Filtration Quality Control

Maximizing Well Potential Through Verification of Filtration System Efficiency

FTC

FOREFRONT OF FILTRATION TECHNOLOGY

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Introduction:

Since clean fluid is essential for maximizing well potential, it is important to verify system efficiency during the filtration process. Complete on-site analysis would include the following operations:

1. *Fluid Sampling*
2. *Centrifugal Testing*
3. *Turbidity Testing*
4. *Gravimetric Analysis*
5. *Determination of Particle Size Distribution*

Fluid Sampling:

Representative fluid samples should be taken from the following locations:

1. ***Upstream of the D.E. unit -*** *This sample gives an indication of the solids content of the dirty fluid and is useful in determining the proper D.E. add-mix ratio.*

2. ***Downstream of the D.E. unit -*** *This sample indicates the efficiency of the D.E. unit and will reveal any D.E. bypass of screen problems. An efficiently operated unit should reduce the solids content to 20 - 30 mg/l.*

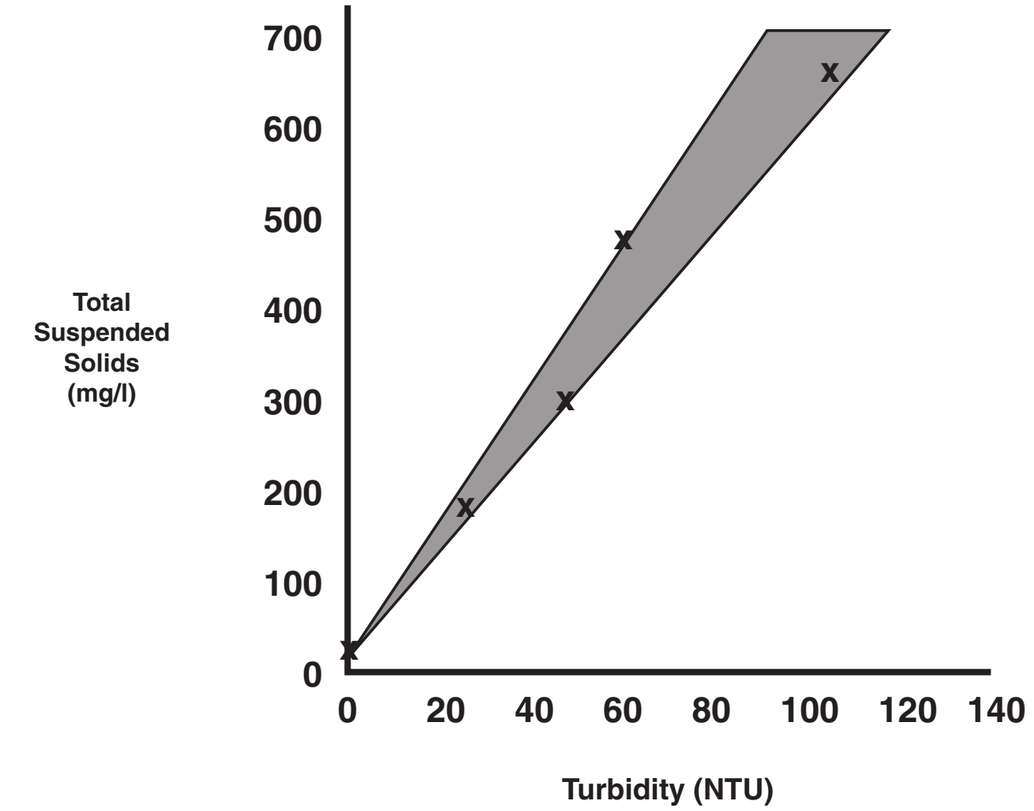
3. ***Downstream of the polishing filters -*** *This sample indicates the overall efficiency of the system. A comparison of the D.E. downstream sample with this sample can reveal element bypass problems.*

4. ***At the shale shakers -*** *These samples are used to monitor well bore cleanup progress.*

Since filtration efficiency can vary with pressure changes, flow rate fluctuations, and cycle lengths, fluid samples should be taken as follows:

1. At the beginning of the cycle
2. At the end of the cycle
3. Once per hour during the cycle

fig 3 -Typical Calibration Curve



Determination of Particle Size Distribution:

It is generally accepted that particles 1/3 to 1/7 the diameter of the average pore throat cause the most significant well bore damage. Actual determination of the particle size distribution can be accomplished by using particle counters or microscopic analysis. On-site particle size distribution can be expensive and time consuming. Unless a trained technician is available, it can also be difficult to obtain reproducable data. For these reasons, field particle size distribution testing is not recommended at this time.

