IDEC Filtration Service

Filtration for Higher Well Productivity

Why is filtration required?

Protect the formation

• The formation itself is like a sponge – a porous, permeable medium that allows fluids or gases to pass through.

• Formation damage is the contamination of the formation with solids, which can considerably reduce the hydrocarbons produced by the formation. Damage can occur during almost any field operation that involves the producing formation.

• In virtually all instances of formation damage, the problems can be traced back to the movement and entrapment of fine solids or to chemical reactions in the formation. Fine solids may be introduced either by wellbore fluids or generated, in situ, by the interaction of filtrate with formation rock or fluid.

• The solids that most commonly cause damage range between 2 and 20 microns in size.

Protect the mechanical equipment in the well

• Solids also contaminate down-hole equipment such as pumps, pre-packed screens, down-hole safety valves etc.

• During the clean-up of the wellbore, fluid is circulated at high flow rates. The fluid passes through mechanical equipment at high pressures and flow rates. Any solids contained in the fluid will act like an abrasive, which could wear down essential components; retrieval of damaged equipment takes a long time and is very expensive.

• Down hole safety valves, flapper valves are also affected, the solids in a stationary fluid will start settling onto the top of these valves, preventing them from functioning correctly.

Why is filtration required?

Optimize the Wellbore Clean-up

• The wellbore clean-up phase commences once the wellbore has been drilled and the final casing/liner section has been run and set. A wellbore clean-up involves removing the drilling mud and all its traces from the wellbore and the surface system and replacing it with a clear fluid (brine).
• This is done using various clean-up pills followed by filtered brine, the cleaner the brine used during the wellbore clean-up, the faster the clean-up can be achieved.

Allows brine to be re-used

• The volume of brine required for a wellbore clean-up, is in the thousands of barrels, very few installations have the storage capacity to hold enough brine to complete the task.
• A filtration system removes the problem by allowing the same brine to be re-used several times.

What is formation damage?

• Formation damage is inevitable, as soon as the drill bit enters the formation or producing zone, damage occurs.

• The drilling fluid or drill in fluid has been designed to minimize the formation damage, as the formation is porous the filtrate part of the drilling fluid invades the formation, most of the solids in the fluid are deposited onto the face of the wellbore, the solids in the drilling fluid have been sized specifically to create what is known as a filter cake.

• The filter cake is a protective layer of solids lining the wellbore to prevent further fluid and solids invasion from the drilling fluid into the formation.

• Solids free completion fluid used during the completion stage, helps prevents further formation damage.

• The completion fluid has none of the properties of the drilling fluid. There are no filter cake building solids in the completion fluid, if there were any solids in the invading completion fluids, they would be transported far into the formation possibly causing irreparable damage to the producing formation, which would reduce the oil production flow rate and possibly cause premature well failure.

What is formation damage?

Particles can affect the formation in three different ways

Particles that invade

Generally, a particle with a size 1/6th or less of the diameter of the average pore throats will flow through a formation with out being trapped but may settle out when fluid velocity decreases. They are usually produced back when a well is in production.

Particles that plug

Particles that plug the formation are within the size range of 1/6th to ½ of the average pore throat size. These particles are permanently trapped in the rock matrix close to the wellbore and cause Significant & Permanent damage to the formation.

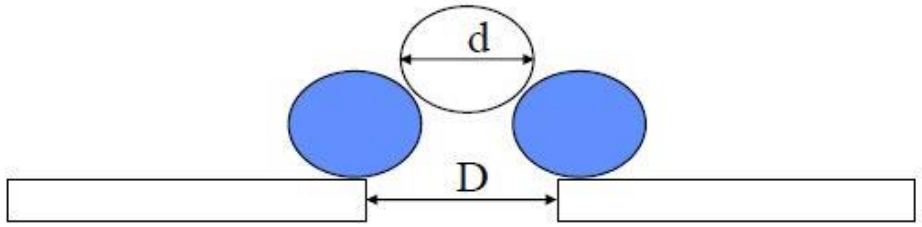
Particles that bridge

Particles that bridge are generally larger than ½ the size of the average pore throat size. These particles are stopped on the surface of the formation and in the perforation tunnels where they form a “Filter Cake”. The larger particles will normally be produced back out of the perforation when the well is put into production.

What is formation damage?

