THE EXCHANGER | HTRI

2019 ISSUE

THE EXCHANGER

2019 ISSUE

IN THIS ISSUE

Notice
The articles and opinions in this newsletter are for general information only and are not intended to provide specific advice.

Contact
Submit all correspondence regarding *The Exchanger* to

HTRI
Attn: *The Exchanger*
P.O. Box 1390
Navasota, TX 77868 USA

htri@htri.net
www.htri.net

+1.979.690.5050 office
+1.979.690.3250 fax

HTRI®
Heat Transfer Research, Inc.

To subscribe to *The Exchanger*, log in to www.htri.net and modify your subscription in your user profile.

MESSAGE FROM THE PRESIDENT & CEO

Reaching Back and *Moving Forward*

In January 2017, we distributed a print version of our newsletter. After that, we began posting it on our website. Mindful of my Baby Boomer status versus the changing demographics of staff and members, I agreed. However, last year a fair number of you let us know you missed it—so we have made the choice to reach back to an annual printed newsletter. We had not lost your address or crossed you off the list! We just stopped printing.

This paper version requires more design effort, comes with the cost of production and distribution, but provides advantages difficult to quantify. I hope you enjoy reading *The Exchanger* at your convenience, in a location of your choice, and without watching the battery power of your device diminish. It makes me smile to picture you paging through it during your daily commute, on a business flight, over a lunch break, or perhaps on a quiet evening in your favorite chair, with lamplight shining on the pages.

In the near future, we also will reach back to reinstate our Horizons Symposium. This conference focuses on topics other than our core research and testing. Stay tuned for more on Horizons 2020.

Change is inevitable. It can be a choice or thrust upon us. Managing challenges and being flexible are critical for business success. At HTRI, as with your companies, change marches on in most every area of operations as we grow and move forward.

Approaching our sixth decade of business, progress continues. In my presentation at the September 2018 Annual Meeting of Stockholders in Milwaukee, Wisconsin, USA, I highlighted

- new and improved products
- modifications to existing rigs
- new rigs
- increased staff
- asset growth

We have eleven test rigs at our Research & Technology Center. Our research staff work closely with technicians and test engineers to conduct research and testing of shared interest to our global customers. Results are reported to members and incorporated into our software, which we are proud to say is the global standard in process heat transfer technology.

As I write this in early March 2019, our membership is strong, with over 850 members and 550 of their registered Participating Affiliates. Membership revenue is augmented by proprietary contracts, licensing of products acquired in recent years, as well as business relationships benefitting members.

Moving forward, we are focused on capturing the knowledge and experience of our staff and our members who are generous with their expertise. A unique attribute of HTRI is active participation of our global members in 63 countries. We applaud the Board of Directors, Technical Committee, Communication Committees, and Task Forces for their ongoing contributions to our success. *The power of the consortium* serves us well.

Claudette D. Beyer
President & Chief Executive Officer

Xchanger Suite® 8 Features Exchanger Optimizer™ Integration

DAVID GIBBONS
Director, Engineering
Software Development

EXCHANGER™ OPTIMIZER

EXCHANGER OPTIMIZER IS AN INNOVATIVE ECONOMIC EVALUATION TOOL THAT ALLOWS ENGINEERS TO FIND THE BEST SOLUTION FOR THEIR HEAT TRANSFER SYSTEMS.

The release of ***X**changer Suite* 8 has brought new features and functionality to HTRI's flagship product.

As a result of the *HTRI Research to Software Initiative*, designed to incorporate as many high-impact methods into the software as possible, ***X**changer Suite* 8 includes 20 new or improved methods.

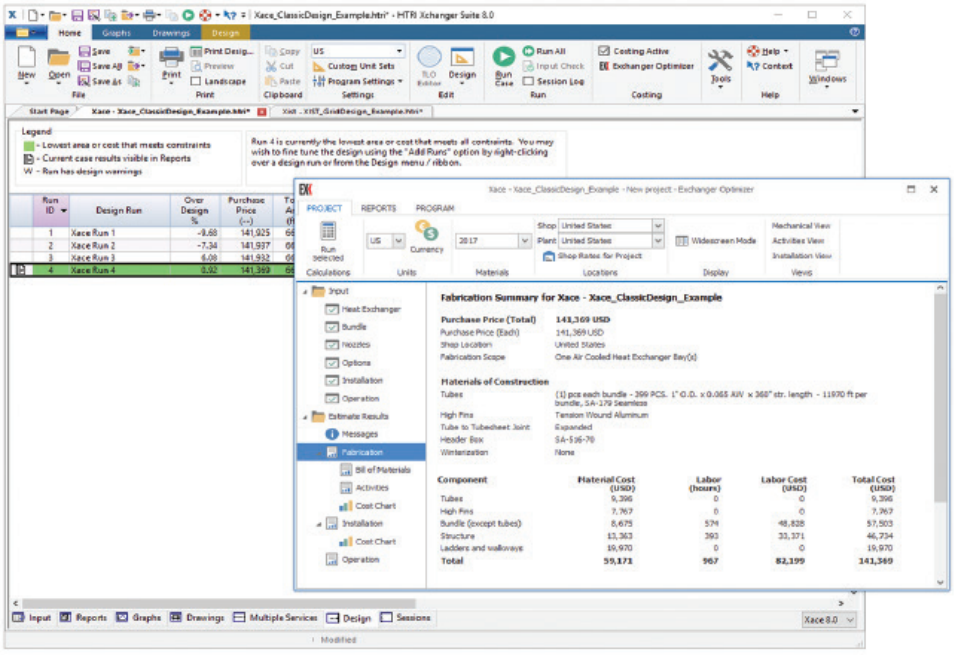


Figure 1. With a valid Exchanger Optimizer license, users can access the embedded costing features, including the Fabrication Summary, for *Xace* design cases

Incorporating changes based on our research is really important. It is also important to enhance the current capabilities that help end users streamline their work. Thus, the decision to integrate Exchanger Optimizer into ***X**changer Suite*.

Exchanger Optimizer is an innovative economic evaluation tool that allows engineers to find the best solution for their heat transfer systems. Previously, Exchanger Optimizer users could import and analyze cases from ***X**changer Suite* 7. However, when the cases changed in ***X**changer Suite*, users had to reimport them.

The power of Exchanger Optimizer 4.0 is now realized more fully with its integration into ***X**changer Suite* 8. With a separate, valid Exchanger Optimizer license, users can access the embedded costing feature, which provides fabrication, installation, and operational estimates for ***X**ist*® and ***X**ace*® cases (**Figure 1**). Costing reports (**Figure 2**) are also available with the other reports in the ***X**changer Suite* interface.

Users can view these reports within ***X**changer Suite* or launch Exchanger Optimizer from a toolbar button (**Figure 3**) to generate customizable, comprehensive cost assessments (**Figures 4 and 5**) and validate designs based on ASME code calculations.

To receive a free evaluation or to request more information, contact us today at htri@htri.net.

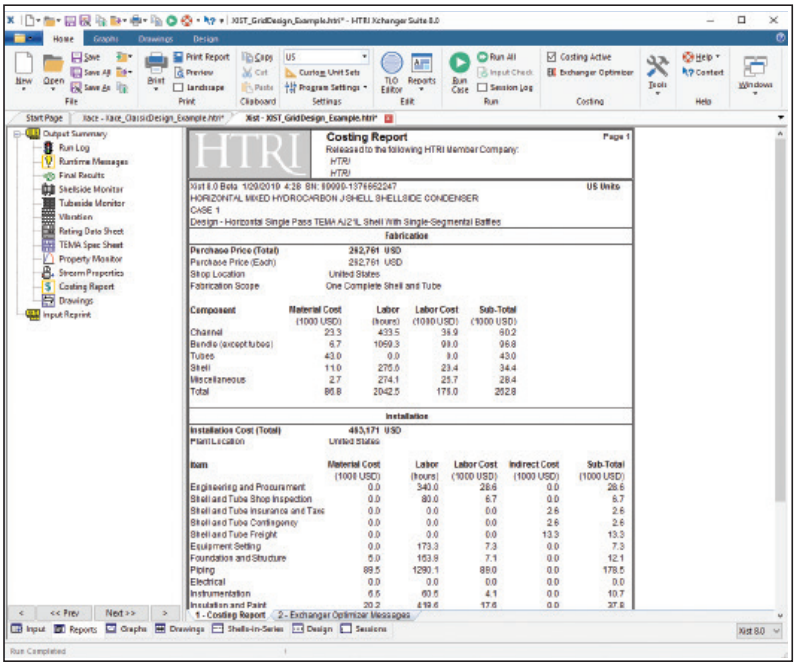


Figure 2. Available Costing Report for *Xist* from within *Xchanger Suite* 8

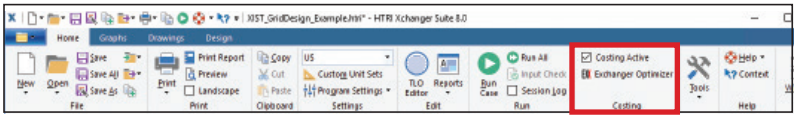


Figure 3. Users can launch Exchanger Optimizer from within *Xchanger Suite* 8

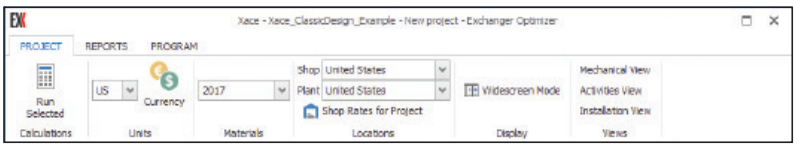


Figure 4. Exchanger Optimizer generates customized costing calculations, including locations where the equipment will be fabricated and installed

