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Filtration Engineering Report

WORLD OF SPA

FILTRATION REFINED

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Spa Filtration | HOW CLEAN IS YOUR WATER?



According to the Association of Pool and Spa Professionals (APSP), there are over seven million spas throughout the United States. A spa, also referred to as a hot tub, is commonly used for relaxation, massage or hydrotherapy. Apart from the jets, one of the key differences between a spa and a pool is the significant variation in water temperature.

On average, spa water is approximately 20 degrees warmer than pool water. Although this may sound like a slight difference, given the higher water temperatures, the chemicals added to a spa have a greater reaction with bodily fluids, detergents from swimwear, lotions and deodorants. With all of these factors combined, a spa will be more conducive for bacterial growth.

*Two people in a 300 gallon spa is equivalent to
200 people in a 30,000 gallon pool*

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PleatcoFiltration
Premium Pool & Spa Filter Cartridges



*“On average,
a child drinks
1.3 ounces of water
every hour they play
in a pool or spa.”*

Filtration Redefined

Since the volume of water in a spa is much smaller than that of a pool, even small amounts of foreign matter (bodily fluids, etc.) introduced into a spa dramatically affect the cleanliness and clarity of the water. Therefore, dirt loaded per unit volume of water is greater in a spa and subject to more rapid fluctuations. Due to the combination of high temperatures and higher bather loads, it is paramount that the filtration system of a spa be well designed and maintained by the end users.

On average, a child drinks 1.3 ounces of water every hour they play in pool or spa.

At Pleatco, we are driven by an innate desire to build the highest-quality products possible. We live by the mantra of ‘continuous improvement’ in every facet of our business. Pleatco believes in research and innovation and our aim is to provide the finest filtration possible while minimizing energy consumption.

Pleatco tested Coast Spas’ Hydro Cyclonic pressure filtration system vs. traditional skim (vacuum) filtration. The test methodology used was initially developed in line with the NSF50 testing protocols. The test was designed to measure extreme conditions while conducting a controlled comparison between pressure filtration and traditional skim filtration which is more commonly found in spas sold today.

The test was conducted using a 500 gallon spa with the plumbing modified to accommodate pressure sensors, vacuum sensors, turbidity sensors and flow meters. The results were recorded using a data logger to capture results in real time.

The test dust used was Sil-Co-Sil 106 which is the standard challenge dust used in NSF50 testing. The dust consist of very fine particles; 75 percent of the dust particles are smaller than 40 microns.

Test configuration:

- 500 gallon spa
- Test 1. One half pound of Sil-co-sil 106
- Test 2. Five Pounds Sil-co-sil 106
- Single speed, four HP Waterway Executive 56fr Pump with 2” plumbing running at low speed.
- Flow, Pressure and Turbidity readings were logged constantly

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Coast Spas Manufacturing Inc.

Coast Spas' uses a hydrocyclonic filtration system. This system is commercial grade, taking the filter canister out of the bathing area. This prevents contaminants from re-entering the spa water when pumps are deactivated and while changing the filter cartridge. Securing the integrity of your spa water keeps you and your family enjoying nothing but clean, clear hot water.



 **DualCore™**
Advanced Filtration System

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Hydrocyclones

The industry for years has been more focused on number of jets in a spa as opposed to filtration and water cleanliness. For instance, in order to reduce costs, many spas are manufactured using skim filtration rather than pressure filtration.

Coast Spas uses a pressure filtration system which incorporates the use of hydrocyclonic action. Hydrocyclones are cylindrical in shape and mounted vertically within the pressure vessel. By using a hydrocyclone, water and dirt particles develop a vortex which results in efficient filtration by forcing particles to more evenly spread throughout the pressure vessel and more importantly, pushed to the uppermost portions of the filter. This creates more rapid and efficient filtration than traditional pressure vessels or skim filtration.

Because of the vortex created by hydrocyclonic action, the concentration of the solids is reasonably high in the upper portion of the cylinder. In the end, not only are a higher percentage of smaller particles filtered, but the entire filtration process is enhanced giving end users cleaner water more rapidly. The Coast system is further enhanced during stage two by the use of an advanced free flow filter cartridge designed by Pleatco.

The hydrodynamic separators similar to the one used by Coast Spas induces centripetal force which causes the denser particles to separate. As a result, more dense particles are thrown out of the main liquid stream and captured by the filter more rapidly. The un-separated finer particles ascend the pressure vessel and as they lose momentum this mixture of oil, dirt and water flows through the pleated media of the cartridge and are captured.

