

# DESIGNING ENHANCED AIR COOLED HEAT EXCHANGERS



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technical information  
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Resource Portal at  
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**CALGAVIN**

RESEARCH - EVALUATION - INNOVATION - SOLUTION

# INTRODUCTION TO CALGAVIN

**Based in the heart of the United Kingdom and with global technical representatives, CALGAVIN® has built up an unrivalled expertise over 35 years in application knowledge, thermal design and analysis of process plants.**

Our technical design and support team have extensive understanding of thermodynamics, heat transfer and fluid flow phenomena, combined with engineering experience offering improvement solutions to hundreds of plants worldwide.

CALGAVIN understands the importance of continuous research to improve the quality and widen the range of the products we manufacture and the services we offer to our clients. This includes investment in developing highly specialised testing equipment to accurately quantify performance of new enhancement devices and understand complex fluid properties with a focus to extend application areas for improving performance enhancement.

Alongside our world class enhancement product range, including hiTRAN® Thermal Systems, we provide practical and objective consultancy advice on improving plant operation.

In addition to our own research, CALGAVIN works with a significant number of universities globally, researching new avenues for our flow modification products and services.

We provide software licenses for our CALGAVIN.SP design and selection program and clients are continually informed of new developments and company updates.



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## RESEARCH

Research is at the centre of CALGAVIN®'s business, with a range of test facilities within its internal Research & Development department. CALGAVIN also actively develops research programmes, in collaboration with UK and overseas universities, to support their cutting-edge process enhancement solutions. This valuable network of research and the generation of performance data provides the high level of confidence needed by its clients.



## EVALUATION

Working closely with clients from the onset, CALGAVIN's engineers carefully assimilate original and current plant data with client needs, to provide practical and economic proposals. The company's Best Practice Policy is supported and achieved by the use of state-of-the-art software including HTRI Xchanger Suite®, Aspen Exchanger Design & Rating, Ansys CFD® and Fluent®, in conjunction with CALGAVIN®.SP design and selection program.



## INNOVATION

For over 40 years CALGAVIN has built up unrivalled expertise in the thermal design and analysis of process plants. New products and new services are developed to meet ongoing process challenges. Our engineering team has extensive knowledge of thermodynamics, heat transfer and fluid flow phenomena, combined with global experience providing improvement solutions to hundreds of plants worldwide. (References upon request).



## SOLUTION

Process systems and operating parameters are complex and often quite different from plant to plant. Each requires a detailed and professional study to find the optimum solution. CALGAVIN's products and services are engineered to meet defined needs for improving heating, cooling, boiling, vaporising, condensing, fouling mitigation, fluid mixing and other fluid management requirements. We provide the solution and the responsibility that goes with it.

**Our warranted hiTRAN® Thermal Systems provide unique solutions to substantially enhance the tube-side heat transfer in all tubular constructed heat exchangers; whether considered at preliminary design phase, or through a retrofit to an existing heat exchanger.**

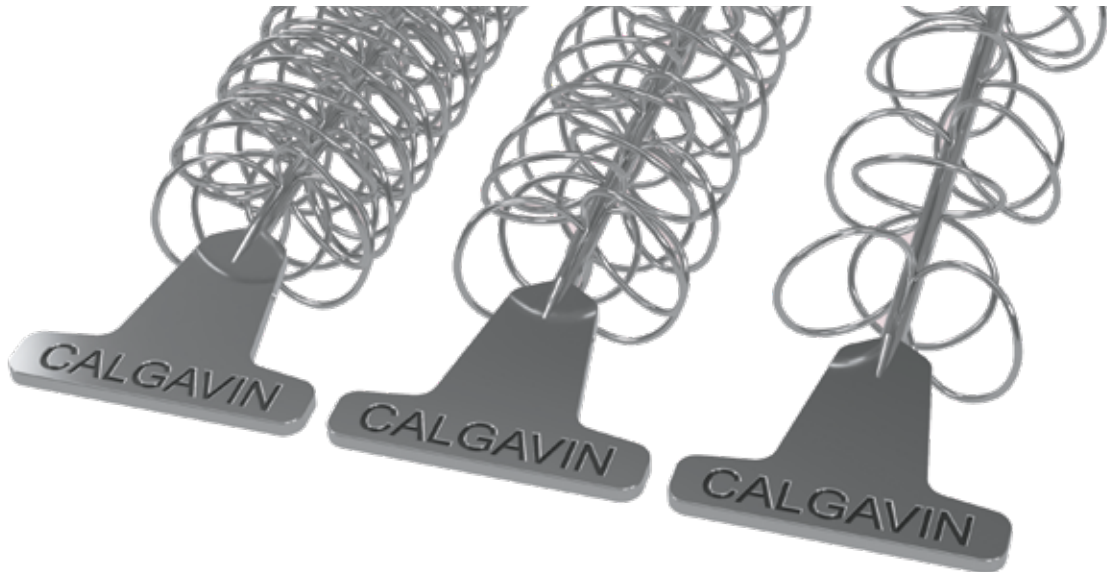
hiTRAN® Thermal Systems are a unique type of tube insert, easily installed to offer the greatest enhancement benefit for laminar and transitional flow regimes where the heat transfer coefficient can be increased up to 16x (dependent upon Reynolds number and turbulator geometry) and they can be used in both single and two-phase flow regimes.