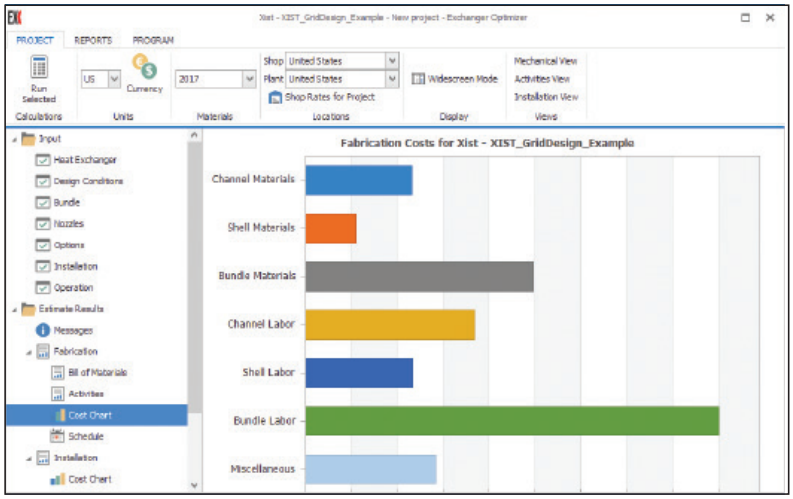


Figure 5. Detailed Cost Chart for shell-and-tube heat exchanger in Exchanger Optimizer

For more information about the Exchanger Optimizer integration into *Xchanger Suite* 8, access the HTRI webinar, *Embedded Costing Features in Xchanger Suite 8.* This webinar is available at www.htri.net/webinars and is free to HTRI members.

SIMULATING AIR-COOLER HEADER AND FAN PERFORMANCE Informs Physical Testing Plans

SALEM A. BOUHAIRIE
Senior Project Engineer, Research

Both tubeside and airside behavior affect the overall performance of an air cooler. Two concerns with air-cooled heat exchanger (ACHE) operation are two-phase process-side maldistribution in headers and misrated airside fan performance.

At HTRI's Research & Technology Center (RTC), we are developing plans to construct a header box for advanced tubeside analysis. In addition, we want to identify differences between the actual and rated air delivery of the Air-Cooled Unit (ACU) fan. Integral to these test plans are computational fluid dynamics (CFD) simulations, in concert with ***X**ace*® software and experimental tests at the RTC, to understand these two performance limitations.

Eventually, we can develop guidelines to help others resolve or troubleshoot these tubeside and airside issues.

CFD STUDY OF AIR-WATER HEADER BOX FLOW

ACHEs in the gas, oil, and power industries often process two-phase fluids. Two-phase maldistribution in headers negatively affects the output products and can cause tube pullout, as indicated in API 661 [1]. HTRI has completed three-dimensional CFD simulations of the hydraulics in the inlet header of an experimental air-water ACHE. **Figure 1** shows a CFD simulation of the vertical distribution of an air-water mixture in the tuberows. **Figure 2** provides insight on the lateral mixture distribution, which ***X**ace* does not report.

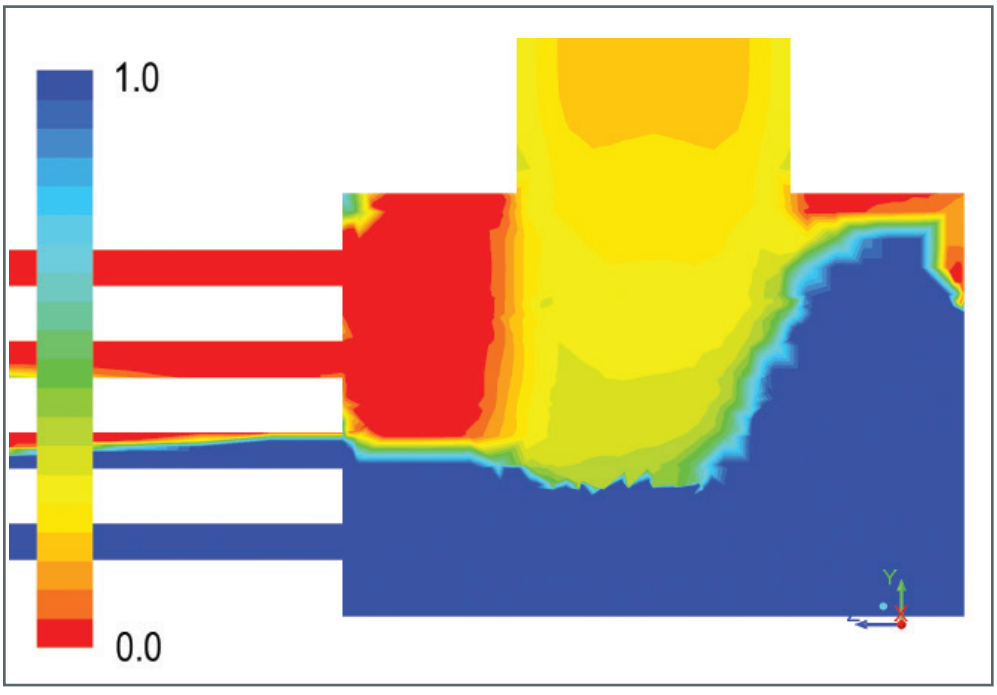


Figure 1. Contours of water volume fraction through four rows of single-pass ACHE inlet header

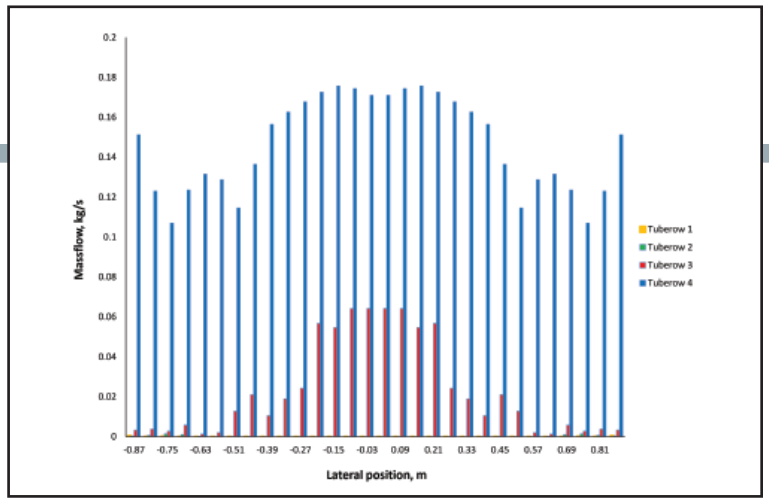


Figure 2. Lateral distribution of liquid in air-water mixture through four rows of single-pass ACHE inlet header

Figure 3. Fan installed in the ACU

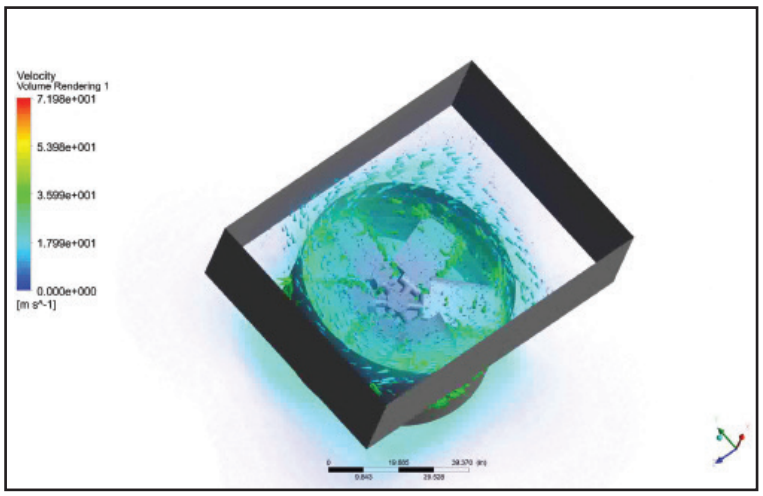


Figure 4. CFD simulation of the ACU fan with velocity vectors

Guided by these predictions, HTRI plans to design and build a scaled-down model of the header and tube bundle for adiabatic air-water testing in the Multipurpose Visualization Unit (MVU). With this approach, we can make recommendations for effective header design and later modify ***X**ace* to report a two-phase flow maldistribution parameter for the header [2].

CFD STUDY OF AIRSIDE FAN PERFORMANCE

Most ACHEs are heat transfer limited on the air side, making the fan the most important component because it affects tubeside product quality. Fan rating software can predict airside performance, but some end users have reported that actual fan operations differ significantly from rated predictions.

Fortunately, we can use CFD to analyze the performance of the ACU fan (**Figure 3**) and compare those CFD results with the fan vendor's rating. **Figure 4** shows a CFD simulation of the velocities generated in the ACU fan in a section of wind tunnel, built according to the ANSI/AMCA 210 [3] standard.

Carefully validated CFD simulations can reveal performance limitations in ACHE headers and fan output. Moreover, the results of these simulations allow HTRI to provide adjustment factors or warnings for ***X**ace* calculations of header maldistribution or fan flow.

To learn more about HTRI's CFD capabilities, email contracts@htri.net.

