ENABLING APPLICATION SPECIFIC HEAT TRANSFER ENHANCEMENT

Software Enabled Performance Mapping

VorTX is an HTRI coded Xchanger suite compatible plugin allowing users to design exchangers using CEI proprietary (and HTRI tested) turbulator technology.

Beyond VorTX

CEI technology that is currently outside the VorTX DLL plugin but can be rated for performance and pressure drop by contacting CEI's design team.

Future VorTX integration of these products is imminent.

What we do. And how we do it.

Concept Engineering International is an out and out heat transfer enhancement solutions company. The outcome we shoot for is typically:

1. Appreciable reduction in heat exchanger size.
2. Through reduction in size, a sizable reduction in cost.
3. Reduced environmental impact.
4. Improvement in existing exchanger performance in case of retrofits.
5. Fouling mitigation.
6. In two-phase applications like vaporizers, mitigation of issues like film boiling and mist flow. The product action also cuts bubbles down to manageable sizes to further improve performance.
7. Even the sensible gas phase heat transfer coefficient can be improved by using a particular turbulator type that is soldered to the tube ID (Rigid Soldered Turbulators) offering up a huge increase in internal surface area and on account of high fin efficiency, the bump in heat transfer coefficient is substantial.
8. Drainage of condensate in vertical condensers to free up more surface area for condensation.

We achieve these objectives with two product ranges; turbulators and wire wound fin tubes.

And with these two ranges we improve coefficient both on the inside and outside of the tube.

Turbulators typically do their thing best in tubeside limited applications. These would be:

1. When tubeside heat transfer coefficient is lower than shellside or airside heat transfer coefficient like with viscous fluids or oil or glycol coolers.
2. When vaporizers have issues like film boiling, mist flow and the bubbles are unmanageably large.
3. When there's fouling in the tubes leading to even normally shell side limited designs becoming tubeside limited over time because of the fouling layer.
4. When vertical condensers need drainage of the fluid from the wall through the center to allow more area on the tube wall for further condensation.

For the outside of the tube we've got wire wound fin tubes. Wire wound fin tubes are a great swap for traditional L Fins when:

1. The material of the fin required is copper. The reason for this is that the wire wound fin tube is the lightest possible config of copper in fin form that can give outsize gains in performance. An equivalent L Fin would be close to 25% heavier, lower in performance and far more expensive. Additionally, Wire Wound Fin Tubes are also stronger and more durable than L Fin Tubes.
2. Steam Air Heaters where the airside is heavily limiting represents a great use-case for wire wound fin tubes.

VorTX Wire
Turbulators

VorTX Spiral
Turbulators

Twisted Tape
Turbulators

Rigid Soldered
Turbulators

Wire Wound
Fin Tubes

What VorTX is.

VorTX is Concept Engineering International's dynamic link library (DLL) developed by HTRI under proprietary contract with Concept Engineering International.

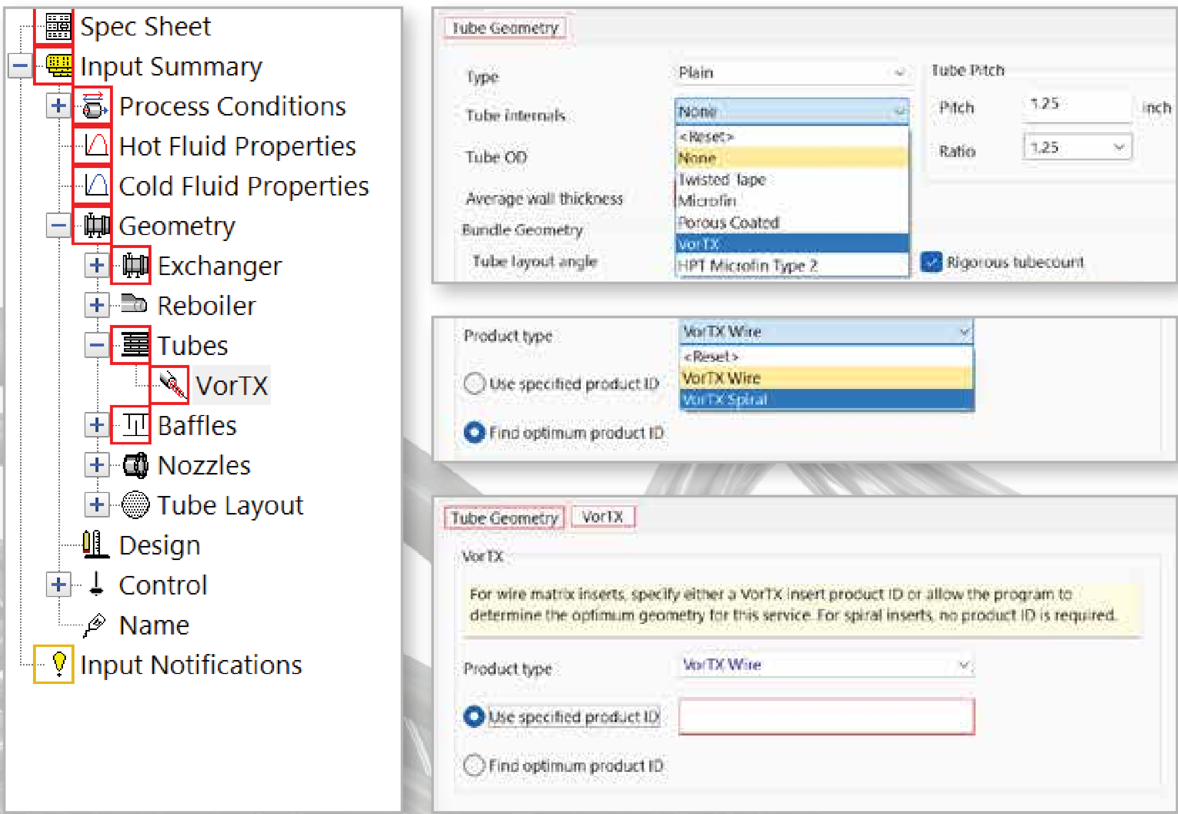
Multiple Concept Engineering International turbulators (wire and spiral tube inserts) were tested at HTRI's Research and Technology Center in Navasota, Texas, USA.

The VorTX DLL contains tube side single phase heat transfer and pressure drop correlations for modeling Concept Engineering International's products which were developed under proprietary contract with HTRI using Concept Engineering International's proprietary data.

HTRI used laminar flow CFD results to supplement empirical testing measurements at Reynolds numbers under 500.

The VorTX DLL can be used with HTRI Software for the following purposes:

1. Identifying an optimal Concept Engineering International product from those supported by the VorTX DLL based on utilizing the maximum amount of pressure drop allowed.
2. Evaluating the performance of a Concept Engineering International product supported by the VorTX DLL that resembles the geometry of those tested by HTRI.