Formation Bridging

d = diameter of bridging particle
D = Diameter of pore throat



If D ≥ 2d Stable bridges will form

RULE OF THUMB

Particles 1/3rd to 1/7th of the pore diameter will bridge and plug pores

Avg. pore size □□□ Core premiability in (mD)□ □ – □

Formation Damage

Formation Permeability (mD)	Pore Size (Microns)	Particles that form Bridges (Microns)	Particles that Invade (Microns)
1000	31.6	5.4 to 15.8	< 5.4
500	22.4	3.8 to 11.2	< 3.8
100	10.0	1.7 to 5.0	< 1.7
50	7.1	1.2 to 3.6	< 1.2
10	3.2	0.5 to 1.6	< 0.5

Oilfield Filtration

Filtration:

• The process of removing suspended particles from a fluid by passing it through a permeable membrane or a media of limited diameter (e.g., sand, anthracite, or diatomaceous earth).

• There are many different types of filter media, each has its own advantages and disadvantages, the media is the actual material used to trap and retain the particulate.

• The filtration equipment, the cartridge unit or the filter press are merely devices that allow us to position the media so a viable amount of fluid can flow through the media, the more filter area the higher the filtration flow rate can be achieved.

Oilfield Filtration

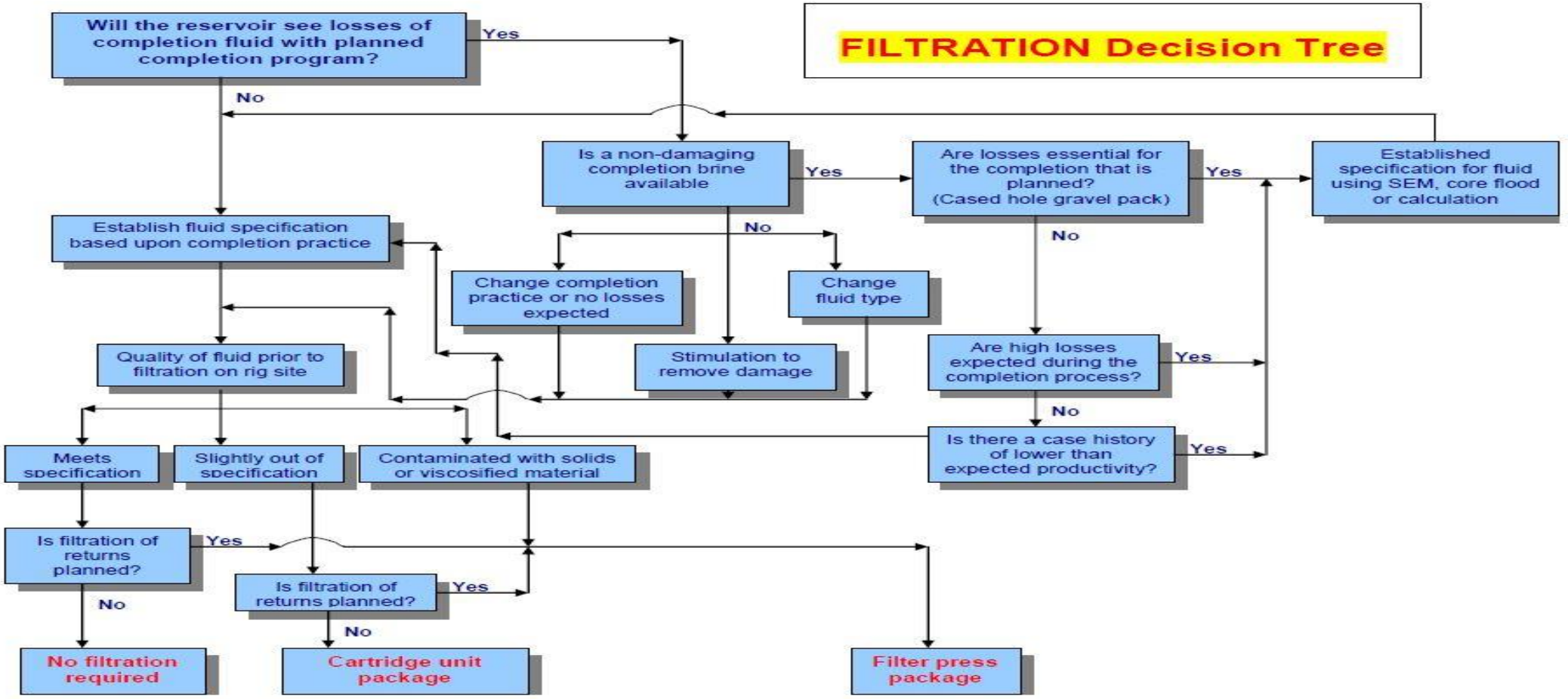
Operations that require filtration in the oilfield :

Any operation where the fluid comes into contact with the formation requires clean, solids free fluid. A level of fluid loss to the formation is inevitable. Since hydrocarbon-bearing formations are porous, the fluid will permeate through the formation, but any particle contamination will be filtered out by the formation. Particles that plug the formation are very difficult to remove. This creates the possibility of reducing the permeability of the formation, which in turn reduces the productivity of the well.

