

Walnut Shell Filter Reuse Potential



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Introduction / Content



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What is the Walnut Shell Filter

- Vertical vessel designed with 48 – 66 inch bed depth of walnut shell
- Utilizes adsorption technology for oil coalescing
- Backwash technologies to regenerate
- Available for on-shore or off-shore application



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How Do They Work?

- Continuous pressurized bed
- Bed cycle based on time or pressure
- Media is recharged using backwash
- Oil is coalesced not adsorbed
- Used to remove SS and free oil
- Walnut shell media have equal affinity for water and oil
- Very low attrition rate



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Typical Walnut Shell Filter Media

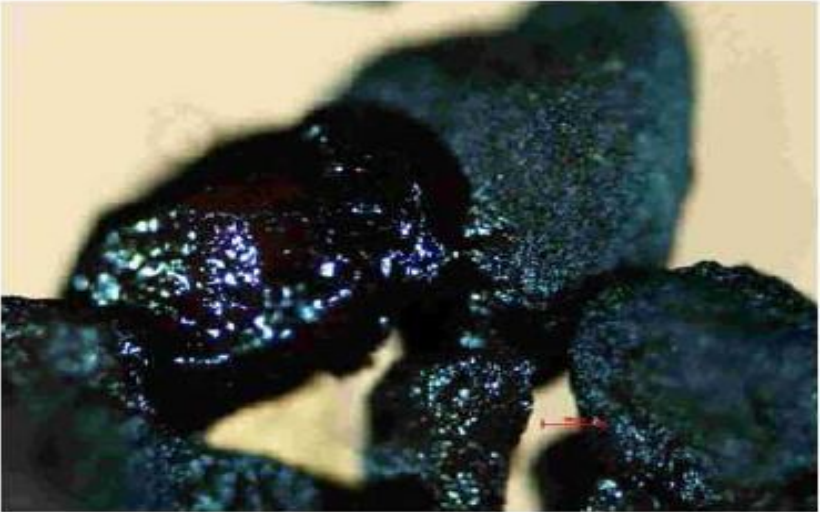
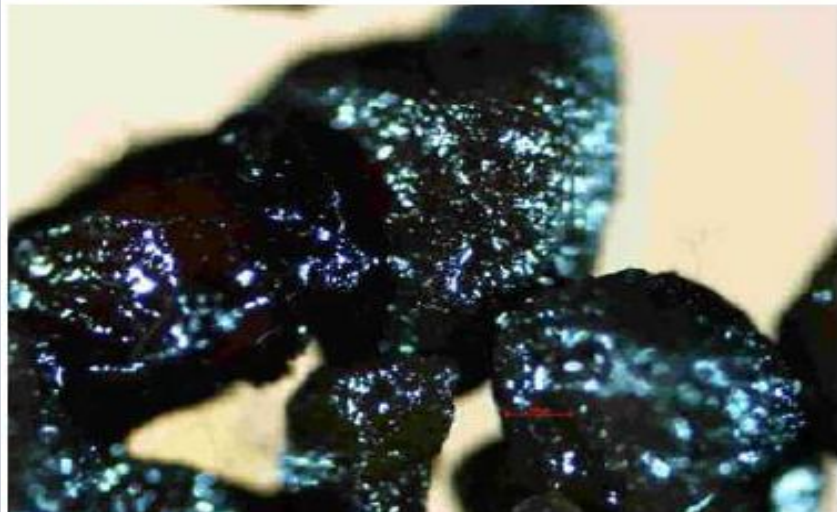
The Black Walnut Shell

- Excellent surface characteristics for
 - Coalescence
 - Filtration
 - High “modulus of elasticity”
 - Chemical free oil separation



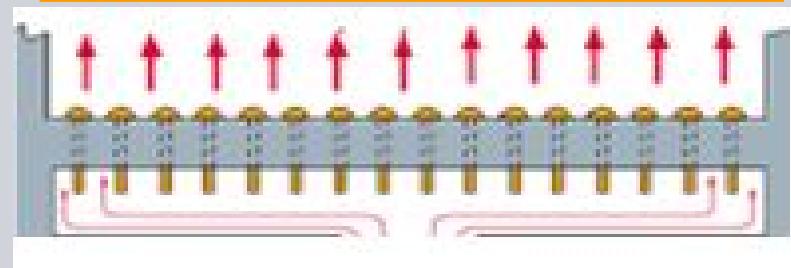
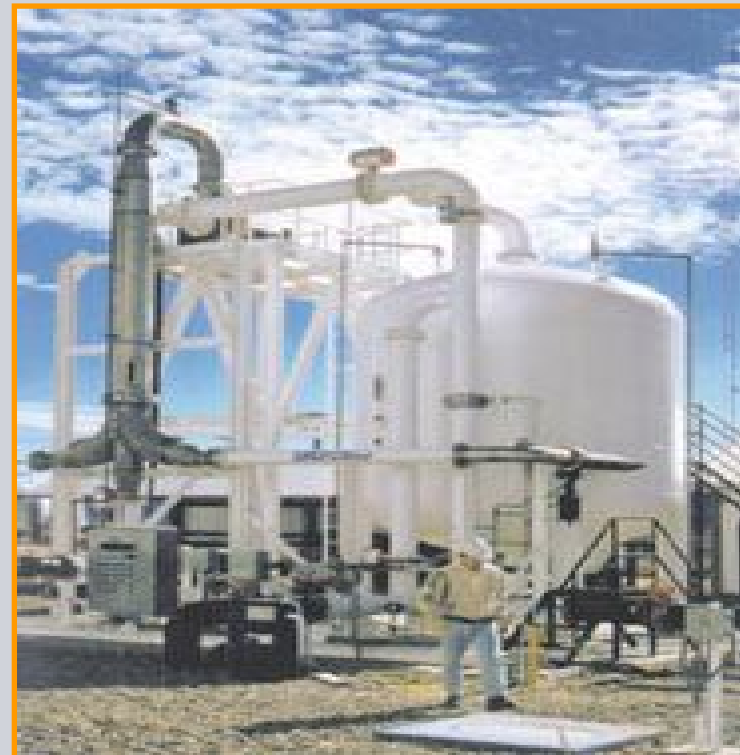
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Oil Coated Nut Shells