REFERENCES

1. *API STD 661: Petroleum, Petrochemical, and Natural Gas Industries—Air-cooled Heat Exchangers,* 7th ed., American Petroleum Institute, Washington, DC (2013).
2. M. Rezasoltani, Air-cooler header pressure drop and flow maldistribution, AC-18, Heat Transfer Research, Inc., Navasota, TX (2017).
3. *ANSI/AMCA 210-99: Laboratory Methods of Testing Fans for Aerodynamic Performance Rating*, Air Movement and Control Association International, Inc., Washington, DC (1999).

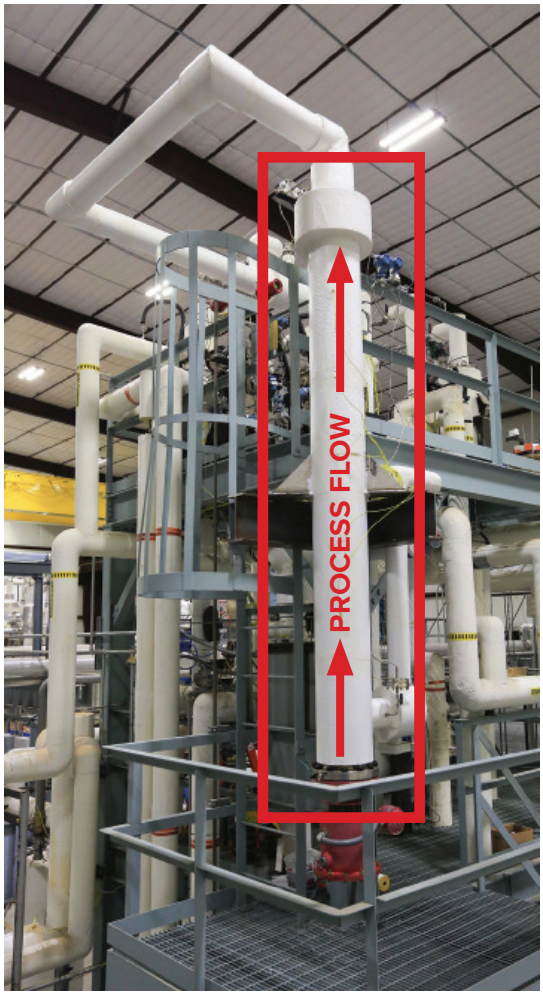


Figure 1. New heater on the LPCU

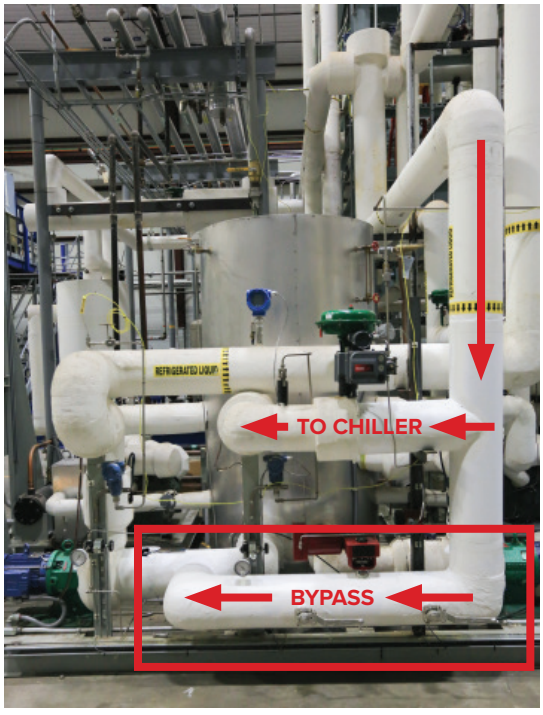


Figure 2. New bypass on the chiller loop

UPGRADES *to the* LOW PRESSURE CONDENSATION UNIT EXPAND ITS TESTING CAPABILITIES

The Low Pressure Condensation Unit (LPCU) was originally built to test low-pressure condensation using both single- and multi-component fluids (specifically hydrocarbons). Based on member interest, HTRI is expanding our research on low-pressure condensation to include water as the test fluid.

We modified the LPCU, adding a new heater and a new chiller bypass line, to enable effective testing of water, which has different physical properties (**outlined in Table 1**) than other test fluids. For example, water has a

- **higher latent heat of vaporization**
  If the same heating input is used, the maximum vapor flow to the test section is substantially reduced.
- **relatively higher freezing temperature**
  The maximum temperature in the cooling loop was -31.7 °C. The back-up condenser (used to help control process-side pressure) tended to freeze the water, making unit operation a challenge.

Table 1. Physical properties of water

Fluid	Pressure, kPa	Temperature freezing point, °C	Latent heat multiplier, water as basis
Pentane	6.89	-128.7	7
Heptane	6.89	-90.4	6
Octane	6.89	-56.6	7
Water	6.89	0	1

Shown in **Figure 1**, a new heater on the LPCU increases the heat input capacity, thereby increasing the achievable vapor flow rates to the test section.

The installation of a new chiller bypass line (**Figure 2**) widens the temperature range of the chiller loop supply, allowing for higher cooling loop temperatures. **Table 2** summarizes the LPCU's operational increases.

Table 2. LPCU capabilities before and after modifications

	Before modifications	After modifications
Heat capacity	0 – 16 kW	0 – 70 kW
Vapor flow rate, water	0 – 0.0068 kg/s	0 – 0.0136 kg/s
Vapor flow rate, hydrocarbon	0 – 0.0378 kg/s	0 – 0.0756 kg/s
Chiller loop supply temperature range	-45.5 to -23.3 °C	-45.5 to 32.2 °C

Additionally, updates to the control system logic enable faster stabilization times and secure the control of the unit. Overall, the unit modifications not only increased the testing capabilities for water but also improved the operations and capacities of the unit for any desired test fluid.

WORD SEARCH

RESEARCH & TECHNOLOGY CENTER

L I W A T E R F M M C Q A R O D G K B Z
F M E X C H A N G E R H S D L K M X H M
O L D U N P D Q D Q R A D Y F N A I X I
B X A C Q U I S I T I O N M O A M P Q F
R H A F N H T H E Q U I L I B R I U M F
P F G P T B U H Y J T W T M L G O T L K
C J T D Z N P J R D L A Q N O J N L Q K
R O T O C U A H Z A R G T Z Q T N S N K
V T N F E J N Y H B X O N S P L O B K B
Q E T D H F L Z I T Z A C B S U C B G G
X M B M E U G L I A F T K A V R V O S N
O P V I R N A B S E D A I P R S H I R I
H E P B E C S G K H A N N O G B L H C L
C R X R T P W A C R T X K Z J V O J M I
I A E O E D I Q T H A S C F V C H N E O
F T L V N S N P W I R V Q H R W H N P B
L U O Z Z V S L H V O U B L D Y Q G M X
O R A S H M V U E D P N Z E O A N V U R
W E D T T Y M R R J T I D D B M O K I K
D E G K W G T W U E H B T T Y K L V V D

CONDENSATION
BOILING
CALIBRATION
DATA
ACQUISITION
PRESSURE
TEMPERATURE
FLOW
FAN
PIPE
EQUILIBRIUM
HEAT
EXCHANGER
HYDROCARBON
WATER

See Solution on page 25

SmartPM™

Gaining traction in the marketplace

Since HTRI's acquisition of SmartPM in 2016, refining companies are increasingly adopting this software for both performance monitoring and predictive maintenance of shell-and-tube heat exchanger networks.

Close to thirty complex network models are now being used to optimize the performance of refinery heat exchanger networks that include crude oil preheat trains, vacuum distillation units, hydrotreaters, visbreakers, cokers, and fluid catalytic crackers. These digital-twin models use artificial intelligence (AI) techniques to predict future fouling performance and assist in operational decision making.

Engineers across the globe are using SmartPM in:

OPERATIONS/MANAGEMENT

- monitoring network performance
- quantifying emission reductions
- optimizing flow splits
- scheduling cleaning and allocating a cleaning budget
- maintaining record of crude slates and fouling trends to assist in future crude processing

ENGINEERING

- improving energy efficiency and productivity
- assessing impact of proprietary heat transfer technologies, including EMBaffle®, HELIXCHANGER®, and tube inserts
- retrofitting and revamping projects

RESEARCH

- bridging research and refinery fouling behavior
- developing, testing, and applying dynamic fouling models

With SmartPM, users create digital-twin models of their heat exchanger networks, which mirror the operation by linking the model to the data historian. The software can then make predictions regarding the future performance of the heat exchangers and generate cleaning schedules to minimize energy use, maximize throughput, and lower CO_2 emissions. SmartPM also allows users to look at possible revamp options for improved fouling performance, such as altering heat exchanger designs or reconfiguring network structure.

Companies typically license SmartPM for in-house use and often combine this with a service contract that allows access to HTRI expertise.

Contact SmartPM@htri.net for a free quote or to request more information.