Operation	Description
Completions	The final process of a wellbore construction prior to putting the well into production.
Perforation	Creating holes in the casing through which hydrocarbons flow into the wellbore.
Gravel Pack	This is a down hole sand filter, which is part of a completion technique used in unconsolidated formations. The wellbore is packed with gravel to support the formation.
Chemical Squeeze	A technique used in workovers and stimulation to affect such things as water-shutoff.
Acid/Fracture	Stimulation techniques used to enhance production by increasing porosity and permeability in the formation.
Water Injection	A technique used to maintain production rates. Water is injected into the formation to increase the pressure.
Workovers	A number of operations that involve the repair or maintenance of an existing well to restore or sustain production levels.
Water shut off	In mature fields, excess water production is a major problem, impacting on surface facilities cost and requiring expensive remedial intervention. Water producing intervals need to be isolated to reduce the level of water production.
Well Kill	To stop a well producing. This can happen during production or workovers and potentially during the completion stage.

In any of these operations if filtering fluid returns for re-circulation is required the level of contamination in the fluid will require a filter unit that is capable of handling higher levels of contamination. Some of the above operations only require new brine to be polished so it can be placed into the well, no returns are expected. The likelihood of high contamination is minimal circulated round the well and returned to the surface for filtering and pumping back down the well.

Oilfield Filtration



Types of Filtration Equipment

The Diatomaceous Earth (DE) Filter Press

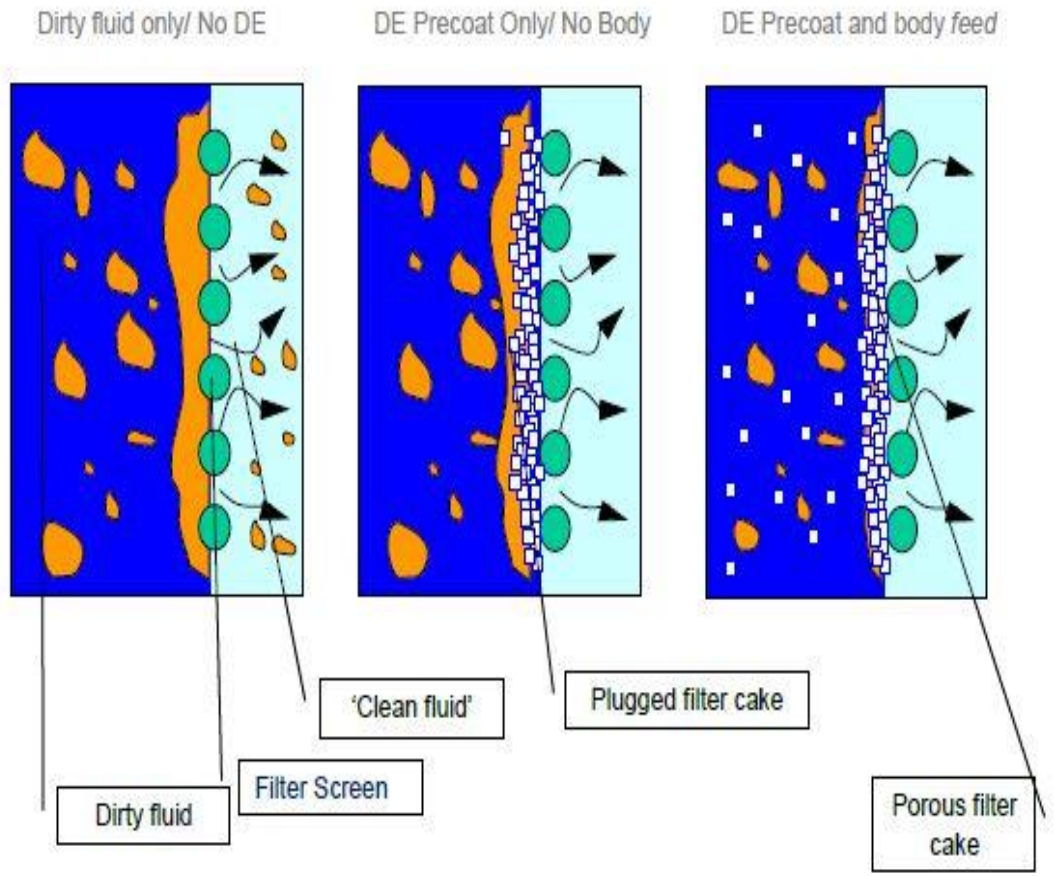
This unit is the work horse in the offshore brine filtration world; it can handle relatively high levels of solids contamination. The DE filtration system can remove as much as 90% to 95% of particulate down to 2 micron in size. A typical 1200 sqft DE filter press has a maximum flow rate of 12 to 15 Barrels Per Minute (BPM) if challenged with a relatively light fluid with a low solids loading.

