empt process upsets by taking action before an impending problem occurs.

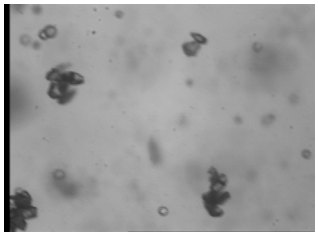
4 – 20 mA outputs further allow control signals to be tied to measured parameters, for example, the d50 mean size of oil droplet could be mapped to a control signal for a demulsifier dosing pump.

The ViPA uses a video microscope in a ruggedised assembly consisting of a video camera and lens and a light source to examine the contents of a liquid. Produced water flows through the ViPA's cell module, which has a pair of transparent windows, and the camera looks through the water at the light source. This allows the video microscope a backlit view of the objects in the water flow, whether these are solid particles, liquid droplets or gas bubbles. The

ViPA operates by freezing a single frame of the video image and analysing the objects present. A database of information is built by rapidly acquiring and analysing sequences of these frozen images. Above is a typical image from the ViPA, the image is of ground garnet mixed with a light lubricating oil. The individual garnet crystals are approximately 35µm in size.

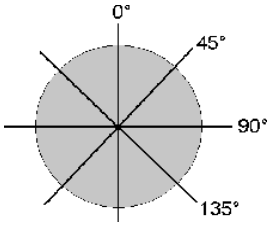
Typically, using three parameters for each object seen; size, shape factor and concentration allows information on the size and concentration for oil droplets and solids to be calculated.





SIZE

The ViPA measures four diameters for every object. These Diameters are measured at fixed angular intervals. These diameters are called Feret Diameters and the ViPA reports size as average Feret Diameter.



SHAPE FACTOR

Shape Factor is mathematically described as:

$$4.\tilde{\Pi}\text{Area} / \text{Perimeter}^2.$$

The shape factor for a perfect circle (sphere) is always 1. As the length of perimeter increases compared to the area enclosed, shape factors decrease very rapidly.

Shape	Shape Factor	Shape	Shape Factor
	1.0		0.19
	0.75		0.0000061

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For example: The non-continuous phase of a liquid-liquid emulsion, such as oil in water, exists as perfectly spherical droplets. Most solids are irregular in shape.

Therefore, in a liquid flow system containing both of the above, shape factor can be used to distinguish and discriminate between the two types of particles or particle populations, i.e. the oil droplets and the solids.

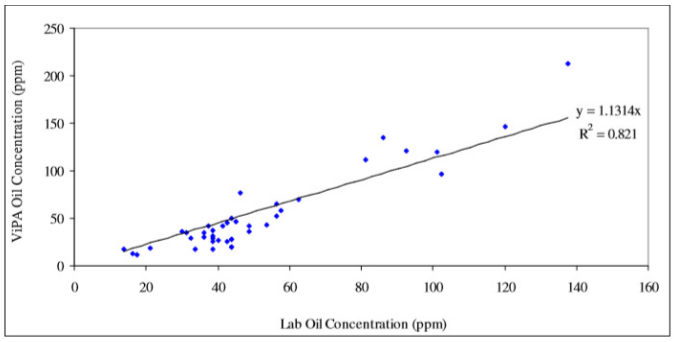
The ViPA can use sets of user defined values for parameters such as shape factor to determine the limit values of a population. Then, in real-time, the ViPA can determine which population an object belongs to and record it's statistical information into a separate database for each population.

CONCENTRATION

The ViPA reports concentration as visible parts per million (ppmv). There is a known volume of liquid for each frame that the ViPA analyses. This volume is calculated as: (the width of the analysed image) x (the height of the analysed image) x (the depth of focus of the image). In each frame the ViPA calculates the volume of the objects for each particle or droplet population/class. At the end of each analysis the ViPA software sums up the volume of all the objects in a population/class and the volume of all the frames, which then allows ViPA to report a volume/volume concentration for each run.

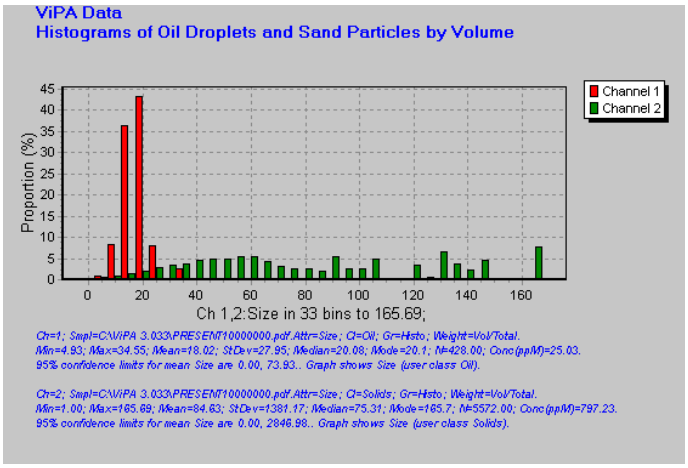
The measured concentration is reported as visible ppm, because only those objects seen are measured and included in the calculation. In other words, materials passing through the cell between frames and objects that are not in focus are not seen and hence not measured.

