

FILTRATION & SEPARATION

جداسازی و فیلتراسیون

Introduction

Namdaran Petrogas Industries (NPI) multi cyclone scrubber is a high capacity separator designed for removing liquids and /or solid from gas flow with a minimum pressure drop.
It is self cleaning, requires no scrubbing liquid, can handle relatively large quantities of entrainment and need only periodic blow down for removal of collected material. It is highly efficient over wide range of operating conditions.

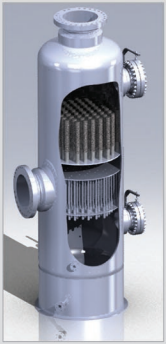
Scrubber

For applications requiring efficient removal of particles solid and liquid.



Filter Scrubber

For applications requiring efficient removal of particles solid and liquid.



Typical applications

- Suction and discharge for air and gas compressors.
- Gas and fuel transmission line.
- Gas process line
- Air and steam line.
- Distribution systems
- Mainline transmission stations
- Industrial process applications
- Gas gathering systems
- Slug catching
- Petrochemical plants
- Absorption processes

Pressure drop

Pressure drop is largely a function of tube velocity and gas density. It may very form a few inches of water to several psi, depending upon application.

General specification

- Namdaran scrubbers are designed and manufactured in accordance with the ASME Section VIII, Division 1 and 2 for pressure up to 10,000 psig.
- Standard scrubbers are constructed of carbon steel; however, scrubber can be custom designed and built from stainless steel, aluminum, monel, inconel and other steel alloys.
- Cyclone tubes are manufactured from shock and water-resistant, high alloy cast steel, to provide dependable, trouble-free service under severe operating conditions.



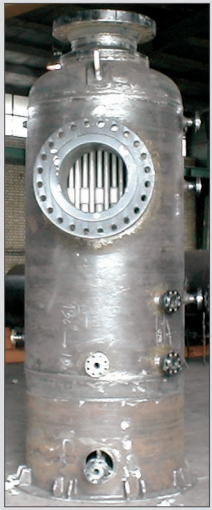
MULTI - CYCLONE SCRUBBER

For applications requiring efficient removal of particles solid and liquid.

Principle of Operation

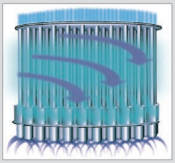
- Multi-Cyclone Scrubbers use centrifugal force to effectively remove solid particles and liquids from a gas. There are no moving parts. The high efficiency, low pressure drop, centrifugal separation is attained by using Namdaran proprietary designed Cyclone Tubes.

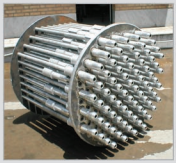
- The entrainment laden gas stream enters the distribution chamber of the scrubber, which contains multiplicity of small cyclone tube arranged in parallel. The gas enters each of the tubes through two tangential opening located near the top. The resulting centrifugal action moves the liquid droplets and/or solid particles to the outer periphery of the tube and downward, causing them to drop into the collection chamber at the bottom of the vessel. The cleanse gas then reverses direction at the vortex of the cyclone tube and moves upward through the riser and into the exit plenum.



Cyclone

NPI uses multiple, small diameter cyclones arranged in parallel to achieve separation of small and large size particles. Depending upon the application, a bank of cyclones may contain as many as 200. Selection of 2" or 4" diameter cyclones depending upon the system gas type.









Multi-Cyclone benefits

- High efficiency liquid and solids removal
- Handling a wide range of flows
- Tolerates intermittent flow spikes
- Maintenance free
- Fixed or removable cyclone elements

Design Features

NPI Multi-Cyclone Scrubbers are constructed to resist many years of abrasive wear and be rugged enough to withstand the pounding of a compressor station operation. In erosive gas applications, the critical parts of NPI Cyclone Tubes may be constructed of erosion-resistant steel alloys.

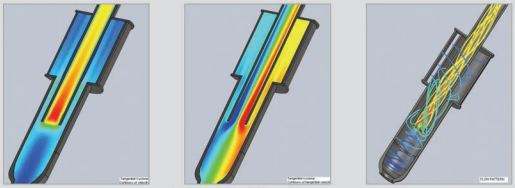
Especially for applications where floor space is limited, NPI Multi-Cyclone Scrubbers are typically furnished in a vertical design. In the case of large gas flow volumes, such as in a gas transmission station, the horizontal configuration is most advantageous.