Our product selection type is software generated to meet a broad range of requirements and conditions; in short, a wide variety of processes can benefit.

Extensive technical and process benefits can be delivered across process plants in addition to cost and energy saving from the enhanced performance of heat exchangers. hiTRAN Thermal Systems have been successful in resolving a wide variety of heat exchanger problems including;

- Energy reduction
- Increased throughput
- Reducing maldistribution
- Predictable performance under downturn
- Mitigation of flow instabilities
- Suppression of film boiling and mist flow.

Our extensive Case Study examples are a powerful statement to the benefits of hiTRAN Thermal Systems installation.



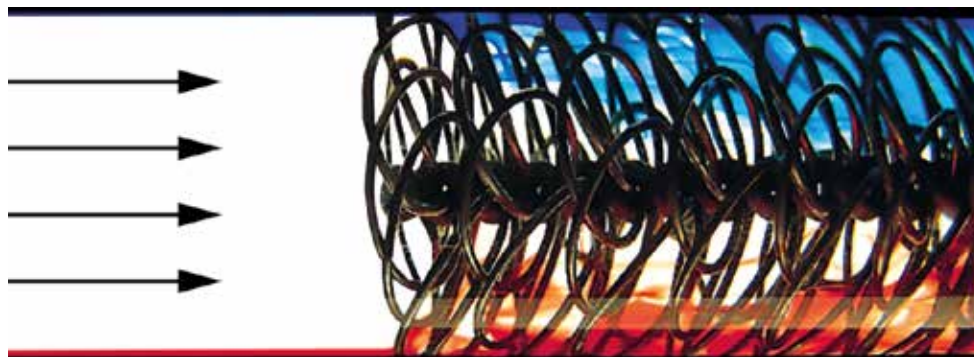
**A****Empty tube for single phase flow (gas or liquid)**

Heat transfer is limited, caused by laminar flow and boundary layer conditions where slow conductive heat transfer is the primary mechanism.

**B****hiTRAN® enhanced tube**

hiTRAN Thermal Systems work based on generating radial mixing of bulk fluid with stationary fluid near the tube wall. This mixing generates turbulence in the boundary layer, increasing wall shear rate. This high wall shear rate creates forced convective heat transfer, a higher rate of heat transfer compared to conduction seen in the empty tube.

Depending on Reynolds number and hiTRAN type, the heat transfer rate can be increased as high as 16 times the empty tube.

**A****B**

For condensing services, hiTRAN can not only enhance wall conditions for heat transfer but also for mass transfer of multi component mixtures that may contain non-condensables, hindering heat transfer. With greater mixing of vapour and condensate within the tube, full condensation can occur.

