Beyond Compliance

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CO-LaN Annual Meeting
Sofitel Mediterranée
Cannes, France
March 9-10, 2006

Assuring CAPE-OPEN Adoption

- A set of standardized interfaces are in place and have been implemented by multiple vendors
- Widespread adoption/use of these interfaces will depend upon more than technical feasibility and availability

Adoption Issues

- Quality of implementation in Process Modeling Environment (PME)
- PME interface capabilities
- Interface experience

Ideally user should not even notice that CAPE-OPEN interfaces are being used.

Implementation Quality

- Implementation should be as seamless as possible
  - Maximize existing knowledge of PME
- Exploit capabilities of PME

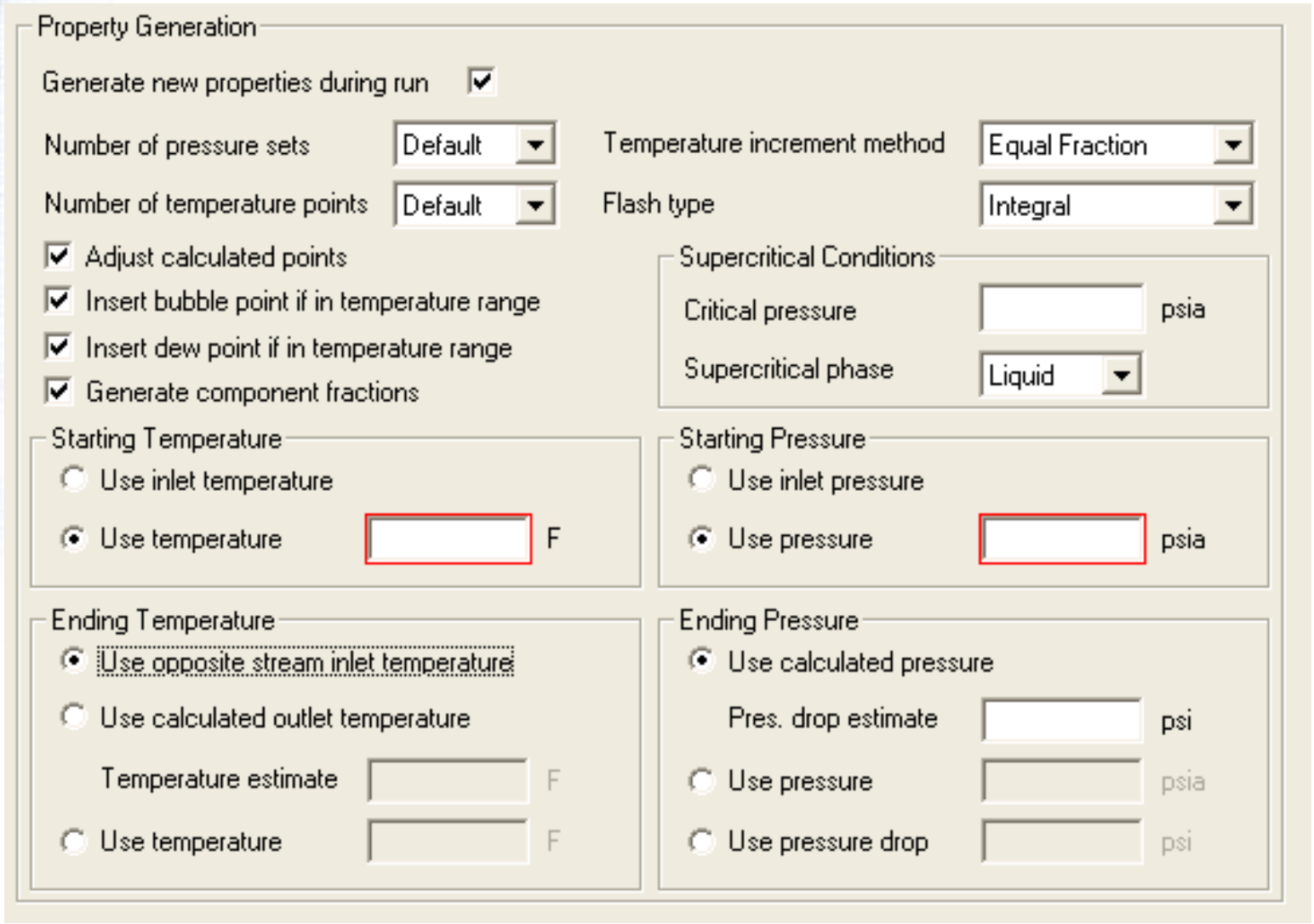
Implementation Quality (HTRI)

