

Comparison between the InvisiHead and wedge-wire screen intakes

The InvisiHead has proved to be more cost effective. It is a well engineered proactive intake system which actively addresses operation and environmental requirements compared to the highly reactive wedge-wire screen intake head systems. The overall performance of the Elmosa Seawater Intake System is higher than any other system operating in the water intake industry. The system entirely utilizes the natural process in its entire operation from the start to the end – from the point where the first water molecule at the offshore end of the system is gently drawn to the InvisiHead and smoothly guided through all the way to the pump intake at the onshore NatSep intake basin.

In contrast, the wedge-wire screen intake head employs several reactive layers of measures needed to keep the system in operation. Wedge-wire screens are not a dedicated seawater intake head system like the InvisiHead but modified well screens. They have to be supported by a costly clean up system to convert them into operational seawater intake heads. Please see Table 1 and Table 2.

Table 1. Technical Comparison: the InvisiHead versus the Wedge-Wire Screen Intake Head

Parameters	Intake Seawater Intake Head Type			
	The InvisiHead		Wedge-wire screen Intake	
	Description	Comment	Description	Comment
Technical Performance				
Entrance Velocity				
	< 0.091 m/sec. steady and constant throughout.	This velocity meets and exceeds the strictest environmental requirements anywhere in the world, but if lower velocities are required, it is practical to achieve that.	>> 0.091 m/sec variable and declining.	Since the open space is 50% or less of the steel structure, 0.091 m/s steady velocity becomes practically unattainable.
Velocity profile	The distribution of the velocity over the entrance area.	Flat and steady throughout the entrance eliminating local eddies, and drastically reducing pressure drop.	Velocity increases toward the intake pipe inlet and non-steady over the screen surface; local suction spots and strips cause impingement, and raise head loss and increase pressure drop and generate higher suction and create a turbulent environment around the entrance area.	Non uniform entrance velocity profile. Velocity goes higher closer to the intake pipe inlet. It is higher at the bottom than any other point over the screen cylinder. Places of higher velocity attract debris, sediment and marine life and become the first to get blocked. Blockage progresses upstream from the inlet, entrance velocities keep increasing until the pressure drop activates the backwash and air purging systems located onshore. Most of the impingent material but not all of it gets pushed away from the screen region. Since the material is not drained away it comes back into the screens with combined with a fresh load .
Flow Pattern	Omni-directional, paraboloidally funneling in.	The paraboloidal flow path smoothly guides in water moving in super slow non seafloor disturbing velocities.	Random non specific, variable, and turbulent.	No measures are made anywhere in the system to have a measured and well controlled flow patterns. Patterns change and fluctuate according to how much debris and marine life drawn in over the screen surface and sucked in inside the intake pipe system.
Flow Domain	3-D Continuous	The effect of the	Non-specific.	The flow domain is influenced by the changing

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	contraction.	paraboloidal shape of the entrance extends outwards into the ambient and rapidly reaches zero.		status of the screen surface porosity and transmissivity. The flow domain is patched and flow continuity is broken in the space surrounding the screens.
Flow Streamline bundle structure	The flow streamline curve upward at the upper portion of the flow bundle, move in straight lines in the mid flow bundle portion, and curve downward at the lower portion. The streamlines are symmetrical or asymmetrical around the central disc.	Streamline behavior environments are decided during the design phase to fit the local site conditions and client's requirements. Since the InvisiHead intake is site specific, the symmetry is decided as per the local site condition. The diffusing-like action of the flow can be made symmetrical or asymmetrical as per the site requirements. The flow streamlines respond to the flaring-in entrance in a matching continuity simulating the physical expansion to extend way beyond its actual location. The top skin of the flow streamlines curve upwards in response to the upper parabolic inlet plate to prevent sucking in the plankton layers near the surface and gradually flattens out towards the middle, straightens out at the middle, and curves downward at the bottom. The taking off point positions at the bottom and top are decided in the design phase so as to fit the site conditions.	Scattered and turbulent.	Streamlines shift, compress, and lose numbers as flow progresses causing velocity to rise and pressure to drop and impingement rate to intensify. The process continues until the low pressure drop threshold is crossed at which time backwash and air purge sensors and mechanisms are activated.
Site specificity and sensitivity	The ability to respond to local site conditions and to comply with regulatory requirements and client's specifications.	The InvisiHead is highly site-specific and can be tuned to respond to site conditions and application requirements.	Non-site specific.	Hairy sea weeds prove to be deadly to intake screen operation and maintenance. Hairy weeds twist and tangle around the wedge wires the screens are made of. Backwash and air purging become ineffective. Mechanical and manual cleaning becomes costly. Screen replacement becomes more viable.
Pressure distribution	Flow entering the intake head faces negligible friction losses.	Uniform at the line of entry- no eddies; head loss is negligibly small at 0.00017 meters.	The head loss starts relatively high at the screen slots increases as the flow progresses.	Friction increases and rises toward the screen-pipe interface due to the higher velocity, suction is highest at the interface, impingement start first at the interface and the blockage progresses toward the upstream end of the screen. Bottom section gets blocked first, blockage intensifies and progresses toward the end until backwash and air purging mechanisms are activated when most of the available head is lost. Head loss is considerably high and becomes an important design parameter.
Capacity delivered	The design flowrate required to keep the plant in full operation	The design capacity is delivered and unhindered at all times regardless of the local site or weather conditions.	The design flowrate required to keep the plant in full operation plus extra water needed for the backwash operation and screen flushing	Constant computerized monitoring and control of pressure drop at the screens offshore and water level drop at the onshore intake-pump basin. Readiness of air compressors and backwash pumps must be maintained to periodically, in most often cases in increased frequencies, flush debris off the screen surface.
Environmental Performance				
Fish eggs and larvae	Most often they remain on the seafloor in spawning areas	The seafloor taking off streamlines velocity are much lower than the terminal velocities of the		The streamline velocities are most often much higher than the terminal velocities of fish eggs and larvae and other creatures like juvenile fish, and therefore, these end up impinging on the screens.