What VorTX enables.

Data really drives every enhancement decision we make.

We're looking for the best operating window for our products from a Reynolds standpoint.

We're diving deep into wall correction factor impact of our geometries in software outputs.

We're looking at the additional hydraulic load of each geometry. Small tweaks in angles of attack.

How much the shear stress is when you pit turbulator vs bare tube.

What the impact on fouling is likely to be because of that additional wall sheer stress.

How we can disrupt film boiling to move over to nucleate boiling, arrest mist flow and reduce bubbles down to size.

These are questions that only data has the answer for.

Our turbulator range (multiple geometries) has been tested for a hard data mining operation.

Post that, the data has been analyzed and curve fitted and then modeled into correlations along with a test report for each insert geometry.

We've also done supplemental CFD work via a proprietary contract to home in on more accuracy.

To completely integrate into software platforms, we've also had developed the **VorTX.DLL** plugin that will hold this data and allow you, the user, to design your exchangers using our products in a matter of seconds if you're using compatible software.

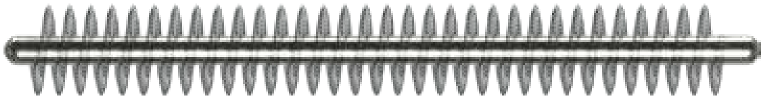
If you're an end–user like a refinery who uses a performance monitoring software, we're also looking at hard coding our mined data in software such as this to see the impact we can have on refinery exchangers to mitigate fouling by looking at shear stress increases and what that will mean for overall CO_2 emissions reduction.

Finding the right turbulator for an application is an exercise we are equipped to handle.

We make a bunch of different turbulator types and many different geometries within those types.

And it's because we make the entire spectrum of turbulator types and have data on where they stand that we can rank them in order of performance without letting bias creep in.

Rigid Soldered Turbulator

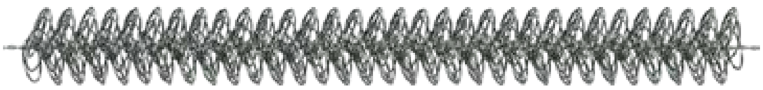


The highest performing turbulator there is as in addition to turbulation it also increases the internal surface area of the tube anywhere between 2x to 4x because of the solder bond effect. It makes drastic size (and cost) reduction in viscous fluid coolers possible.

It is also a gamechanger in gas coolers where the surface area extension is the dominant play other than simply turbulation as gas is naturally turbulent anyway. A 4x increase in internal surface area at 75% bond efficiency would still give a 3x bump in heat transfer coefficient.

Wire Turbulator

vortx enabled



Wire turbulators offer the flexibility of easy insertion and the second highest performance profile in our range. Second only to rigid soldered turbulators. Their performance and pressure drop correlations are mapped into our VorTX DLL. Wire Turbulators are ideal for cases where tubeside limitation is severe.

Spiral Turbulator

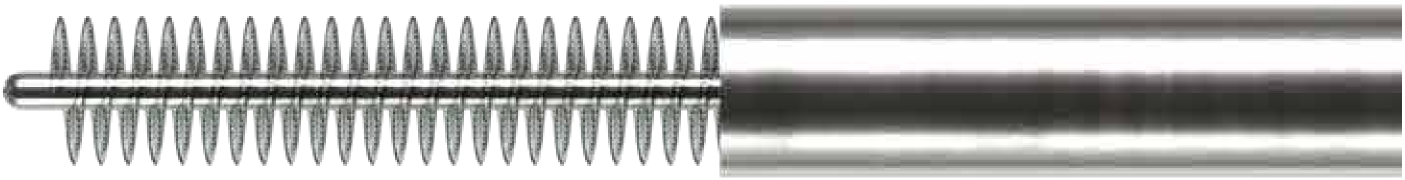
vortx enabled

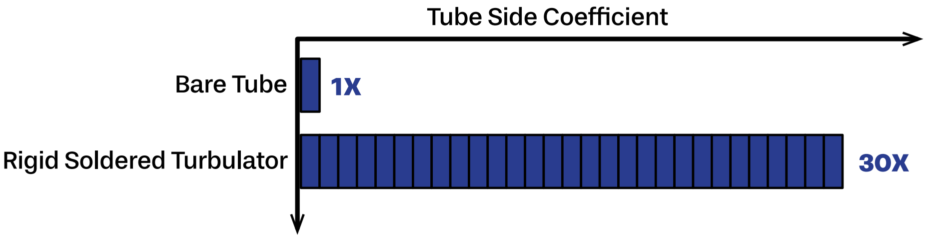
Spiral Turbulators sit in between the performance of tight L/D Twisted Tape and Low Dense Wire Turbulators. A sweet spot in terms of pressure drop penalties. Spiral Turbulators also have their performance and pressure drop correlations mapped into our VorTX DLL. Spiral Turbulators are ideal for viscous and semi-viscous applications where pressure drop allowance is tight and twisted tapes can't give enough performance.

Twisted Tape

CEI Twisted Tapes have perfect L/D conformance and can be made in a wide range of materials and sizes. Even the L/D range that we can make these in is large giving a lot of flexibility in terms of design choices.

If we're talking maxed out heat transfer gains, Rigid Soldered Turbulators is where the conversation begins and ends.





They come in at the #1 spot by a fair distance.

The reason for this is twofold but to understand that we have to first understand their construction and install method.

Rigid soldered turbulators have a central rod on which are soldered wire loops. The entire turbulator is then installed inside the tube where the wire loops are soldered to the inner tube wall.

So, the twofold reason for why they occupy top spot in the performance rankings is:

1. They offer convective heat transfer on account of the wire loops turbulating the fluid flow and breaking the boundary layer by creating vortices much like a wire turbulator. However, the packing density of loops on rigid soldered turbulators from a manufacturing standpoint can be a lot higher than wire turbulators. And the net free flow area is a lot lower increasing velocity.
2. They offer conductive heat transfer as the solder bonding of the wire loops to the turbulator and to the inside of the tube acts as a surface area extension making it perform like an internal fin tube. This massively increases the Ai (Internal Surface Area) and in turn, the actual U (Overall HTC). The area increase ranges from 2x to 4x depending on the config chosen.

While the pressure drop is also the highest as compared to other turbulator types, the overall performance is unmatched. Something to really think about is, if you take the same loop count of a rigid soldered turbulator and a wire turbulator, the pd would be level pegging for the most part but you'd also get a massive bump in free performance (performance without an increase in pd) over the wire turbulator because of the bonding effect making it an internal surface area extension play.

Typically, ordering these involves ordering the tubes and turbulators soldered to them by us.

Big Use Cases

1. Super viscous oil coolers.
2. Air Intercoolers.
3. Any viscous fluids that could use both conductive and convective heat transfer bumps.