The gravimetric analysis procedure that is used in this field evaluation is outlined below:

1. *Weigh pre-dried filter disc and record original weight.*

2. *Load weighed disc into hand pump making certain that the o-ring seals the filter completely.*

3. *Pass 100 ml of sample through the disc in 20 ml portions. (It may not be feasible to filter the entire 100 ml of sample if the solids loading is too high.)*

4. *Pass 500 ml of distilled water through the disc to dissolve any soluble salts.*

5. *Carefully remove the filter disc. and dry at 140 degres Fahrenheit for one hour.*

6. *Cool the disc at room temperature in the dessicator for 30 minutes, weigh it to the nearest 0.1 mg, and record the result as final weight.*

By convention, solids content is measured in the number of milligrams per liter of fluid (mg/l). Since there are 1000 milliters in one liter of fluid, the following calculation can be used to determine the solids content in a given fluid based on a gravimetric analysis:

$$\textbf{total suspended solid (mg/l)} = \frac{\textbf{(final weight (mg) - original weight (mg)) x 1000}}{\textbf{sample volume (ml)}}$$

The **"Recommended Practice For Testing Heavy Brines"** published by API June 1, 1986 provides a method of correlating turbidity readings to total suspended solids. This technique utilizes a calibration curve that is generated from gravimetric analysis. As detailed in Section 3 of the publication, the procedure involves taking turbidity measurements on five fluid samples that have increasing levels of suspended solids. Gravimetric analysis is then run on each sample. The data is the plotted with turbidity on one axis and suspended solids on the other axis. The resulting linear calibration curve can be used to estimate suspended solids at any given turbidity reading.

It is important to remember that accuracy of the correlation is dependent upon the analysis of the same fluid using the same turbidity meter throughout the filtration operation. If a different fluid, or the same fluid containing a different particle type, size, or distribution is introduce to the system, a new calibration curve should be generated. (see *fig. 3*)

It is important to ensure that each sample taken is representative of the overall fluid mix. Sample port locations should insure that fluid is drawn from a flowing stream, not from dead fluid traps. The following practices will assist in obtaining good samples:

1. *Sample ports should be flushed for 30 seconds prior to drawing sample.*

2. *Flush sample bottles several times with fluid before catching the final sample.*

3. *If samples are not analyzed immediately, treat with a bactericide to prevent organic growth.*

4. *Label each sample with well information, sample port location, date, time, fluid type and weight.*

Centrifugal Shakeouts:

A centrifugal shakeout of suspended solids is a useful technique for obtaining a rough estimate of the percentage solids in a given fluid. Using this information, a proper D.E. add-mix ratio can be chosen to maximize flow rate and filtration cycle.

The use of shakeouts to determine final well bore cleanliness is not recommended because the most accurate devices will only read as low as 0.05% solids or 500 ppm.

Turbidity Testing:

Turbidity is a measurement of fluid clarity and is recorded in Nephelometric Turbidity Units (NTU). The lower the NTU reading, the better the fluid clarity. Turbidity is one of the optical properties of a liquid and is related to the presence, nature and concentration of discrete aggregations of material different from the pure liquid center. Since it is defined as an appearance parameter, it can be measured by optical techniques.

The basic measuring systems of different brand nepholmeters are similar. A linear photodetector mounted in the detector section of the instrument senses a narrow optical beam that is projected through fluid. This detector, mounted 90 degrees to the lamp source, measures the intensity of the light scattered by the particles in the fluid. Electronic components amplify this signal and provide a meter reading that corresponds to the concentration of particles. (*fig. 1*)

Turbidity readings have no direct relationship to total suspended solids. The degree of turbidity in a sample is strongly dependent upon the particle size, shape and color, the host liquid refractive index, the wavelength of the observation light, and the viewing geometries. Therefore, turbidity measurements are only proportional to mass concentrations if all these parameters are held constant.