SmartPM is helping refineries: ***better understand the operation of their network*** + ***clean exchangers for the greatest benefit*** + ***achieve significant savings***

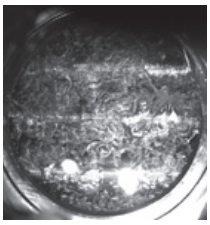
PROPRIETARY TESTING AND RESEARCH

THOMAS LESTINA
Senior Vice President,
Engineering

Figure 1. **Welded plate heat exchanger provided by Hisaka Works, Ltd. (single-phase, boiling, and condensing tests)**

Figure 2. **Plate-and-shell heat exchanger provided by Vahterus Oy (single-phase and boiling tests)**

Figure 3. **Shell-and-plate heat exchanger provided by Tranter, Inc. (single-phase and boiling tests)**



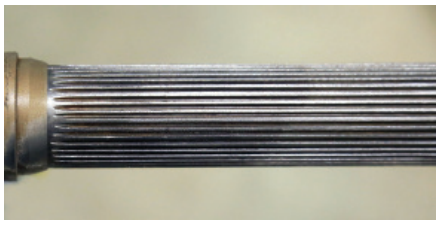


Figure 4. **(left) Double-enhanced boiling tube provided by Neotiss, Inc. (boiling OD and condensing ID tests, methods for *Xist*®)**

Figure 5. **(right) Double-enhanced tube provided by Beijing Groundsun Technology Co., Ltd. (boiling ID and condensing OD tests)**

HTRI members can participate in research projects in a number of ways. Over the past several years, members have donated heat exchangers, purchased test sections, funded test data collection, and collaborated on the development of heat transfer and pressure drop methods. Sponsoring research is a great way for companies to highlight new heat transfer technology, gain acceptance of proprietary commercial products, validate performance claims with HTRI testing, and facilitate implementation in HTRI software. Each of these projects is customized, and the activities are performed under contract.

If you are interested in participating in HTRI research, email contracts@htri.net.

DAVID OAKLEY
Principal Engineer,
Software Development

Xfh® *Ultra* 2.0

Xfh® *Ultra* 2.0 offers improved calculation for refinery fired heaters

In the upcoming release of ***Xfh** Ultra*, HTRI has focused on providing a more complete calculation tool for fired heaters in refineries. For example, Version 2.0 can handle multiple dissimilar fireboxes with shared convection section and stack. In addition, users can specify transfer lines and crossovers, the unheated pipework that is an integral part of any fired heater. The calculation for the convection section was extended to allow users to specify the presence of corbels, if any, and the duct size. Other improvements to the user interface include a new flowsheet-style configuration diagram (**Figure 1**) and 3D diagrams of the firebox and radiant coils (**Figures 2 and 3**).

Version 2.0 provides significant improvements for vacuum heaters and multi-firebox units, such as reformer interstage heaters.

STEAM INJECTION

This is an important consideration in most vacuum heaters. ***Xfh** Ultra* evaluates the impact on the vaporization and temperature of the process stream at as many steam injection points as required.

TRANSFER LINES

In vacuum heaters, the pipework on the outlet side is considered integral to heater design, because pressures are generally controlled in the flash zone of the vacuum column. Treatment of low-pressure tubeside flows includes an assessment of the approach to sonic velocity.

MULTIPLE FIREBOX ARRANGEMENTS

These heaters typically consist of three or four fireboxes, each with different process conditions and duties. The flue gas exiting the fireboxes is then combined before entering a shared convection section. ***Xfh** Ultra* 2.0 allows users to quickly set up these configurations in the new heater configuration diagram (see **Figure 1**), and calculations may be performed using either specified fuel flows or process duties in each individual firebox. The software also allows the introduction of a flue gas mixer unit for more complex flue gas arrangements, such as multiple fired heaters sharing a common stack, supplementary heating, and air ingress.

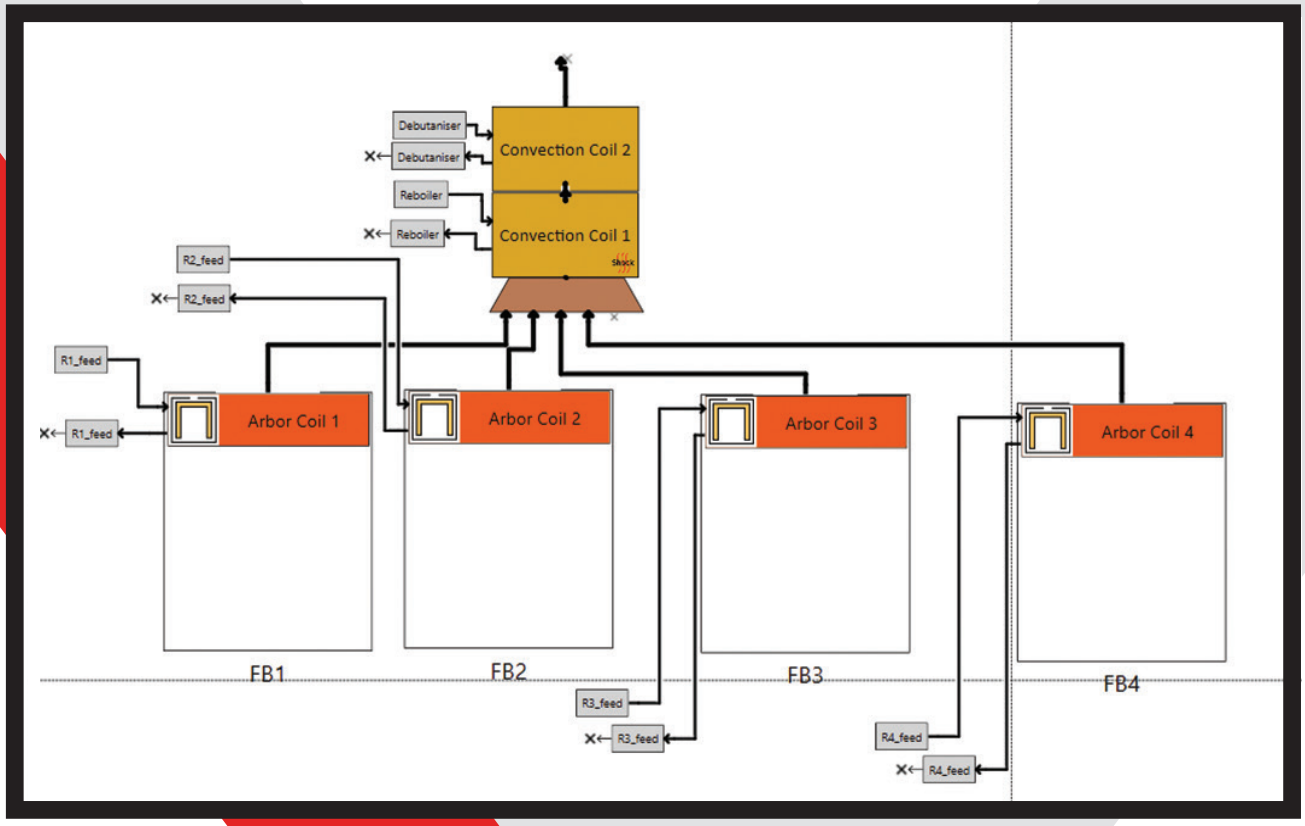


Figure 1. Configuration diagram with multiple firebox arrangement

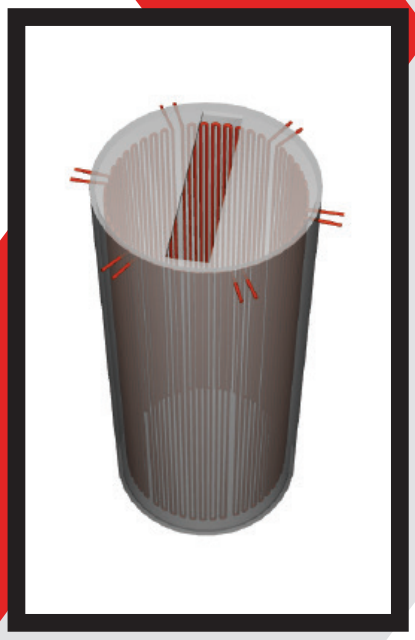


Figure 2. Cylindrical firebox

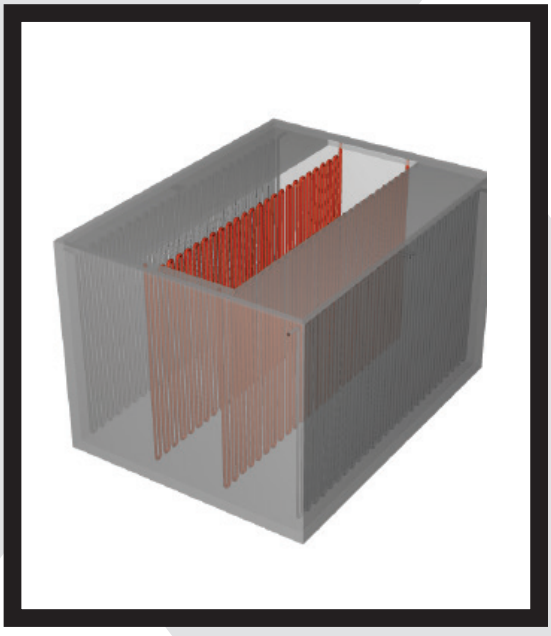


Figure 3. Box firebox with central tubes

For more information, view *Xfh Ultra* 2.0 on our website.

We offer a wide range of research and testing services for process heat transfer and fouling, as well as consulting and customized software solutions.

TESTING
Research and testing is performed at our multimillion-dollar Research & Technology Center (RTC) in Navasota, Texas, USA. With eleven operating research units, the RTC provides a controlled environment to evaluate the performance of heat exchangers and enhanced heat transfer surfaces, measure the fouling potential of crude oil and petroleum products, study process phenomena, and more.