Types of Filtration Equipment

The Diatomaceous Earth (DE) Filter Press

• Most filtration operations are done during the wellbore clean-up. This involves filtering high volumes of dirty brine returns from the well during the wellbore clean-up. The brine must be filtered as fast as possible and to a very high standard. The filter press package can achieve this, with the help of a cartridge unit acting as a polish filter.

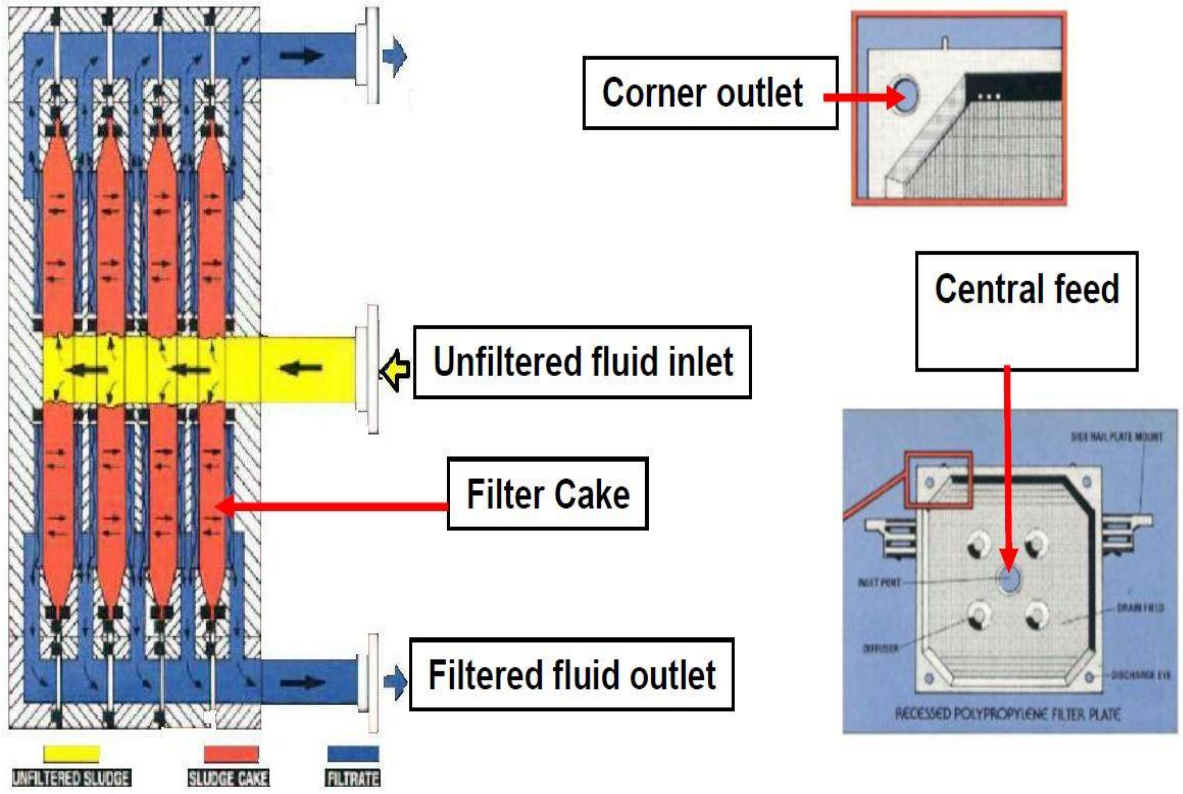
• The way the filter press can handle the higher levels of solids is down to the filter media and the way it's added, unlike a cartridge or similar type filter with a set surface area, the filter press has filter media added continuously during the operation which continually renews the filter's surface filtration area. The continuous addition of filter media prevents the build up of an impermeable layer of solids which normally causes the demise of most other forms of filtration.