Advantages of a Vertical Design

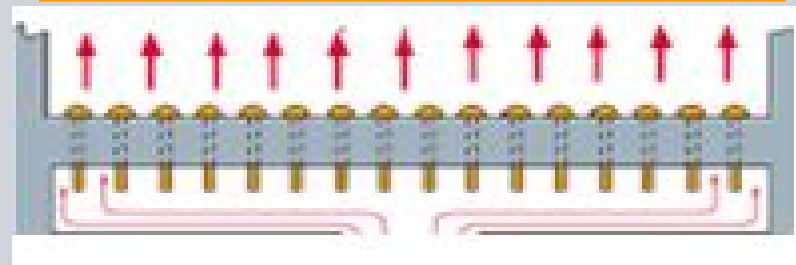
- Constant flux during forward flow throughout entire bed.
- Even bed fluidization during cleaning cycle - low chances of stagnation – ensures longer filter run times and overall media longevity.
- Full depth capture of oil and particulates.
- Minimum chance for suspended solids to break through to downstream units.



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Points to Consider

- 5% loss of shells per year.
- Oil is not absorbed by the shells, but attached.
- Backwash is typically performed every 24 hours, unless bed becomes fouled with TSS.
- Typically 20 minute backwash cycle
- Media need to be washed prior to placing them in service.
- Typical Loading rate = 13.5 GPM/ft²
- Maximum Oil loading = 100 PPM oil and 100 PPM TSS, expect 90% to 95% removal efficiency.



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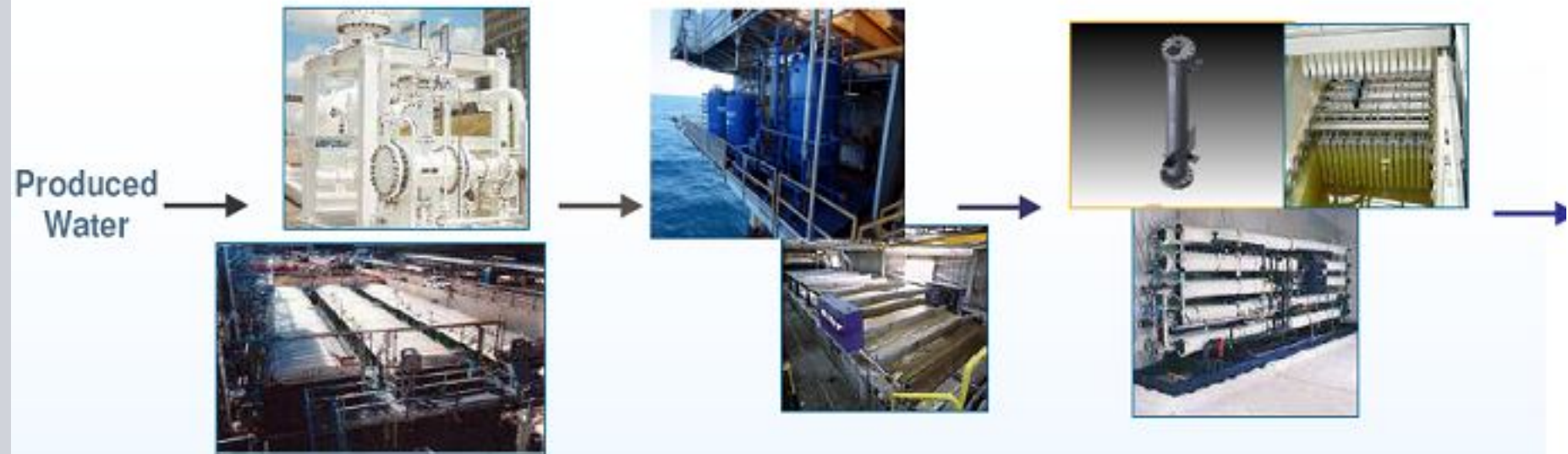
Typical Process Restrictions/Advantages

- 100 PPM inlet free oil
- 100 PPM inlet TSS
- 13.5 GPM/ft² (33 m³/hour/m²)
typical flux rate
- 95% removal > 2 micron
- 98% removal > 5 micron
- <5 PPM free oil/TSS in effluent
- Fully automatic backwash system
- Thirty (30) minutes off line
- 1% of throughput to waste
- Backwash with raw inlet water
- No interruption of feed
- No chemicals



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Produced Water Treatment



→ Primary Separation

- u Hydrocyclones
- u API Separator
- u Plate separators
- u Skimmer

→ Secondary Separation

- u Dissolved Air Flotation (DAF)
- u Dissolved Gas Flotation (DGF)
- u Induced Gas Flotation (IGF)

→ Tertiary Separation

- u Walnut shell filter
- u Coalescing filter
- u Cartridge filter
- u Sand filter

Pilot Testing – BP Valhall Platform

Objectives

- Prove walnut shell media can handle North Sea produced water
- Test efficiency of system
- Suitable for off-shore?

