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Revision Memo

9/2004 Extensive revisions based on HEXTRAN Version 9.01 and HTRI
Xchanger Suite 3.0 software updates.

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1 SCOPE

This section of the **DESIGN PRACTICES** describes the computer programs available within ExxonMobil for heat exchanger thermal and hydraulic analysis. All computer programs described in this document are available to Standard Research Agreement (SRA) member companies for installation on standard ExxonMobil desktop or laptop computers. These programs can be used to analyze most common types of heat exchangers used within ExxonMobil facilities, including:

- shell-and-tube heat exchangers
- double-pipe heat exchangers
- multi-tube hairpin heat exchangers
- air-cooled heat exchangers
- brazed aluminum heat exchangers (also known as plate-fin heat exchangers)
- plate-and-frame heat exchangers

There are currently no computer programs available within ExxonMobil dedicated to the analysis of spiral-wound heat exchangers (typically used for LNG liquefaction) or printed circuit heat exchangers (PCHE).

2 RESOURCES

<i>Heat Transfer Telephone Help Line</i>	(703) 846-2000, maintained by the Heat Transfer and Engineering Standards Section, Plant Engineering Division, ExxonMobil Research and Engineering, Fairfax VA, USA. Provides assistance in heat exchanger design and interpretation of simulation results.
<i>Technical Software Telephone Help Line</i>	(703) 846-6444, maintained by the Technical Computing Section, Automation and Optimization Division, ExxonMobil Research and Engineering, Fairfax VA, USA. Provides information on how to access the technical software discussed in this DESIGN PRACTICE .
<i>EMRE Training Course</i>	"Simulation of Heat Exchangers Using HEXTRAN and HTRI Programs" (course manual available).
<i>Heat Transfer Research, Inc. (HTRI) internet site</i>	All ExxonMobil SRA members have access to the HTRI secured web site (http://www.htri.net) which contains general information about heat exchangers and HTRI software. Note that HTRI software must be installed to enable access.
<i>Computer Program Manuals</i>	Online documentation is included with the installation of the heat transfer software discussed in this DESIGN PRACTICE .

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3 DEFINITIONS

ACHE	Air-cooled heat exchanger
BAHE	Brazed aluminum heat exchanger, also known as plate-fin heat exchanger
DPE	Double-pipe exchanger module available in HEXTRAN
EDL III	ExxonMobil Data Library, fluid property database
HEXTRAN	Heat exchanger network solution program by Simulation Sciences, Inc.; provides access to HTRI's Xchanger Suite software and EDL III.
HTFS	Heat Transfer and Fluid Flow Service
HTRI	Heat Transfer Research, Inc.
MUSE	Plate-fin heat exchanger program developed by HTFS
PFHE	Plate-fin heat exchanger, also known as brazed aluminum heat exchanger
PHE	Plate-and-frame heat exchanger
PRO/II	Process simulation software by Simulation Sciences, Inc.; allows access to EDL III.
S&T	Shell-and-tube exchanger
Xace	Air-cooled heat exchanger program developed by HTRI, part of Xchanger Suite
Xchanger Suite	Heat exchanger analysis software package developed by HTRI, includes Xace, Xist, Xphe, and Xvib
Xist	Shell-and-tube heat exchanger program developed by HTRI, part of Xchanger Suite
Xphe	Plate-and-frame heat exchanger program developed by HTRI, part of Xchanger Suite
Xvib	Tube vibration analysis tool developed by HTRI, part of Xchanger Suite

4 GENERAL OVERVIEW

The primary software programs available within ExxonMobil for heat exchanger analysis are:

- **HEXTRAN** - The current version of HEXTRAN is release 9.01 (with a patch released in December 2004). It provides the preferred analysis environment for most types of heat exchangers. HEXTRAN contains internal models for several common types of heat exchangers and can also access the heat exchanger models within Xchanger Suite. Both single heat exchangers and networks of multiple heat exchangers can be analyzed within HEXTRAN. This program can access the EDL III v3.0 fluid property package to ensure compatibility with other ExxonMobil analyses such as process simulations. The use of EDL III is strongly recommended for any final calculations.
- **Xchanger Suite** - The current version of this program is 3.0 Service Pack 3. It contains the Xace, Xist, Xphe, and Xvib heat exchanger models, which can be accessed directly for the analysis of single heat exchangers (no heat exchanger networks except for simple parallel / series arrangements of similar exchangers). Xchanger Suite does not have direct access to the EDL III fluid property package, so it is recommended to access these models via HEXTRAN.
- **MUSE** - The current version of this program is release 3.3. It provides analysis tools specific to plate-fin heat exchangers. MUSE does not provide access to the EDL III fluid property package and cannot be accessed via HEXTRAN.