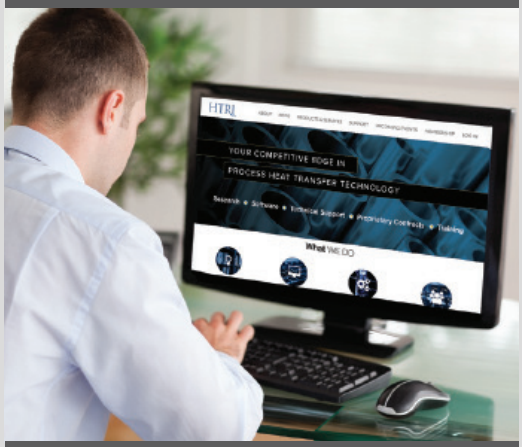
CONSULTING
Experts review thermal designs, perform air-cooler studies, troubleshoot heat exchangers, and help with managing refinery maintenance and operation. Our knowledgeable staff use a variety of tools, including computational fluid dynamics (CFD), laser anemometry, high-speed visualization, ***X**changer Suite*®, SmartPM™, Exchanger Optimizer™, and Edgeview®.

CUSTOM SOFTWARE SOLUTIONS
We can implement an interface to exchange data between your software and any HTRI software, such as ***X**changer Suite* and SmartPM. This facilitates performance analysis of process heat exchangers using your proprietary heat transfer devices or equipment in combination with HTRI methods.

PROPRIETARY CONTRACTS

HTRI® SERVICES

SUPPORT



HTRI's Technical Support staff is dedicated to providing timely and accurate answers to member questions about HTRI technology and software (e.g., ***X**changer Suite*). Our experienced team consists of staff from around the globe. They can help you use our software, interpret HTRI reports and software methods, and troubleshoot installation.

Technical support is available to all members. Email support@htri.net with any questions or issues you may have. You will receive prompt assistance.

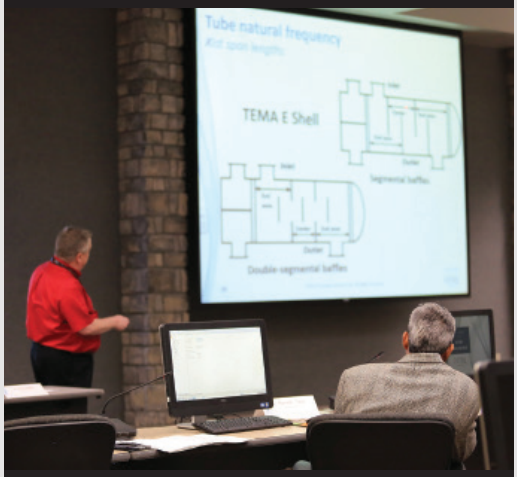
For more information, read the *Technical Support* article on page 16.

Each year, HTRI trains more than a thousand end users worldwide through online or face-to-face interactions. We provide the most comprehensive training program for heat exchanger technology and its application in industry.

Live and recorded webinars are available on the HTRI website and are free of charge to HTRI members. *Getting Started* webinars, presented by HTRI engineers, walk you through the steps of building and running your first case in various ***X****changer Suite* modules. Tutorials are more focused, providing short "how to" guides on specific software functionality.

The HTRI Heat Transfer Academy is a collection of heat transfer content specifically developed for engineering educators, students, and working engineers. HTRI membership is not required, and the academy is suitable for all skill and experience levels.

Short courses and workshops are offered regionally throughout the year; visit www.htri.net/events for a list of upcoming events. Onsite training is also available upon request.



TRAINING

For more than half a century, HTRI has conducted applied research in heat transfer and fluid flow technology for the design and simulation of process heat transfer equipment. From the collected data, HTRI has developed reliable heat transfer and pressure drop methods, providing this expertise to customers through a definitive *Design Manual*, advanced software technology, technical reports, and a variety of services.

MEMBERSHIP SERVICES

We have a dedicated team that interacts with and supports HTRI member companies in daily tasks, including

- facilitating license renewals and communicating with members to ensure continuous access to HTRI products
- distributing licenses and instructions for software downloads
- verifying users and prospects that register to access content on the HTRI website
- updating information with regard to changes in member companies (e.g., address, phone number, end user)

DEMYSTIFYING THERMOSIPHON OPERATION

SIDDHARTH TALAPATRA
Group Lead, Research

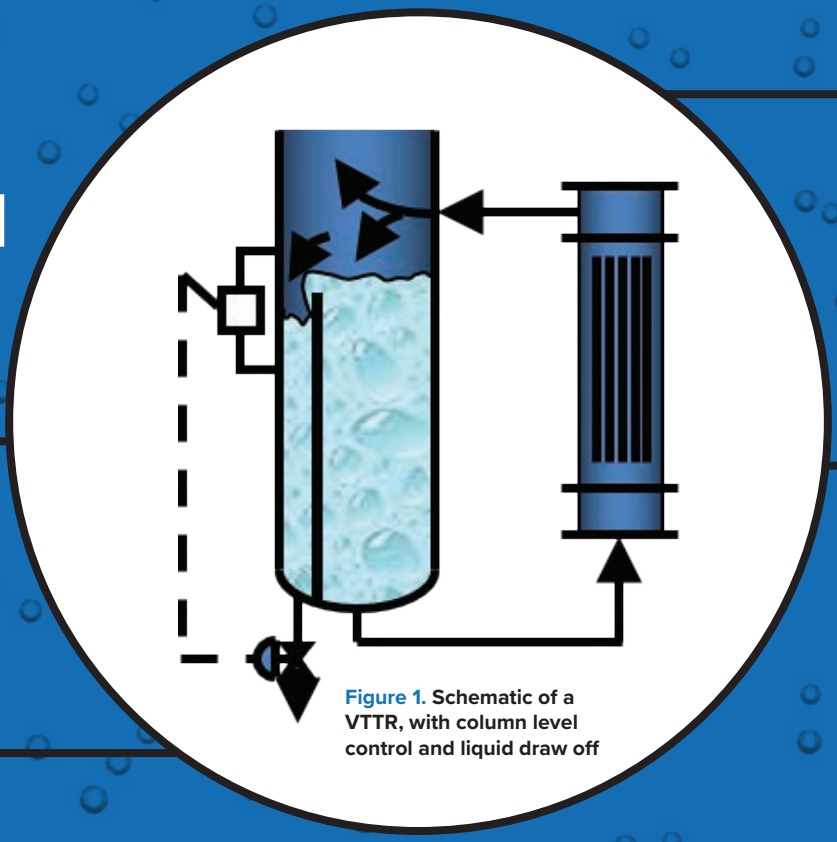


Figure 1. Schematic of a VTTR, with column level control and liquid draw off

Engineers focused on the thermal and hydraulic aspects of heat exchangers sometimes forget that exchangers do not operate as standalone units. A thermosiphon reboiler is one application where understanding the flow loop around the heat exchanger is vital.

Essential to refineries and chemical processing plants, a thermosiphon reboiler operates by natural circulation—there is no external pumping source. **Figure 1** shows a vertical tubeside thermosiphon reboiler (VTTR). In this sketch, a column of liquid drives the flow through the inlet piping, the reboiler, and the outlet piping back into the column based on the density difference between the single-phase fluid in the column and the two-phase fluid in the reboiler and outlet piping. Strongly coupled thermal-hydraulic performance makes operation and prediction of such units difficult. Poorly performing thermosiphon reboilers remain a challenging problem for the process industry, costing millions of dollars in lost production.

Different configurations of thermosiphon reboilers are possible. Our recent research efforts have focused on VTTRs. There are three main operational concerns with VTTR that are not encountered with other exchanger operations.

1 STARTUP: Because boiling the fluid in the reboiler is needed to start the circulation, and effective boiling is only possible once circulation is established, we are left with a chicken-and-egg problem. From our operational experience of running a VTTR at HTRI, the following are some guidelines to help establish circulation.

- Slowly heat up the unit to avoid thermal shocks. A high mean temperature difference (MTD) does not help speed up startup when circulation has not been established.
- After some limited pool boiling has started, pull a vacuum on the overhead condenser vent (if possible). This may help kick-start the unit.
- Starting with a high liquid column height makes it easier to establish circulation.

2 INSTABILITIES: There are several instability mechanisms attributed to VTTRs. Our research has indicated that Ledinegg instability (or flow incursion) is unlikely in a VTTR. Bouré instability (also called *density wave oscillations*) is the most common mechanism responsible for oscillatory behavior. Installing a valve in the inlet piping can help resolve this issue at the operational stage. Predictive methods are far from accurate, and HTRI is actively working on improving them.

A column of liquid drives the flow through the inlet piping, the reboiler, and the outlet piping back into the column based on the density difference between the single-phase fluid in the column and the two-phase fluid in the reboiler and outlet piping.

3 TURNDOWN LIMITS: HTRI is collecting data to understand how far a VTTR can be turned down before liquid recirculation stops. Preliminary analysis indicates that all available criteria to predict the onset of shutdown are inadequate. Several interesting trends have been observed.

- For some pure fluids, maintaining a sufficient MTD for the onset of nucleate boiling prevents unit shutdown.
- For other pure fluids, normal operation requires a minimum heat flux, below which the unit transitions to a pool-boiling mode.
- For a wide boiling range (40 – 55 °C) binary mixture, rapid shutdown may occur below a threshold heat flux, which is a strong function of the column height to tube length ratio and a weak function of the two-phase density ratio.

