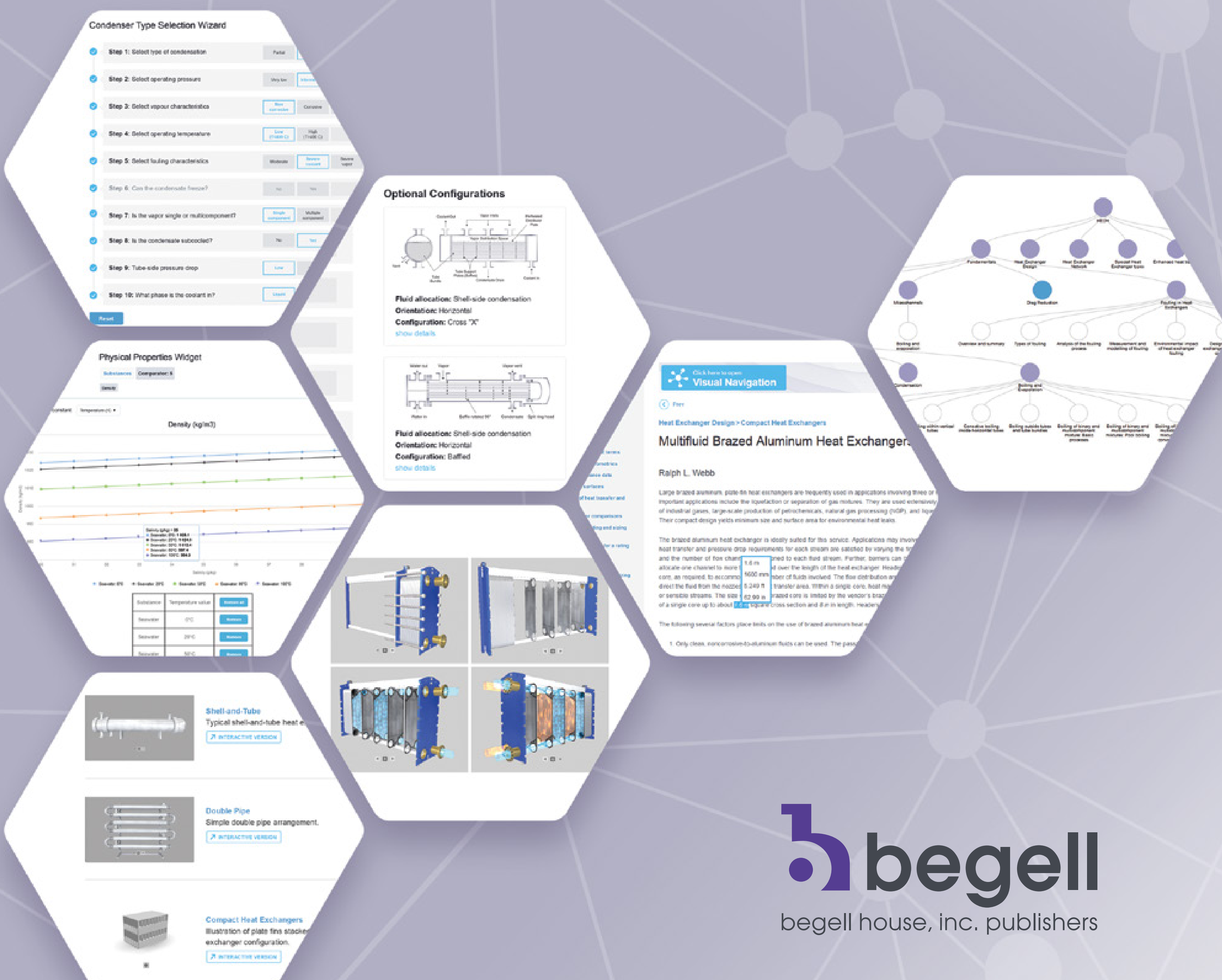
multimedia

heat exchanger design handbook

multimedia edition



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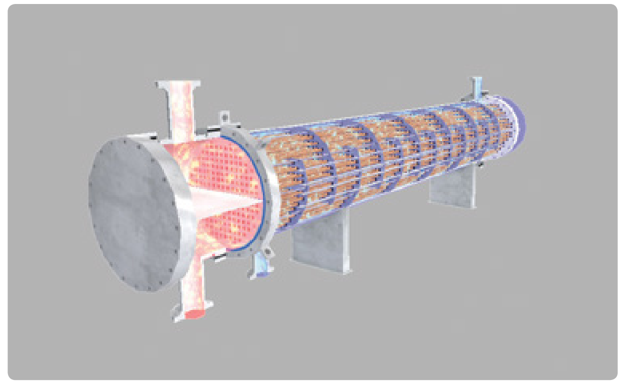
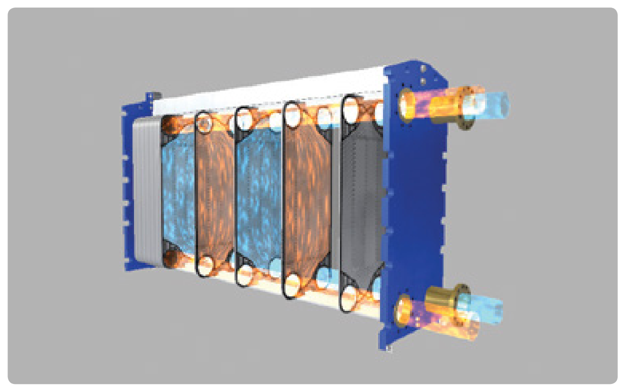
HEAT EXCHANGER DESIGN HANDBOOK
Multimedia Edition

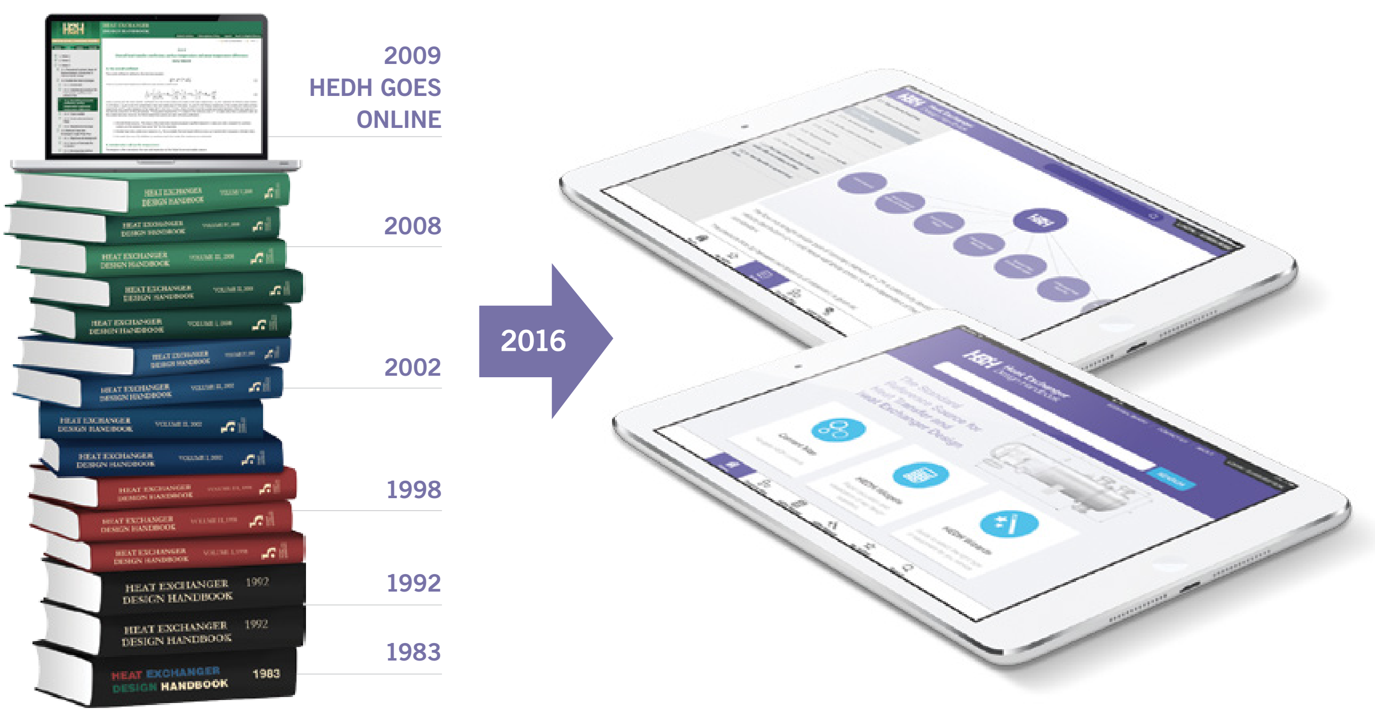
HEDH Multimedia Edition (HEDH-ME), is regarded by many specialists around the world as the standard reference source for heat exchanger design and associated technologies. The print edition has been converted to a fully searchable interactive web-based multimedia product. The content is presented in an exciting interactive HTML format with in-text unit conversion and references, widgets for key heat transfer calculations, wizards to guide heat exchanger selection and 3D interactive visualization of equipment. The HEDH-ME platform runs on a semantic search navigation system and built-in taxonomy of over 8,000 technical terms which provides interactive visual correlations between terms.