- Implemented Unit Operation interface for three most used *Xchanger Suite* modules
  - Xist (Shell and Tube)
  - Xace (Air-coolers/Economizers)
  - Xphe (Plate and frame)
- Implemented Thermodynamic interface within *Xchanger Suite*
- Tested against multiple process simulators and property packages

Implementation Quality (HTRI)

- *Xchanger Suite* calculation modules evolved as stand alone engines
  - Optimized for rigor instead of calculation speed
    - Fluid property handling modified
    - Known versus unknown duty
  - Significant input/runtime problems result in diagnostic messages and end of calculations
  - Process condition handling not consistent with most process simulators
    - HTRI based on property grid
    - Simulators provide temperature and vapor fraction which may be inconsistent with interpolated conditions

Property Options



PME Capabilities

- Reporting
- Unit operation interface

Reporting (Native)

PARAMETERS

Exchanger Design (End Point)

Tube Side DeltaP:	0.6895 kPa *	Shell Side DeltaP:	68.95 kPa *	Passes:	---
UA:	845.7 kJ/C-h	Tolerance:	1.0000e-04 *		

Tube Side Data		Shell Side Data	
Heat Transfer Coefficient	---	Heat Transfer Coefficient	---
Tube Pressure Drop	0.69 kPa *	Shell Pressure Drop	68.95 kPa *
Fouling	0.00000 C-h-m2/kJ *	Fouling	0.00000 C-h-m2/kJ *
Tube Length	1.00 m *	Shell Passes	1
Tube O.D.	20.00 mm *	Shell Series	1 *
Tube Thickness	2.0000 mm	Shell Parallel	1 *
Tube Pitch	50.0000 mm *	Baffle Type	Single
Orientation	Horizontal	Baffle Cut(%Area)	20.00 *
Passes Per Shell	1 *	Baffle Orientation	Horizontal
Tubes Per Shell	80 *	Spacing	800.0000 mm *
Layout Angle	Triangular (30 degrees)	Diameter	530.0259 mm *
TEMA Type	A E L	Area	5.03 m2

SPECS

	Specified Value	Current Value	Relative Error	Active	Estimate
Heat Balance	0.0000 kJ/h	1.279e-010 kJ/h	-3.553e-014	On	On
UA	---	845.7 kJ/C-h	---	On	On