The hydrocyclone vessel is a dynamic separator working on the principle of inertial forces generated by the velocity of the incoming fluid stream. As it centrifuges, the rotational action of the fluid creates a centrifugal force so that the settling velocity by Stokes' law for normal gravity is now multiplied by the extra rotational force. The settling velocity is directly proportional to the square of the particle diameter, directly proportional to the difference between particle and fluid densities and indirectly proportional to fluid viscosity. It will readily be seen from the form of Stokes' law that sedimentation in a liquid filtration system will separate solids from liquids, because of the density difference, and separate two or more solids, one from the other, because of their different rates of settling caused by different densities or different particle sizes.

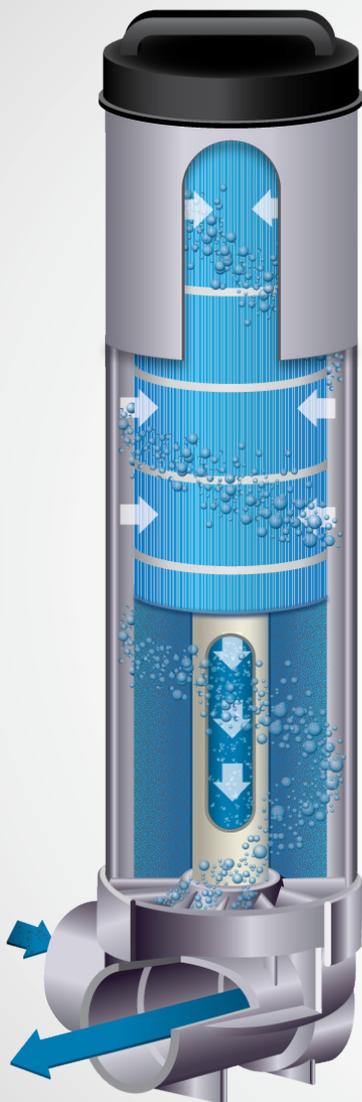
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Hydrocyclones

Coast Spas Manufacturing Inc.



Stokes Law:

If the particles are falling in the viscous fluid by their own weight due to gravity, then a terminal velocity, also known as the settling velocity, is reached when this frictional force combined with the buoyant force exactly balance the gravitational force. The resulting settling velocity (or terminal velocity) is given by:

$$v_s = \frac{2(\rho_p - \rho_f)gR^2}{9\mu}$$

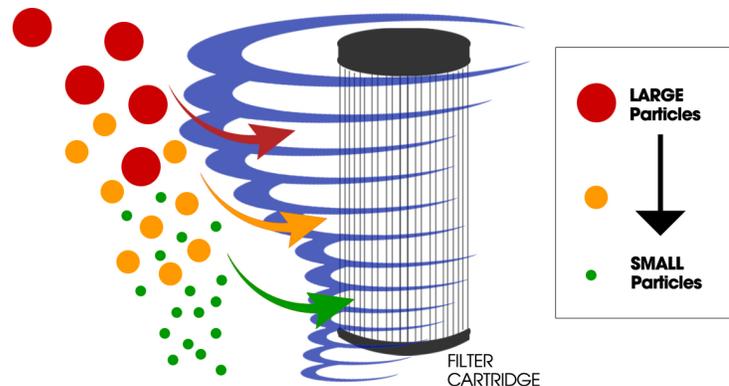
v_s is the particles' settling velocity (m/s) (vertically downwards if $\rho_p > \rho_f$)

g is the gravitational acceleration (m/s²),

ρ_p is the mass density of the particles (kg/m³), and

ρ_f is the mass density of the fluid (kg/m³).

STOKE'S LAW IN ACTION



COAST SPAS: Hydro Cyclonic Filtration System

1. After passing over the skimmer or being drawn through the suction ports, the spa water is pumped into the commercial grade Cyclonic Filter Canister.
2. The water then passes through the Water Diversion Blade® creating a cyclone effect, pushing water up and over the entire filter surface via centrifugal force.
3. Water is then evenly drawn through the Pleatco dual core filter media. A filter is measured by the square footage of its media surface area. Coast Spas® offers the largest filter in the industry at an incredible size of 175 sq.ft.
4. The water then exits the filtration area crystal clean and pure.