Building on a 33-year-long tradition, HEDH-ME content is peer-reviewed and updated quarterly by the foremost experts in the field. Covering topics ranging from theory, fundamentals and applied research to design and operations of both traditional and unconventional heat exchanger types, HEDH-ME is a one-stop reference source readily available on the web and tablets.

HEDH-ME is designed for researchers and engineers at all levels of expertise in both Academia and Industry.



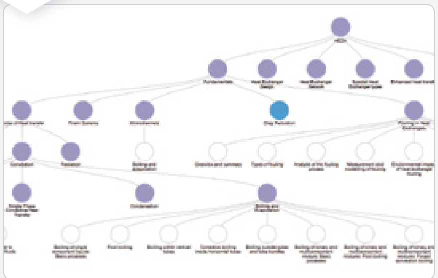




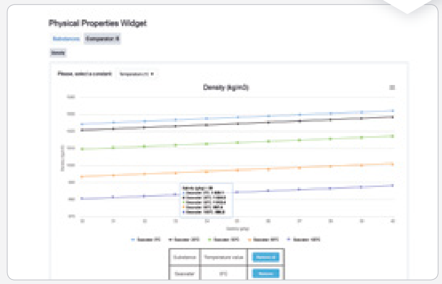
For Academia and Industry

Design Heat Exchangers Supported by Multimedia Tools

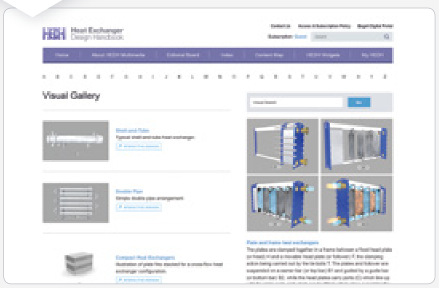
Visual Navigation Tree Map
Explore the content in a convenient graphical way



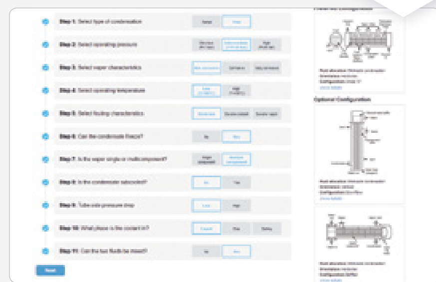
HEDH Widgets
Bring formulas to life: calculate and visualize key heat transfer quantities



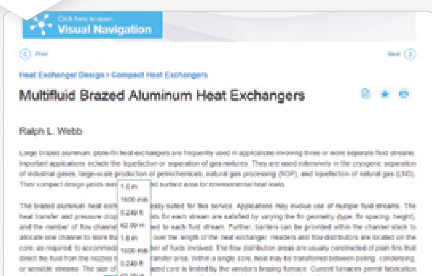
Visual Gallery
Visual Gallery collects all the videos and interactive images included in the website



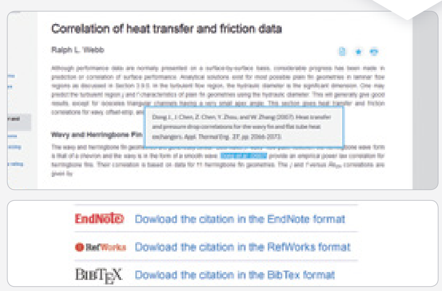
HEDH Wizards
Assists in the selection of the correct type of equipment for your specific service



Interactive HEDH
HTML full-text articles in interactive format



References & Print
Add to citation manager and print multimedia pages



Semantic Search Taxonomy

Over 8,000 Technical Terms

www.hedhme.com

HEAT EXCHANGER
DESIGN HANDBOOK

33 Years of History and Editorial Influence

The Heat Exchanger Design Handbook (HEDH) had its origins in the 1970s when, under the leadership of the two founding editors, Professor Ernst Schlünder and Prof. Geoffrey F. Hewitt, a group of leading authorities in the fields of heat transfer and fluid flow began to discuss the possibility of producing a handbook dealing with all aspects of heat exchanger design and operations including the basic design methodology, the associated heat transfer and fluid flow technology and the physical data required for design.

HEDH's first edition, published in 1983 by Hemisphere Publishing Corporation, contained about 1500 pages of original material structured in five parts covering: (i) heat exchanger theory and generic application technology, (ii) fluid mechanics and heat transfer, (iii) thermal and hydraulic design of heat exchangers, (iv) mechanical design of heat exchangers and (v) physical properties. Ever since the first edition was released, the editors strived to keep the content up-to-date which included progress on cutting edge fundamental research and progressively add material on applications that were becoming available in the market.

Four major editions followed the first 1983 release. Over the years, HEDH has progressively grown in number of volumes and pages (over 6,000 in the latest 2008 edition) by including detailed information not only on all the major types of heat exchangers (e.g. shell-and-tube, compact, condensers, reboilers, furnaces etc.) but also on special types (e.g. evaporators, heat pipes, waste heat boilers), heat transfer enhancement devices (e.g. tube inserts, dimpled surfaces etc.) and on fundamental theory. Today, HEDH is regarded by many specialists around the world as the standard reference source for design and other information on heat transfer, heat exchangers, and associated technologies.

Geoffrey F. Hewitt,
Editorial Advisor

HEDH Multimedia Edition (HEDH-ME)

Begell House has recently made a major investment by developing a new multimedia platform which implements the latest information technologies for the presentation of the material in an exciting, interactive and fresh format. The new **HEDH Multimedia Edition (HEDH-ME)**, inherits and improves on the quality of the legacy material and has been completely revamped in a fully searchable, single column and tablet-friendly format. This provides the reader with the freedom to access HEDH's accurate information wherever convenient and readily find relevant content.

Several advanced features have been included to enhance the reader's experience such as videos, animations, interactive worked examples and the in-text unit conversion which allows the user to select the preferred unit of measurement. HEDH Wizards guide the reader through the material, helping the selection process of the correct type of heat exchanger for a specific service and pointing to the relevant sections. HEDH Widgets provide simple but rapid and highly effective ways of calculating important heat exchanger design/performance parameters as well as necessary physical properties.

To keep the material relevant and up-to-date, the Editorial team will ensure that regular updates are delivered each quarter. The scientific standards of the material are maintained by rigorous peer-review of all the material published by at least two experts in the field. Moreover, new to the Multimedia Edition, is the industrial review concept: where appropriate, manuscripts submitted by an author are also reviewed by an experienced practitioner in industry who comments on the industrial relevance and usefulness of the content.

The Publisher and the Editors firmly believe that the multimedia features of this new HEDH edition including Wizards, Widgets, interactive worked examples, videos and animations will bring the rigorous and authoritative HEDH content to life for a whole new reader experience.

Francesco Coletti,
Executive Editor

- Visual Semantic Navigation
- Advanced Search
- Watch Videos and Animations
- Select the Right Heat Exchanger Type with HEDH Wizards
- Use HEDH Widgets for Quick Calculations

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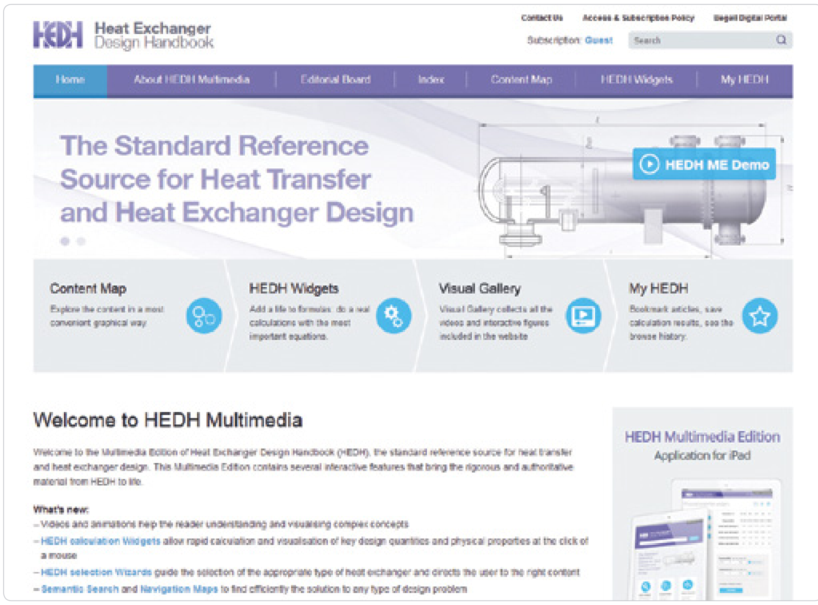
HEDH Multimedia Edition (HEDH-ME)