Types of Filtration Equipment

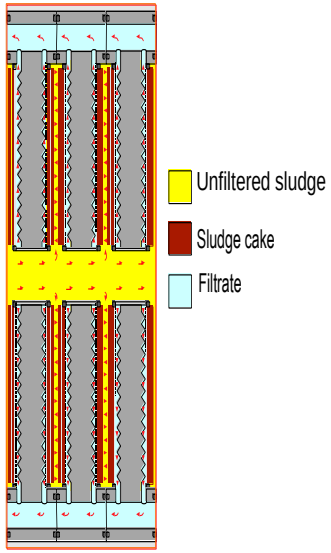
The Diatomaceous Earth (DE) Filter Press

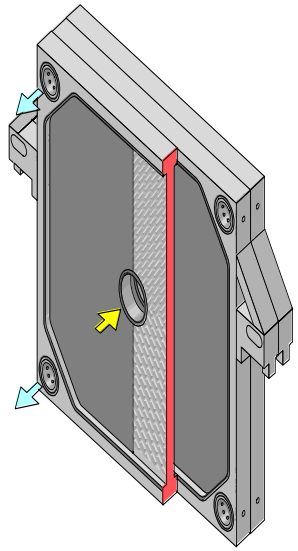
The recessed filter plates when pressed together form a series of filter chambers, each plate has a center hole, four corner holes, and a built-in filter cloth. Before filtration starts, a protective layer of filter media, known as the pre-coat is applied, a slurry of brine and filter media is introduced into the filter chambers, the fluid is allowed to pass through the filter cloths, which deposits the media onto the filter cloths which in turn forms the thin protective layer.



Types of Filtration Equipment

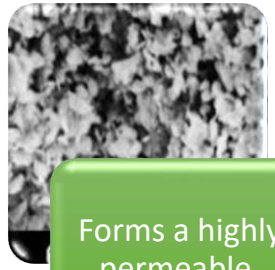
The Diatomaceous Earth (DE) Filter Press





Composed of fossil skeletons of microscopic water plants called Diatoms

DE is mostly silica - which is insoluble



Forms a highly permeable, stable filter cake

Comes in various grades and media pore sizes

Types of Filtration Equipment

The Diatomaceous Earth (DE) Filter Press

Our filter press DFP 1200 is complete equipped with all necessary auxiliaries. The drip free construction guarantees an environmentally friendly operation.
The heavy-duty system is powered by a hydraulic system which is driven by compressed air booster pumps. The robust constructed unit is easy to operate and maintain.

FEATURES

- Compact footprint
- Pneumatic powered hydraulic system
- Frame designed and certified according DNV 2.7-1/ISO 10855/ EN12079
- All wetted parts SS316
- Connections unions fi g. 206
- Stainless steel control cabinet

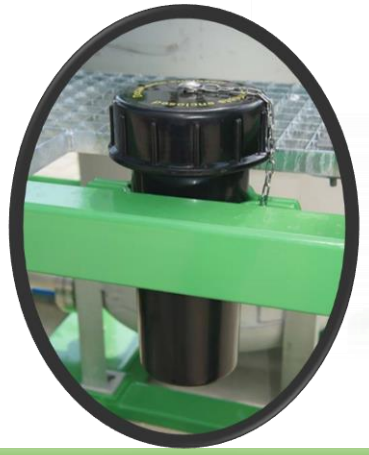
BENEFITS

- Fit on every on-/offshore installation
- Designed to fit global on / offshore Requirements
- Simple and reliable
- Robust and no corrosion
- 100% leak-proof and easy sealing with uniform pressure

Types of Filtration Equipment

The Twin Vessel Cartridge Filter

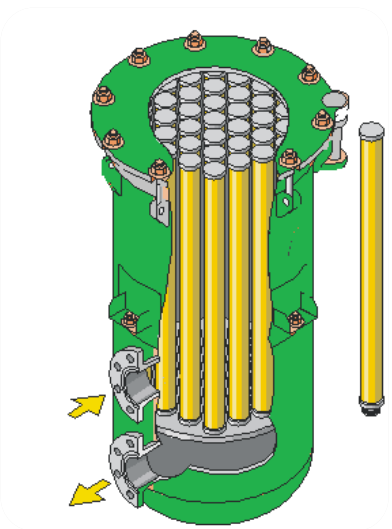
This is the most efficient filter unit of the three, it relies on disposable filter cartridges to carry out the filtering, there are several different types and sizes of cartridges available which provides a multitude of jobs it can be utilized on. The unit can work as a stand-alone unit, used to filter seawater/light brines, chemicals or specialty fluids, it's mostly employed as a polish/guard filter down stream of the DE Filter Press. This type of unit has a maximum flow rate of 18 BPM when filtering seawater.



