Gas Filter-Separator vs. Gas Coalescer Performance Comparison

Liquid & Solid Removal Methods from Natural Gas

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GAS Filter-Separator vs. GAS Coalescer
performance comparison

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- **Presentation Outline**

I. Technology Review
II. Project Goals
III. Testing Protocol
IV. Results
V. Technology Application

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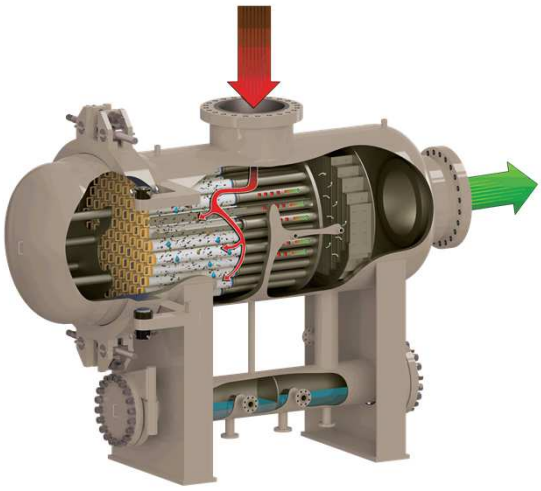
Technology Review
Gas Filter-Separator



TYPICAL PERFORMANCE STATEMENT

- 99.98% liquids and solids 1 micron and larger
- 720 Gallons/Day per Cartridge (40 lbs/cu.ft. and greater)

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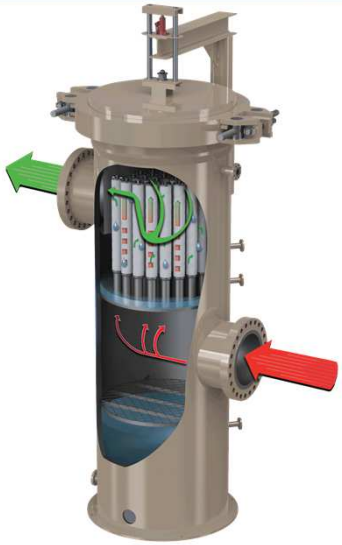
Technology Review
Vertical Gas Coalescer

TYPICAL PERFORMANCE STATEMENT

- 99.99% liquids and solids 0.3 micron and larger
- 25 Gallons/Day HC per Cartridge (less than 40 lbs/cu.ft.)



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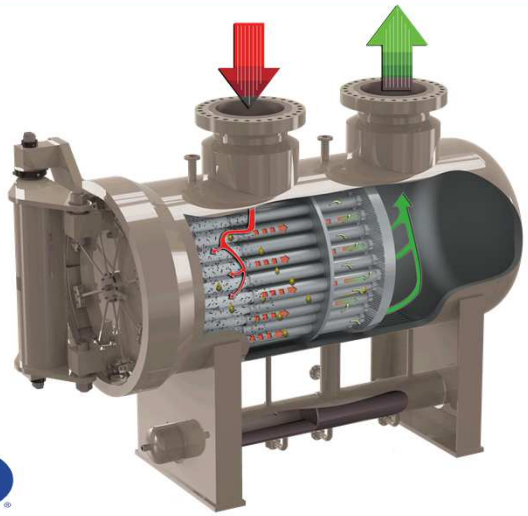
Technology Review

Two Stage Horizontal Gas Filter-Coalescer



TYPICAL PERFORMANCE STATEMENT

- 99.99% liquids and solids 0.3 micron and larger
- 360 Gallons/Day HC per Cartridge (less than 40 lbs/cu.ft.)

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Project Goals

1. Compare **Filter-Sep** and **Vertical Coalescer** liquid removal performance.
2. Compare **Two-Stage Horizontal Filter-Coalescer** performance with **Vertical Coalescer** performance.