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		creatures, and therefore they remain at their habitat undisturbed.		The mortality rate increase with the increase of vacuum around the screens.
Entrainment				
Entrainment mortality losses	Finer eggs and larvae may be found in suspension.	Any eggs and larvae found in suspension due to local currents that move in the InvisiHead are swept through and out of it, and no mortalities take places.	Entrainment rate is proportional to the slot width. All egg and larval sizes, most of juvenile fish entrain.	Due to high approach and entrance flow velocities, and to high vacuum created at the screen slots, impingement of marine life is high and so is the mortality rate.
Sediment and debris	Negligible		High	
Bottom Sediment Disturbance	Negligible		High	
Operation and maintenance equipment				
Seawater intake pumps	Yes		Yes	
Trash racks	None		Yes	
Traveling screens	None		Yes	
Intake basin backwash screen pumps	None		Yes	
Offshore intake screens	None		Yes	
Offshore screen backwash pumps	None		Yes	
Basin screen backwash blowers	None		Yes	
Backwash equalizing basin blowers	None		Yes	
Air purging pumps	None		Yes	
Air compressors	None		Yes	
Intake Head Features				
Flow movement	Low approach velocity 0.0025 m/sec max. at 5 meters away.		Non-specific	
Entrance velocity	Slow and smooth at <0.091 m/s		Turbulent at >0.091 m/s	
Approach of flow @ 5 m away and beyond	<0.0025 m/s decays to 0 m/s a short distance further.		>>0.0025, patchy and none predictable	
Head loss	<0.00017 m		Rises close to the available operating head and if not debris frequently flushed off, total blockage takes place.	
Flow phases	4 sequential, progressive providing self cleansing and self maintaining and self operating mechanisms of the		External interference and human controlled operation and maintenance is a major factor	

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	system.		required to keep the system in operation.	
External interference	None		Is an integral part to keep water flowing	
Intake pipe sizes	smaller		larger	
Basin	shallower		deeper	
Pumping energy	lower		Much higher	
anti biofouling chemical dispensing system	Built-in		none	
Backwash	Not needed and not implemented.		Debris and organisms back-flushed from the screens would immediately re-impinge on the screens following the back-flush cycle.	
Operation & maintenance	None		Required	
Use as outfalls	Provides a high performance brine, coolant, and municipal and industrial discharging diffuser.		N/a	
Compliance with the US EPA 316(b) 0.15 m/s entrance intake velocity or less	Meets and exceed this standard and other international standards @ 0.091 m/s or less.		It is very difficult for the system to practically comply with this EPA standard	
Loss of service	0% of the time		It is the time required for backwash, air purging and frequent maintenance – a good portion of the time is used in system shutdown for maintenance.	
Overall intake system reliability	Highly reliable, heavy duty, and robust, keeps operating under all environmental and weather conditions.		Can be overwhelmed by the sudden presence of large loads of debris including marine life, sediments and debris that would lead to system shutdown especially in hurricane active locations.	

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Table 2. Cost comparison between the InvisiHead and the Wedge-Wire Screen Intakes

Parameter	InvisiHead	Wedge-wire screen intake
Costs per installed cubic meter per hour	It is the cost of material, fabrication and installation.	About the same.
Costs of the Seawater intake pumps installed in the onshore intake basin	To cover costs of pumps required to pump 100% of the plant capacity.	To cover pumps required to pump 100% of the plant capacity plus backwash and flushing water quantities.
Costs to cover backwash screen pumps	No costs involved since no backwash is not required.	Added since back wash is an integral part of the system.
basin screen backwash blowers	No costs involved since no basin screen backwash is required.	Added since back wash is an integral part of the system
Costs to cover offshore screen backwash pumps	No costs involved since no offshore screen backwash is required.	Added since back wash is an integral part of the system.
Air compressors, air purging	No costs involved since no air purging is required.	Added since air purging is an integral part of the system.
Backwash equalizing basin blowers	No costs involved since no screens are required.	Added since screening is an integral part of the system
Offshore screen	No costs involved since no offshore screens are required.	Added since screening is an integral part of the system.
Trash racks	No costs involved since no screening is required.	Added since screening is an integral part of the system.
Traveling screens	No costs involved since no screening is required.	Added since screening is an integral part of the system.
Costs of the complete Elmosa offshore seawater intake system	They include the costs of the offshore portion (the passive InvisiHead) the pipeline, the passive onshore intake basin, and the seawater pumps. The pipeline costs are less due to the smaller pipes required for the operation. The costs of the intake basin are less due to its smaller size. The costs of seawater pumps are less due to the lesser capacity required for the system operation.	The costs of the wedge wire screen intake system include the costs of the active wedge wire screen intake head, the pipelines, and the equipment-full onshore intake basin. Extra costs are required for a larger pipeline, a large intake basin, and backwash, flushing, and air purging equipment including compressors and pumps, and computer monitoring systems to activate the backwash and cleanup pressure when pressure drop threshold is reached.
Energy costs	The only costs involved are those involved with the seawater intake pump operation	Higher costs are involved in the operation of the seawater intake pumps, backwash and flushing pumps, blowers, compressors, etc.
Overall operation & maintenance costs	0 costs	The costs are related to keeping the active parts active and that involves energy costs, personnel, parts replacement, loss of operation, etc