Types of Filtration Equipment

The Twin Vessel Cartridge Filter

Our unit is designed and built-in accordance with DNV 2.7-1 and certified by DNV. Our standard DFC24 has two vessels of each 50 cartridges in series and by-pass operation.



FEATURES

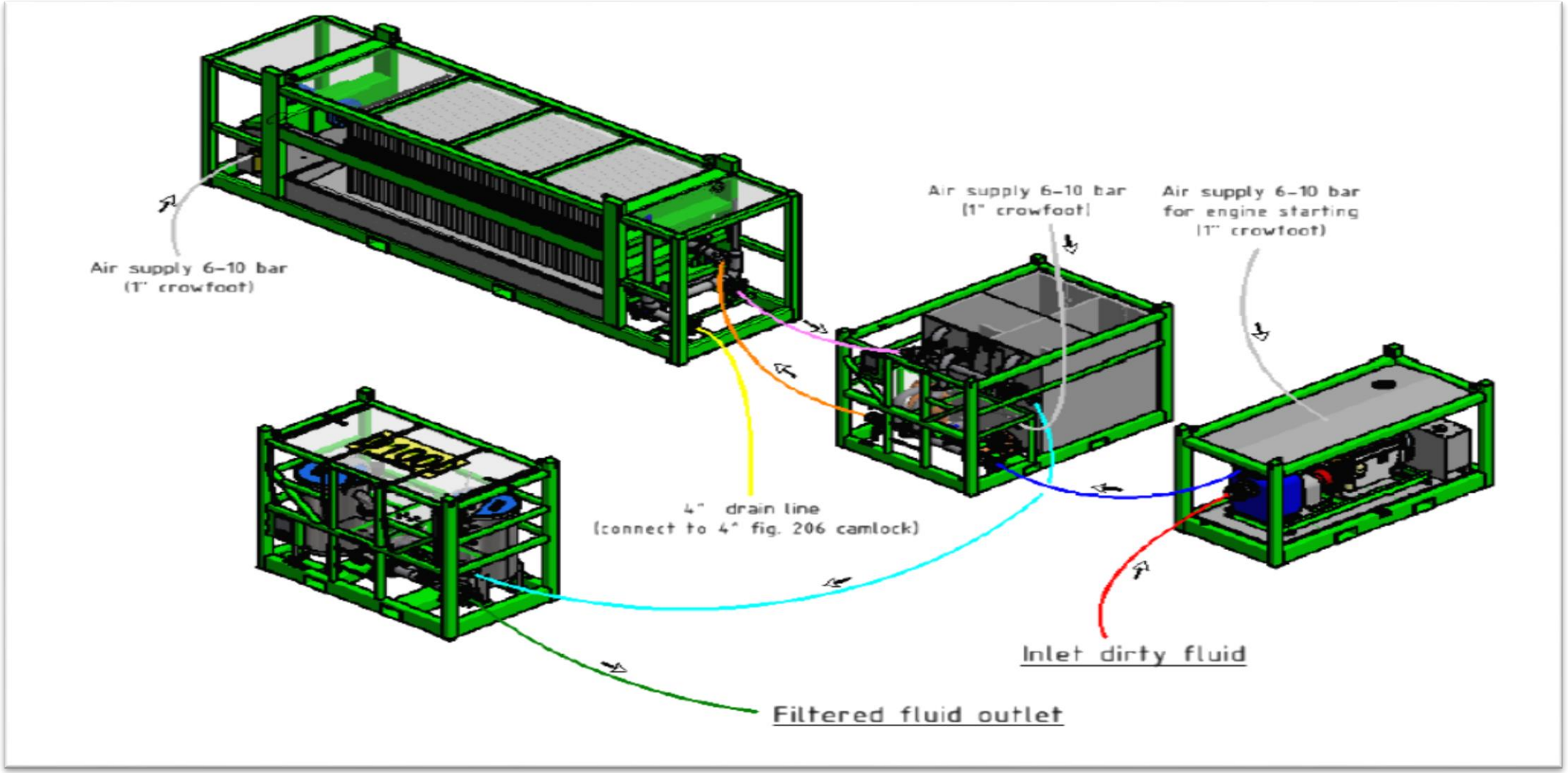
- Compact footprint
- Quick opening closure lid
- Simple Davit
- Frame designed and certified according DNV2.7-1 / ISO10855/ EN12079
- All wetted parts SS316
- Connections unions fi g. 206
- Standard 10 bar design to PED