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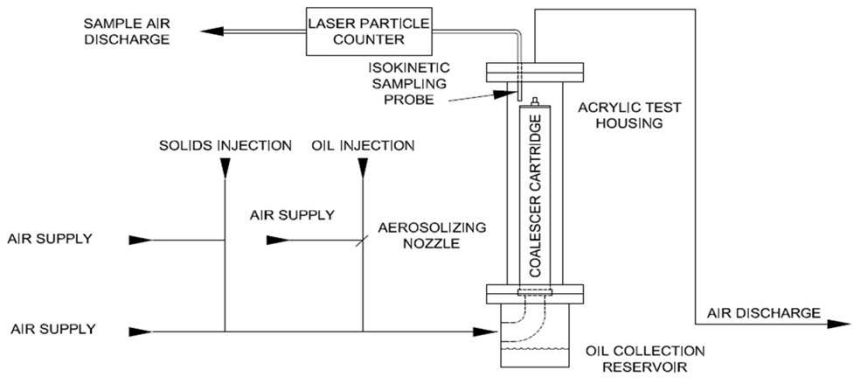
Testing Protocol

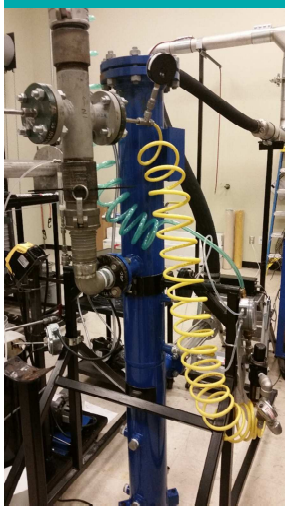
1. New filter cartridges are loaded into test stand.
2. Flow conditions are set to be within 10% of max cartridge capacity at process conditions.
3. Liquid injection is set at a certain rate and recorded.
4. Liquid is captured or measured downstream of the filter unit.
5. Liquid concentration is compared upstream and downstream of the filter device to calculate efficiency.

Testing Protocol

Test Loop



Testing Equipment

Filter-Separator	Vertical Coalescer
	

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Testing Equipment

Laser Particle Counter used for gravimetric efficiency

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Testing Equipment

Photometer used for aerosol efficiency (CAGI, ISO)

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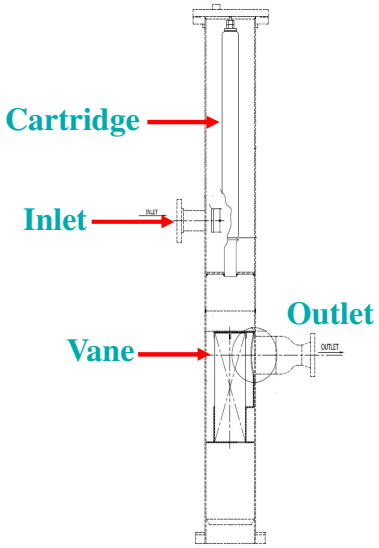
Filter-Separator Test Vessel and Test Conditions

Test Vessel (Filter-Separator) PECO Series 85

- PCHG-24 PEACH Test Cartridge
- # 2 Vane (Open Area 0.0938 sq.ft.)

Test Conditions

- Flow Rate 105 SCFM
- Fluid Medium (Air)
- Temperature 70 deg F
- Cartridge DP 12" (WC)
- Contaminant (NGL)
- Flow Rate 21 ml/minute



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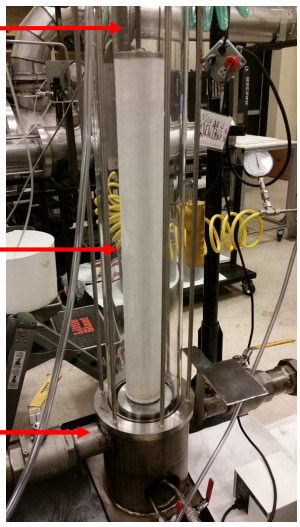
Vertical Coalescer Test Vessel and Test Conditions

Test Vessel (Coalescer) PECO Acrylic 77V

- NGGC-336 PL23 PEACH Test Cartridge

Test Conditions

- Flow Rate 185 SCFM
- Fluid Medium (Air)
- Temperature 72 deg. F
- Cartridge DP 40" (WC)
- Contaminant (NGL)
- Flow Rate 21 ml/minute