Further, NPI Multi-Cyclone Scrubbers require no maintenance at a comparatively low initial cost.

CFD Simulation of the Separation

Today, Computational Fluid Dynamics (CFD) has become well-known in simulating real flow patterns and can be a useful tool to supplement the empirical methods in high cost or Difficult experimental cases. CFD can simulate the two-phase and high swirl flows in cyclones and determine the pressure and velocity profile in each part of the cyclone. The numerical solution of the fluid flow equations were carried out by commercial CFD Package Fluent 6.3. Discrete Phase Model of Fluent is capable to track the solid and liquid particles until they escaped from the outlet pipe or separated from the bottom.

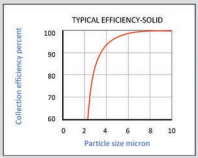
CFD is the best tool for simulating the separation mechanisms and designing the scrubbers with high separation efficiency in specified pressure drop and controlled abrasive wear.



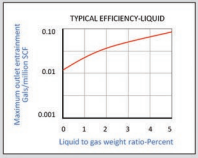
CFD flow simulation of cyclones

Performance guaranty

- ✣ Solids removal efficiencies:
  - ✓ 100% of 8 micron size particles and larger
  - ✓ 99% of 6 to 8 micron size particles
  - ✓ 90% of 4 to 6 micron size particles
  - ✓ 85% of 2 to 4 micron size particles



- ✣ Liquid removal efficiencies:
  - ✓ Outlet gas will contain less than 0.10 gallon of entrained liquid per million standard cubic feet of gas passed through the separator
  - ✓ 100% of all droplets 8 microns in diameter and larger



FILTER SCRUBBER

For Maximum Separation Efficiency of Solid particles and Liquid Droplets

Introduction

Namdaran Petrogas Industries (NPI) Filter Separator provides the maximum possible separation. Down to 3 microns of both liquid and solid particles from a gas stream with a 100% turndown ratio. To obtain this separation efficiency NPI uses a two stage process; the primary stage knocks out the bulk of the incoming liquids and solids which increases the life of the coalescing filters in the final stage.



Design Features

- NPI Absolute Separator is a multistage device. At the inlet of the Primary Separation section, small diameter cyclones or vanes remove liquid and solid particles by utilizing the dynamics of centrifugal force and gravity, by removing the bulk of the entrained liquid in this stage, the NPI design increases the life of the Fetal Separation Elements and holds the pressure drop buildup to a minimum. This allows for lime between changing the elements .reducing operating cost and down time.
- NPI Two-stage absolute separator utilizes all the forces of mechanical separation. The primary separation section in use to decrease the liquid and/or solids loading in the gas stream. This is accomplished through the use of NPI proprietary separating device such as its high efficiency inertial vanes or its multi cyclone packs. Proper liquid separation is imperative to ensure maximum life and efficiency of the final separation elements.
- Final separation select utilizes high efficiency element which are cylindrical, fibrous vacuum formed elements with a controlled pore structure. The result is a seamless tube with a matrix of micro- fibers having up to 95% void fraction. This design offers lower maintenance costs by extending the element life.

Typical application

NPI Fitter Scrubber is intended for use in applications where near complete removal of all entrained particles is required such applications includes:

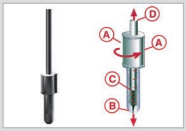
- ✓ Combustion Turbines, Gas Compressors
- ✓ Dessicarit Bed or Molecular Sieve protection
- ✓ Instrumentation, Meters and Analyzers
- ✓ Atmospheric Exhaust
- ✓ Reboriers and Line Heaters
- ✓ Membrane Separators, Chemical plants
- ✓ Fuel gas conditioning
- ✓ Gas transmission/ metering, Oil mist removal

Principle of operation

As the mist- end solids-laden gas enters the primary separation section of the vessel, the entrained liquids and solid particles are subjected to centrifugal force.

Cyclone tube:

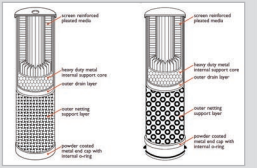
The gas enters the cyclone tube at tow points (A) and sets up a swirling motion. Solid and liquid particles are thrown outwardly and drop from the tube at (B).The clean swirling gas reverses direction at the vortex (C) and rises through the exit portion of the tube (D).