The software programs listed above perform thermal and hydraulic calculations, but not mechanical design calculations. Three types of thermal calculations can be performed:

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- **Design** - The process conditions and heat duty are known; the program calculates a heat exchanger geometry to transfer the required heat. Some geometry limits or ranges may need to be specified.
- **Rating** - The heat exchanger geometry, the desired process conditions, and heat duty are known; the program determines whether the heat exchanger surface area is adequate to transfer the required heat.
- **Simulation** - The heat exchanger geometry and four of the six process conditions are known; the program calculates the remaining two unknown conditions. The six process conditions are two inlet temperatures, two outlet temperatures, and two flow rates. The most common unknowns are the two outlet temperatures.

The programs described in this **DESIGN PRACTICE** can accommodate process streams that are single-phase (liquid or gas) or two-phase (condensing or boiling). In most cases, EDL III should be selected for fluid physical properties; however, some calculations must be done using internally-stored properties or manually-input properties. Programs not linked to EDL III may be used for cases where HEXTRAN lacks required capabilities; however, a review of these cases by EMRE is recommended if the results are to be used for final design.

Table 1 below summarizes the recommended software programs to use for various heat exchanger types.

Table 1
Recommended Software Programs for Heat Exchanger Analysis

Heat Exchanger Type	Recommended Software Program	Comments
Shell-and-tube	HEXTRAN using HTRI Xist model	Validated by EMRE when used with EDL III
Double pipe	HEXTRAN using HTRI Xist model	Validated by EMRE when used with EDL III
Multi tube hairpin	HEXTRAN using HTRI Xist model	Validated by EMRE when used with EDL III
Air cooler	HEXTRAN using HTRI Xace model	Validated by EMRE when used with EDL III
Plate-and-Frame	HTRI Xphe	Not validated for direct use - HTRI software does not have direct access to EDL III; contact EMRE for assistance.
Brazed Aluminum / Plate-Fin	HTFS MUSE	Not validated by EMRE - HTFS software does not have direct access to EDL III; contact EMRE for assistance

5 DETAILED DESCRIPTIONS

This section contains details of the programs listed in the **GENERAL OVERVIEW** section. The description for each program contains a summary of its applications, lists of references, capabilities, limitations, known bugs, and hints for its effective use.

5.1 HEXTRAN

HEXTRAN, licensed from Simulation Sciences, an Invensys Company, is a program for analyzing either single heat exchangers or heat exchanger networks. A key feature of HEXTRAN is that it can access EDL III fluid property data via PRO/II to ensure consistency with other ExxonMobil calculations. HEXTRAN contains several internal heat exchanger models that are generally not recommended for final calculations; however, it can also access the HTRI Xace and Xist heat exchanger models which have been validated by EMRE. A complete list of the heat exchanger models that can be accessed by HEXTRAN is provided in Table 2 below.

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Table 2
Heat Exchanger Models Available in HEXTRAN

Internal / External Model	Model Name	Type	Validated by EMRE	Restrictions / Remarks
HEXTRAN Internal Models	ACE	Air cooled	No	Not recommended - use Xace by selecting "Use HTRI" in the Configure panel in HEXTRAN ACE
	DPE	Double pipe	No	Not recommended - use Xist by selecting "Use HTRI" in the Configure panel in HEXTRAN STE
	FTE	Finned tube	No	Not recommended - use Xace by selecting "Use HTRI" in the Configure panel in HEXTRAN ACE
	MTE	Multi-tube	No	Not recommended - use Xist by selecting "Use HTRI" in the Configure panel in HEXTRAN STE
	PHE	Plate-and-frame	No	Use only when no alternatives exist; contact EMRE for assistance
	RBE	Rod baffle	No	Not recommended - use Xist by selecting "Use HTRI" in the Configure panel in HEXTRAN STE
	STE	Shell and tube	No	Not recommended - use Xist by selecting "Use HTRI" in the Configure panel in HEXTRAN STE
HTRI Xchanger Suite Models	Xace	Air cooled (including finned)	Yes	None when used with EDL III
	Xist	Shell and tube Double Pipe Multi-tube Rod Baffle	Yes	None when used with EDL III

HEXTRAN has been validated by EMRE for design, rating, simulation, and monitoring calculations using the HTRI models Xace and Xist. It cannot access HTRI's Xphe and Xvib models. Figure 1 illustrates the relationship between HEXTRAN, Xchanger Suite, PRO/II and EDL III.