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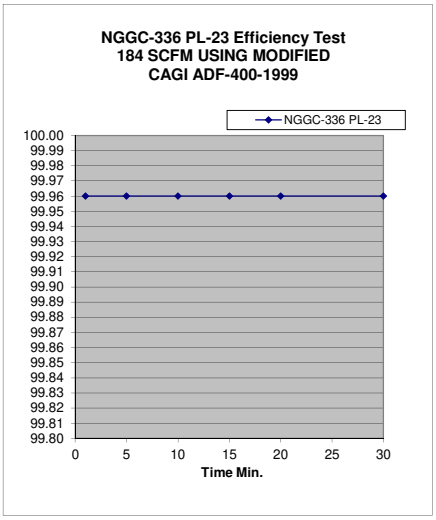
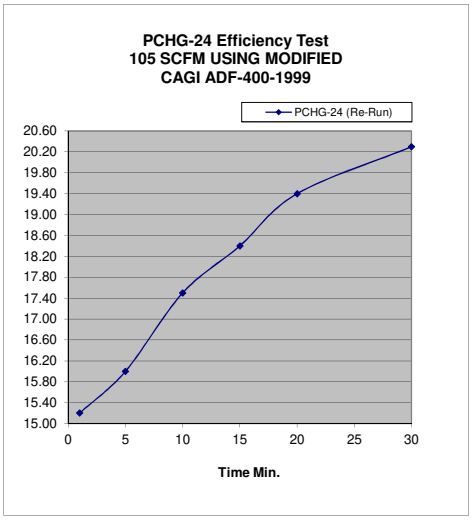
Modified CAGI Comparison





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Principles of Surface Tension (S.T.) (dynes/cm)

Two kinds of intermolecular forces:

(i) **Cohesion** – force of attraction between molecules of a liquid.

(ii) **Adhesion** – force of attraction between unlike molecules, i.e. liquid and a solid.

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Properties of Surface Tension

Drag Force vs Retaining Force:

Fd ≥ Fσ = Carryover

Drag Force (Fd) – High shear flow of gas acting on the liquid wave crest.

Surface Tension (Fσ) – Boundary force between a liquid and vapor phase.

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Filter-Separator Efficiency Using Alternate Contaminants

Test results illustrating the test vessel efficiency using water or a hydrocarbon contaminant in Filter-Separators.

ST (Surface Tension) Comparison:

- Water / Air – 73 dynes / cm
- Stabilized NGL / Air – 35.3 dynes / cm

Filter-Separator and Vertical Coalescer Effluent Carryover

- Filter-Separator (Series 85)

  NGL **– 1033 gm fed | 12.9 gm carry-over**

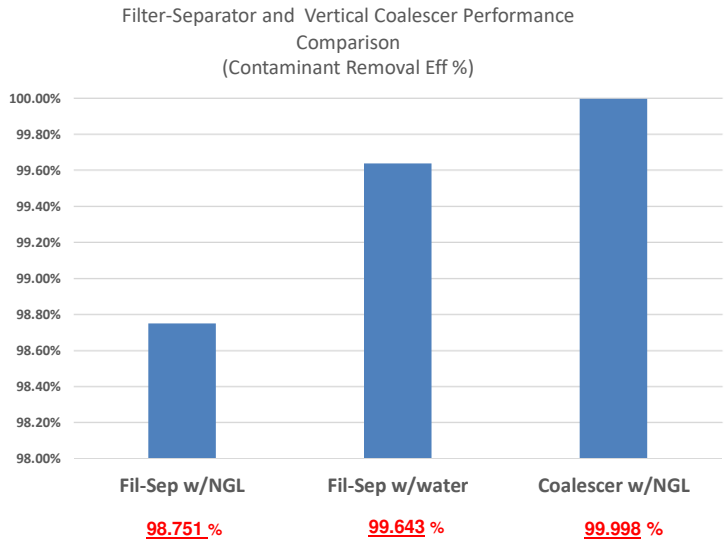
- Filter-Separator (Series 85)

  Water **– 1260 gm fed | 4.5 gm carry-over**

- Vertical Coalescer (Series 77V)

  NGL **– 1048 gm fed | 0.00116 gm carry-over**

Filter-Separator and Vertical Coalescer Comparison using Water and NGL



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Filter-Separator and Vertical Coalescer Vessel Comparison

- **Vessels Compared:**
  - **Filter-Sep 75HTL-31-343-32I-1480 WP (31 Cartridges)**
  - **Vertical Coalescer 77V-18-336-32-1480 (18 Cartridges)**

- **Total Contaminant Fed (1 day)**
  - **10 Barrels (420 gallons)**

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Filter-Separator and Vertical Coalescer
Vessel Comparison