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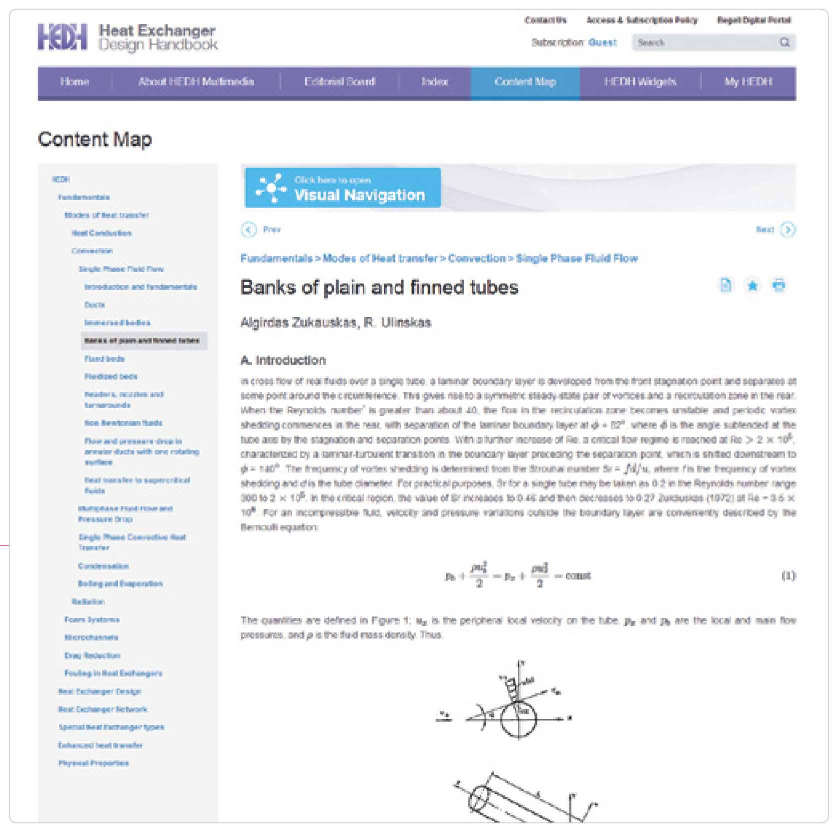
ISBN 978-1-56700-422-9

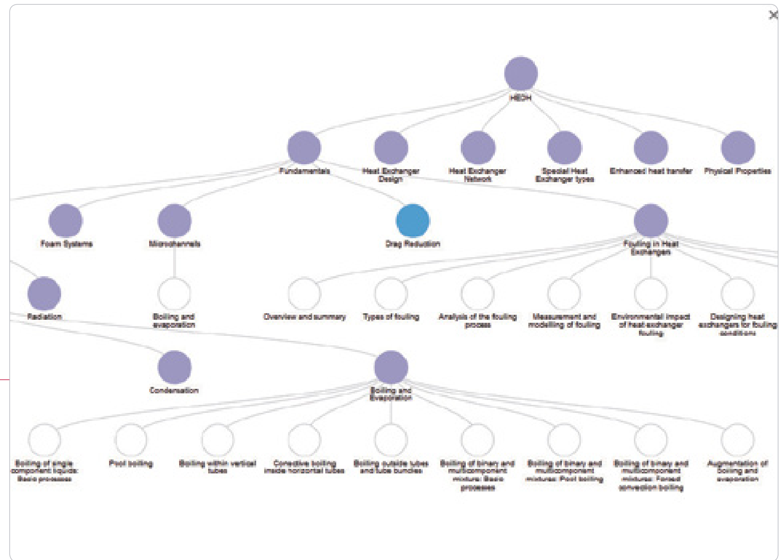
All articles are presented in a interactive HTML format with in-text unit conversion and references, widgets for key heat transfer calculations, wizards to guide heat exchanger selection and 3D interactive visualization of equipment

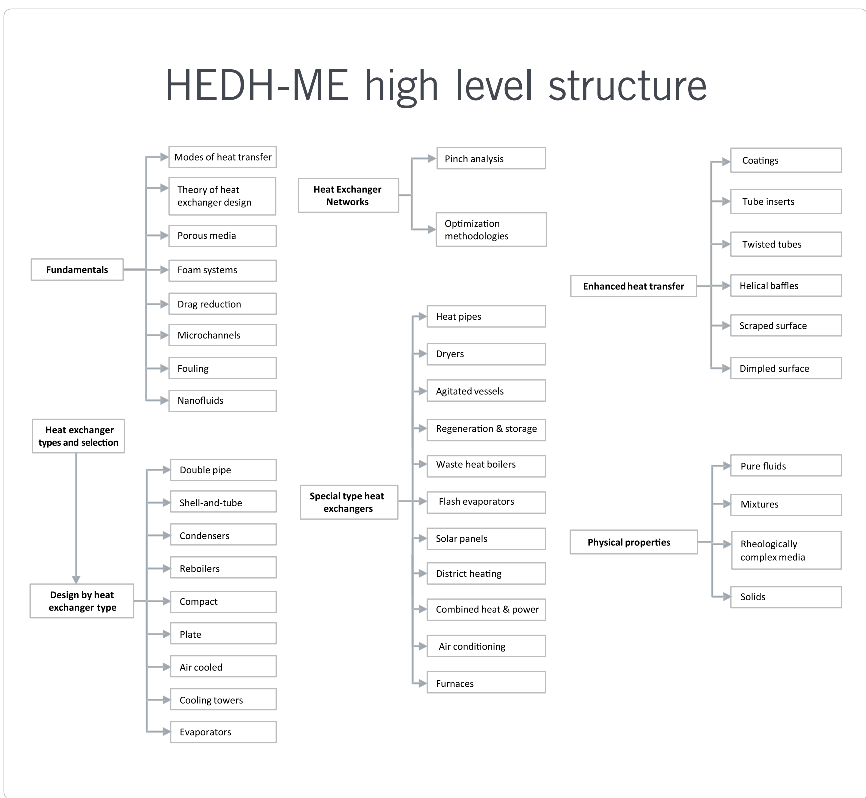


HEDH-ME runs on a semantic search navigation and a built-in taxonomy of over 8,000 technical and scientific terms and provides interactive visual correlations between terminologies.

HEDH-ME Content Navigation Tree

HEDH-ME has a built-in **Visual Navigation Tree Map** that helps visualize the relationship between taxonomy terms, and the correlation between scientific and technical terms and entries by showing the hierarchical structure of the various topics



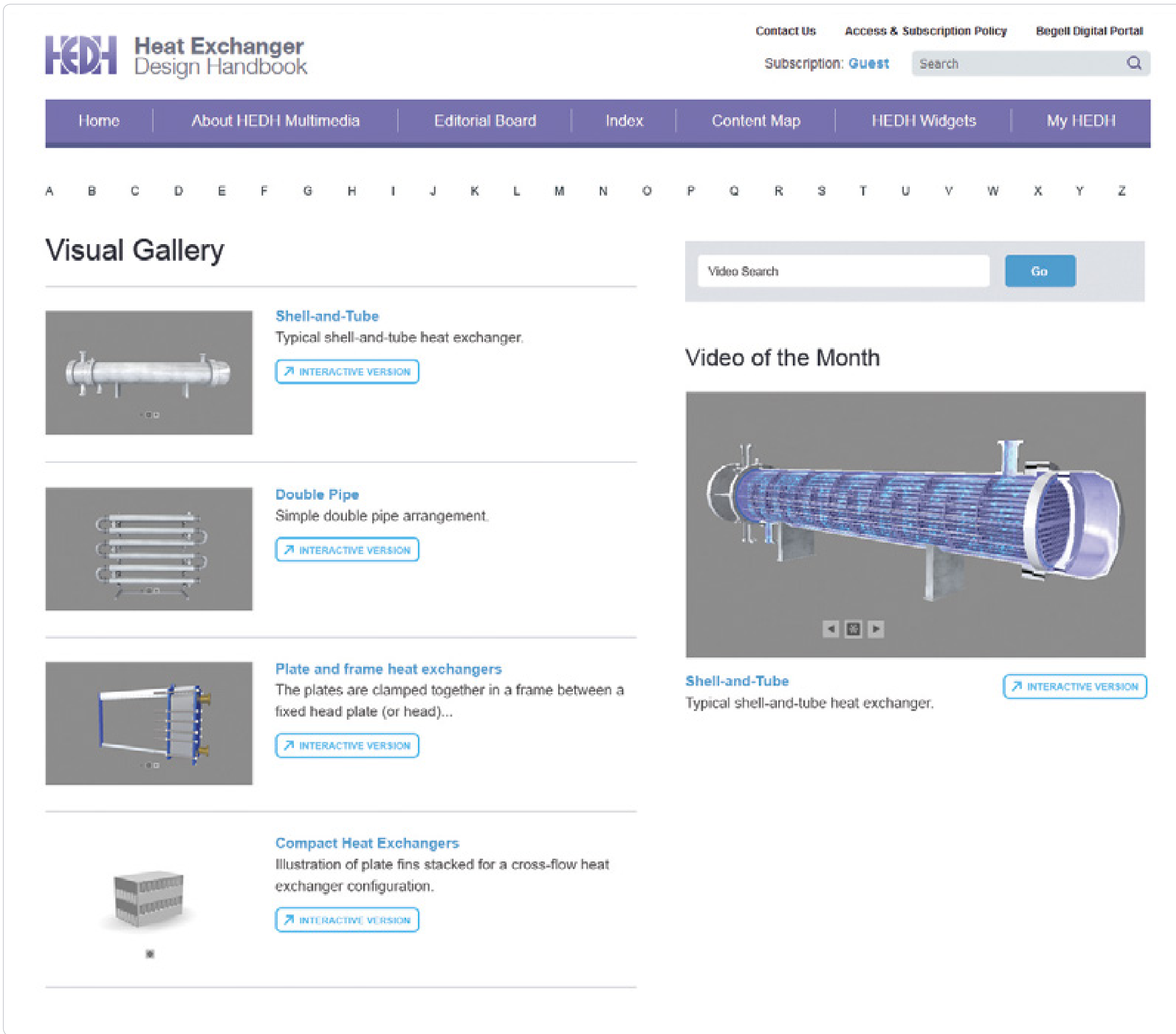


HEDH semantic-taxonomy is intended to provide comprehensive, targeted search results, with entry level tagging that connects users to relevant content. This includes articles, widgets, and links to related journals articles, ebooks, references, and videos within the entire Begell Digital Portal

HEDH-ME Visual Navigation Tree Map provides a helpful aid for visual users and makes it easy to see the connection between different topics and interlinking them by scientific relevance.