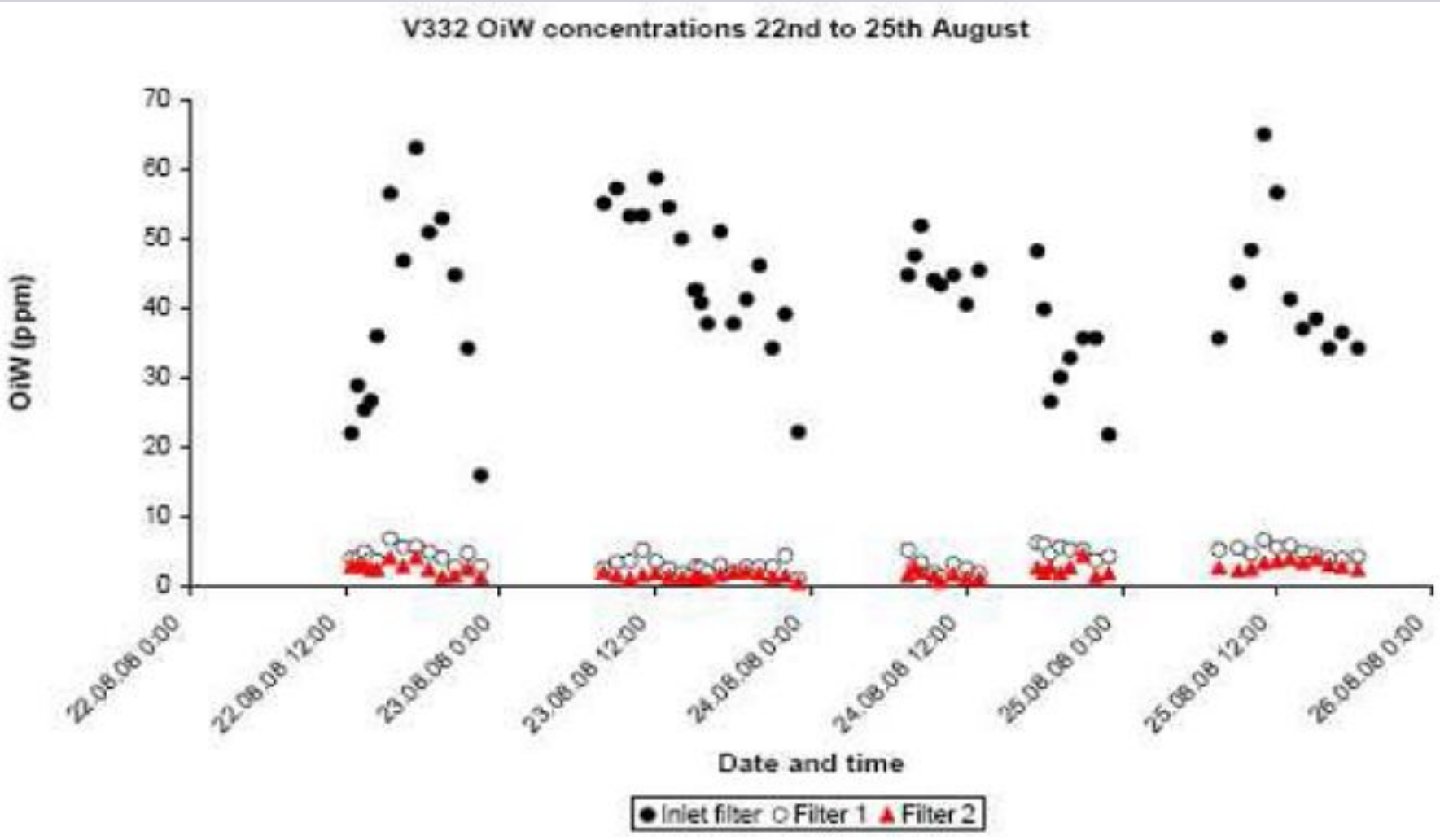


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Backwash Procedure Used in Test