HOW HITRAN® WORKS

# EXPORT OIL TRIM AIR COOLER

## Less than half the cost!

### END USER

Kuwait Oil Company

### SERVICE

Export oil trim cooler

### EXCHANGER

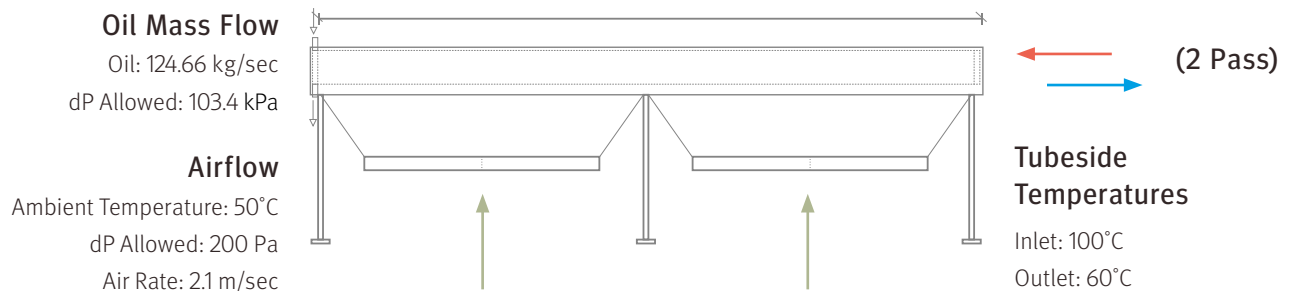
API 661 Forced draft air cooler, 4 Bays in parallel, 2 bundles per bay with 473 tubes per bundle (31.75 x 2.1 x 12,800 mm) Duty: 9.7MW

### BENEFIT

- Capital cost reduced by 52% after designing with hiTRAN® (compared to empty tube design)
- Plot size reduced by 57%
- Resulted in capital cost saving of \$2.9MM
- Operating cost savings over 10 years of \$1.9MM (through reduced power consumption)



### Air Cooler Duty - 9.7MW

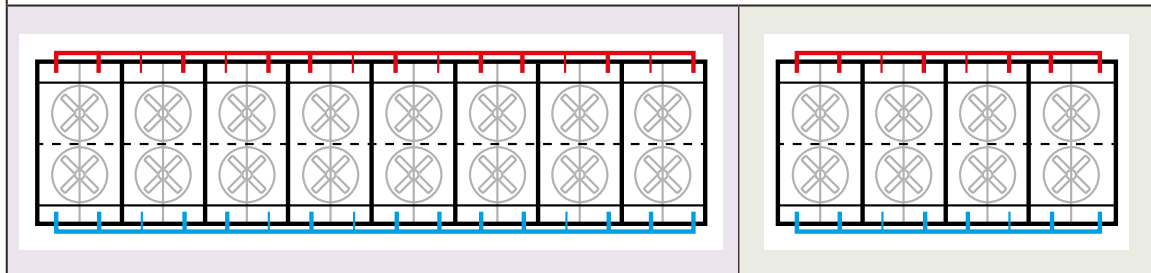


Geometry	Empty Tube	hiTRAN® Design
Bays in parallel	8	4
Bundles per bay	2	2
Tubes per row / rows / passes	50 / 12 / 8	43 / 11 / 2
Tube per bundle / total	600 / 9600	473 / 3784
Tube length (m)	12.8	12.8
Plot area (m <sup>2</sup> ) bundle	712.3	309.7
Fan power bay / total (kW)	34 / 271	26.8 / 107
Tube side pressure drop total / allowable (kPa)	80.9 / 103.4	101.9 / 103.4 (uses full dP allowance)
Tube side heat transfer (W/m <sup>2</sup> K)	<b>50</b>	<b>252 (5x Empty Tube)</b>

## COST COMPARISON

Purchase and Installation Cost (USD)	<b>\$5.6 MM</b>	<b>\$2.7 MM (hiTRAN® included)</b>
10 year Operating Costs (USD)	<b>\$3.1 MM</b>	<b>\$1.2 MM</b>

**hiTRAN® Design = half the size and weight of the Empty Tube Design**



# ENHANCING THE WORLD'S EXCHANGERS...

## CUSTOMER REFERENCES



Note: This is a small selection from our complete list of air cooler references





**...SINCE 1980**

## DESIGN & SIMULATION SOFTWARE

CALGAVIN®.SP

DESIGN & MODELLING OF HITRAN® THERMAL SYSTEMS



Download Our  
FREE Proprietary  
Software  
[WWW.CALGAVIN.COM](http://WWW.CALGAVIN.COM)

hiTRAN® Thermal Systems convert available pressure drop more efficiently into heat transfer, in laminar and transitional flow and this can be modelled using our free proprietary software CALGAVIN.SP design and selection program.