HTRI is planning to publish multiple reports on VTTR operation in fiscal year 2019. We hope our improved guidelines and methods will help demystify the challenging tasks of designing, operating, and troubleshooting thermosiphon reboilers.

Create an HTRI Account Today

You can learn about the many benefits to being an HTRI member by visiting our website. The website provides a central location for news and notifications about upcoming events, research, future products, and more.

It's the "more" that matters most. Logging in with an HTRI Account opens up a greater level of content.

FOR EVERYONE

If your company is not a member of the HTRI consortium, creating an optional HTRI Account lets you subscribe to the HTRI newsletter and sign up for free educational webinars. You can also access the HTRI Heat Transfer Academy, a collection of heat transfer content specifically developed for engineering educators, students, and working engineers.

FOR EMPLOYEES OF MEMBER COMPANIES

If your company is a member of the HTRI consortium, you may have access to HTRI software products like ***X**changer Suite*® and their extensive user documentation. What you may not know, though, is that the HTRI website offers much more.

Every individual who works at an HTRI member company can (and should) create an HTRI Account. You can then log in and access all the technical information that your company's membership level allows.

When you log in to the HTRI website, you can

- obtain personalized help via a Technical Support inquiry – our Technical Support group includes engineers with years of experience to help with your request
- register for training courses and use your Profile to view your registration history, retrieve certificates, and print invoices
- view articles in the Knowledge Base that offer additional guidance in using our software
- download software
- play back webinar recordings and view tutorials
- view technical plans that guide our annual operations

Benefit from the "more" HTRI can provide you.

Sign up for an HTRI Account today!

TECHNICAL SUPPORT

LAUREN MORAN, Manager, Technical Support
ASHLEY SIMMONS, Engineer, Technical Support

HTRI's Technical Support staff is dedicated to providing timely and accurate answers to member questions about ***X**changer Suite*® and other HTRI technology. Our daily immersion in HTRI products allows us to maintain a thorough knowledge of our research and software. This knowledge, along with broad experience in the process industry, ensures that members receive "best-in-class" advice.

Technical Support is a user's ultimate resource, and we respond to every inquiry within three business days. We are able to assist with explaining program inputs, interpreting outputs, clarifying warning messages, and discussing the impacts of service packs and software updates. We also keep track of possible program bugs and suggested improvements that come from support cases. **Figure 1** shows the monthly distribution of support inquiries for fiscal year (FY) 2018, where we averaged 263 inquiries per month.

All of the Technical Support staff perform additional duties at HTRI, which further broaden our expertise. Support personnel conduct training events, complete contract work, and perform software QA tasks. We also manage the online help documents and prioritize what errors to fix and what new features or methods to include in future software releases. Our close relations with other HTRI staff (software developers, researchers, and subject matter experts) mean we can call on the knowledge and experience of the entire HTRI organization to cultivate the best possible answers to member inquiries.

Meet the **SUPPORT GROUP**

LAUREN MORAN
Manager, Technical Support

LOCATION: USA

ANDY MOUNTFORD
Senior Consulting Engineer, Technical Services & Sales

LOCATION: SPAIN

PETER JOOSTEN
Senior Consulting Engineer & Regional Sales Manager, Australia/Oceania

LOCATION: AUSTRALIA

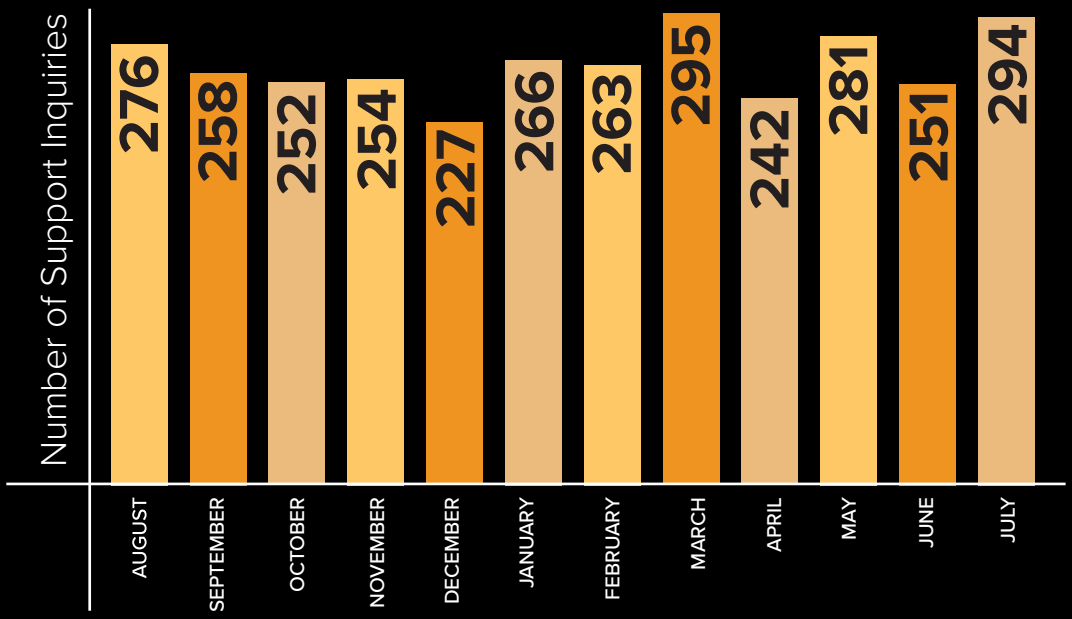


Figure 1.
Monthly distribution of support inquiries for FY 2018

Technical Support also plays an integral part in the Research to Software process, as we represent the members' point of view to sort and prioritize implementation of methods and software fixes. Member inquiries to Support are a prolific source of software feedback. A single support inquiry can spark an investigation, leading to a new research project, a new method, a new software feature, or something else. In fact, member inquiries led us to include 20 new or improved methods in ***X****changer Suite* 8.

Technical support is available to all members. To raise a support ticket, email support@htri.net; be sure to include your corporate affiliation to avoid response delays. Remember that we are here to help you get the most out of your HTRI membership, so please do not hesitate to contact us.

DAVID FRANKUM
Senior Engineer, Technical Support

LOCATION: UK

MICHAEL GARRETT
Senior Software Support Specialist

LOCATION: USA

ASHLEY SIMMONS
Engineer, Technical Support

LOCATION: USA

THOMAS LESTINA
Senior Vice President, Engineering

LOCATION: USA

HTRI's 2018 Global Conference & Annual Meeting of Stockholders

Both HTRI staff and members share their knowledge with attendees throughout the conference. Shown at the podium: (left) Alex McRae, *Technip Stone & Webster Process Technology, Inc. (Boston),* and (right) Himanshu Joshi, *Shell Global Solutions (US) Inc.*

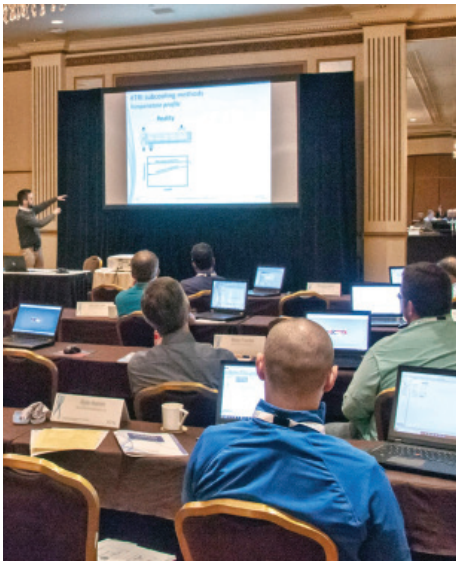
The 2018 Global Conference & Annual Meeting of Stockholders took place September 17 – 20 at The Pfister Hotel in Milwaukee, Wisconsin, USA. Attendees participated in

- informative presentations and poster sessions detailing ongoing research initiatives
- software demonstrations, including previews of upcoming releases
- interactive roundtable discussions
- insightful panel sessions, featuring topics on cooling water fouling and condenser design
- networking opportunities

Each year the conference offers a unique opportunity to learn about new HTRI research and products, exchange ideas about process heat transfer technology, and participate in optional training. HTRI's 2018 Global Conference was no exception!

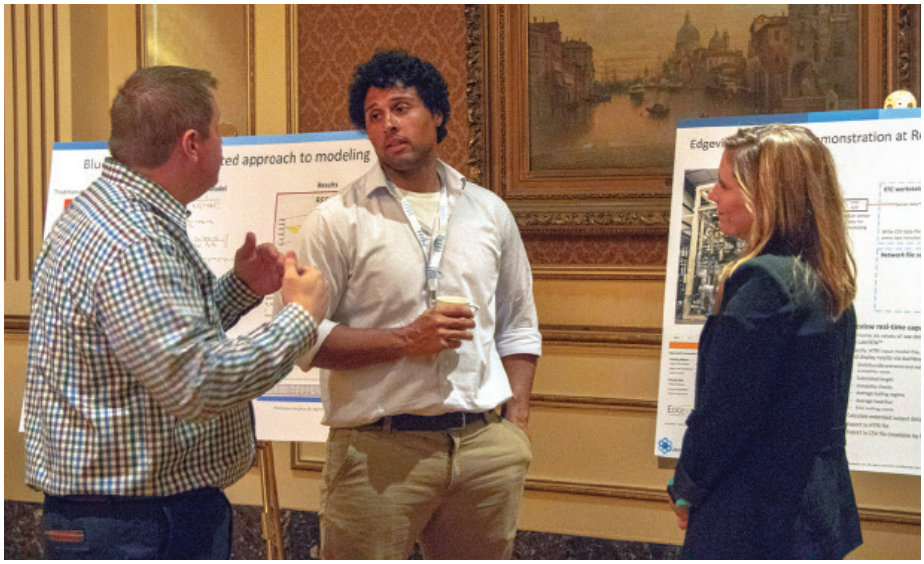
Attendees are given a sneak peek at upcoming software releases.