COALESCING FILTER

Coalescing elements:

The final separation section consists of multiple high efficiency coalescing elements. The gas and fine mists pass from the inside to the outside of the elements where the particles diffuse and impinge on the closely spaced surfaces. The liquid particles ag glornerate into larger liquid droplets and emerge on the outer surface of the coalescing elements. The liquid then runs down the elements and in to the liquid collection chamber. Gas, free of liquid particle entrainment, passes out the vessel discharge nozzle.



The unfiltered product is pumped under pressure to flow through the housing inlet chamber and inside/out through the multi media coalescer cartridges. This specially developed multi - media cartridge configuration traps and holds minute solid particles to less than one micron, while forcing small water droplets to commingle and grow into heavier, larger drops (see figure 1). These large gropes then carried to lice outside surface of the cartridge. Having a higher specific gravity than the hydrocarbon fluid, they release and settle to the bottom of the vessel or sump area (see Figure 2). In general, particle removal efficiency increases with coalescing efficiency. This is accomplished by employing a tighter, finer filtration media.

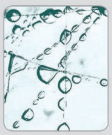


Fig. 1.-Photomicrograph of coalecing process inside fiberglass media.

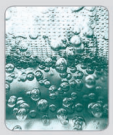
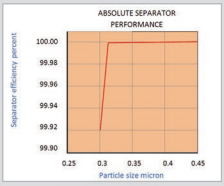


Fig. 2.- Coalesced water drops releasing from the knitted sock at the outside surface of the cortridge.

Performance guarantee

Namdaran absolute separators meet separation efficiencies' of 99.98% of droplets 0.3 micron and larger. The separation efficiency of the NPI filter scrubber is depended upon the coalescing element used for each application.



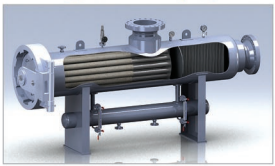
Design specification:

NPI Coalescing Filler Separator is dependent upon the coalescing element used for each application,

- ✓ Designed by ASME Pressure Vessel code
- ✓ Available in sizes starting at 6" nominal diameter
- ✓ Custom designed for any application
- ✓ Available in carbon steel, stainless steel and alloy.
- ✓ Filter access through several styles of full or reduced opening closures

FILTER SEPARATOR

For Higher efficiency separators of solid and liquid Contaminants



Principle of operation

The common mechanical separator cannot effectively remove particles less than 8 to 10 microns. Their efficiencies based on percent weight removal are quite low for aerosols or entrainment with high concentration of small particles. In order to achieve an efficient removed of the these small particles, a process of particle conditioning must be introducted to increase these particle to a size that can effectively be removal by conventional separating equipment.
NPI filtrate is a multi stage unit that utilizes four or more methods of gas conditioning in order to remove 100% of the solid and liquid particle 8 microns and larger, and 99.5% of the particles as small as 3 microns.
Namdaran Petrogas Industries provides and maintains high efficiency and performance throughout a wide flow range by conditioning particle in the gas stream as follow:
1-High particle acceleration, providing centrifugal action, impingement and diffusion.
2-High inter particle contact by providing a coalescing media
3-Sudden expansion of the gas, providing effective settling of liquid droplets.
4-Good flow dynamics by controlling boundary layers.
The entrainment laden vapor entering the vessel will encounter a labyrinth of pipes which are an extension of the element carries.
These obstacles will impinge on the gas and their geometry will impart a certain amount of centrifugation, which will move particles 10 micron and larger to the bottom of the separator.
Smaller particles which exhibit significant Brownian movement will collide with each other coalescing to a single droplet .inelastic collision of solids will produce aggregates which subsequently are swept by the liquid into the sump, where they are beyond the in fluence of the gas stream.
Particles that remain suspended will encounter the filter Coalescer elements, which consist of porous mat of relatively fine fibers molded into a cylinder for ease of handling and to provide maximum area for solid retention. Liquid particles collide with and adhere to the fibers or other droplets and coalesce.
Two mechanisms are involved in this action: deposition by impaction and by diffusion. The agglomerated liquid is then forced thru the media by drag of the gas subsequent removal by the second stage separator.
The second stage element or coalescing media is designed for each specific application, and many used NPI hookless vanes or other elements in order to achieve optimum performance.