However, while the concentration figures are not absolute, they are repeatable and indicate how the concentration of a material is changing relative to previous or later measurements. Work has been done demonstrating the strong correlation between the concentration reported by the ViPA and those reported by other industry accepted methods such as the Rivertrace system and the Infracal solvent extraction method.1



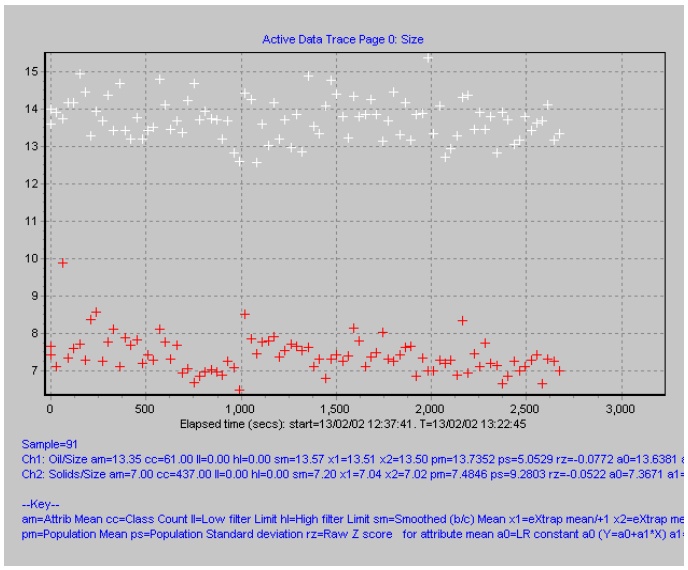
DATA OUPTUT FROM VIPA

Typical Histogram:



For each of the seventeen measured parameters a full set of sample statistics including: Minimum, Maximum, Mean, Standard Deviation, Median, Mode, Number and Concentration.

Typical Continuous Monitoring Graph:



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Instrument Data Sheet

General				
1.01	Type	Droplet & Particle Analyser		
1.02	Manufacturer	Jorin Limited		
1.03	Model	ViPA FZ2 AFW		
1.04	Sample Temp Limits	0 – 120°C		
1.05	Max Operating Pressure	120 Bar		
1.06	System Description	Fully automated with wash system and remote control		
1.07	Tag Number	-		
1.08	Instrument Fittings	Swagelok 316SS		
Instrument Characteristics				
2.01	Accuracy	±2% Full Scale		
2.02	Repeatability	±1.5%		
2.03	Linearity	±7.5% in range 0 – 100PPM		
2.04	Drop Size Range	0 – 200 microns		
2.05	Particle Size Range	0 – 200 microns		
2.06	Oil Concentration	0 – 2500 ppm		
2.07	Solids Concentration	0 – 2500 ppm		
2.08	Span Adjustment	N/A		
Physical Characteristics				
3.01	Sample Feed	½" Tube		
3.02	Analyser Drain	¾" Tube		
3.03	Wash Connection	½" Tube		
3.04	Purge Air Connection	½" Tube		
3.05	Mounting	Analyser Field Panel	316 SS Backplate	
		Wash Tank	316 SS Freestanding Structure	
		Control Cabinet	42U Floor Standing Rittal Cabinet	
3.06	Weights (dry)	Analyser Field Panel	350 Kgs	
		Wash Tank	95 Kgs	
		Control Cabinet	175 Kgs	
3.07	Materials	Analyser Wetted	316 SS, Viton, Industrial Sapphire	
		Analyser Environment	316 SS	
		Purge System Environment	316SS & Painted	
		Flow Control Wetted	316 SS, Ceramic Tube	1
		Flow Control Environment	316 SS	
		Wash Tank	316 SS	
		Wash Pump Wetted	316 SS	
		Wash Pump Environment	Painted	
		Wash Pump Starter Environment	Painted	
		Filter Housing Wetted/Environment	GRP	
		Junction Boxes	GRP	
		Control Cabinet	Misc	
3.08	Enclosure Rating	ViPA Analyser	IP65	2
		Wash Pump Motor	IP56	
		Other field components	IP65	
		Control Cabinet	IP54	
3.09	Hazardous Area	Zone 1		
3.10	Classifications	EEx-e-p-d IIC T4		
3.11	Cable Gland	Hawke Nickel Plated Brass M20		3
Electrical Data				
4.01	Supply Voltage	Analyser	110/240 V AC or 24V DC	4
		Flow Control	NA	
		Flow Indication	110/240 V AC or 24V DC	4
		Wash Tank	NA	
		Wash Pump & Starter	110/240 V AC	4
		Control Cabinet	110/240 V AC	
4.02	Consumption	Analyser	60 Watts	
		Flow Control	NA	
		Flow Indication	50 Watts	
		Wash Tank	NA	
		Wash Pump & Starter	300 Watts	
		Control Cabinet	1200 Watts	

Supply Requirements			
5.01	Purge	Clean dry air, 225 litres per minute @ 4 bar	
5.02	Instrument Air	Clean dry air, 25 litres per minute @ 4 bar	
5.03	Water	Potable water approximately 300 litres per quarter	
5.04	Cleaning Fluid	Rigwash (Sobo S Gold or Similar)	

Notes	
1	Krohne electromagnetic flow meters have ceramic tube sensor
2	ViPA analyser is air purged and has a magnetic flapper valve for air flow; this flapper valve does not conform to IP65
3	M20 glands to be used for all instrument entries. Control cables between field and control room will be sized in accordance with cables used.
4	Power supply can be configure to suit installation