- *Filter-Separator* (Series 75HTL)

  NGL **– 420 gal fed | 5.2458 gal effluent (0.1249 BBL)**

- *Filter-Separator* (Series 75HTL)

  Water **– 420 gal fed | 1.4994 gal effluent (0.0357 BBL)**

- *Vertical Coalescer* (Series 77V)

  NGL **– 420 gal fed | 0.0084 gal effluent (0.0002 BBL)**

Filter-Sep with NGL Contaminant

Video

Filter-Sep using Water as the Contaminant

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Video

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Filter-Sep using HC Fog as Contaminant

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Vertical Coalescer using Mineral Oil as Contaminant

Video

Vertical Coalescer Test Report

Input Values	
Vessel Flow Rate: (SCFM)	185
Vessel Pressure: (PSIG)	0.857
Vessel Temperature: (F)	74.9
Specific Gravity:	1
Vessel ID: (inches)	8.25
Liquid Density: (lbs/ft3)	51.9

Calculations	
Compressibility:	1.000
Flow Rate: (acfm)	180
Gas Density: (lbs/ft3)	0.079
X-Sec Area: (ft2)	0.371
Sample Velocity: (ft/sec)	8.1
Flow Meter Setting: (ml/sec)	0.53

Testing Notes	
Test Liquid:	Generator Oil
Sample Collection Time: (sec.)	10
Sample Connection:	Top Head
Atm Press:	14.65
Sampling Period:	15:20:00 - 16:20:00
Sampling Duration: (min)	60

Ave. Liquid Injection Rate: (ml/min)	21.00

Total Vol. Liquid Injected: (mils)	1680

Sample Sequence:	10 Sec

Ave. Particle Size (micron)	Particle Wt (lbs)	Sample Average	Average Sample wt
0.300	2.59E-17	159.74	4.136E-15
0.350	4.11E-17	42.67	1.7543E-15
0.400	6.14E-17	27.19	1.6688E-15
0.450	8.74E-17	15.23	1.3306E-15
0.500	1.20E-16	1.86	2.2242E-16
0.550	1.60E-16	3.20	5.1098E-16
0.600	2.07E-16	3.34	6.9101E-16
0.650	2.63E-16	2.44	6.4374E-16
0.700	3.29E-16	1.98	6.5052E-16
0.750	4.05E-16	1.16	4.6973E-16
0.800	4.91E-16	3.46	1.7007E-15
1.000	9.59E-16	6.71	6.4382E-15
3.000	2.59E-14	0.69	1.7908E-14

Elmt Dry Weight: (grams)	n/a
Elmt Wet Weight: (grams)	n/a

Dry DP: (*WC)	18
Wet DP: (*WC)	26

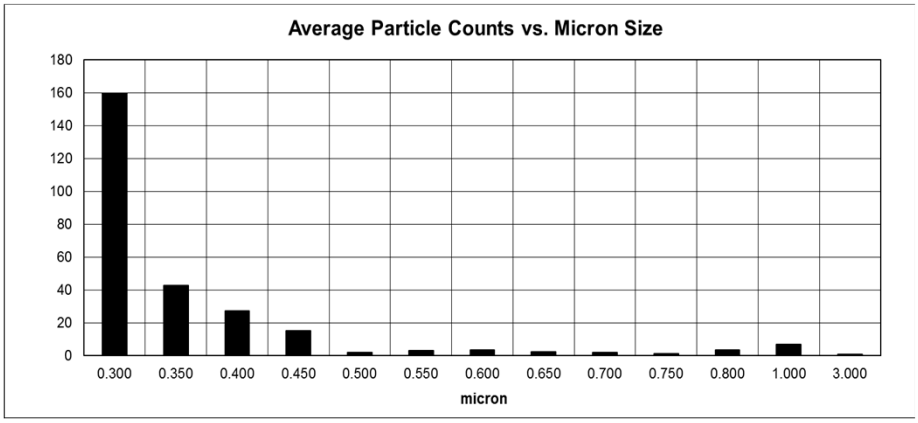
Total Accumulated Sample Wt: (lbs/10sec)	3.81E-14
Total Accumulated Sample Wt: (lbs/sec)	3.81E-15

Carryover PPM (wt)	0.00275
Efficiency	99.9999242

NOTE: PPM Level and Efficiency are calculated based off of counts of particles ranging from 0.3 to 8 microns in size.