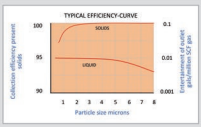
Applications

NPI filtration is a multi- stage separator used in a variety of applications in the natural gas and chemical process industries. These include:

- ✓ Compressors station
- ✓ Reciprocating Compressors
- ✓ Metering station and city gates
- ✓ Protection of desicant beds
- ✓ Gas storage
- ✓ Fuel lines to power plants and engines
- ✓ Contactor and absorption tower
- ✓ Process tower and contactor

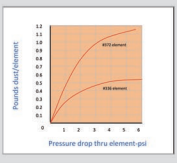
Performance / Efficiency

Namdaran Petrogas Industries filter separator guarantee 100% removal of all liquid droplets 8 microns and larger and 99.5% removal of particles down to 3 microns.
For solid it guarantees 100% removal of particles as small as 3 microns.



Pressure drop

Namdaran Petrogas Industries filterator is normally designed for an initial pressure drop through the unit of 2 psi with clean elements and at maximum design flow conditions.
However, this is not a limitation, lower or higher pressure drop design is used dependent on customer requirements.



Element life

The filter Coalescer element is designed for a collapsing pressure of 35 to 50 psi to insure that elements will not fail should the pressure differential reach this magnitude. To prolong the life of the elements, Namdaran Petrogas Industries filterator provides a blowdown connection to allow cleaning of the element while in operation. When opened the blowdown connection will generate a pulse with enough energy to shake loose any solid built up on the surface of the elements with subsequent blowdown of these solids. The pressure drop created by the loading elements will be reduced, extending the time required for element replacement.

Code and standard

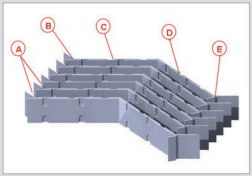
- ✓ Design: ASME Sec. VIII Dev.1 & 2, ANSI B31.8, B31.3, B31.4
- ✓ Fabrication: ASME Sec. VIII
- ✓ Welding: ASME Sec. IX
- ✓ NDT: ASME Sec. V

Configurations

Namdaran Petrogas Industries filter separators are available in vertical and single or double barrel horizontal configurations. Closures for access to the filter elements can be bolted for either a full or reduced diameter, quick opening design.

Vane elements:

In application where solid particles are not factor, vane mist extractors are used as the primary separator. As the mist laden gas enters the vane unit, it is divided into many vertical ribbons (A). As each ribbon of gas is subjected to changes of direction (B). Semi turbulence and rolling of the gas occurs against the vane walls(C). The entertained droplets are forced to make contact, impinge and adhere to the vane surface (D). The liquid droplet then moves in to the pockets (E) and out of the gas stream



Various separation design					
Separation device / Design parameters	Internal vane	coalescers	Centrifugal	Combination filter separator	filters
Contaminant removal	LIQUID	LIQUID	LIQUID & SOLID	LIQUID & SOLID	LIQUID & SOLID
Efficiency	HIGH	ULTRA-HIGH	HIGH	VERY HIGH	HIGH
ΔP	LOW	MEDIUM	HIGH	MEDIUM	MEDIUM
Flow range	FULL	FULL	4 TO 10:1	FULL	FULL

NOTE:

- **Intrinsic 2 stage configuration**
- **Flexible primary stage separator designs**
- **A variety of coalescers media efficiencies**
- **Guaranteed performance**
- **Built to ASME code or international standards**
- **Consult a Namdaran specialist for your separation, retrofit and spares requirements**

DRY GAS FILTERS

Effective & efficient removal of liquids/solids from gas flows

All gas lines have dry contaminants (such as pipe scale, dirt, and rust) that will damage or even destroy your downstream equipment. Using a Namdaran Petrogas Industries "NPI" Dry Filter will remove all forms of dry contamination, lengthening the life of your equipment and saving thousands of dollars in maintenance costs.

Namdaran Petrogas Industries range of Dry Gas Filter is multiple elements filter designed for filtering dust and other solids from gas flows with a minimum pressure drop.