Visual Gallery

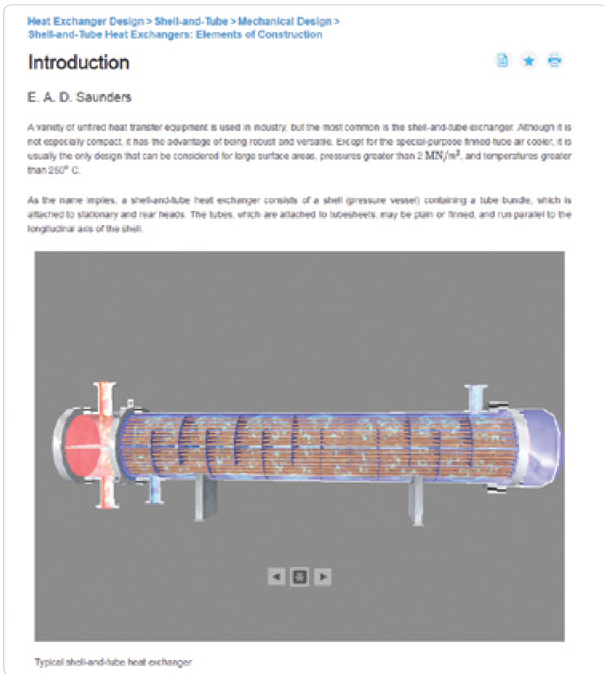
HEDH-ME is building an extensive library of videos and interactive 3D models of heat transfer equipment, thermal and fluid flow processes, and heat exchanger operation. HEDH-ME visual gallery provides a powerful aid for visual learning to advance technical and professional skills.



www.hedhme.com/visual_gallery/

Interactive 3D Images

The interactive 3D images allow the user to disassemble and see inside the various types of heat exchangers. The user can rotate, zoom and interact with the image to identify key elements of the mechanical construction and visualize the fluid flow inside the exchanger.


Heat Exchanger Design > Shell-and-Tube > Mechanical Design > Shell-and-Tube Heat Exchangers: Elements of Construction

Introduction

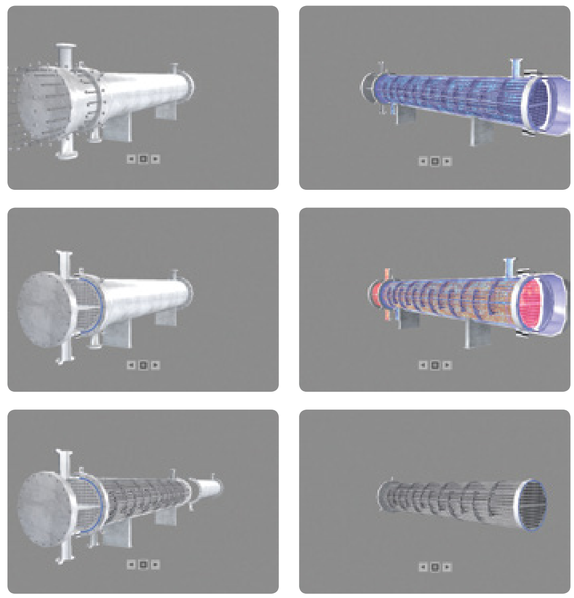
E. A. D. Saunders

A variety of unfired heat transfer equipment is used in industry, but the most common is the shell-and-tube exchanger. Although it is not especially compact, it has the advantage of being robust and versatile. Except for the special-purpose finned-tube air cooler, it is usually the only design that can be considered for large surface areas, pressures greater than 2 MN/m^2, and temperatures greater than 260° C.

As the name implies, a shell-and-tube heat exchanger consists of a shell (pressure vessel) containing a tube bundle, which is attached to stationary and rear heads. The tubes, which are attached to tubesheets, may be plain or finned, and run parallel to the longitudinal axis of the shell.

Typical shell-and-tube heat exchanger

Typical shell-and-tube heat exchanger



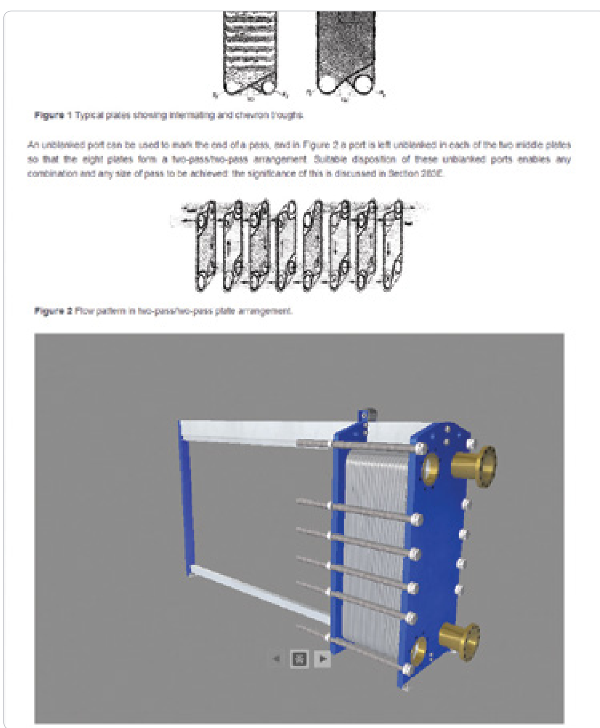
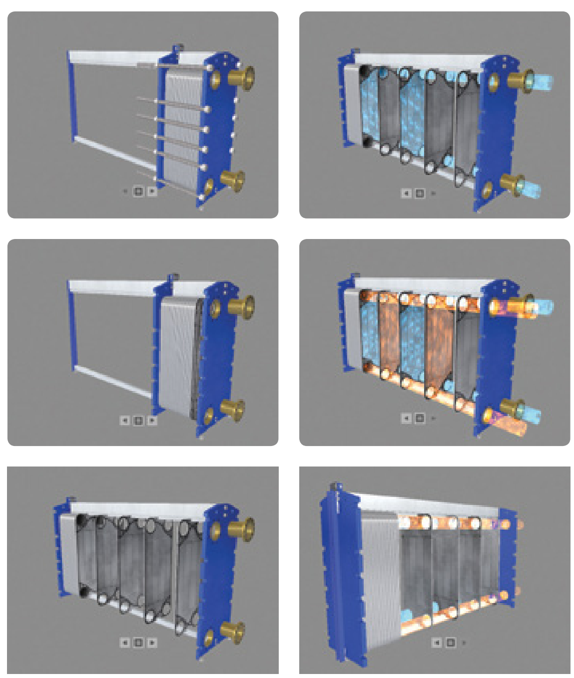


Figure 1 Typical plates showing intermating and chevron troughs.

An unblanked port can be used to mark the end of a pass, and in Figure 2 a port is left unblanked in each of the two middle plates so that the eight plates form a two-pass/two-pass arrangement. Suitable disposition of these unblanked ports enables any combination and any size of pass to be achieved: the significance of this is discussed in Section 2E.

Figure 2 Flow pattern in two-pass/two-pass plate arrangement.