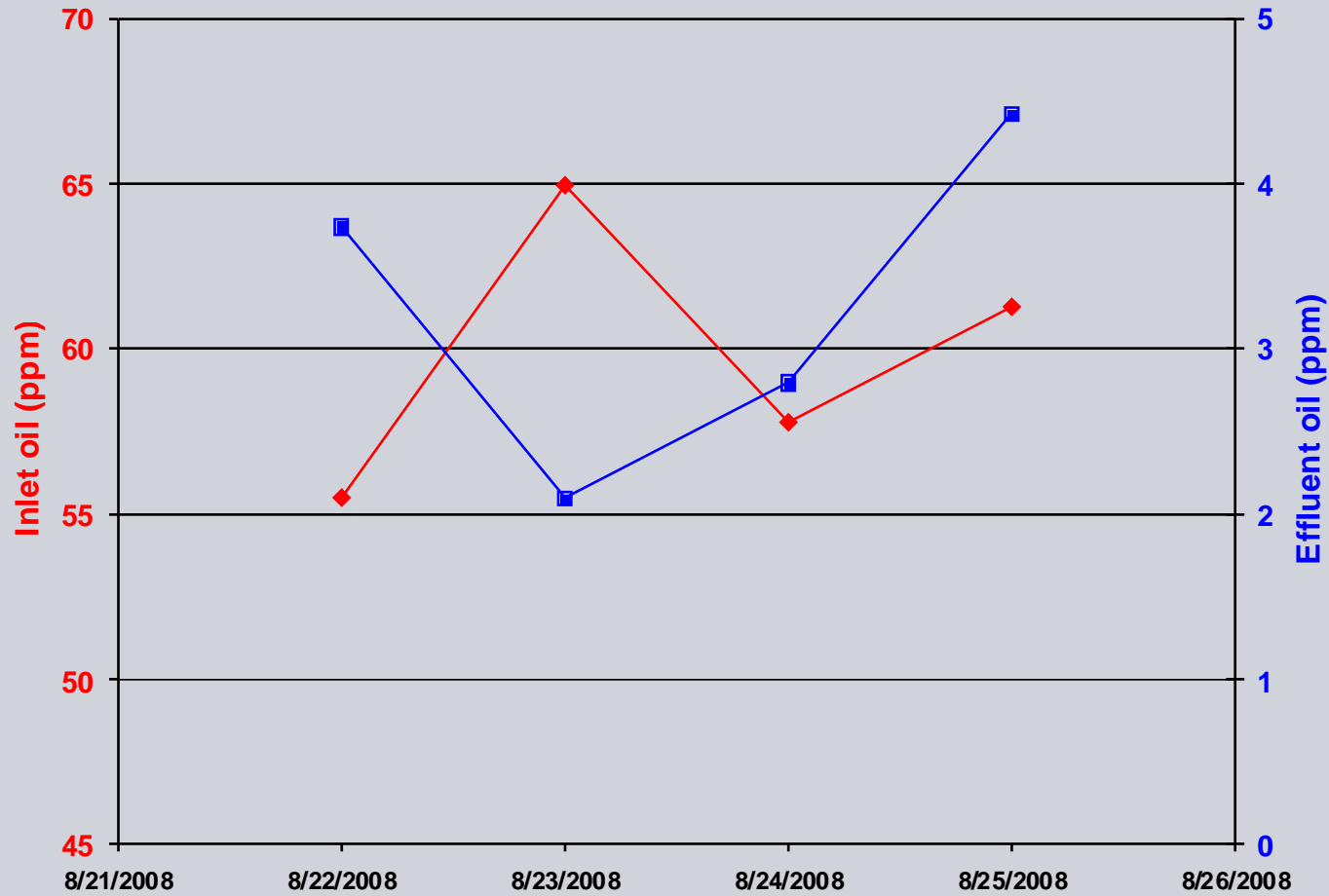


Pilot Study Results from the North Sea



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Results from Pilot Testing – Inlet and Effluent Oil Concentrations



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Monosep™ High-flow WSF



Pilot Unit Characteristics

- 2 vessels
- 1300 lbs. black walnut shells
- Flow Range – 42 to 168 gpm
- Flux Range – 13.5 to 27 gpm/ft²
- Backwash Waste:
 - 300 – 420 gallons
- Gas Requirements/Usage:
 - 90 – 250 SCF total usage



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Pilot Site Information

- Located in Western US
- Treatment of produced water from oil field
- Oil field production is a mixture of 98% water and 2% oil
- Producing rate ~50 bpd oil (2500 bpd produced water)
- Treatment Equipment – Gravity separation, VOC/H₂S stripping, WSF, carbon
- Pilot duration from Tuesday, April 27, 2010 through July 9, 2010



Pilot Flow – Typical Produced Water Treatment

Primary Separation

- Gravity Separation



Secondary Separation

- Dissolved Air/Gas Flotation
- (not used at Western US site)



Tertiary Separation

- Walnut Shell Filter
- Carbon



Typical WSF applications:

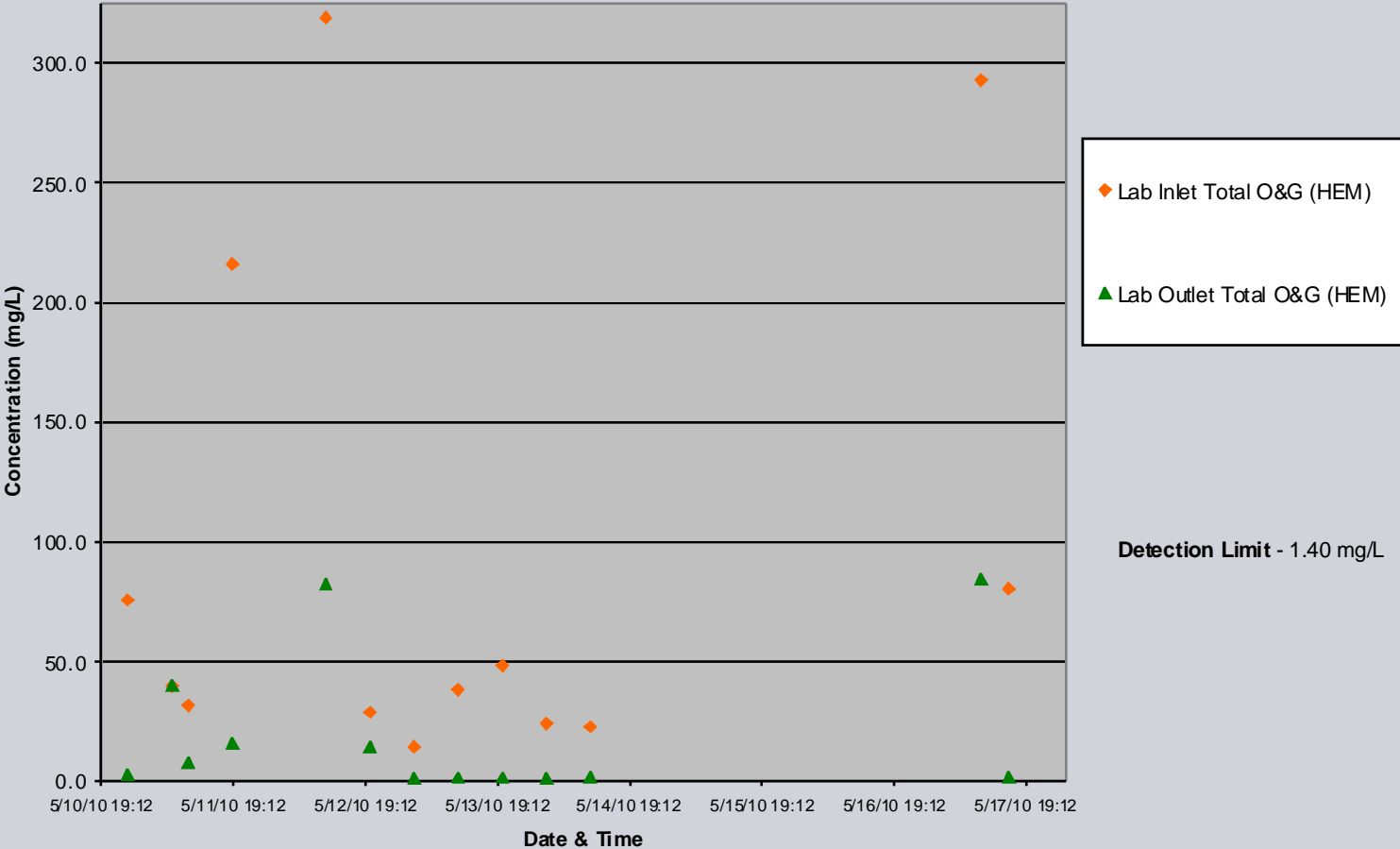
- Oil and Grease influent concentrations ~ 50 ppm
- Total Suspended Solids (TSS) influent concentration ~ 10 ppm