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Results & Findings

“The hydrocyclonic system with Pleatco cartridge is 80% more efficient in turbidity reduction as compared to skim filtration”

“Coast Spa’s hydrocyclonic filtration with a Pleatco cartridge is 20% more flow efficient than skim filtration”

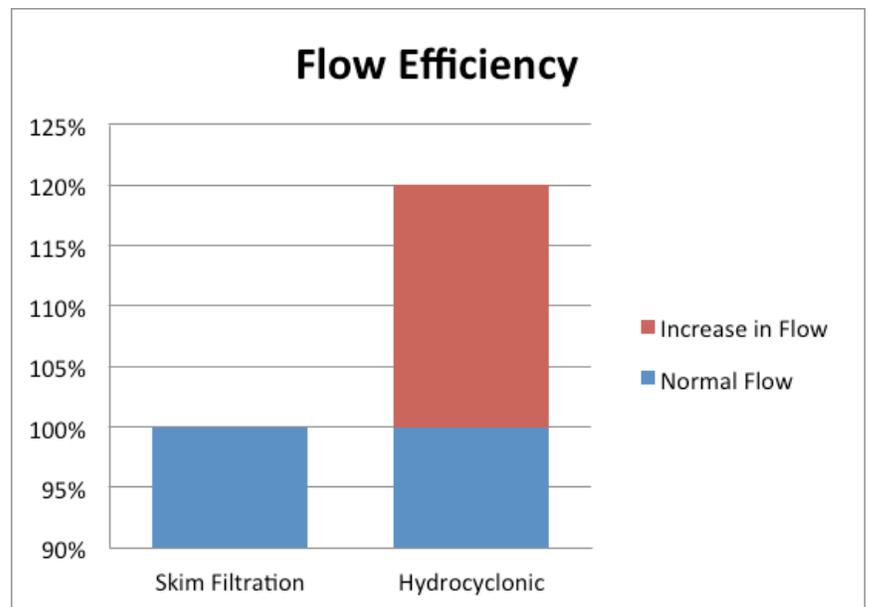
PLEATCO RESEARCH
ENGINEERING DEPARTMENT

We compared the Hydrocyclonic filter system to a skim filtration system. The plumbing was modified to accommodate the two filtration systems independently. In order to accurately track pressures, flow rates, and water cleanliness, Pleatco’s state of the art data logging system and sensors were installed on the spa. The results of our test showed a twenty percent (20%) increase in flow while at the same time approximately an eighty percent (80 percent) more rapid reduction in turbidity.

FLOW EFFICIENCY

With the same pumps used in each test, the Hydrocyclonic filtration system exhibited better flow curves as compared to a skim system.

The Coast Spa’s hydrocyclonic filtration system is 20% more efficient than the traditional skim filtration.



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Results & Findings

Performance assessment: Turbidity

Comparing turbidity curves of the two different types of filtration systems, the results indicate pressure filtration is not only more effective at reducing cloudiness but also faster in this reduction.

The combination of Pleatco's free flow cartridges and Coast Spas' Hydro Cyclonic Filter System resulted in increased turbidity reduction (clearer water) by 76%-83%.

The time taken by the skim filtration system to clean the spa with a half of pound (0.5 lbs) of Sil-co-Sil 106 (silica #140) was 64 hrs. The second test conducted using five pounds (5.0 Lbs) of Sil-co-Sil (silica #140) was 18 hrs. In comparison, the same tests were completed using Pleatco cartridges in a Hydrocyclonic filter canister filtered the half pound (0.5 Lb) of test dust in 15 hrs and five pounds (5.0 Lbs) of dust in 3 hrs; a dramatic improvement in filtration.

The image below clearly shows the drawbacks of skim filtration. The circulation (Circ) pump is operating continuously; however, the dust that settled to the floor of the spa was never filtered. The kinetic energy necessary to dislocate a particle of well-settled dirt for filtration is much more than what is required to filter a floating dust particle. This is why it is important to filter water as rapidly as possible prior to particles settling. It should be noted that Coast Spas have designed a "Sweeper Jet" (not used in these tests) in their spas to "Kick Up" particles which may have settled on the spas' floor.

*“Coast Spa’s
Hydrocyclonic Filtration
system with Pleatco AFS
Cartridges perform uniform
loading of dirt due to the
efficient flow ensuring
superior filtration”*

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ENGINEERING DEPARTMENT

Skim filtration with dirt settled at the bottom of the Spa

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Pleatco Filtration

Premium Pool & Spa Filter Cartridges

Pleatco Cartridge: Engineered

Pleatco uses superior quality raw material from some of world's leading companies to construct a strong and superior filter cartridge; Engineered Free Flow cores, Media, End Cap and Banding.



JM Media

Pleatco's co-developed Johns Manville media with uniform pore size distribution filters dirt more effectively and efficiently than all other competitor media.



Free Flow Cores

Pleatco FREE FLOW CORES deliver better water flow rates enhancing filtration efficiency, reducing wear and tear on pumps, conserves energy, and provides longer life to cartridge.