Typical plate-and-frame heat exchanger



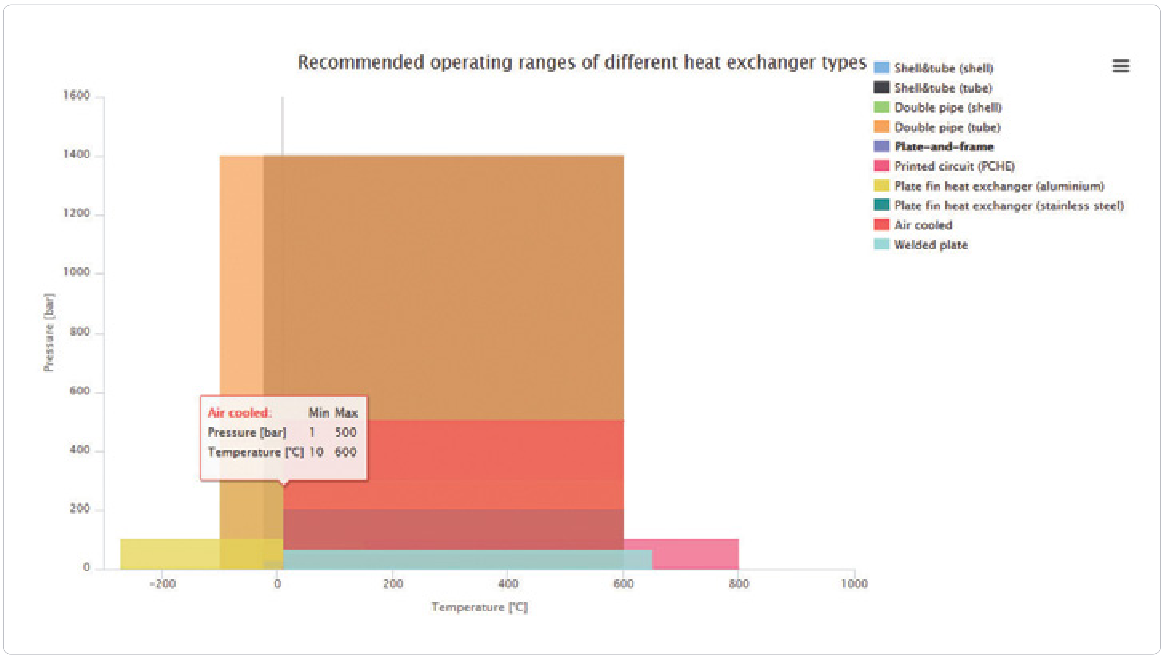
HEDH-ME Widgets

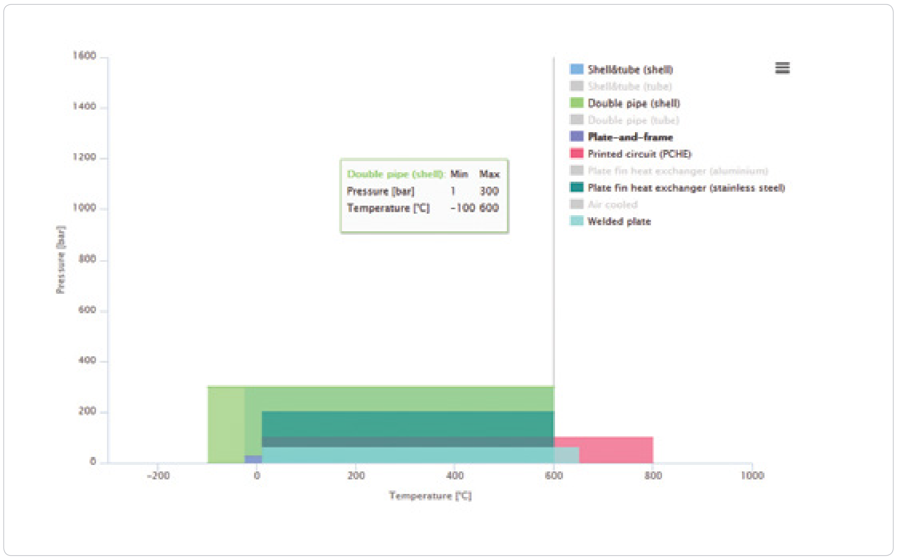
HEDH Widgets provide quick and simple but highly effective ways of calculating key heat transfer quantities, heat exchanger design/performance parameters and necessary physical properties.

www.hedhme.com/hedh_widgets/

Operating Ranges Widget

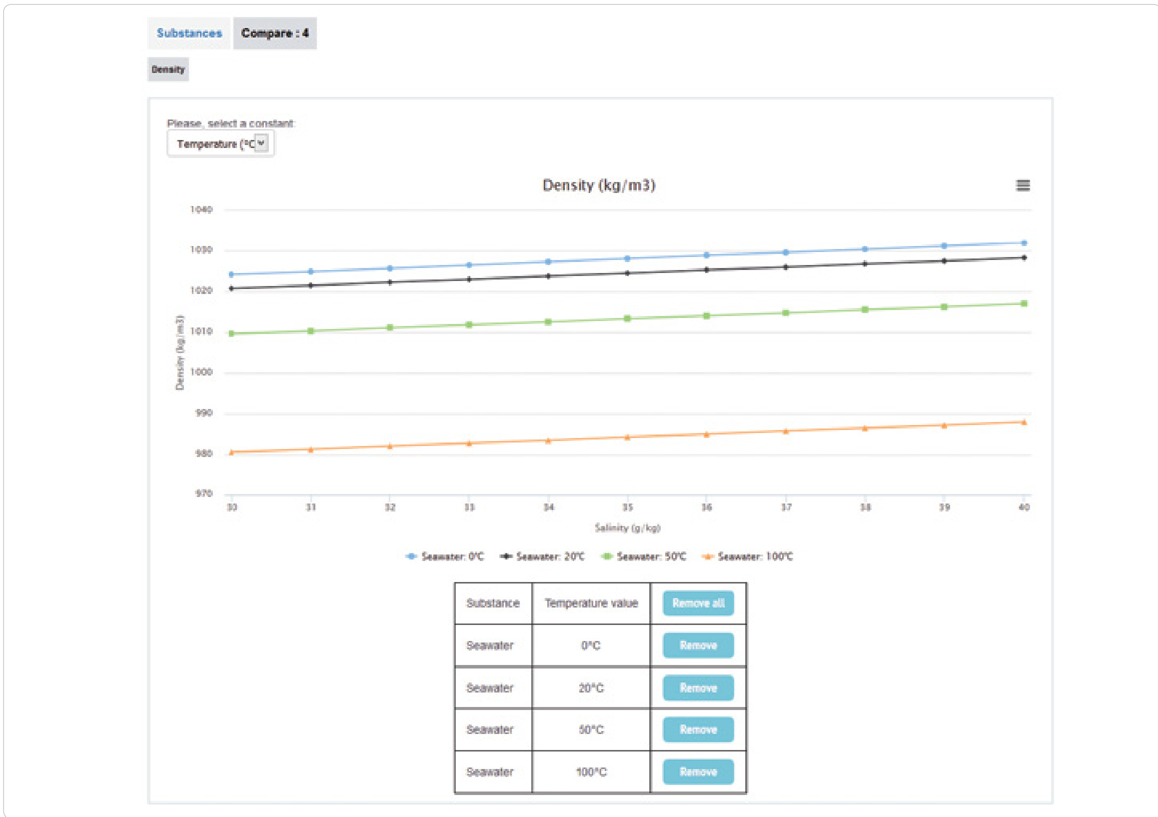
Recommended operating ranges of different heat exchanger types.

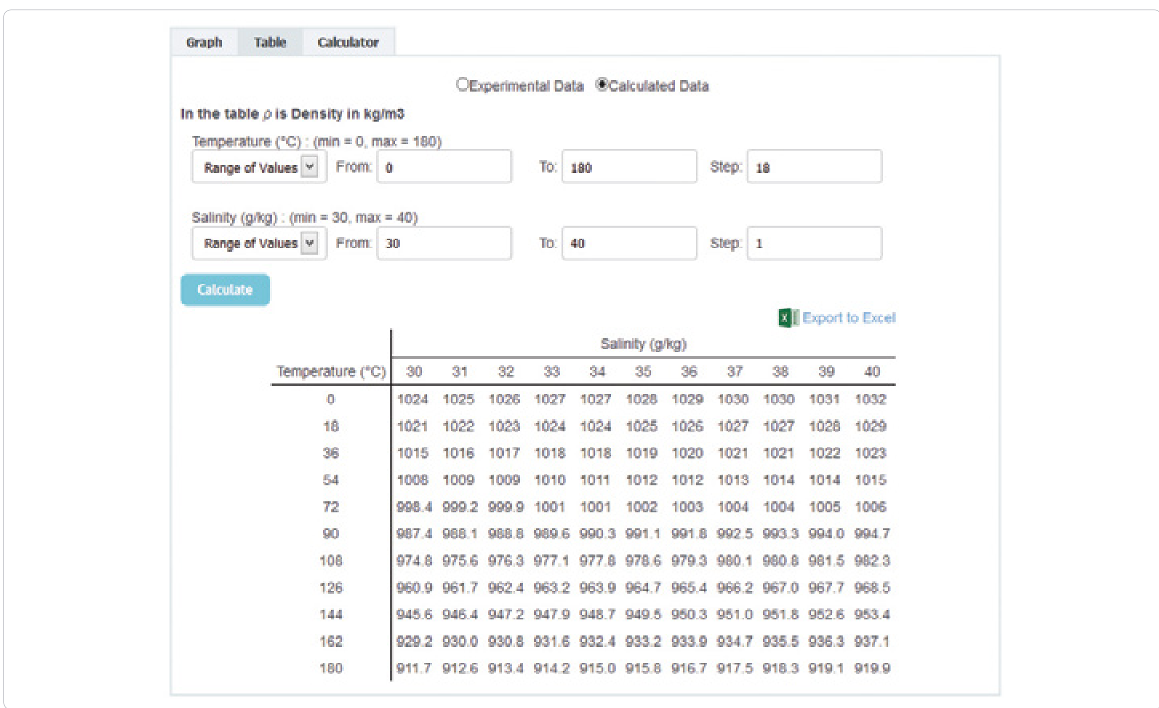




Physical Properties Widget

View and plot key properties for selected substances at different operating conditions.