Pilot Study Objectives

- Test the recovery capabilities of the internalized backwash
- Internalized backwash system with no moving parts
- Increasing the flux rate from 13.5 gpm/ft² to 20.25 gpm/ft²
 - Not enough flow to test 27 gpm/ft²
- Particle size range removal efficiency
- Water suitable for recycle – carbon/RO treatment

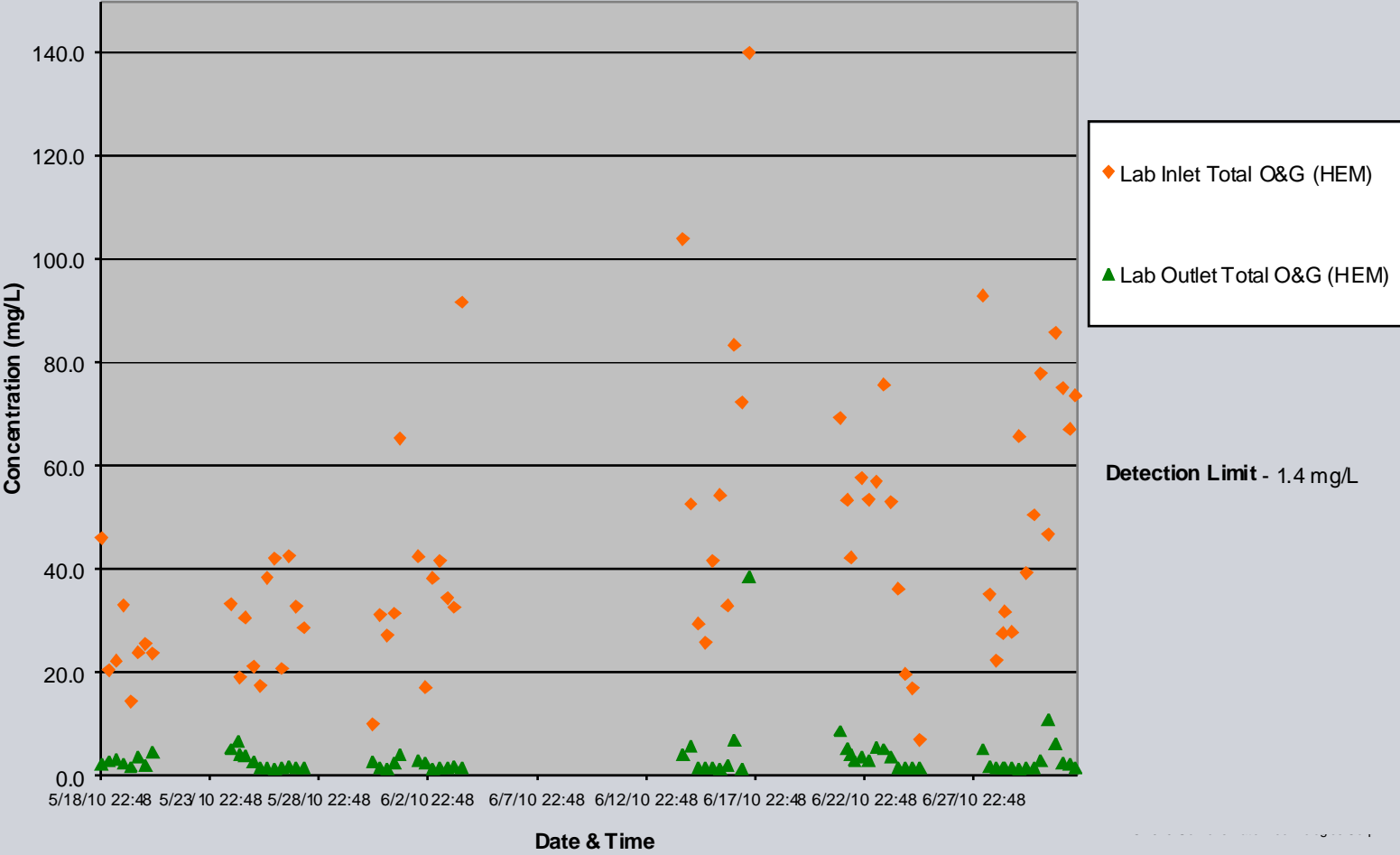
Overall Oil Removal - Flux Rate 13.5 gpm/ft²

Influent and Effluent Oil Concentration (13.5 gpm/ft²)
Samples Analyzed by EPA Method 1664A