Design Method

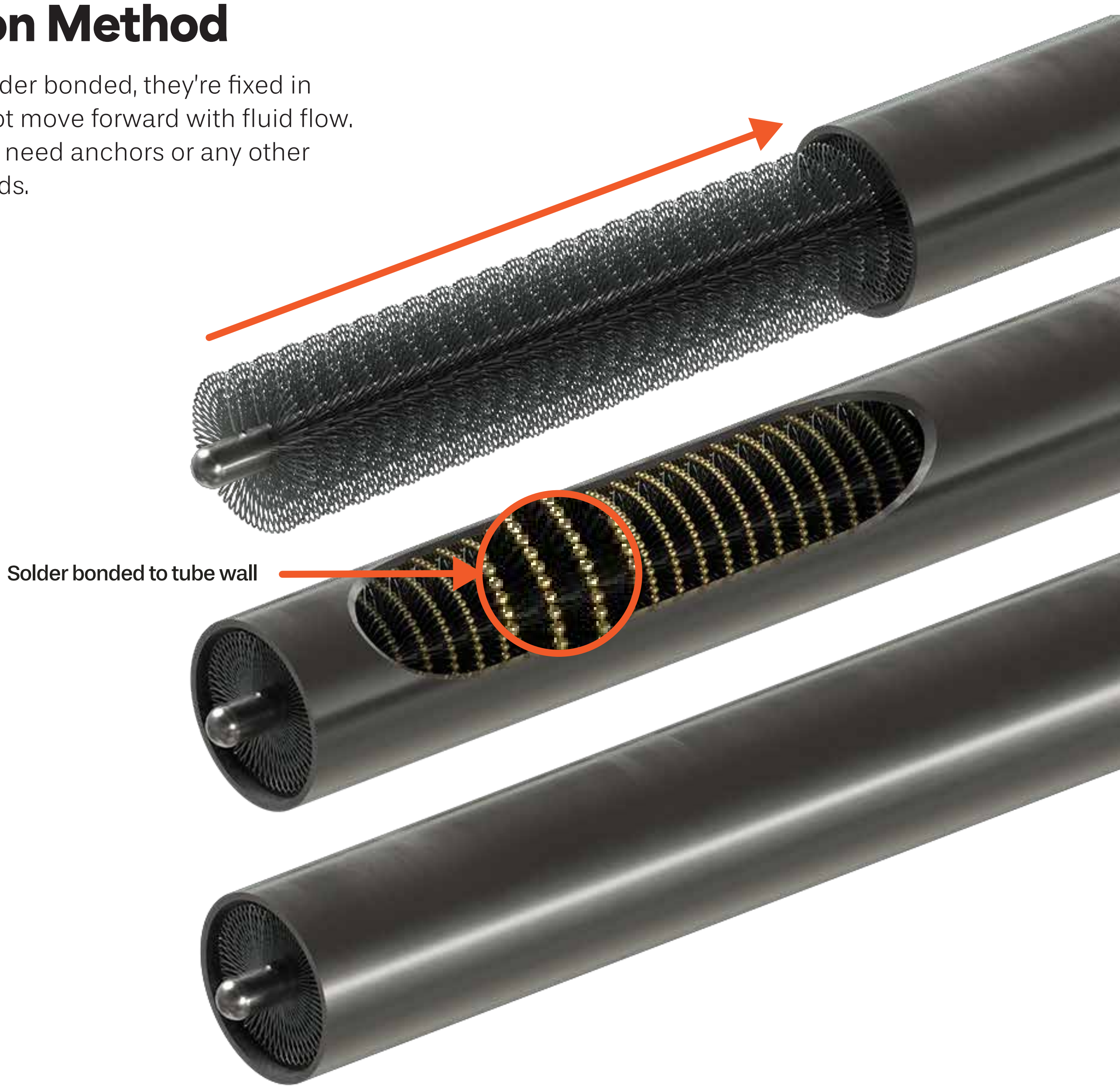
To design using Rigid Soldered Turbulators, please send us your design file (native to the software you use) or a data sheet of your exchanger and our design team will create a rating based on our legacy data. Rigid Soldered Turbulators have not been tested in Texas by CEI but run very close to actual performance experienced on-site.

Installation

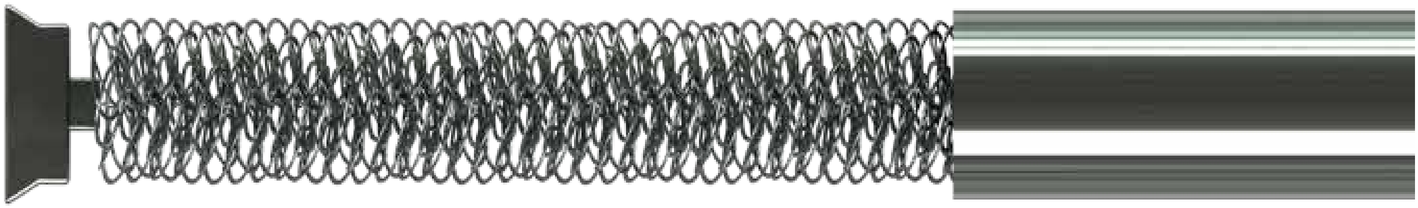
Since these are solder bonded to the inside of the tube, they come pre-installed by CEI inside the tube required.

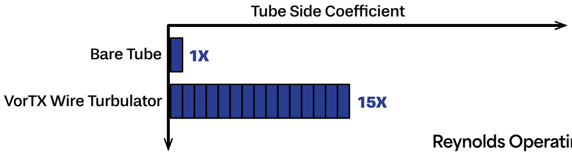
Retention Method

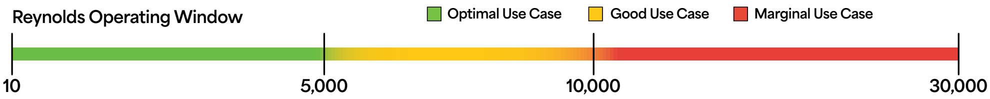
Since they're solder bonded, they're fixed in place and will not move forward with fluid flow. It's why we don't need anchors or any other retention methods.



If you're on the lookout for massive performance gains but have 'easy installation' on the checklist, look no further than VorTX Wire Turbulators.







Sure, in overall performance, wire turbulators come in second to rigid soldered turbulators.

But when you throw in the usability and ease-of-install criteria into the equation, they're basically top of the charts.

We've tested multiple wire turbulator geometries both in-house and in Texas.

We've analyzed every possible parameter like loop angle, loop density, twist recurrence, loop wire thickness, central spine integrity at different thicknesses, the works.

And it's given us a goldmine in terms of data at a very large Reynolds operating window all the way down from 10 to 30,000.