BENEFITS

- Fit on every on-/offshore installation
- Quick and safe filter change out
- Easy opening and closing
- Designed to global on / offshore requirements
- No corrosion issues
- 100% leak-proof and easy sealing with uniform pressure
- Suitable for most applications

Types of Filtration Equipment

Filtration Package setup

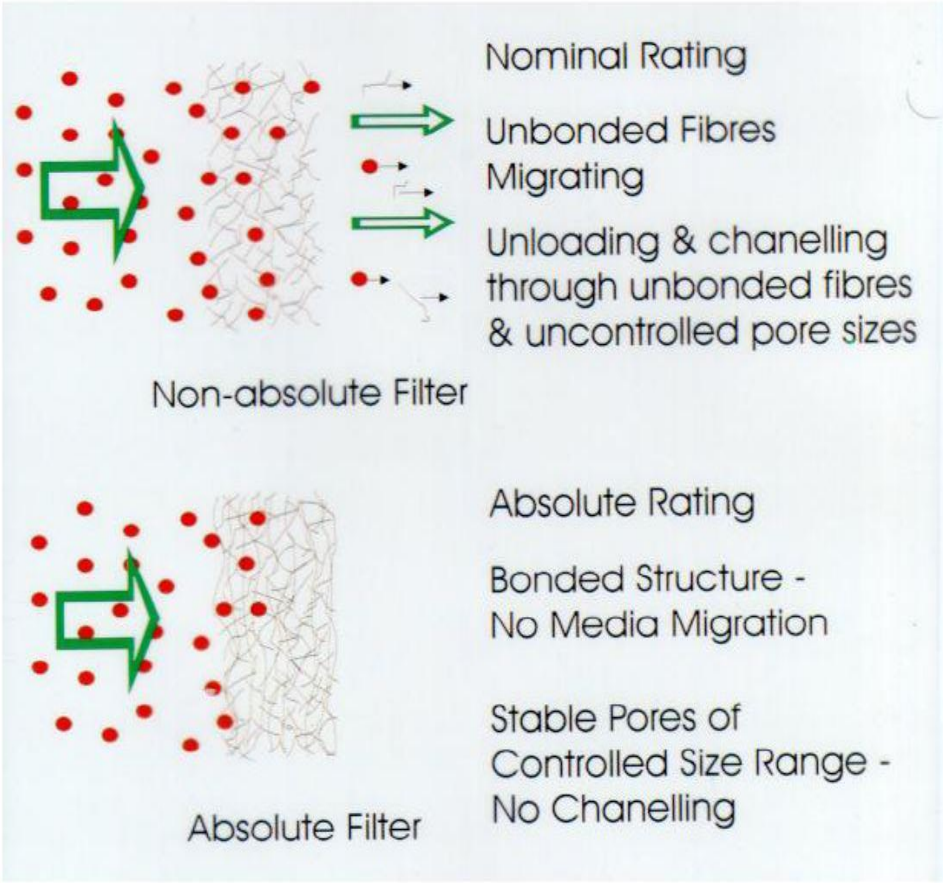


Types of Filtration Equipment

Cartridge Filters – Nominal and Absolute

• **Surface Filtration** as the name implies, is a surface filter, which has a very thin cross-section that retains oversized particles on the upstream side of the media. Surface filters are particularly suited to removing ridged, irregularly shaped particles. The particles accumulate with time to form a cake across the pores in the media, but still allow the fluid to flow through. The standard Absolute cartridge is classed as a Surface Filter.

• **In Depth Filtration** the particles are trapped predominantly within the internal structure of the filter media, depth filters are manufactured with a relatively thick media that requires the fluid to travel through a tortuous path as it proceeds from the upstream surface of the filter to the downstream surface. As the fluid twists and turns during its journey, decreasing sizes of all particles become trapped and adsorbed as the matrix of fibers becomes tighter. The standard nominal cartridge is classed as a Depth Filter