Attendees receive a warm welcome from Ivan Olson, *Chair, HTRI Board of Directors*.



Our training provides you valuable insights into our technology and use of our software.

HTRI technical presentations focus on new research and software, which help you gain the full value of your membership.



Poster sessions are the perfect opportunity for staff and attendees to share insights, gaining in-depth knowledge of HTRI technology.

HTRI®
2019 GLOBAL CONFERENCE
& ANNUAL MEETING OF STOCKHOLDERS
SEPTEMBER 16 - 19 | PORTLAND, OREGON, USA

Join us at the Hilton Portland Downtown for two days of presentations, demonstrations, and poster sessions on September 16 and 17. Stay two additional days to gain the value of our excellent training.

REGISTRATION OPENS
May 2019
at www.htri.net.

BE SURE TO REGISTER BEFORE
JULY 25, 2019 TO RECEIVE A
10% DISCOUNT.

A block of rooms has been secured for September 13 – 20, 2019. Room rates will start at $204 (plus tax) per night. Reservations will be available until August 26, 2019 or until the reserved block fills.

The Hilton Portland Downtown is conveniently located just ten miles from the Portland International Airport (PDX), which offers 15 airlines with nonstop service to more than 50 cities. A variety of dining, entertainment, and attractions are just a short MAX light rail ride away.

FY 2019 Board of Directors and Technical Committee

BOARD OF DIRECTORS

Ivan M. Olson, *Chair*
Independent Director

Paul D. Harte, *Vice Chair*
North West Redwater Partnership

Sam E. Chapple
Hudson Products Corporation

George A. Denavit
Independent Director

Michael J. Holtz
Joseph Oat Corporation

Peter J. Redman
Independent Director

Snezana Velimirovic
Chemetics Inc.

TECHNICAL COMMITTEE

Richard P. Casebolt, *Chair*
ExxonMobil Research and Engineering Company

Ray E. Tucker, *Vice Chair*
UOP LLC

Christian Andersson
Alfa Laval Lund AB

Ray G. Broussard
INVISTA S.à r.l

Edwin M. van Doorn
Fluor B.V.

Les Jackowski
Chevron Energy Technology Company

Himanshu Joshi
Shell Global Solutions (US) Inc.

Thomas Lang
Wieland-Werke AG

Richard J. Lorenzo-Arocho
Eastman Chemical Company

Alex McRae
Technip Stone & Webster Process Technology, Inc. (Boston)

John Michelin
Exchanger Industries Limited

Mohan V. Punganur
The Dow Chemical Company

Carolyn E. Schmit
BP Products North America Inc.

M. Venkatesh
Larsen & Toubro Limited

HTRI Welcomes New Member to the Technical Committee

Christian Andersson, Alfa Laval Lund AB, Process Engineer, Oil & Gas Technology, Lund, Sweden. Andersson has ten years of experience in process engineering. As a process and application specialist, he is responsible for the design of compact heat exchangers for two-phase applications, development of new heat exchanger technologies, and solving process-related heat exchanger issues, including failures and under-performance. Andersson provides technical support to sales engineers, business managers, and product centers, with thermodynamics, process control, P&ID review, and heat exchanger design. He is also involved in the training of sales engineers, business managers, and product centers in Oil & Gas applications, shell and tube heat exchanger design, two-phase flow and heat transfer, and compact heat exchanger design. Andersson has been an active participant in HTRI conferences and training events for many years. MS, Chemical Engineering, Luleå University of Technology, Luleå, Sweden. Licentiate of Engineering, Bioprocess Engineering, Luleå University of Technology. PhD, Bioprocess Engineering, Luleå University of Technology.

Our thanks to . . .

Steven Barnett
HTRI Technical Committee: 2014 – 2018

Toshiaki Momoki
HTRI Technical Committee: 2016 – 2018

T. Michael O'Connor
HTRI Board of Directors: 2004 – 2018
Vice Chair: 2014 – 2018

Weiming Zhu
HTRI Technical Committee: 2012 – 2018

IDENTIFYING THE LIMITS OF EXCHANGER DESIGNS:

HTRI Research to Software Initiative

LAUREN MORAN
Manager,
Technical Support

PATRICK REDMILL
Group Lead,
Engineering Software
Development

HTRI plays an influential role in the heat transfer community, due in large part to the impact of our software.

The targeted users of our earliest software were typically experts who were familiar with the strict limitations of HTRI software and did not look for a polished software product. More recently, our software is created for users with different experience levels and backgrounds (from engineering novices to heat transfer experts) and helps users identify the boundaries of good exchanger design.

Early in our history, HTRI engineers often performed both the research and the software development tasks necessary to bring our software products to market.

As the target user-base expanded, HTRI software applications grew in functionality, usability, and complexity. This growth eventually required that some HTRI engineers focus solely on research activities and others on software development activities. This separation of responsibilities may have been efficient, but it may also have been counterproductive to the naturally symbiotic relationship between HTRI research (the knowledge we seek) and HTRI software (the application of that knowledge).

The introduction of these distinct HTRI technical departments suggested the need for a formalized collaboration process.

In 2017, the *HTRI Research to Software Initiative* was implemented to improve communication between research and software engineers. It established a process designed initially to incorporate as many high-impact HTRI methods into ***X****changer Suite*® 8 as possible, including thorough vetting of all methods to ensure their appropriateness.

The process consists of the following phases:

1. A committee of researchers and software developers, with assistance from HTRI Technical Support staff, identify high-impact methods and add them to a list of potential candidates for inclusion in a software product.
2. The committee considers the relative priority of each method and the feasibility of its implementation.
3. Upon assignment of a method, an HTRI engineer produces an implementation document that explains the impact of the method and provides implementation details for an HTRI software developer.
4. A software developer provisionally implements the method into the software product, runs tests with the modifications against HTRI's large database of cases, and adds results to the implementation document.
5. A third party on the Research to Software committee reviews the implementation document, with test results, and advises the committee.
6. The committee either approves, declines, or sends the implementation document back to the appropriate researcher or software developer for more testing.

Having representatives from Software, Research, and Technical Support groups on the committee helps ensure that our software is faithful to the research methods and offers direct benefits to users.

The results of the *HTRI Research to Software Initiative* speak for themselves. Our latest software releases demonstrate our increased focus on user interface development, as well as our concentrated efforts to incorporate more generalized correlations while actively identifying their limitations. ***X****changer Suite* 8 includes 20 new or improved methods. The implementation documents developed for methods in this software version will continue to inform HTRI engineers in the years (and versions) to come.

The thorough testing of each method should translate to enhanced user confidence in using the methods to extend the boundaries of exchanger design.

CASE STUDY

REDUCING SHELLSIDE MALDISTRIBUTION IN A CONDENSER

SUMMARY

An engineering, procurement, and construction company asked HTRI to investigate methods—constrained by permissible pressure drop—to mitigate shellside flow maldistribution for an X-shell condenser (as shown in Figure 1), using cold seawater on the tube side to condense an off-gas on the shell side.

CHALLENGE

- Determine optimal geometric design modifications that minimize maldistribution and potential structural damage
- Assess the potential maldistribution in a modified X-shell condenser

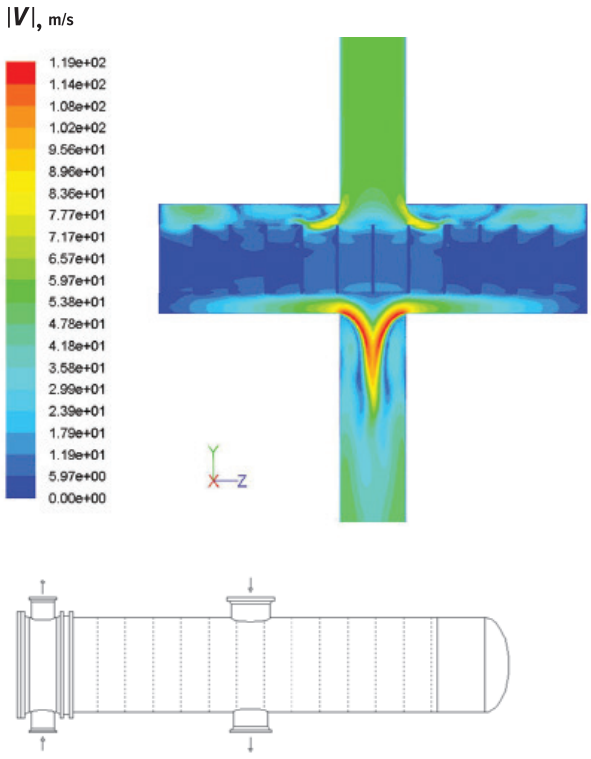


Figure 1. Uneven velocity distribution in the original X-shell condenser as the flow passes through the baffles across the exchanger. Flow enters from a single nozzle at the top and exits at the bottom. The central crosspasses have more than twice as much flow as others.