Allow us to break down the data-gather and correlation development protocols involved in making this ratable within compatible software platforms.

1. Multiple geometries were tested in a side-by-side with a no-turbulator case. Each geometry has its own part ID.
2. The Reynolds range covered was between 10 and 30,000.
3. The data for each part ID was tested and verified.
4. A test report was created for each part ID with correlations to calculate heat transfer and pressure drop.
5. Those correlations are then picked up by our VorTX DLL that has been made for us which will tell the user the Part ID that will solve their heat transfer problem for them.
6. Users can use the VorTX DLL in one of two ways:
   A. Users can put in a pressure drop constraint and the software will throw out the best possible performance available at that pressure drop. It will spin out a Part ID. That Part ID is what the user needs to send CEI for running up a quote or potential order.
   B. Users can input a part ID they've used previously and see how it'll perform for the case they're currently working on. The Part ID can again be sent to CEI to either run up a quote or potential order.

Big Use Cases

1. Any application where the tubeside is the limiting factor like oil or glycol coolers. In some cases, even water, where the other side is Steam.
2. Where fouling mitigation on account of increasing shear stress is possible.
3. Where issues like film boiling and mist flow plague vaporizers. Further, enhancing bubble cutting will also help with overall HTC improvement.
4. Draining condensate from the wall to allow for more area for condensation in vertical condensers. The geometry can be angled in a way where the loops take the fluid from the wall and drain it through the center.

Design Method

For software users, write in with a request for VorTX.DLL. That will allow users to simply input the pressure drop allowance as a constraint to have the software determine the best part ID available that will give the max performance for that pd allowance. Users can also input a part ID they have and see how it will perform for a particular use case.

For non-software users, you can send your datasheet and we'll model it in software and send you a pdf output summary.

Possible Refinery Performance Monitoring Software Integration:

This will allow users to look at the possible improvement in furnace inlet temp by the addition of turbulators in one or more heat exchangers and the cross impact that performance will have on the overall furnace inlet temp. The data from our tests can be hard coded into the software to show even fouling mitigation using the shear stress principle.

Installation

There is a pull hook at one end. Simply insert wire through the tube from the outlet to inlet side and then use the wire to grapple onto the hook and pull the turbulator through the tube in the direction of the fluid flow, the anchor will then hit the tube once insertion is complete.

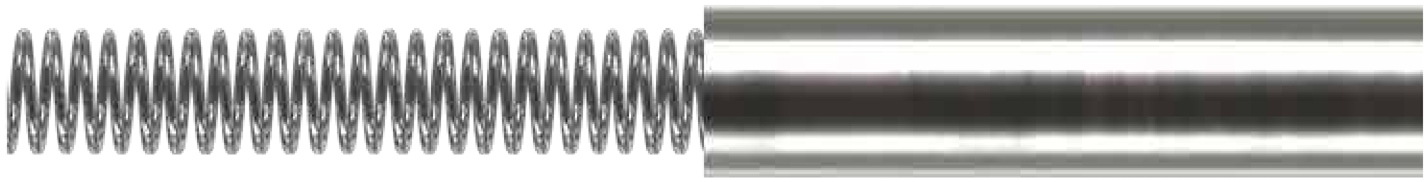
Retention Method

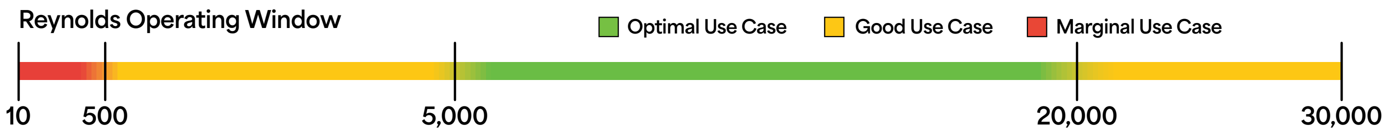
There are two anchor types. Plate Anchors with a flat head. Plate Anchors with a non-flat head. The anchors will be sized so that they can pass through the plug header ID but stop short of passing through the tube ID.

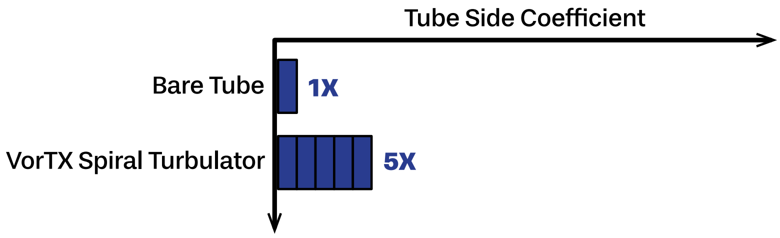
Tube Size Ranges with Data Backing: 3/8 inch, ½ inch, 5/8 inch, 0.75 inch, 1 inch, 1.25 inch and 1.5 inch.

Tube Size Ranges without Data Backing: We can make turbulators as small as ¼ inch and as large as 1.5 inches.

Spiral turbulators are the classic underdog story.







Spiral turbulators are basically the dark horses in the range. They offer up more performance than twisted tapes for a very reasonable increase in pressure drop. In fact, a spiral turbulator offers performance that is in between a twisted tape and a low dense wire turbulator.

This makes it a great plug-and-play for retrofit scenarios with lower pd allowances and even in refinery crude preheat trains to both improve performance and mitigate fouling on account of the additional shear stress.

CEI Spirals have been tested in Texas and the performance data on htc and pd is mapped into CEI's VorTX.dll

The key parameters when testing these in were to get the correct pitch, thickness of wire and clearance to give the best possible performance characteristics.

Big Use Cases

1. Any application where the tubeside is the limiting factor like oil or glycol coolers.
2. Where fouling mitigation on account of increasing shear stress is possible.
3. Where issues like film boiling and mist flow plague vaporizers. Further, enhancing bubble cutting will also help with overall HTC improvement.

Design Method

Software users can request a licensed dll from CEI. That will allow users to simply input the pressure drop allowance as a constraint to have the software determine the best part ID available that will give the max performance for that pd allowance. Users can also input a part ID and see how it will perform for a particular use case.

For non-software users, you can send your datasheet and we'll model it in software and send you a pdf output summary.