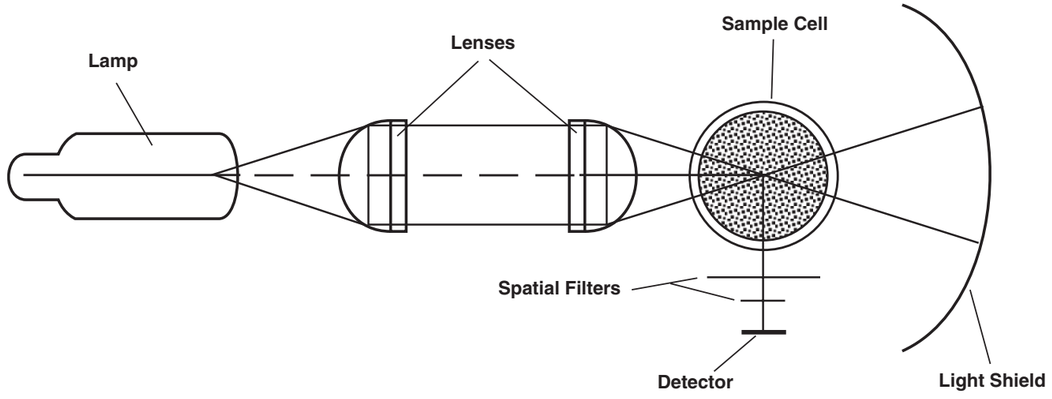


fig. 1 - Optical Diagram

Although turbidity readings alone cannot determine solids content, they are very useful in monitoring filter performance and well bore clean up. Clarity differences between filter influent and effluent samples reflect filter efficiency. Plotting turbidity of well returns versus circulating time is helpful in determining when optimum well bore clean up is achieved. *(fig. 2)*

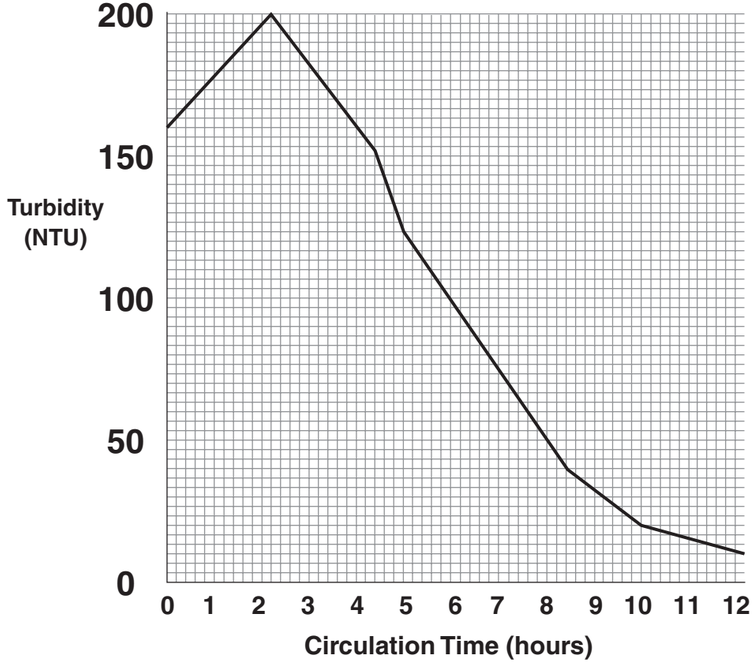


fig. 2 - Typical Well Bore Clean Up Curve

The accuracy of turbidity measurements is dependent upon instrument limitations and the use of proper field testing techniques. The following points should be considered while using a nephelometer:

1. *Each new instrument is supplied with its own unique "turbidity transfer standard" that has been calibrated to duplicate factory settings. Using an off the shelf replacement standard can affect the accuracy of a given nephelometer by as much as 20%.*

2. *Since turbidity readings are optical measurements, any extraneous distortions caused by scratched or dirty glassware will affect the NTU reading. Keep the "transfer standard" and sample vials free of finger prints, scratches, and particle contamination.*

3. *Sample preparation is important for consistent and accurate turbidity readings. The collected sample should be passed through a 200 mesh screen to remove particles larger than 74 microns then allowed to stand for a few minutes. The sample used for measurement should not contain any settled or floating solids.*

4. *Turbidity readings between different nephelometers on the same sample will not produce the same results unless the units have identical optical systems.*

Gravimetric Analysis:

Gravimetric analysis is used to determine the total amount of suspended solids in a completion fluid. It is common knowledge that fluid containing high solids content can cause severe formation plugging through partical invasion. On-site gravimetric analysis is now available by utilizing a compact analysis kit that contains the following apparatus:

1. *Electronic balance accurate to 0.1 milligram*
2. *Hand pump filtration system*
3. *Hot plate set a 140 degrees Fahrenheit*
4. *Dessicator*
5. *100 milliter graduated cylinder*
6. *Packet of 1.2 micron filter discs*
7. *Forceps for handling discs*
8. *Distilled water*
9. *Waste container for discharge fluid*