Pleatco Superbond Bands

Pleatco break-resistant bands keep the pleats clearly defined and evenly separated for increased water flow.

Antimicrobial End-Caps

Pleatco Antimicrobial End-caps are formulated to withstand chlorine degradation and prohibits the growth of bacteria

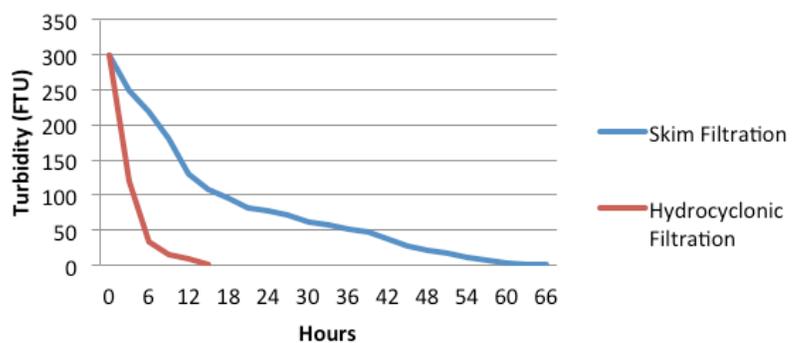


Results & Findings

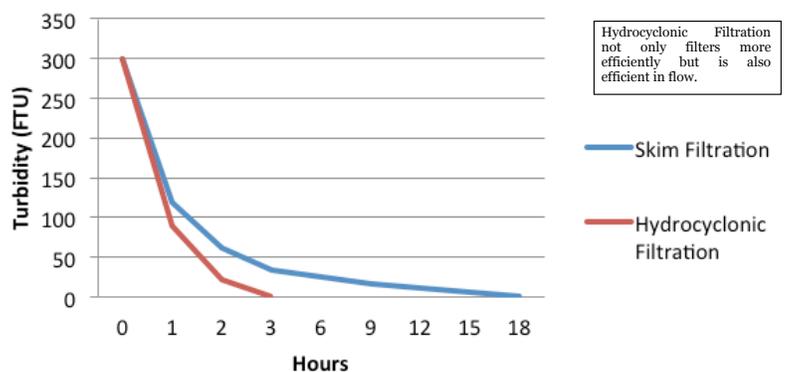
Turbidity Reduction Curves

Hydrocyclonic filtration system will separate solids from liquids, because of the density difference. This makes it easier for the filter cartridge to trap particulates without compromising the flow of the system.

Turbidity Test with HALF pound (0.5 Lbs) test dust



Turbidity Test with FIVE Pounds (5 Lbs) test dust



Hydrocyclonic Filtration not only filters more efficiently but is also efficient in flow.

Coast Spas' Hydro Cyclonic Filtration System with an engineered free flow Pleatco cartridge can offer an efficient and cost-effective means for separating large or small quantities of liquid-liquid effluent mixtures.

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| GLOSSARY



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#	GLOSSARY	Tool / Instrument
1	Turbidity: Turbidity is the cloudiness or haziness of a fluid caused by individual particles (suspended solids) that are generally invisible to the naked eye, similar to smoke in air. The measurement of turbidity is a key test of water quality. Measured in Formazin Turbidity Unit (FTU) or Nephelometric Turbidity Unit (NTU). * 1 FTU = 1 NTU	Turbidity meter
2	Total Suspended Solids: Total suspended solids, is a water quality measurement abbreviated TSS. Measured in Parts per Million (PPM)	TSS Meter
3	Operating Pressure: Measured in pounds per square inch (PSI), it is the measurement of the state of loading on the cartridge.	PSI Gauge
4	Flow: The system flow is measured in gallons per minute (GPM) from a body of water to tank through the filter and back to the body of water.	Ultrasonic Flow meter
5	Silico Sil 106: Used in NSF 50 due to its fine particle distribution (75% below 40 Microns) to establish proof of filtration. Larger particles can be easily filtered however the real test of filtration is the capture of these fine particles.	
6	Motor Speed: Measured in revolutions per minute (RPM). The flow of the system depends on the motor speed.	
7	Denier: Unit of measure for the linear mass density of fibers. It is defined as the mass in grams per 9,000 meters	
8	Filter cake: It is the layer of dust/debris formed over the media. Which filters other particles of dust passing through it creating a 'snowball effect' of filtration	
9	Hydro Cyclone: A hydrocyclone is a device to classify, separate or sort particles in a liquid suspension based on the ratio of their centripetal force to fluid resistance.	

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