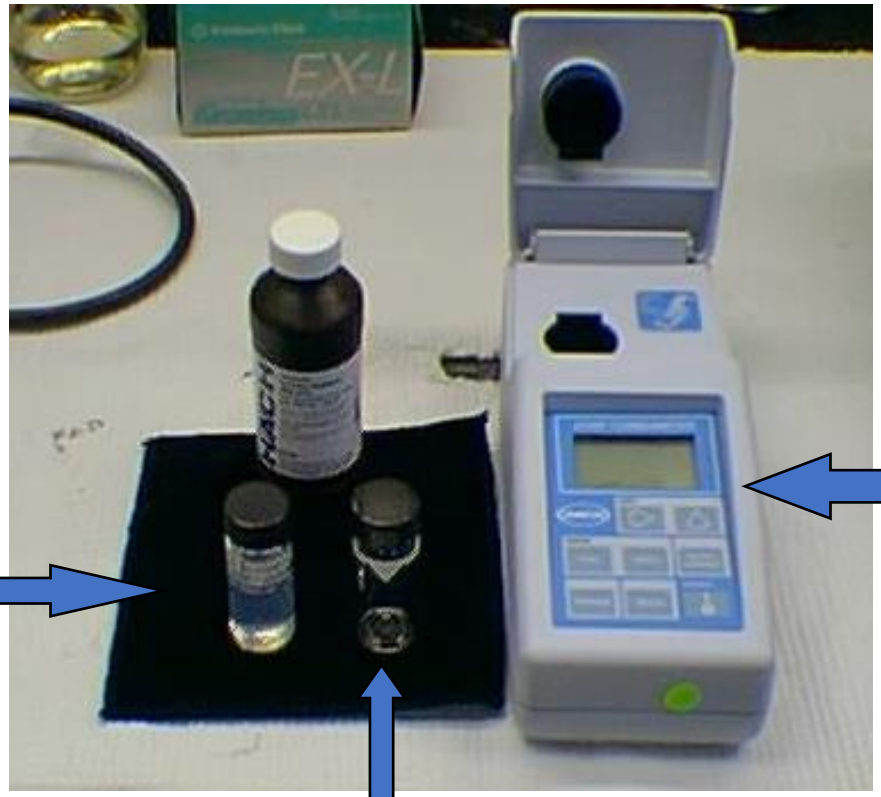
On-Site Quality Control

What is Turbidity?

NTUs ?

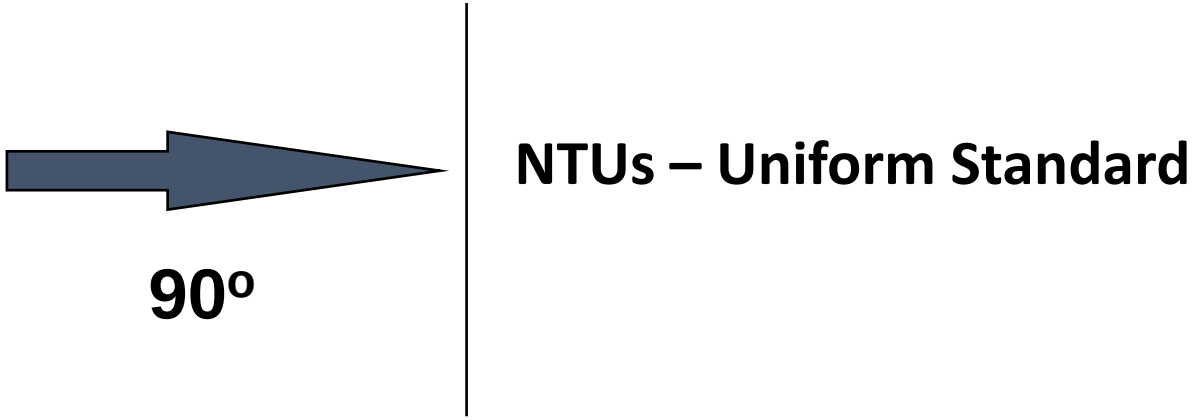
The Property of a Liquid That Causes it to Scatter or Absorb Light.

On-Site Quality Control



On-Site Quality Control

- Nephelometry is the Technique of Beaming Light on a Sample, and Measuring the Amount of Light Scattered at a Certain Angle



NTUs – Uniform Standard

Industry Standard = 20 NTUs

Turbidity Testing

- Fluid Clarity Expressed in Nephelometric Turbidity Units (NTU)
- No Direct Relationship with Total Suspended Solids
- Affected by Air Bubbles, Fingerprints, Smudges on Sample Jar, etc.

Filtration Summary

- Filtration of brines is necessary to ensure that fluid is solids free.
- DE Filtration with downstream guard cartridges is recommended.
- Filtration rates are affected by flow rate, pressure, fluid viscosity, size of solids, and filter area.
- Completion fluid engineer is responsible for ensuring fluid/filtration quality.

- **Filtration efficiency is a function of**
  - ✓ The effectiveness of the of the filtration system,
  - ✓ The physical characteristics of the brine and the suspended solids,
  - ✓ The Expertise of the Filtration Engineer.

Thank you