TECHNICAL APPROACH

To determine the optimal geometric design modifications, HTRI used ANSYS FLUENT® to develop CFD simulations to

- determine the vapor flow distribution above the bundle of the X shell prior to condensation
- quantify the uniformity of flow through the 12 crosspasses of the client's exchanger
- evaluate the effect of adding different numbers and sizes of nozzles, as well as a distributor plate

The client supplied ***X****ist*® ratings that were used to calibrate the CFD pressure drop model. The ***X****ist* calculations of pressure drop across the tube bundle enabled the substitution of porous media in the simulations. CFD models developed from the ***X****ist* analysis provided reliable prediction of other flow conditions.

HTRI modeled a symmetric half of the exchanger along a longitudinal, diametrical-cut plane through the X-shell cross-section. This approach reduced the computational effort through the exchanger model domain while maintaining good solution accuracy. A Reynolds-averaged Navier-Stokes solver was applied, which employed a k-omega Shear Stress Transport (SST) turbulence model. Second-order accurate discretization schemes were used for momentum and mass continuity equations.

This setup provided pressure and flow distribution data throughout the domain. The information was used to modify the mechanical design of the nozzles and distributor plate, as well as to predict the erosion and vibration potential of the first row of tubes.

Visit www.htri.net to access additional case studies.

RESULTS

From the CFD simulation of the baseline geometry and conditions (listed in Table 1), HTRI determined that the central crosspasses of the X shell had more than twice as much flow as others. Additional simulations were run using

- a single nozzle with an added distributor plate of various lengths, as well as different pressure loss coefficients
- two inlet nozzles (fed from a distribution manifold with a distributor plate)

Centering a 3.0-m long distributor plate with discretely variable porosity beneath the inlet nozzle improved the distribution so that the flow rates between the crosspasses differed by only 16%. Adding a distributor plate along the entire length of the bundle provided essentially uniform flow to the entire bundle.

As shown in Figure 2, placing two 1.1-m diameter inlet nozzles, with inflow from a 1.6-m diameter distribution manifold, indicated a level of maldistribution only slightly better than the baseline case with a single inlet nozzle. Again, adding a distributor plate with discretely variable porosity along the entire length of the bundle provided essentially uniform flow to the bundle.

Contact us for more information at contracts@htri.net.

Table 1. Baseline geometry and conditions for X-shell condenser

Length	9.1 m
Diameter	2.4 m
Crosspasses	12
Support plates	11
Tubeside fluid	Cold seawater
Shellside fluid	Off-gas
Total shellside inlet mass flow rate	12.6 kg/s
Inlet temperature	61.7 °C
Inlet nozzle	One 1.5-m diameter
Distributor plate	None

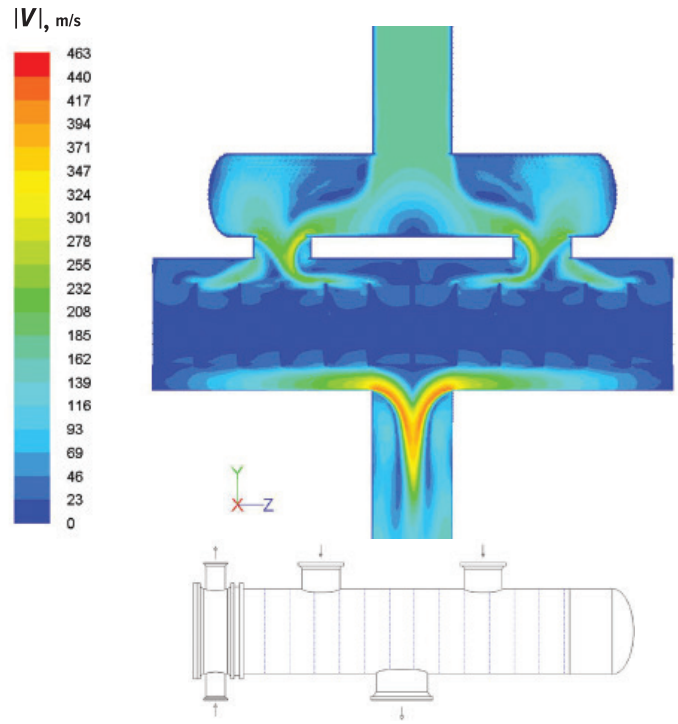


Figure 2. The same X-shell condenser with two inlet nozzles. As shown, the flow distribution improved due to an additional distribution plate along the entire bundle length.

HTRI® Upcoming Events

Training

HTRI Training – Japan
June 25 – 27, 2019
World Business Garden
Chiba, Japan

HTRI Training – China
October 22 – 25, 2019
Hilton Xi'an
Xi'an, China

HTRI Training – Europe
November 5 – 7, 2019
Park Hotel Amsterdam
Amsterdam, The Netherlands

Conferences

2019 Heat Exchanger Fouling & Cleaning Conference
June 2 – 7, 2019
Holiday Inn Warsaw • Józefów, Poland

2019 Global Conference & Annual Meeting of Stockholders
September 16 – 19, 2019
Hilton Portland Downtown • Portland, Oregon, USA

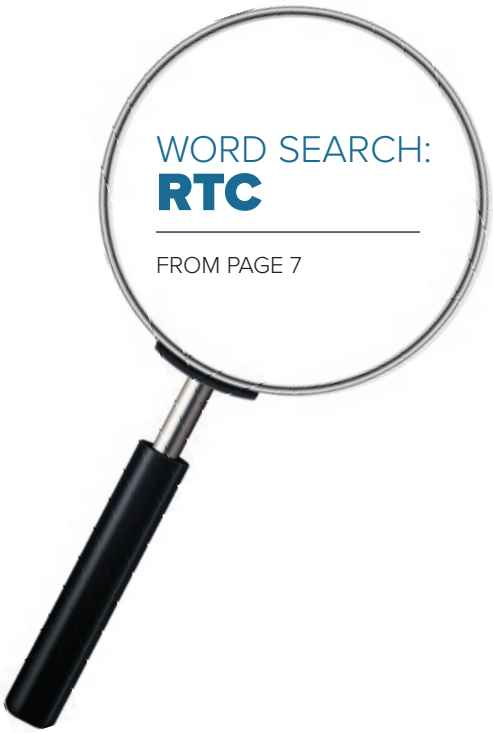
2020 Global Conference & Annual Meeting of Stockholders
September 21 – 24, 2020
Four Seasons Hotel Baltimore • Baltimore, Maryland, USA

2021 Global Conference & Annual Meeting of Stockholders
September 20 – 23, 2021
Four Seasons Hotel Denver • Denver, Colorado, USA

2022 Global Conference & Annual Meeting of Stockholders
September 19 – 22, 2022
The Langham Huntington, Pasadena • Pasadena, California, USA

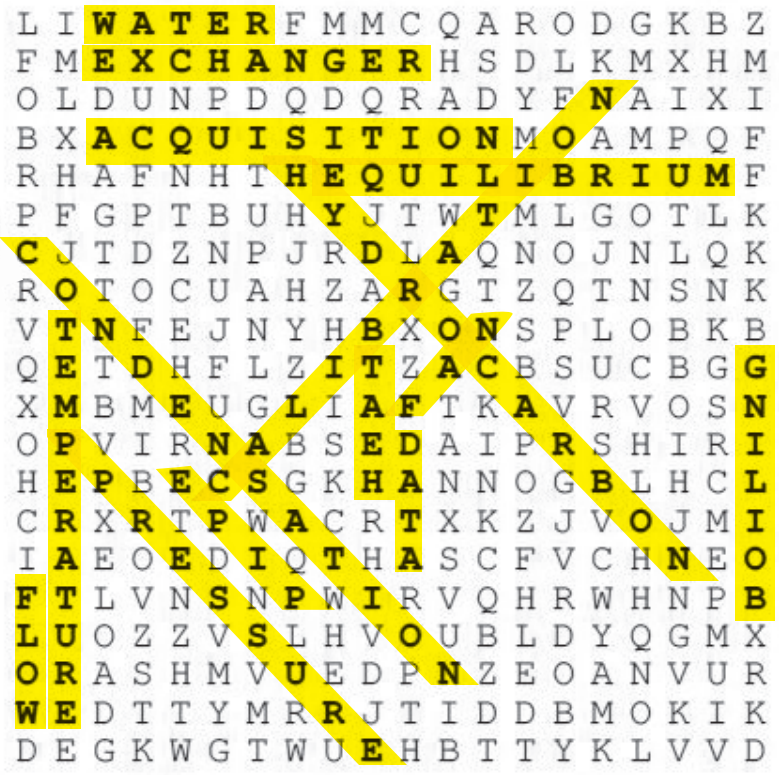
For more information and schedule updates, visit www.htri.net/events.

SOLUTION



WORD SEARCH:
RTC

FROM PAGE 7



DON'T MISS

HTRI's 2019 Global Conference & Annual Meeting of Stockholders!

September 16 – 19, 2019

Hilton Portland Downtown • Portland, Oregon, USA

Contact HTRI

CORPORATE HEADQUARTERS

HTRI

P.O. Box 1390

Navasota, TX 77868

USA

To subscribe to *The Exchanger*, log in to www.htri.net and modify your subscription in your user profile.

To change the mailing address of an existing subscription, contact membership@htri.net.

www.htri.net

www.linkedin.com/company/htri

www.twitter.com/heattransfer

www.facebook.com/htri.net

HTRI®

Heat Transfer Research, Inc.

THE EXCHANGER

2019 ISSUE