Principles of Operation

Namdaran Petrogas Industries Dry Gas Filters offer efficient and effective removal of dust and other solids from gas flows at relatively low pressure drop. The larger, heavier particles settle to the bottom of the inlet chamber upon entering. The gas then passes through the filter elements which trap and retain the finer particles. A 'Quick Opening End Closure' is provided for access to and cleaning or replacement of the filter elements. The life cycle of the filter is dependent upon dust and dirt loading and the corresponding increase in pressure drop.

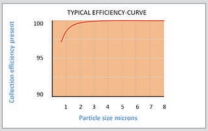
Performance

✓ **Efficiency**

Efficiency of the Dry Gas Filter is largely a function of particles size and distribution, particle loading, element face velocity and pressure drop.

A removal efficiency of 99% plus in the 1 micron range is maintained over the full flow range of 0 to 100% because this unit does not require high velocity impingement, centrifugal force, or wetted surface to clean the gas.

Typical performance is shown as below:



✓ **Pressure drop**

NPI Dry Gas Filters are designed for pressure drops ranging from a few inches of water to several psi, depending on application. The pressure on most applications will range between ¼ and 1 psi. Filter elements should be cleaned or replaced when the pressure drop exceeds 5 psi. Pressure gauge connections are provided for monitoring pressure drop.

Features

• **Standard Configurations**

NPI Dry Gas Filters are available in a variety of sizes and configurations to meet virtually any piping configuration.

• **Mechanical Features**

✓ ASME Pressure Vessel Code, Section VIII, Div. 1, and Div. 2

✓ Standard Filters are constructed of carbon steel, however, Filters can be custom designed and built from stainless steel and other steel alloys.

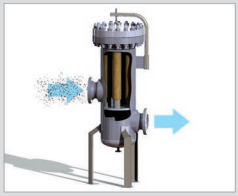
✓ High efficiency Elements can be either in carbon steel or stainless steel construction.

Applications

✓ Namdaran Petrogas Industries multiple-element Dry Gas Filters can be used to remove dust and other solids from gas streams in chemical plants, pipeline stations, gasoline plants, refineries and other gas processing applications.

✓ Dry Gas Filters protect meters, regulators, valves and other related in-line equipment, by effectively removing unwanted particles from the gas stream.

✓ The resulting clean process stream tends to extend the life cycle of compressor vanes, and reduce downtime and maintenance costs.



DRY GAS FILTERS

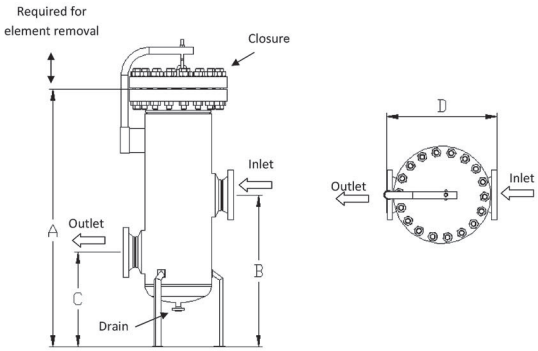


TABLE OF DIMENSIONS												
VESSEL Dia.	Inlet & Outlet Nozzle Size	Filter Elements			Dimensions				Weight Vs Design Pressure			
		Max number	length	Max Face area Sq.Ft.	A	B	C	D	300#	600#	900#	1500#
6	2	1	12	1.16	54	35	26	18	117	121	123	154
8	3	1	24	2.37	69	37	27	20	262	270	275	142
8	4	1	36	3.58	84	39	28	20	316	335	341	429
12	6	2	36	7.16	90	43	30	28	597	633	810	975
12	6	3	36	10.74	90	43	30	28	608	644	820	986
14	6	4	36	14.32	91	44	30	32	638	671	935	1091
16	8	5	36	17.91	97	48	32	34	1010	1068	1578	1799
18	8	7	36	25.07	97	48	32	38	960	1019	1665	1908
20	8	8	36	28.65	98	49	33	40	1315	1543	2319	2631
20	8	8	72	57.71	134	49	33	40	1595	1905	2878	3325
24	10	13	72	93.78	140	53	35	46	2194	2597	4336	5673
26	10	16	72	115.43	140	53	35	50	1828	2263	3927	4936
30	12	21	72	151.50	146	57	37	56	2734	3685	5694	6948
32	12	23	72	165.93	148	59	38	60	2840	3867	6285	7209
36	14	31	72	223.65	152	62	40	64	4515	5943	8805	11258
42	16	38	72	274.15	158	66	42	72	5458	7105	11970	15563
48	18	56	72	404.01	165	71	45	80	11817	13822	19355	23818
54	20	74	72	533.07	172	76	48	86	14092	17466	24143	30476