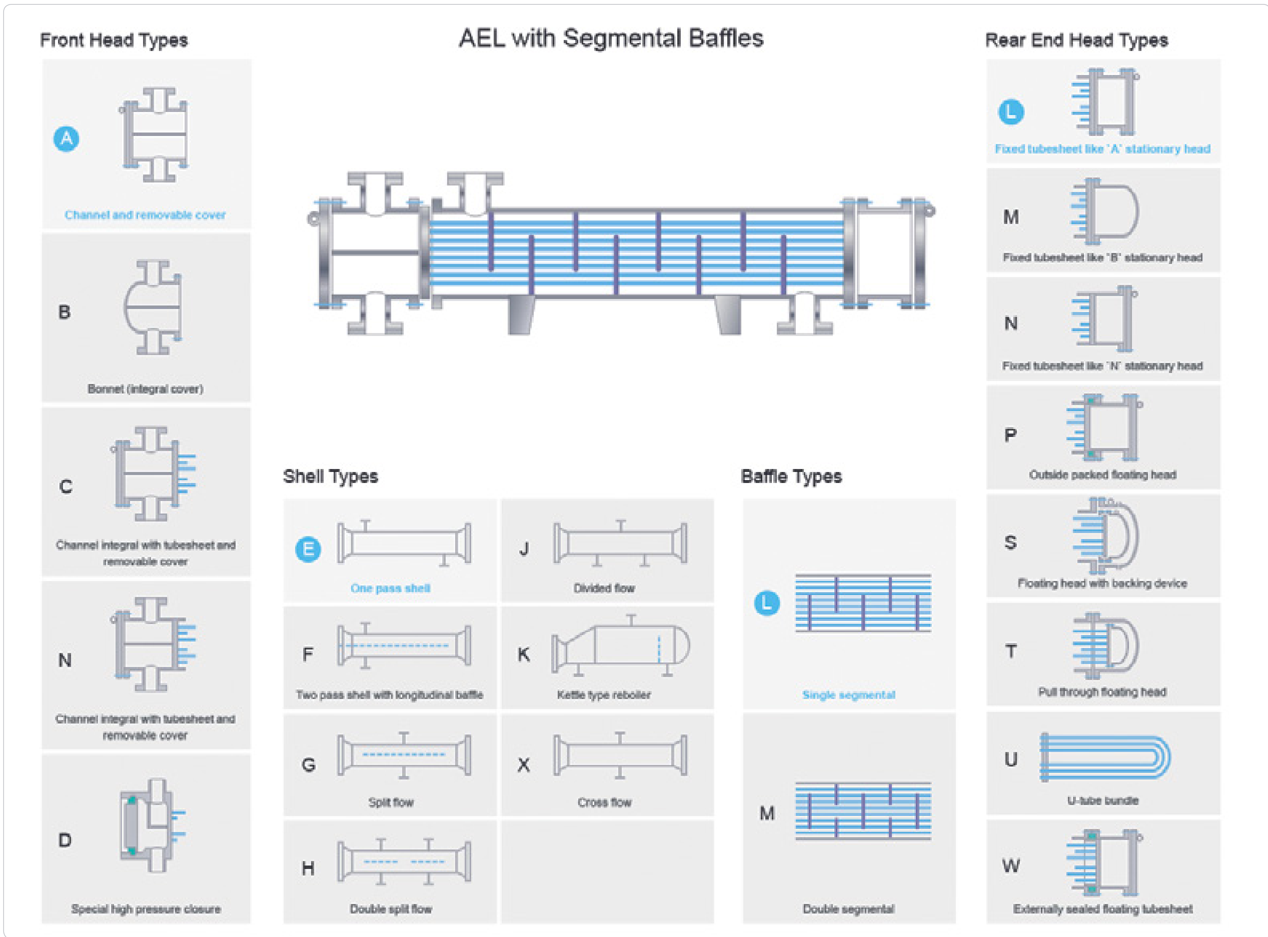


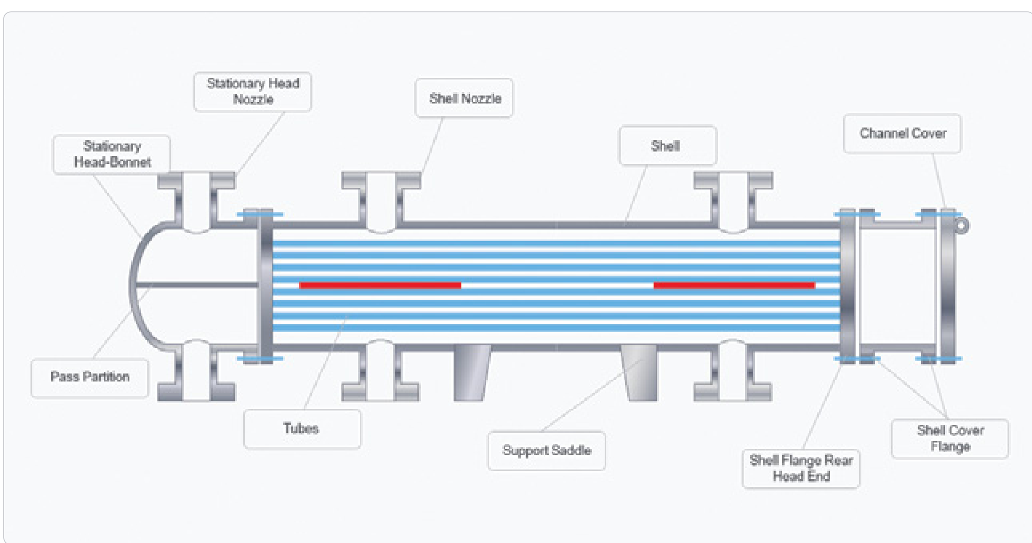


	Salinity (g/kg)										
Temperature (°C)	30	31	32	33	34	35	36	37	38	39	40
0	1024	1025	1026	1027	1027	1028	1029	1030	1030	1031	1032
18	1021	1022	1023	1024	1024	1025	1026	1027	1027	1028	1029
36	1015	1016	1017	1018	1018	1019	1020	1021	1021	1022	1023
54	1008	1009	1009	1010	1011	1012	1012	1013	1014	1014	1015
72	998.4	999.2	999.9	1001	1001	1002	1003	1004	1004	1005	1006
90	987.4	988.1	988.8	989.6	990.3	991.1	991.8	992.5	993.3	994.0	994.7
108	974.8	975.6	976.3	977.1	977.8	978.6	979.3	980.1	980.8	981.5	982.3
126	960.9	961.7	962.4	963.2	963.9	964.7	965.4	966.2	967.0	967.7	968.5
144	945.6	946.4	947.2	947.9	948.7	949.5	950.3	951.0	951.8	952.6	953.4
162	929.2	930.0	930.8	931.6	932.4	933.2	933.9	934.7	935.5	936.3	937.1
180	911.7	912.6	913.4	914.2	915.0	915.8	916.7	917.5	918.3	919.1	919.9

TEMA Types Widget

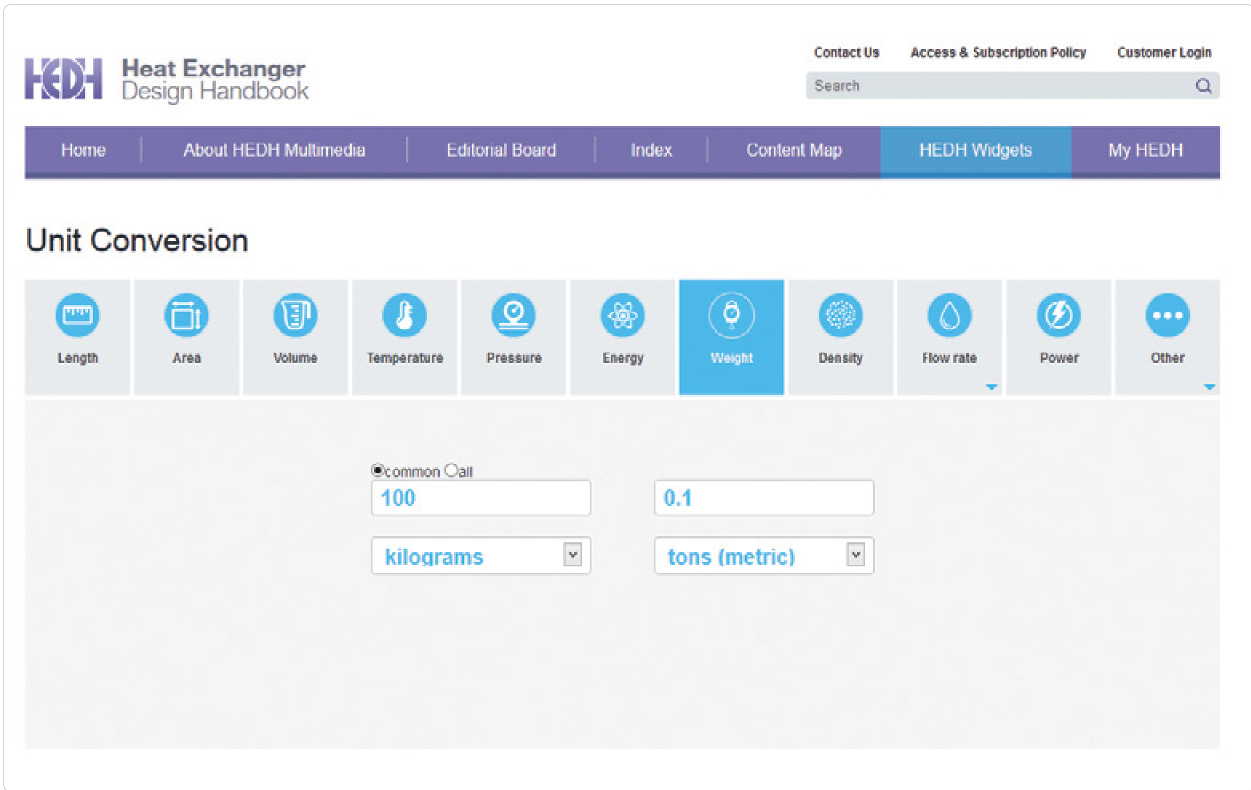
Visualize the different TEMA type configurations of shell-and-tube heat exchangers.