For HTRI Xchanger Suite® and Aspen Exchanger Design & Rating, two of the most powerful software packages on the market, CALGAVIN® has developed the CALGAVIN.SP software plug-in to simulate tubular heat exchangers equipped with hiTRAN. The research taken from our single-phase test rig (heat balance accuracy +5%) has contributed to the basis of our thermal and hydraulic program calculations, warrantable for clean recirculating fluids.

During the simulation calculation, CALGAVIN.SP assigns unique hiTRAN turbulator configuration, determined by bundle geometry, process conditions and property data. Each turbulator is designed to fully use the allowable pressure drop, in order to maximise the heat exchanger performance. The plug-in is available to calculate air cooled heat exchangers in Xace® (HTRI) and Aspen Air Cooled Exchanger (AspenTech). This program is also suitable for shell & tube heat exchangers.

For users without access to HTRI or AspenTech software, hiTRAN.SP can be used as a standalone selection program for input into clients own calculations.

 CALGAVIN®.SP

 aspentech

 Xchanger Suite®

Enhancing Design [WWW.CALGAVIN.COM](http://WWW.CALGAVIN.COM)

Since 1980 we have been active in the process industries in plants around the world, helping to review, design and install our warranted hiTRAN® Thermal Systems in heat exchangers. We serve the below industries and many more...



POWER



OIL &amp; GAS



OFFSHORE

PETROCHEMICAL  
& CHEMICAL  
PROCESSINGEV &  
AUTOMOTIVE

REFRIGERATION

INDUSTRIES SERVED **INCLUDE**

# INSTALLATION OF HITRAN® THERMAL SYSTEMS

## INSTALLATION MANUAL

To maximise the efficiency of hiTRAN® Thermal Systems, it is important that they are installed correctly. In summary, the installation of hiTRAN for straight tubes is simple and can be completed in three steps, sizing, fitting and retaining. Installation tools for sizing and fitting are provided in the supply, along with details on the retention of hiTRAN within the tubes.



**CALGAVIN®** provide a thorough step by step pictorial installation manual, custom made to your project. The manual covers the project summary, introduction, storage, content requirements, installing hiTRAN, maintenance, troubleshooting and contact information.

Our engineers have the know-how and the expertise to advise on any type of installation method, based on the application viability. Our video library is continuously being expanded to meet new hiTRAN Thermal Systems installations for a wider variety of heat exchangers.

Please contact our head office if you have any queries regarding how to perform an installation or if you have any maintenance questions about our hiTRAN Thermal Systems.

## EXCHANGER SUPERVISION SERVICES

Users of our technology are offered our optional installation supervision service, where a member of our team will attend your workshop or process plant. This visit will include demonstrations of how to correctly install hiTRAN® Thermal Systems into air-cooled heat exchangers, including information on how to use the specialist tools such as our re-sizing dies for efficient installation.

Supervision will achieve an agreed target, leaving the customer with the peace of mind of a complete and successful installation, and fully trained personnel for future projects.



# AIR COOLER FREQUENTLY ASKED QUESTIONS

## Q) CAN I REUSE HITRAN® THERMAL SYSTEMS?

Provided the correct removal procedure is followed and the elements are handled and stored carefully; they can be reinstalled into the same exchanger. Where a bundle or tubes are replaced, differences in tube tolerances may cause a poor fit. For such tubes replacement, re-supply of hiTRAN is recommended.

## Q) CAN HITRAN® BE DESIGNED TO MEET MY PROCESS REQUIREMENTS AND APPLICATION SPECIFICATIONS?

hiTRAN has a large degree of flexibility in design geometry, which provides variable heat transfer and pressure drop characteristics. This flexibility is incorporated into our hiTRAN.SP plug-in, which enables the user to assess designs based on defined allowable tubeside pressure drop. The hiTRAN.SP algorithm will revert to the lowest pressure drop or highest enhancement geometry, respectively, for the given conditions, where the allowable pressure drop is either too low or higher than required. This provides the designer with the necessary software tool to find the optimum solution.

## Q) WHAT MATERIALS CAN HITRAN® THERMAL SYSTEMS BE MANUFACTURED FROM?

hiTRAN Thermal Systems can be manufactured from most material that can be sourced in wire form. hiTRAN is most often manufactured from the same material as the heat exchanger tubes to prevent any possibility of galvanic corrosion. The most common material selections tend to be stainless steels, however, special alloys and exotic materials such as Hastelloy®, tantalum and even silver have been supplied.