Remark:

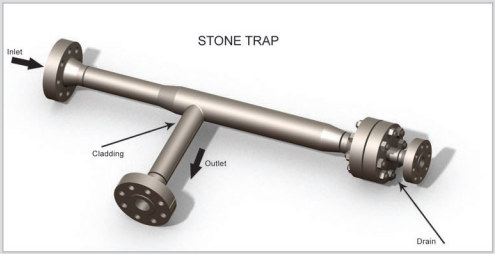
All dimensions in inches

Dimensions are approximate and many change without notice. Certified dimensional drawings and pricing available upon request.

Grid Trap

Namdaran Petrogas Industries offers several types of grit traps and stone traps for oil and gas industry, both are designed to international codes.
The service is to trap the solid parts, running into the medium coming from the wells.
Materials are selected to withstand the severe erosion.
Often, to prevent the reduction of wall thickness, the internal body of the trap is hardened through a weld deposit like nickel or cobalt alloy.
Traps are equipped by a quick closure or a flanged connection to remove the separated grit.

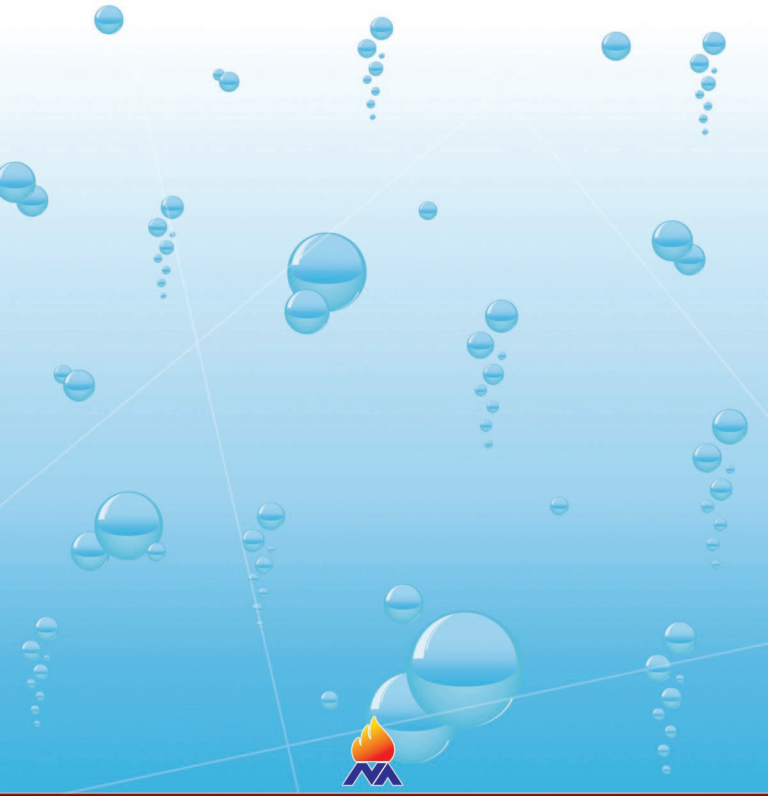




Size Nominal	Working Pressure	Material pipe	Material of flange
4"	3000 psi	API 5Lx52	45 K
	5000 psi	API 5Lx52	60 K
	10000 psi	API 5Lx52	60 K
6"	3000 psi	API 5Lx52	60 K
	6000 psi	API 5Lx52	60 K
	10000 psi	API 5Lx52	60 K
8"	3000 psi	API 5Lx52	60 K
	5000 psi	API 5Lx52	60 K
	10000 psi	API 5Lx52	60 K

Remark:

All materials will be supplied NACE MR 01 75



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ISO/TS 29001:2003
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