NOTE: Efficiency is calculated with the following equation: Eff = (Liquid injected wt - liquid lost wt based on average counts)/(Liquid injected wt)*100

Vertical Coalescer
Average Particle Counts



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Testing Protocol

Two-Stage Horizontal Filter Coalescer Test Housing

Solids Contaminant Feed

Liquid Contaminant Feed

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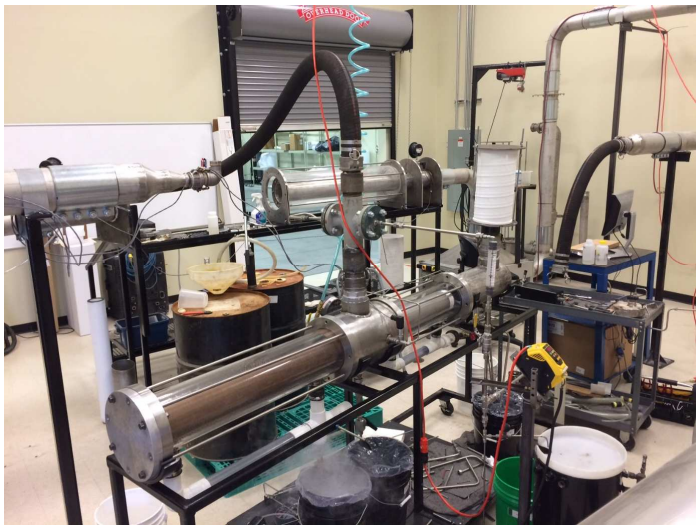
Testing Protocol

Two-Stage Horizontal Filter Coalescer Test Housing



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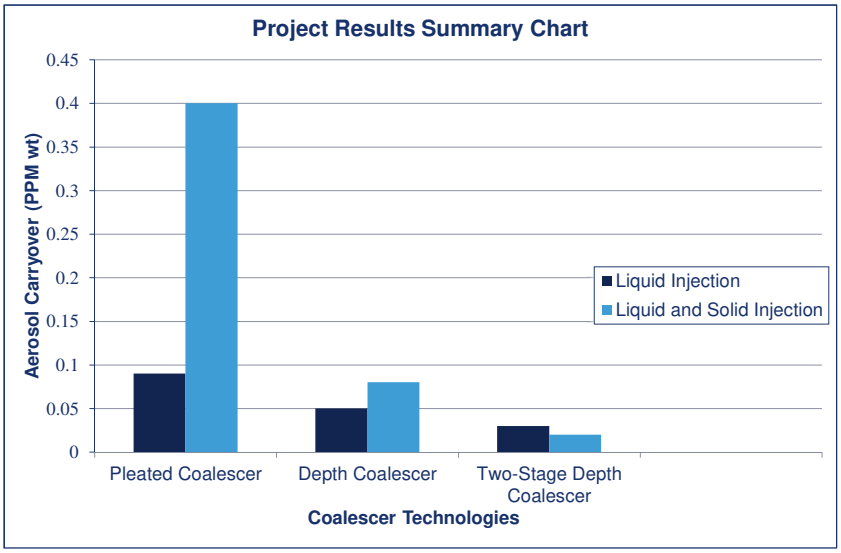
Testing Results



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Testing Results

Vertical Coalescer Cartridge

- Vertical coalescer cartridges utilize the same media to coalesce liquids and filter solids.
- As the media plugs with solids the gas velocity increases through open areas as shown.
- As the gas velocity increases, the media's coalescing efficiency decreases.

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Testing Results

Two-Stage, Horizontal Filter-Coalescer Cartridge

- First stage captures solid particles.
- Second stage stays clean for optimum coalescing efficiency.

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Application Guide

1. Filter-Separators will allow some free liquid carryover.
2. Filter-Separators will not effectively remove submicronic aerosols.
3. Vertical Coalescers will effectively remove submicronic aerosols.
4. Vertical Coalescers have a limited liquid and solids handling capacity.
5. Two Stage Horizontal Filter-Coalescers will effectively remove submicronic aerosols when operating in high liquid and solids loading applications.