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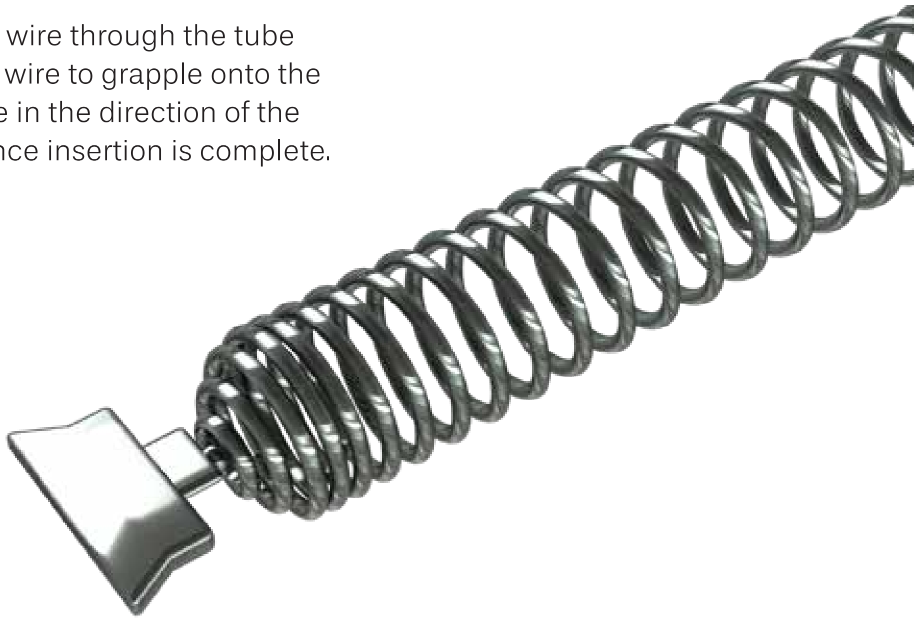
Installation and Retention

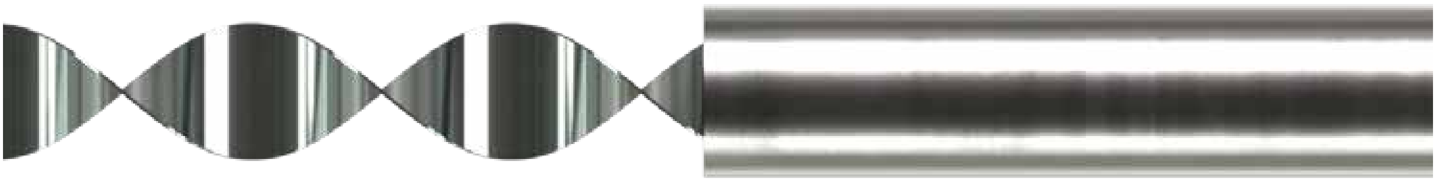
There is a pull hook at one end. Simply insert wire through the tube from the outlet to inlet side and then use the wire to grapple onto the hook and pull the turbulator through the tube in the direction of the fluid flow, the anchor will then hit the tube once insertion is complete.

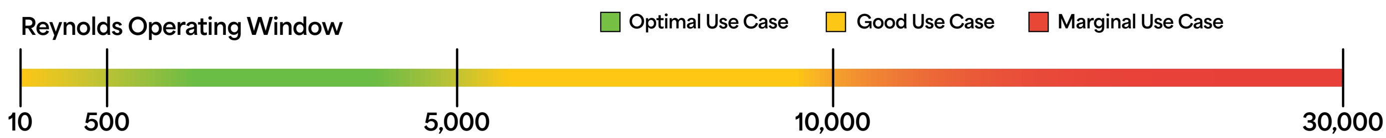


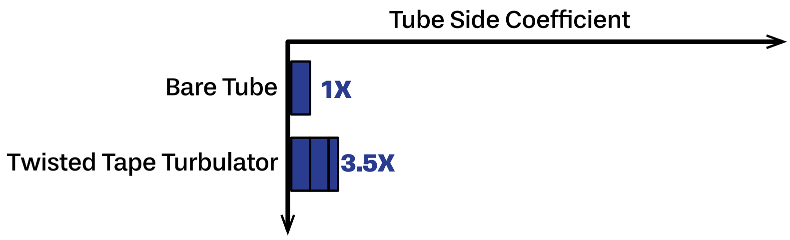
Tube Size Ranges with Data Backing: 3/8 inch, ½ inch, 5/8 inch, 0.75 inch, 1 inch, 1.25 inch and 1.5 inch.

Tube Size Ranges without Data Backing: We can make turbulators as small as ¼ inch and as large as 1.5 inches.

Vanilla is good. Because vanilla is consistent with your expectations.
Twisted Tapes are no different.







Twisted tape turbulators are the most universally used and understood turbulator type. The reason is that these have been tested by multiple people and their correlations (almost open-source) are hard coded into multiple software platforms giving a reliable measure of htc and pd improvement.

In terms of performance rankings, they come in fourth in our range. And this is a fair comparison as the data we have on the other turbulator types leads us to that conclusion.

The important thing is L/D conformance as the prime factor for performance and pressure drop is the twist ratio.

Twisted tapes will give you the lowest pressure drop in our range and the neat thing is that we can also make asymmetric twisted tapes. Asymmetric tapes are nothing but twisted tapes where the L/D can be varied over the length of the tube.

Big Use Cases

1. Any application where the tubeside is the limiting factor like oil or glycol coolers.
2. Where fouling mitigation on account of increasing shear stress is possible.
3. Where issues like film boiling and mist flow plague vaporizers. Further, enhancing bubble cutting will also help with overall HTC improvement.

Possible Refinery Performance Monitoring Software Integration:

This will allow users to look at the possible improvement in furnace inlet temp by the addition of turbulators in one or more heat exchangers and the cross impact that performance will have on the overall furnace inlet temp. The data from our tests in Texas will be hard coded into the software to show even fouling mitigation using the shear stress principle.

Installation

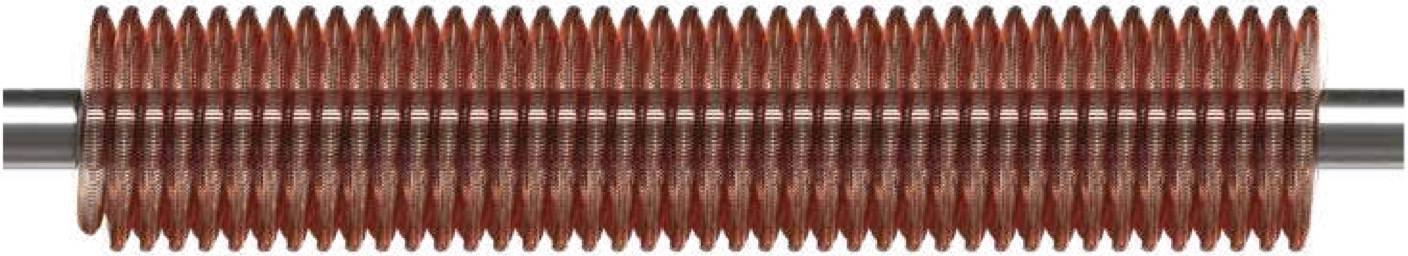
Simply push a long piece of wire through the tube and hook it into the hole provided at one of the twisted tape. Pull it through the tube till the anchor hits the tube OD.