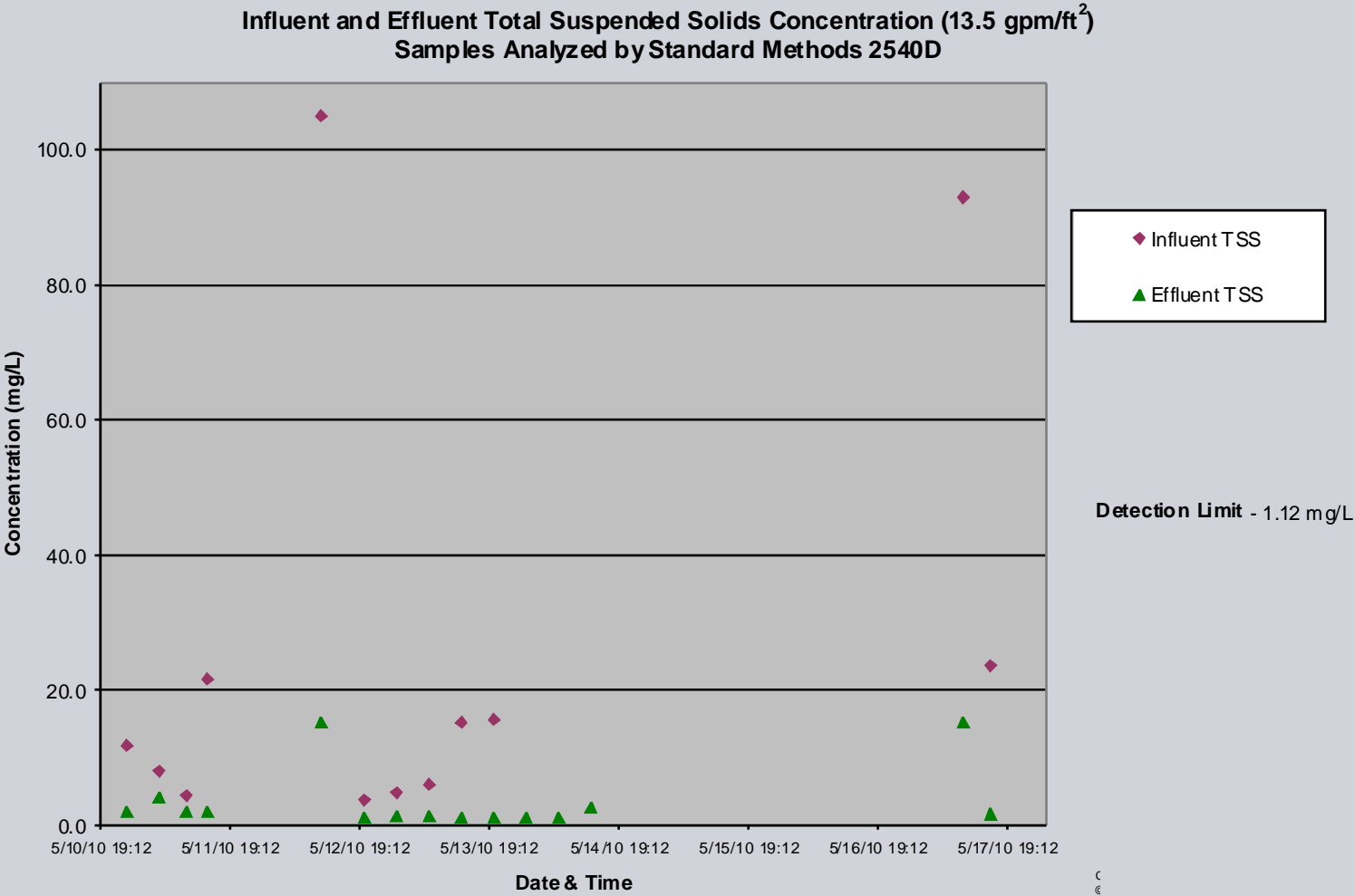


Overall Oil Removal - Flux Rate 20.25 gpm/ft²

Influent and Effluent Oil Concentration (20.25 gpm/ft²)
Samples Analyzed by EPA Method 1664A