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Natural Gas Filtration Technology Application Guide

No.	Application	Bulk Contaminant Separation	Primary Filtration Selection	Alternative Equipment Selection	Special Challenges
1	Production & Gathering TEG Dehydrator Feed	Vane or Cyclonic Style Separator[1,2]	Dual Stage Horizontal Filter Coalescer	Filter Separator	Lube oil from compression
2	Production & Gathering TEG Dehydrator Discharge	Not Required.	Vertical or Dual Stage Coalescer	Filter Separator or multi-stage cyclone separator	TEG mixing with other pipeline contaminants
3	Production & Gathering Recip Compressor Suction	Vane or Cyclonic Style Separator[1,2]	Dual Stage Horizontal Filter Coalescer	Filter separator followed by vertical coalescer	Salt deposits on compressor valves
4	Production & Gathering Recip Compressor Discharge	Not Required.	Dual Stage Horizontal Filter Coalescer	Vertical Coalescer	Submicronic sized lube oil fog is tough to remove.
5	Amine Plant Feed	Vane or Cyclonic Style Separator[3]	Dual Stage Horizontal Filter Coalescer[4]	Filter separator followed by vertical coalescer[4]	Amine solvents require very clean feed gas.
6	Amine Plant Discharge	Not Required.	Vertical Coalescer or Dual Stage Coalescer[5]	Cyclonic Style Separator	Amine will contaminate downstream processes.
7	Processing Plant Feed	Normally Not Required.	Vertical Coalescer or Dual Stage Coalescer[5]	No alternatives are recommended.	Filtration at hydrocabon dew point is difficult.
8	Gas Transmission Recip Compressor Suction	Vane or Cyclonic Style Separator[2]	Filter Separator or Dual Stage Coalescer[6]	No alternatives are recommended.	Slug catchers must be sized correctly.
9	Gas Transmission Recip Compressor Discharge	Not Required.	Vertical Coalescer or Dual Stage Coalescer[7]	No alternatives are recommended.	Submicronic sized lube oil fog is tough to remove.
10	Metering Station Inlet	Vane or Cyclonic Style Separator[8]	Vertical Coalescer or Dual Stage Coalescer[9]	No alternatives are recommended.	Meters require very clean feed.
11	Gas Transmission Turbine Compression Suction	Vane or Cyclonic Style Separator[8]	Vertical Coalescer or Dual Stage Coalescer	Filter Separator	Contamination deposits
12	Compressor Engine Fuel Gas	Not Required.	Vertical Coalescer	Filter Separator	Low Nox Nozzle Protection (0.3 micron level).
13	Gas Fired Power Plant Fuel Gas	Vane or Cyclonic Style Separator[2]	Vertical Coalescer or Dual Stage Coalescer[9]	No alternatives are recommended.	Turbine fuel must be extremely clean.
14	Custody Transfer Stations	Vane or Cyclonic Style Separator[8]	Vertical Coalescer or Dual Stage Coalescer[9]	No alternatives are recommended.	Meters require very clean feed.

Notes:

1 Production field separators should be designed with self cleaning internals. Clean out nozzles and manways are commonly necessary.
2 Separators are only desgined to handle small slugs caused by pipeline elevation changes. Commonly larger slug catchers are also needed downstream of pigging operations.
3 Cyclonic separators should be used on rich gas streams. Cyclonic separators are more efficient than vane separators when removing NGL's.
4 Sour gas streams contain submicronic sized iron sulfide contaminants, lube oil, and NGL's. Coalescers rated at 0.3 micron are required to remove these contaminants.
5 Coalescers must utilize cartridges that are compatible with amine carryover. Polypropylene is commonly used as a cartridge material. Fiberglass is not compatible with amine due to pH limitations.
6 Dual Stage Horizonal Coalescers can be used to extend compressor valve life.
7 Dual Stage Coalescers are horizonal placing control equipment mostly all at ground level.
8 A separator is sometimes needed if pipeline elevation changes or pigging operations are common upstream of the station.
9 Dual stage horizontal filter coalescers should be used if high solid or liquid contaminant loading is expected.
** Parker Hannifin offers the information, provided herein, to be used as a reference guide only. Parker assumes no responsibility for its use. Users should also consider other process and environmental factors and are ultimately responsible for any and all equipment selections made.

Questions?