Retention Method

Twisted tapes have two anchor types. Plate Anchors and Notch Anchors.

Tube Size Ranges with Data Backing: ¼ inch, 3/8 inch, ½ inch, 5/8 inch, 0.75 inch, 1 inch, 1.25 inch, 1.5 inch, 2 inch and 3 inch.

The secret to Wire Wound Fin Tube superiority lies within the periodic table.



Copper has a huge leg up over other metals on its thermal conductivity.

Why Wire Wound Fin tubes are so popular is because they are the most inexpensive way to get Copper on Copper fin tubing as equivalent L Fin Tubing in Copper would be too heavy and hence super expensive as Copper raw material rates are way higher than stainless steel.

Why they're lighter is because the wire loops have a lot of free surface area.

Why they perform so well is because those same wire loops turbulate the air and the solder bond between the loops and the tube conducts heat super efficiently.

We can also make Stainless Steel Wire Fin on Stainless Steel/Carbon Steel Tube or Carbon Steel Wire Fin on Carbon Steel Tube but the performance derating off of Copper is substantial.

Wire Wound Fin Tubes are the most inexpensive way to get at copper gains

Design Capability: Our design team can rate exchanger performance using Wire Wound Fin Tubes but it's done with legacy methods outside of regular software and then can be inputted into software through some bridge calculations.

Copper Wire Wound Fin Tube	**L Fin Tube**
The weight of a Copper Wire Wound Fin Tube would be 2.140 kg in a standard 1 inch config which is about 80% of the weight of the L Fin Tube if it were with a Copper Fin and Copper Tube. Plus, weight aside, it also offers about 7-8% more performance for the equivalent Copper L Fin Tube with 11 FPI.	The weight of an L Fin Tube in a Copper-Copper config is 1.25 times more than a wire wound fin tube in Copper. That would result in a more expensive fin tube. And as a double whammy performance of the wire wound fin tube is up by 7-8% on the Copper L Fin Tube.
Temp limit maxes out at either 180C or 280C depending on the solder used.	Temp limitation is 130C.
If you take a Copper Wire Wound Fin Tube and compare its performance with a conventional Carbon Steel Al 11 FPI Fin Tube the performance improvement is in the range of 30-40%.	A conventional L Fin Tube with Carbon Steel Tube and Al Fin would have a much lower performance than a Copper Wire Fin Tube.
The Tube and Fin Contact is both metallurgical and mechanical and all fins are in perfect contact with the tube.	Since Fins are stapled at both ends, they're susceptible to loosen up in operation due to vibrations and other operating conditions.
Good corrosion and erosion resistance. Perfect for desert and off shore conditions.	Not great in the corrosion and erosion resistance department.
Plot space requirement would be super low. Almost 50% that of an L Fin Tube Cooler.	Much more area needed as compared to a Copper Wire Fin Tube.
Tube and Fin joint is way stronger than an L Fin.	Much lower Tube and Fin joint.
Super rigid. Can withstand vibration levels up to 7G.	Good for 3G vibration levels max.
Heat transfer capacity is tremendous.	Average heat transfer capacity.

We know this list seems like a lot. But it’s not everything.

List of applications including (but not limited to just these) scenarios where turbulators, if given a shot, would appreciably increase performance.

a. **Vaporizers:** Vaporizers are plagued with issues like film boiling, mist flow and unmanageably large bubbles. Turbulators keep the boiling mechanism in nucleate boiling or as close as one can be to it, take out the aspect of mist flow and cut bubbles down to size, this prevents htc from dropping off a cliff in vaporizers. Very useful in LNG Vaporizers.

b. **Furnace Inlet Temp Improvement in CPHTs:** Turbulators can improve furnace inlet temp in refineries to improve refinery yield and reduce CO2 emissions. 2 birds, one stone.

c. **Fouling Mitigation in CPHTs:** Turbulators, on account of the increase in shear stress, can mitigate fouling in certain exchangers in the CPHT. This can also keep the Furnace Inlet Temp consistently high over a period reducing the fouling drop-off in performance.

d. **Vertical Condensers:** In vertical condensers, turbulators can help drain the liquid from the wall through the center to allow for more condensation. This can really improve performance.

e. **Liquid Cooled Heat Sinks for Power Electronics:** Most liquid cooled heat sinks use some mix of glycol water and turbulators are known to improve the tubeside performance appreciably to enable more powerful electronic components to be designed in a smaller area.

f. **Inline Static Mixer Reactors:** Using turbulators as the prime driver, agitated vessels for batch reactions can be replaced with Shell and Tube Reactors with Turbulated Tubes to enable inline reactions that are significantly quicker, lower on power and have equipment that is a fraction of the normal size.

g. **Wet/Dry Crude Exchangers:** The dehydration of wet crude involves units with high viscosities which operate in laminar flow and are the nailed on use-case for VorTX Wire, VorTX Spiral or twisted tape turbulators.

h. **Produced Water Exchangers:** If you're dealing with tight approaches with internal temp crosses, VorTX turbulators can help reduce passes and keep performance up even in laminar flow and low velocities.

i. **Dry Crude Heaters:** When dry crude is being heated by water there's laminar flow on the tubeside where performance can be appreciably improved by using VorTX technology.

j. **Glycol Dehydration Processing:** Glycol is used in absorption dehydration of gas streams. Glycol being viscous operates in laminar flow and is another use-case that's a great candidate for VorTX performance enhancement.

k. **CDU/VDU Bottoms Coolers:** Bottoms out of any distillation process are high in viscosity and exhibit laminar flow which can see sizable improvements in performance using VorTX technology.

l. **Reactor Effluent Coolers**: Effluent cooling is generally needed for either further processing or storage. When a fluid cools its viscosity goes up and that leads to laminar flow. And laminar flow is a happy hunting ground for VorTX technology.

m. **Crude Oil Heaters:** Heating crude where crude is on the tubeside makes it the limiting side for heat transfer. An improvement on the tubeside with VorTX technology will improve overall coefficient in a big way.

n. **Feed/Effluent Exchangers:** Tight approaches on heat recovery applications necessitate tubeside enhancement. Enter VorTX turbulators that can improve this in cases of both vaporizing and condensing of multicomponent reactor effluent.

o. **Olefin Vaporizers/Condensers:** VorTX tech can improve phase distribution through the tubes and prevent film boiling or stratified flow. This will improve overall performance.

p. **Resin Coolers:** High tube side viscosities and having water on the shell side make resin coolers a star use case for VorTX tech heat transfer enhancement. Because water on the shell side means that the tubeside is heavily controlling.

q. **Polymer Exchangers:** With viscosities as high as 1000cP make this a great candidate for enhancement using VorTX technology since Reynolds Numbers will be depressed.