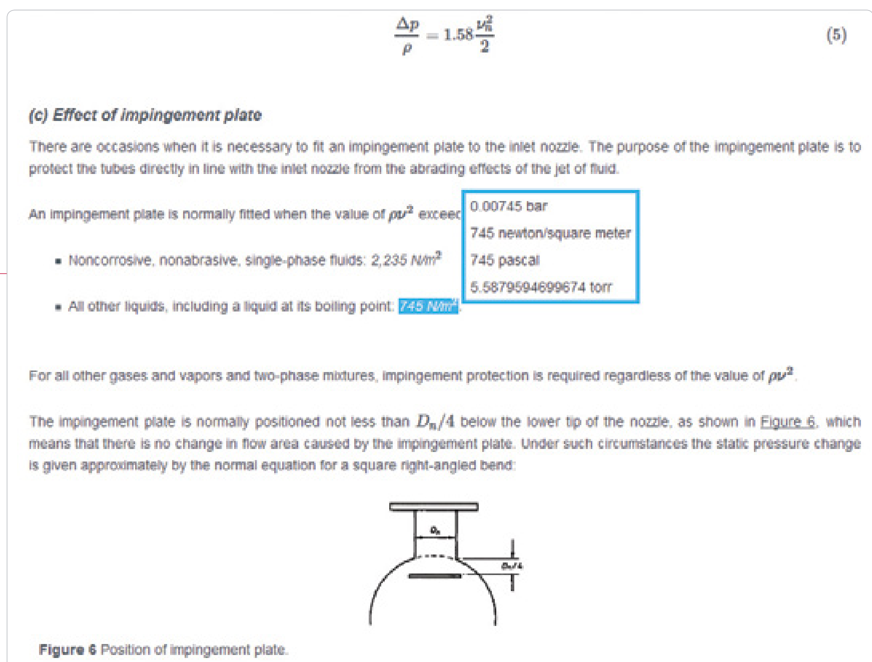


Unit Conversion Widget

Easily convert between different units of measurement.



Widget integrated into the article



$$\frac{\Delta p}{\rho} = 1.58\frac{v_n^2}{2} \qquad (5)$$

(c) Effect of impingement plate

There are occasions when it is necessary to fit an impingement plate to the inlet nozzle. The purpose of the impingement plate is to protect the tubes directly in line with the inlet nozzle from the abrading effects of the jet of fluid.

An impingement plate is normally fitted when the value of ρv^2 exceed

- Noncorrosive, nonabrasive, single-phase fluids: 2,235 N/m^2
- All other liquids, including a liquid at its boiling point: 745 N/m^2

0.00745 bar
745 newton/square meter
745 pascal
5.5879594699674 torr

For all other gases and vapors and two-phase mixtures, impingement protection is required regardless of the value of ρv^2.

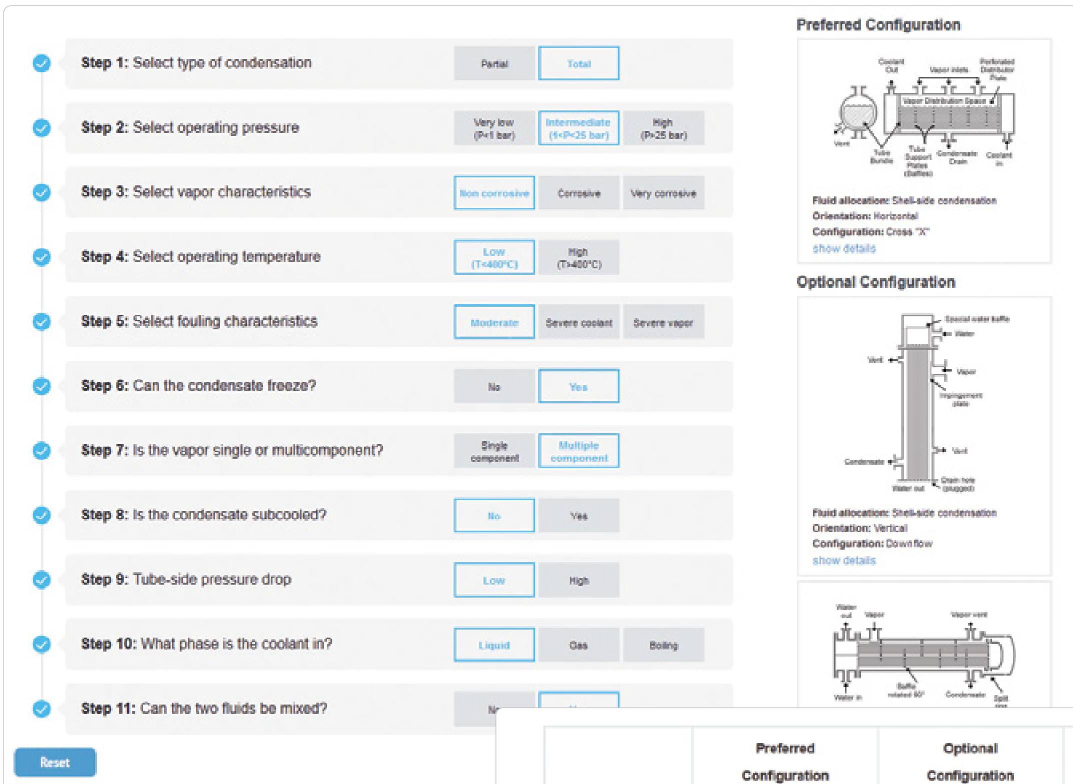
The impingement plate is normally positioned not less than $D_n/4$ below the lower tip of the nozzle, as shown in Figure 6, which means that there is no change in flow area caused by the impingement plate. Under such circumstances the static pressure change is given approximately by the normal equation for a square right-angled bend:

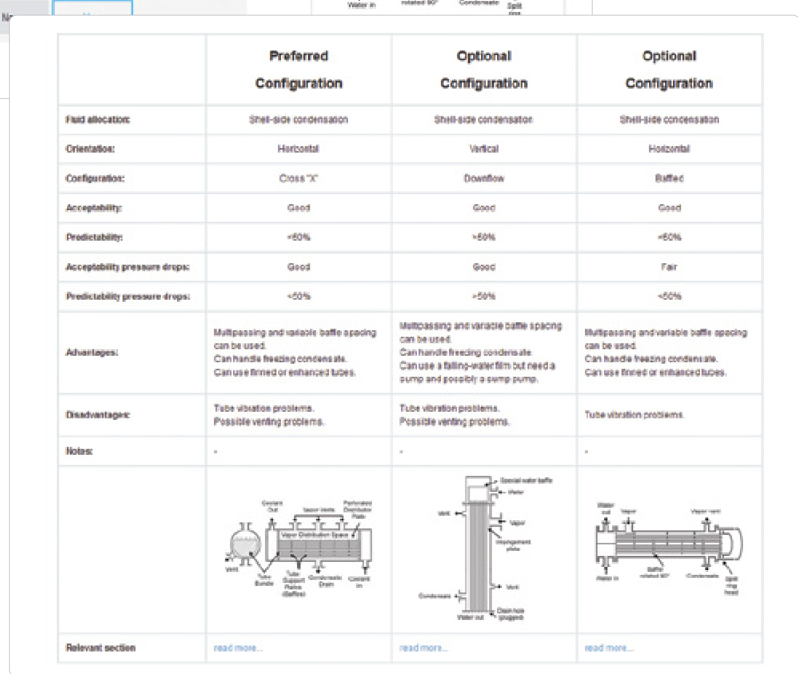
Figure 6 Position of impingement plate.

HEDH-ME Wizard

HEDH Wizards guide the reader through the selection process of the correct type of heat exchanger for a specific service. The user is then pointed to the relevant sections in HEDH-ME to complete the design of the equipment selected.

Condenser Type Wizard





	Preferred Configuration	Optional Configuration	Optional Configuration
Fluid allocation:	Shell-side condensation	Shell-side condensation	Shell-side condensation
Orientation:	Horizontal	Vertical	Horizontal
Configuration:	Cross "X"	Downflow	Baffled
Acceptability:	Good	Good	Good
Predictability:	<60%	>60%	<60%
Acceptability pressure drops:	Good	Good	Fair
Predictability pressure drops:	<50%	>50%	<50%
Advantages:	Multipassing and variable baffle spacing can be used. Can handle freezing condensate. Can use finned or enhanced tubes.	Multipassing and variable baffle spacing can be used. Can handle freezing condensate. Can use a falling-water film but need a sump and possibly a sump pump.	Multipassing and variable baffle spacing can be used. Can handle freezing condensate. Can use finned or enhanced tubes.
Disadvantages:	Tube vibration problems. Possible venting problems.	Tube vibration problems. Possible venting problems.	Tube vibration problems.
Notes:	-	-	-
Relevant section	read more...	read more...	read more...