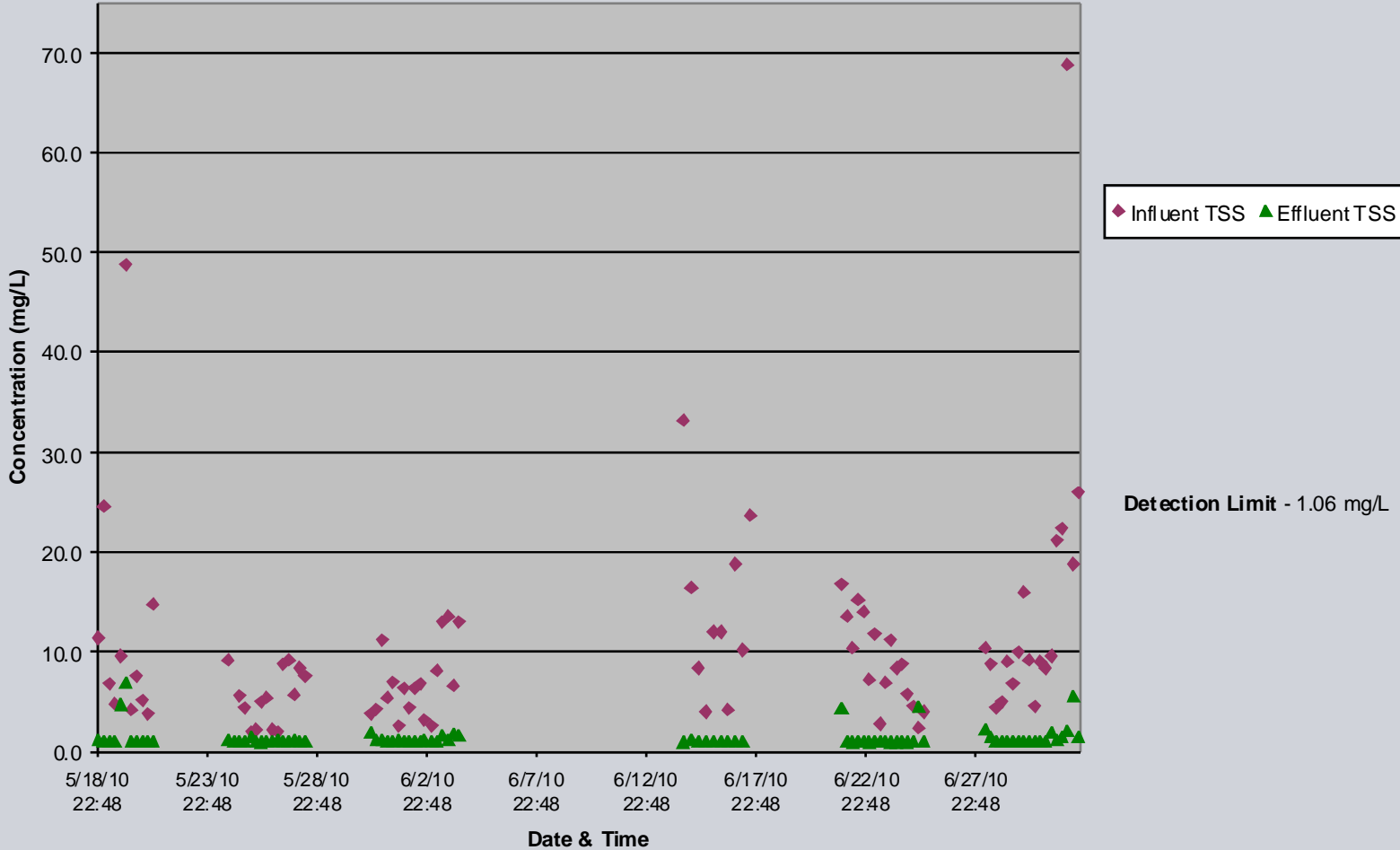


Overall TSS Removal - Flux Rate 13.5 gpm/ft²

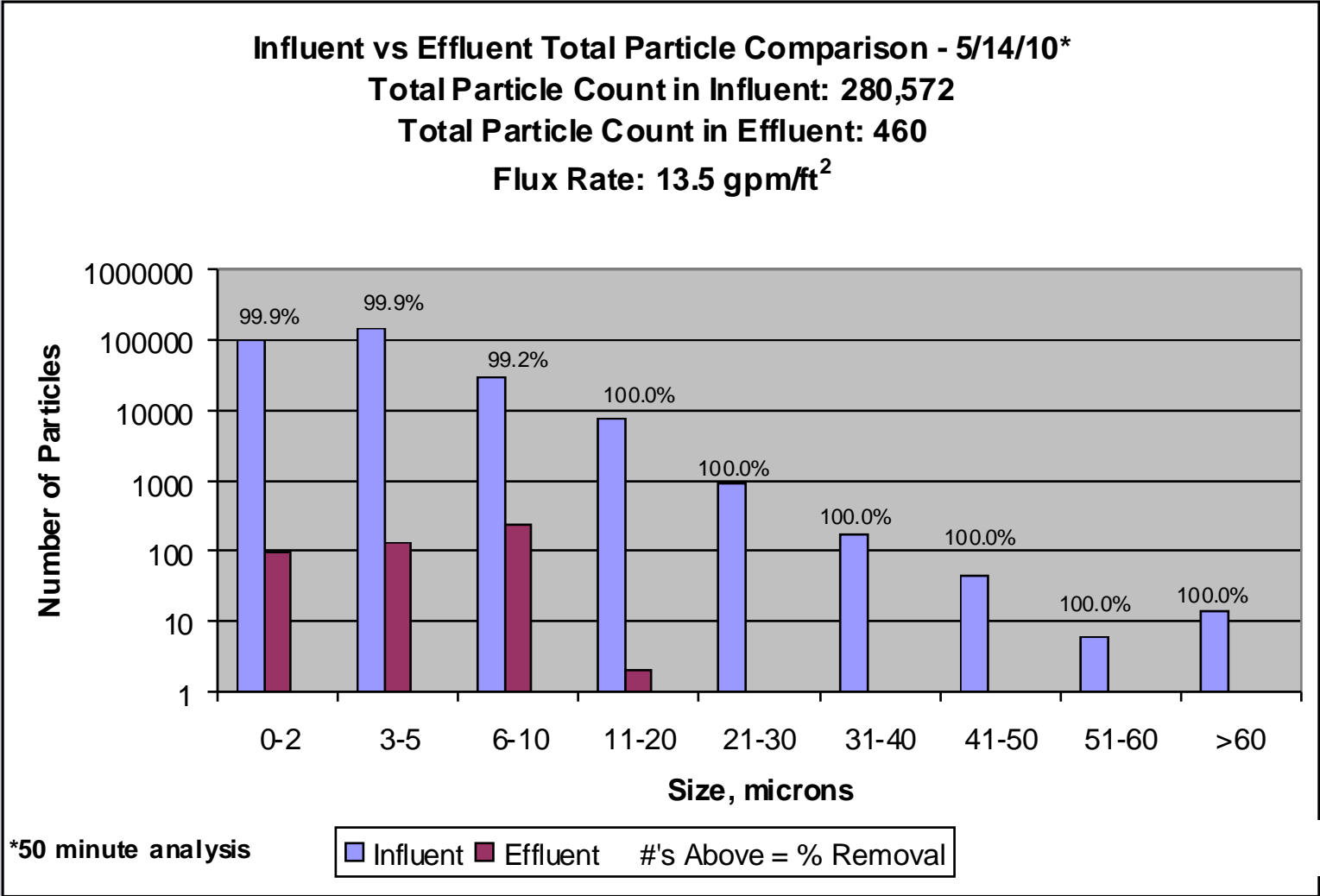


Overall TSS Removal - Flux Rate 20.25 gpm/ft²

Influent and Effluent Total Suspended Solids Concentration (20.25 gpm/ft²)
Samples Analyzed by Standard Methods 2540D