r. **MDI Exchangers:** Cooling or even condensing of MDI would do well with VorTX tech as it would bulk mix the components and even drain off excess condensate to free up more area for condensation.

s. **TDI Exchangers:** VorTX tech can help achieve high product quality and improve throughput by a number of product actions. Improving phase distribution through the tubes for starters. And improving boiling mechanisms to move away from film boiling, stratified flow towards nucleate boiling.

t. **Polyol Exchangers:** Polyols are an ingredient in the production of resins and their characteristically viscous and operate in laminar conditions best suited for VorTX enhancement.

u. **Amide Coolers:** Amide Coolers in the nylon process can have their cooling impacted through yearly condition changes. VorTX technology can help maintain optimal performance of these units.

v. **Ammonia Vaporizers:** To keep decent vapor qualities, VorTX tech can mitigate phase stratification and improve vapor heating.

w. **Gas Compressor Lube Oil Air Coolers:** Gas transporation pipeline compressors need lube oil at a cool enough temp. Air coolers that cool them can be smaller in size (upwards of 50% in the majority of cases) with the use of VorTX technology. Add to that lowered fan power consumption and it's easy to see why it's a glowing use-case.

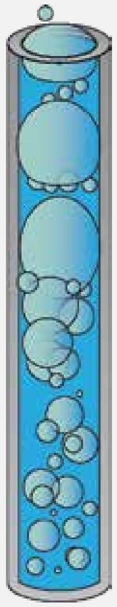
x. **Fuel Gas Heaters:** Fuel Gas Heaters generally have a temp cross problem which can be alleviated by making them a 1 pass design powered by VorTX technology.

y. **Fuel Cell Humidifiers:** The last thing you want is droplet carryover to downstream equipment. To prevent this you need full vaporization which is something VorTX can give you by maintaining performance even at high vapour qualities my mitigating droplet formation at the outlet.

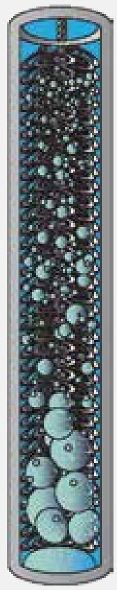
z. **Transformer Oil Coolers:** Transformer oil is viscous and it means that units operate under severely laminar conditions. To maintain efficient transformer operation, one can use VorTX technology to increase heat transfer in this low Reynolds environment and maintain process target temps.

If you're trying to picture how turbulators work in different settings, this ought to spell it out.

Bubble Cutting Ability



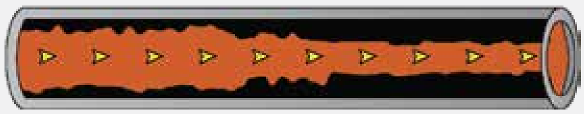
Large bubbles form in the tube as gas flows



Turbulator cuts and prevents large bubbles

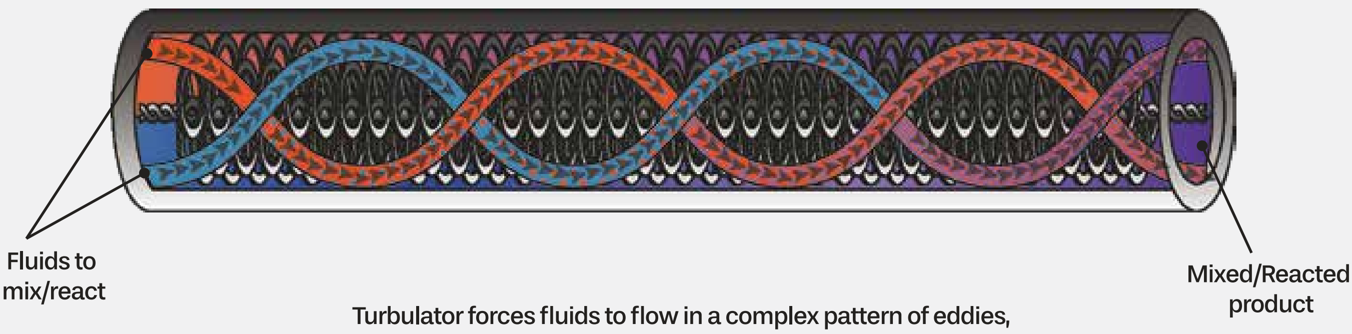
Fouling Layer Prevention

Fouling layer build-up on tube wall reduces heat transfer



Turbulators prevent build up by converting laminar flow to turbulent flow, increasing heat transfer