HEDH-ME Content Management

References

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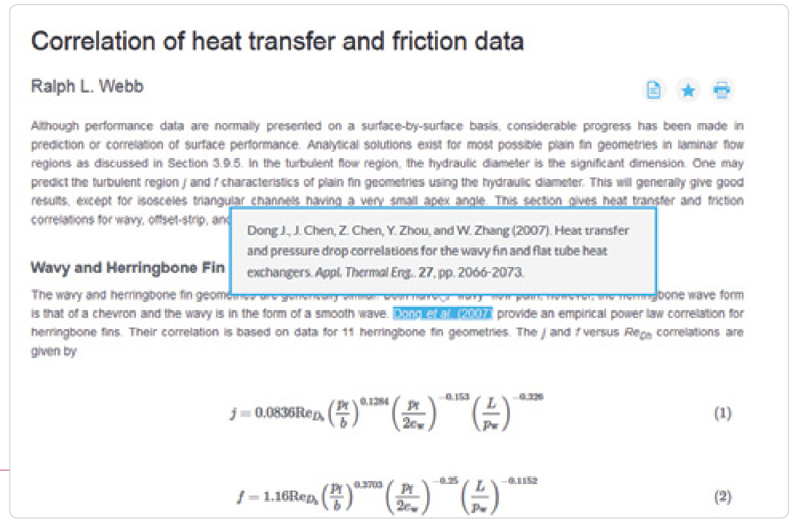


Correlation of heat transfer and friction data

Ralph L. Webb

Although performance data are normally presented on a surface-by-surface basis, considerable progress has been made in prediction or correlation of surface performance. Analytical solutions exist for most possible plain fin geometries in laminar flow regions as discussed in Section 3.9.5. In the turbulent flow region, the hydraulic diameter is the significant dimension. One may predict the turbulent region j and f characteristics of plain fin geometries using the hydraulic diameter. This will generally give good results, except for isosceles triangular channels having a very small apex angle. This section gives heat transfer and friction correlations for wavy, offset-strip, and

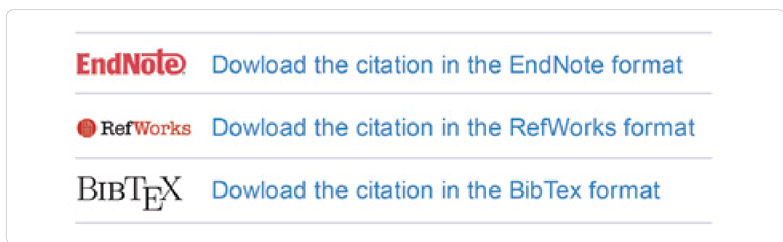
Dong J., J. Chen, Z. Chen, Y. Zhou, and W. Zhang (2007). Heat transfer and pressure drop correlations for the wavy fin and flat tube heat exchangers. *Appl. Thermal Eng.*, 27, pp. 2066-2073.

Wavy and Herringbone Fin

The wavy and herringbone fin geom... bone wave form is that of a chevron and the wavy is in the form of a smooth wave. Dong et al. (2007) provide an empirical power law correlation for herringbone fins. Their correlation is based on data for 11 herringbone fin geometries. The j and f versus Re_{Dh} correlations are given by

$$j = 0.0836 Re_{D_h} \left(\frac{p_f}{b}\right)^{0.1284} \left(\frac{p_f}{2e_w}\right)^{-0.153} \left(\frac{L}{p_w}\right)^{-0.326} \quad (1)$$

$$f = 1.16 Re_{D_h} \left(\frac{p_f}{b}\right)^{0.3703} \left(\frac{p_f}{2e_w}\right)^{-0.25} \left(\frac{L}{p_w}\right)^{-0.1152} \quad (2)$$



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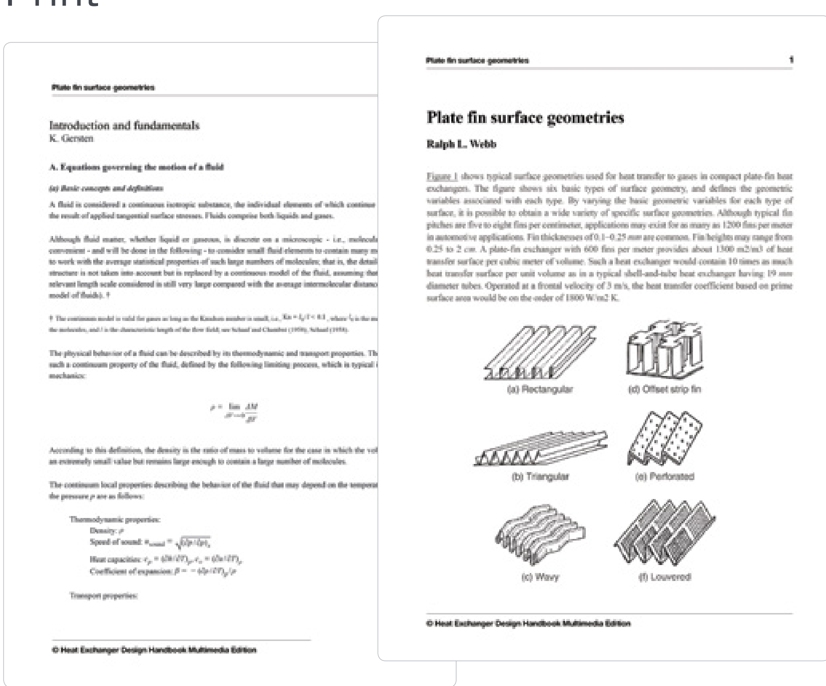

Plate fin surface geometries 1

Plate fin surface geometries

Ralph L. Webb

Figure 1 shows typical surface geometries used for heat transfer to gases in compact plate-fin heat exchangers. The figure shows six basic types of surface geometry, and defines the geometric variables associated with each type. By varying the basic geometric variables for each type of surface, it is possible to obtain a wide variety of specific surface geometries. Although typical fin pitches are five to eight fins per centimeter, applications may exist for as many as 1200 fins per meter in automotive applications. Fin thicknesses of 0.1–0.25 mm are common. Fin heights may range from 0.25 to 2 cm. A plate-fin exchanger with 600 fins per meter provides about 1300 m2/m3 of heat transfer surface per cubic meter of volume. Such a heat exchanger would contain 10 times as much heat transfer surface per unit volume as in a typical shell-and-tube heat exchanger having 19 mm diameter tubes. Operated at a frontal velocity of 3 m/s, the heat transfer coefficient based on prime surface area would be on the order of 1800 W/m2 K.

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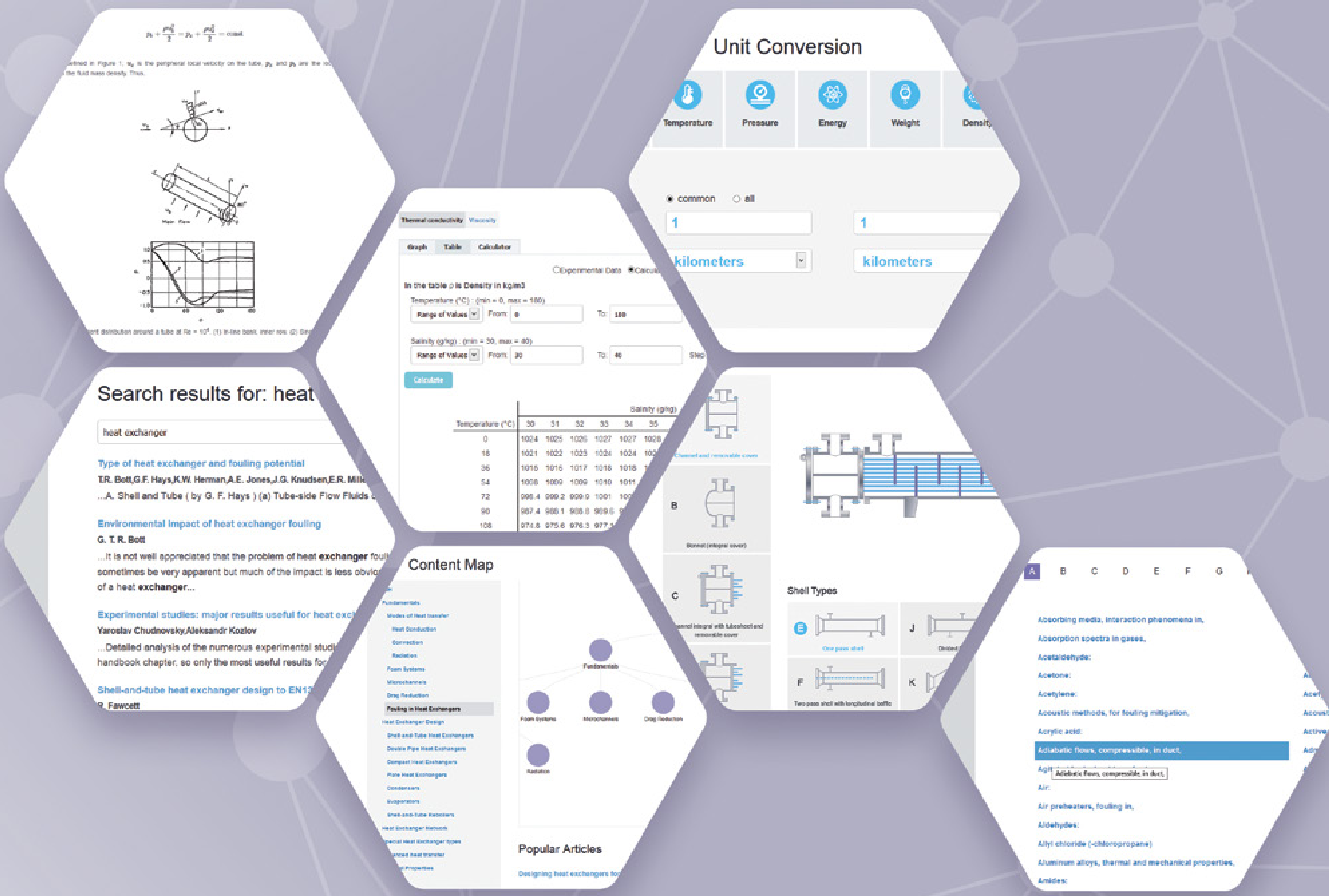

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