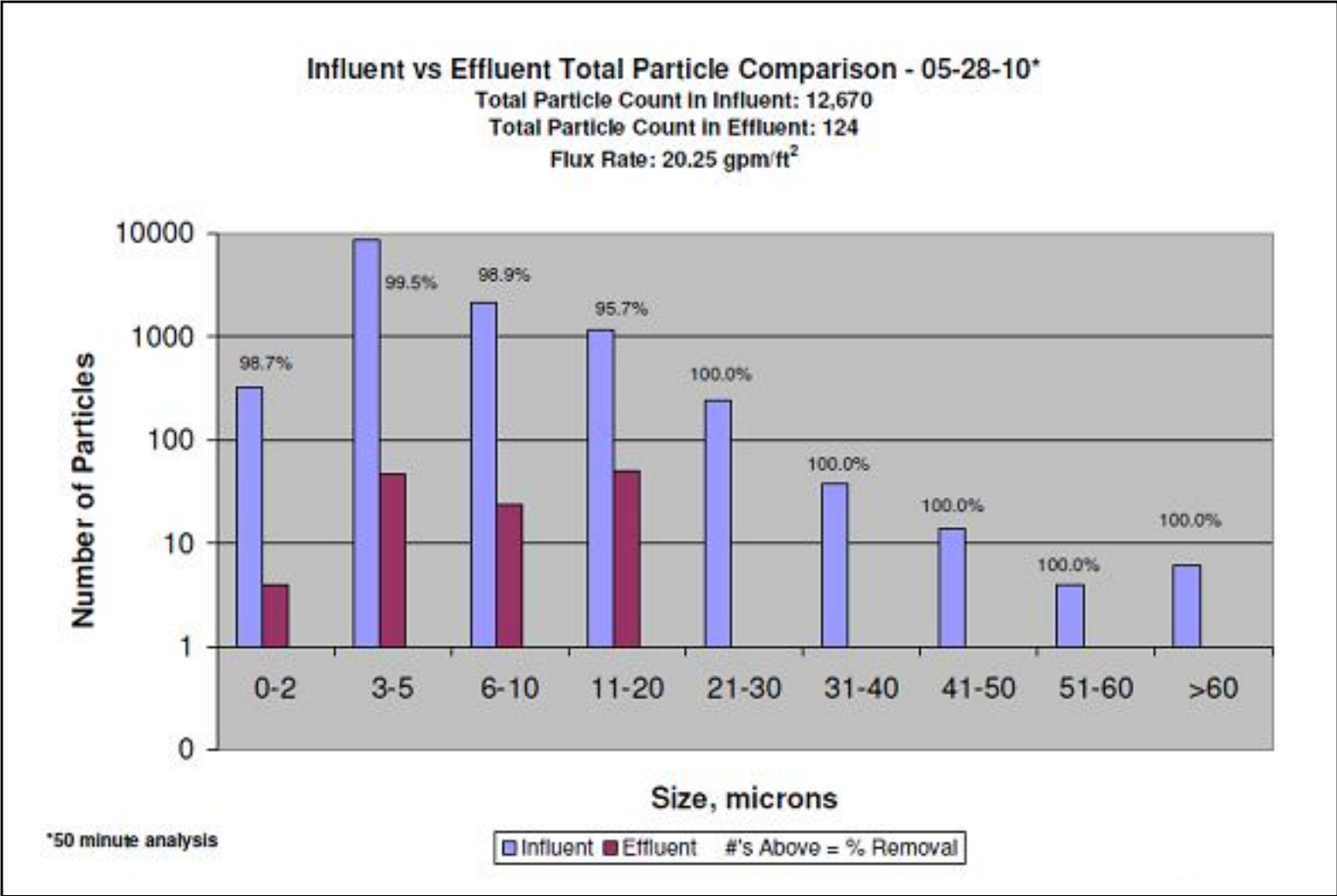


Particle Size Comparisons – 13.5 gpm/ft²



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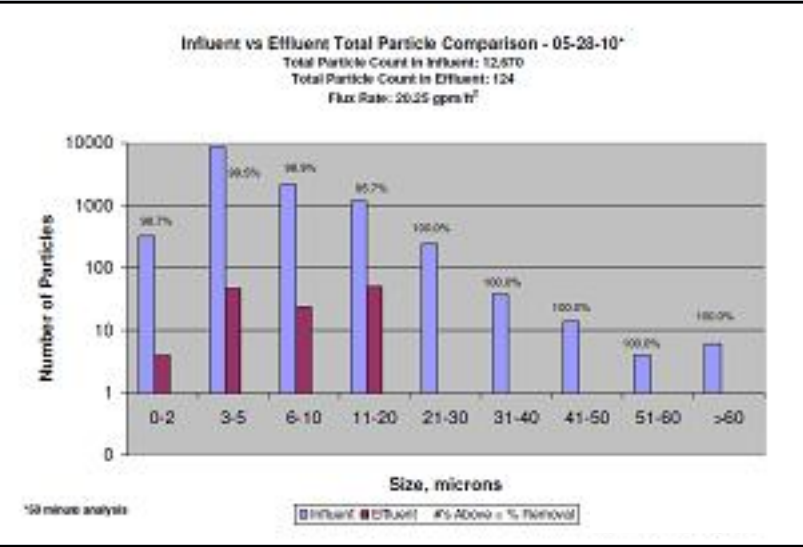
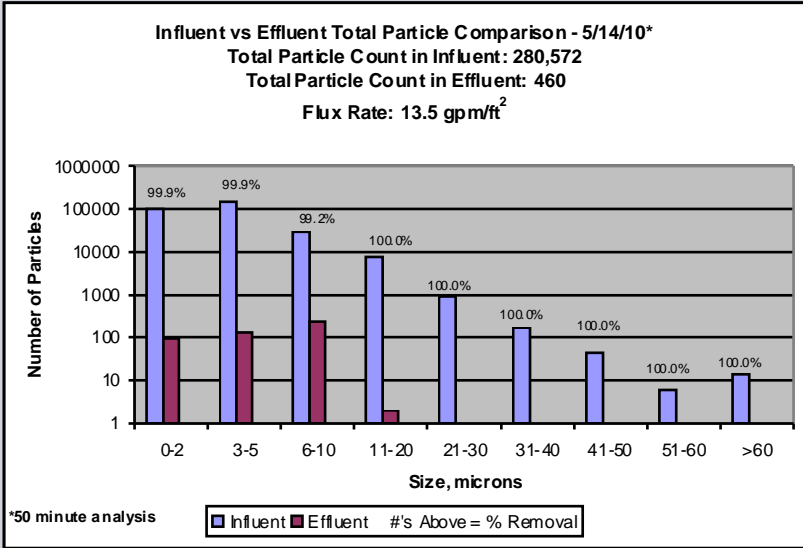
Particle Size Comparisons – 20.25 gpm/ft²



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Overall Particle Comparisons

- All particles greater than 20 microns were removed
- At 13.5 gpm/ft² greater than 99% of particles were removed
- At 20.25 gpm/ft² greater than 95% of particles were removed



Conclusions

1. Reliable – treated produced water at the pilot sites.
2. Robust – During US pilot, WSF encountered significant variation in influent concentrations of oil and solids, the pilot unit was able to recover from the encountered upset conditions.
3. On several occasions during the pilot study, the backwash system was able to recover from upset conditions (>200 ppm oil)
4. BETX compounds were not removed by the WSF at this site.
5. 100% of particles > 20 microns were removed.
6. >96% of particles smaller than 20 microns were removed.
7. Reuse – Water sent to carbon to create RO feed quality water

Questions???

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of the world's water