## Q) CAN HITRAN® THERMAL SYSTEMS BE FITTED AS A PARTIAL INSTALLATION IN A PORTION OF THE TUBE?

CALGAVIN® engineers will look at all options to provide the most effective solution to your problem, including installation in only one or some tube passes or part of the tube length. Likewise, suitable installation and retention systems are available for these options.

## Q) CAN HITRAN® BE RETROFITTED TO EXISTING AIR COOLED EXCHANGERS?

Thermally and hydro-dynamically the suitability of an air cooler for improvement with hiTRAN is no different than a shell and tube. However, retrofitting with hiTRAN may require modification of the pass arrangement, and with air cooler headers, other than cover plate type, this can be difficult, such that, replacement is more practical. This has been done in cases where the benefit is very large.

## Q) ARE HITRAN® THERMAL SYSTEMS SUPPLIED AS A STOCK ITEM OR IS IT CUSTOM DESIGNED FOR EACH ORDER?

hiTRAN Thermal Systems are custom designed and manufactured based on process analysis, using the hiTRAN.SP plug-in, considering thermal performance and pressure drop implications. CALGAVIN can support clients in optimising designs allowing hiTRAN to solve a greater range of problems.

# FREQUENTLY ASKED QUESTIONS AIR COOLER

## Q) CAN HITRAN® THERMAL SYSTEMS BE FITTED IN A U-TUBE BUNDLE?

Installation in U-tubes results in reversing the fitting direction in one leg and requiring a lesser interference fit. Modified performance is taken into account in the calculations where U-tube is specified. Alternate installation and retention options are required and instructions are provided in our Installation Manual and on-site assistance can be provided.

## Q) IN WHAT APPLICATIONS ARE HITRAN® THERMAL SYSTEMS NOT APPROPRIATE?

Benefits from enhancing performance with hiTRAN are greatest when the tube-side coefficient is substantially controlling (very low). This benefit reduces as the tube-side coefficient approaches equality with the outside coefficient at which point little overall enhancement is achieved. By example, applications where enhancement will not provide a benefit include:- where the outside coefficient is very low or where, on the tube-side, there is a high co-efficient like steam or other condensing fluid.

## Q) WHAT IS THE ADVANTAGE OF USING HITRAN® THERMAL SYSTEMS VERSUS TWISTED TAPE TYPE TURBULATORS?

The enhancement mechanisms are different between these turbulator types and this leads to markedly better performance by hiTRAN in the laminar and transitional flow regimes. hiTRAN can still offer higher heat transfer rates in turbulent flow, but lower pressure drop offered by twisted tapes means it can be a good option at high Reynolds numbers.

## Q) WHAT CONSIDERATIONS NEED TO BE TAKEN WHEN APPLYING HITRAN® TO FOULING PROCESS FLUIDS?

Fouling is a complex issue with many different types and mechanisms. The enhancement effect hiTRAN has on flow inside tubes can be beneficial for some types of fouling, thereby providing a mitigation process. In practice, detailed information about the mechanisms is rarely available, such that a fouling reduction benefit cannot be easily calculated or guaranteed. Therefore, heavily fouling services need to assume that periodic cleaning will be required. As with empty tubes, it is important to monitor the exchanger performance to avoid excessive foulant build-up. While chemical cleaning options can be carried out with hiTRAN in-situ, mechanical cleaning methods require removal of hiTRAN before cleaning. Following the installation and removal procedures, including safe storage of the hiTRAN while cleaning, allows for reuse of the hiTRAN. Some spares would be advisable.

## Q) WHAT ARE THE MINIMUM AND MAXIMUM TUBE DIAMETERS HITRAN® CAN BE MANUFACTURED FOR?

The smallest tube diameter hiTRAN can be designed for is 6mm and the range extends up to 150mm.

## Q) ARE HITRAN® THERMAL SYSTEMS WARRANTIED?

CALGAVIN® warrants both thermal and hydraulic calculations provided directly or via the hiTRAN.SP plug-in, based on customer data and design conditions, for clean recirculating fluids. In cases where uncertainties exist and for fouling applications, additional advice regarding expected performance may be provided.

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