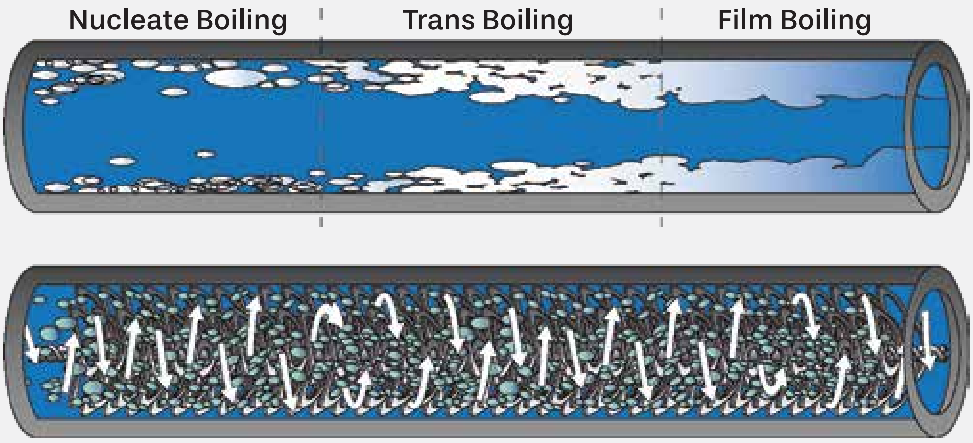
In Tube Mixing / Reaction Enhancement



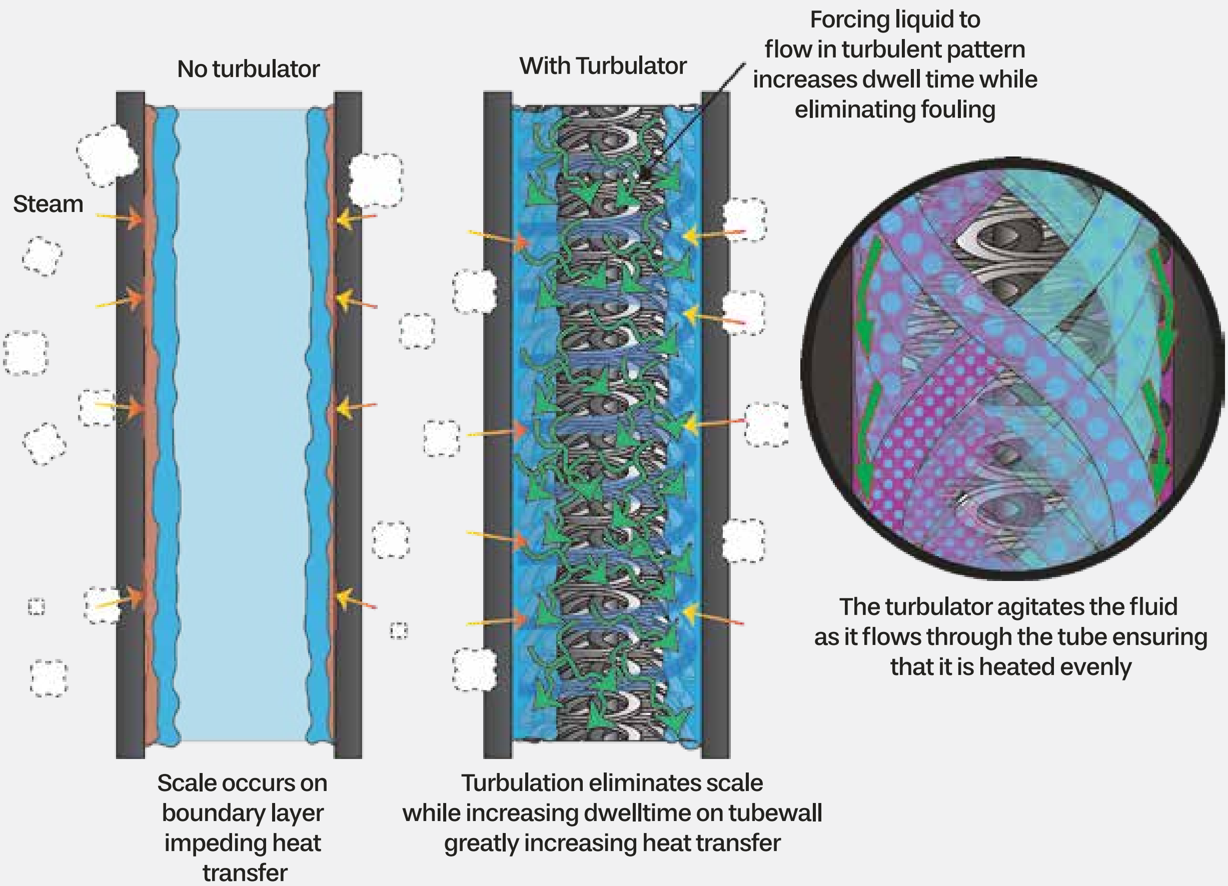
Turbulator forces fluids to flow in a complex pattern of eddies, causing multiple self-collisions that lead to a more homogenous mixture

Evaporators and Vaporizers (Cryogenic & refrigeration)

Vaporizers are plagued with issues like film boiling, mist flow and unmanageably large bubbles. Turbulators keep the boiling mechanism in nucleate boiling or as close as one can be to it, take out the aspect of mist flow and cut bubbles down to size, this prevents htc from dropping off a cliff in vaporizers. Very useful in LNG Vaporizers.



Heat Transfer Enhancement



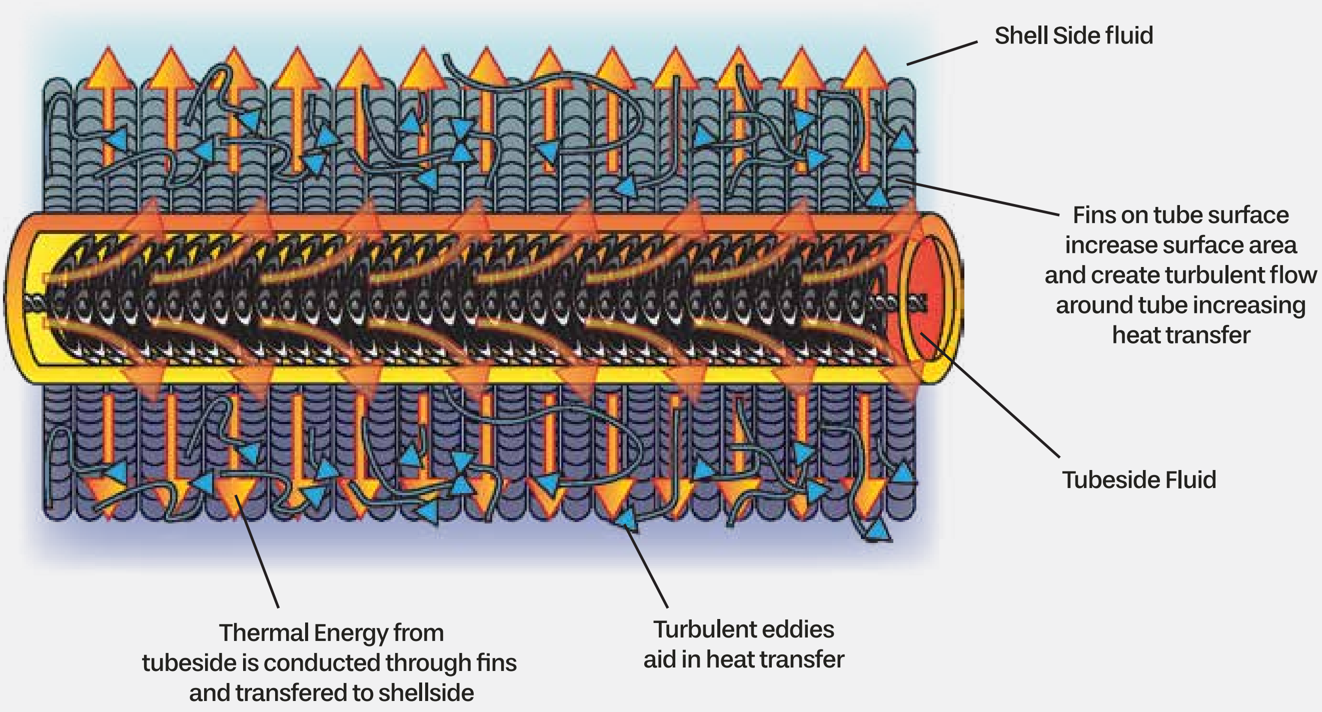
Vertical Condensers

In vertical condensers, turbulators can help drain the liquid from the wall through the center to allow for more condensation. This can really improve performance.

Falling Film Evaporators

Turbulators direct all the liquid to the tube wall improving heat transfer as more fluid is in contact with the wall. It also agitates the film along the tube wall and the zig-zag pattern created increases dwell time and thickens the film layer. This also reduces fouling and increases the interval between cleanings.

Fin Tubes + Turbulators



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