Detailed Specifications

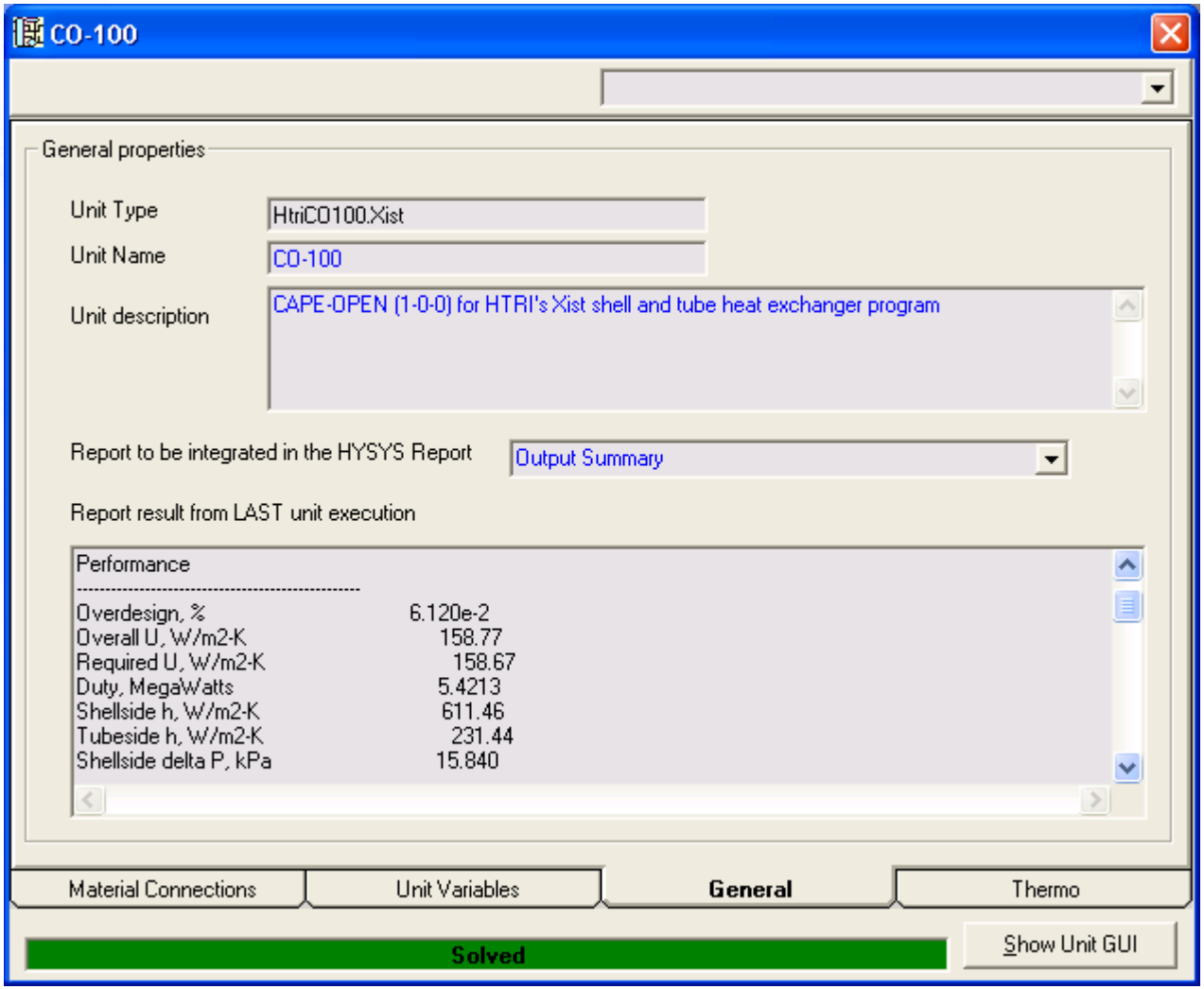
Heat Balance

Type: Duty	Pass: Error	Spec Value: 0.0000 kJ/h

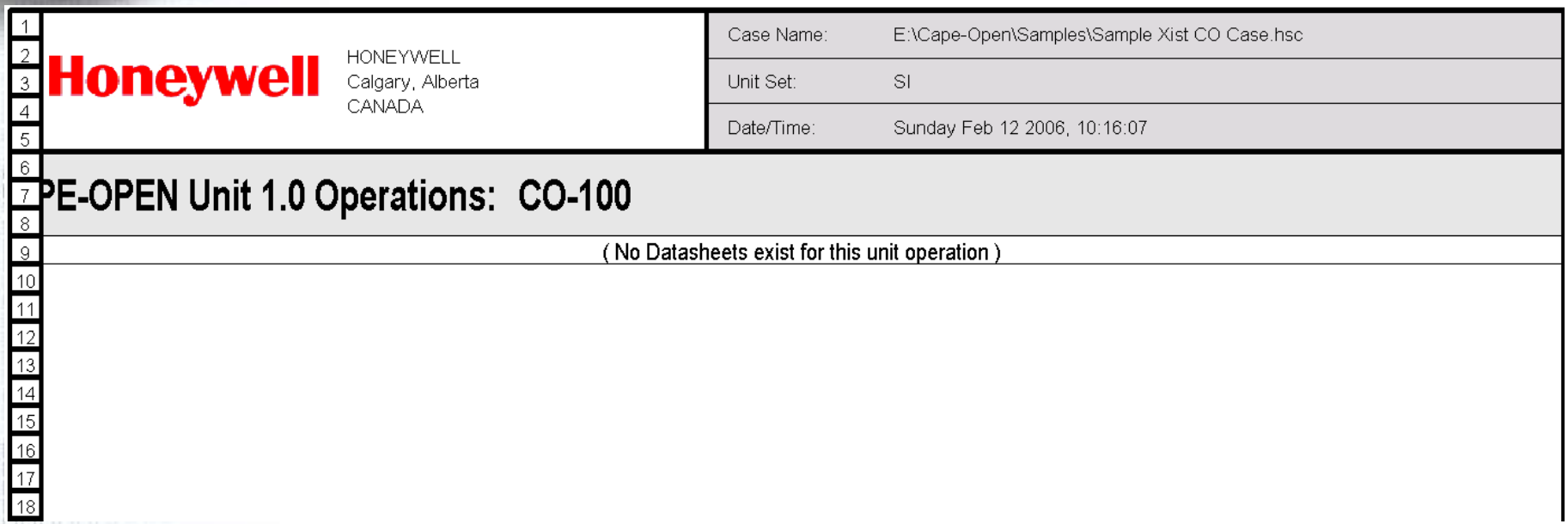
UA

Type: UA	Pass: Overall	Spec Value: ---

Reporting (CAPE-OPEN)



Reporting



Honeywell
HONEYWELL
Calgary, Alberta
CANADA

Case Name:	E:\Cape-Open\Samples\Sample Xist CO Case.hsc
Unit Set:	SI
Date/Time:	Sunday Feb 12 2006, 10:16:07

PE-OPEN Unit 1.0 Operations: CO-100

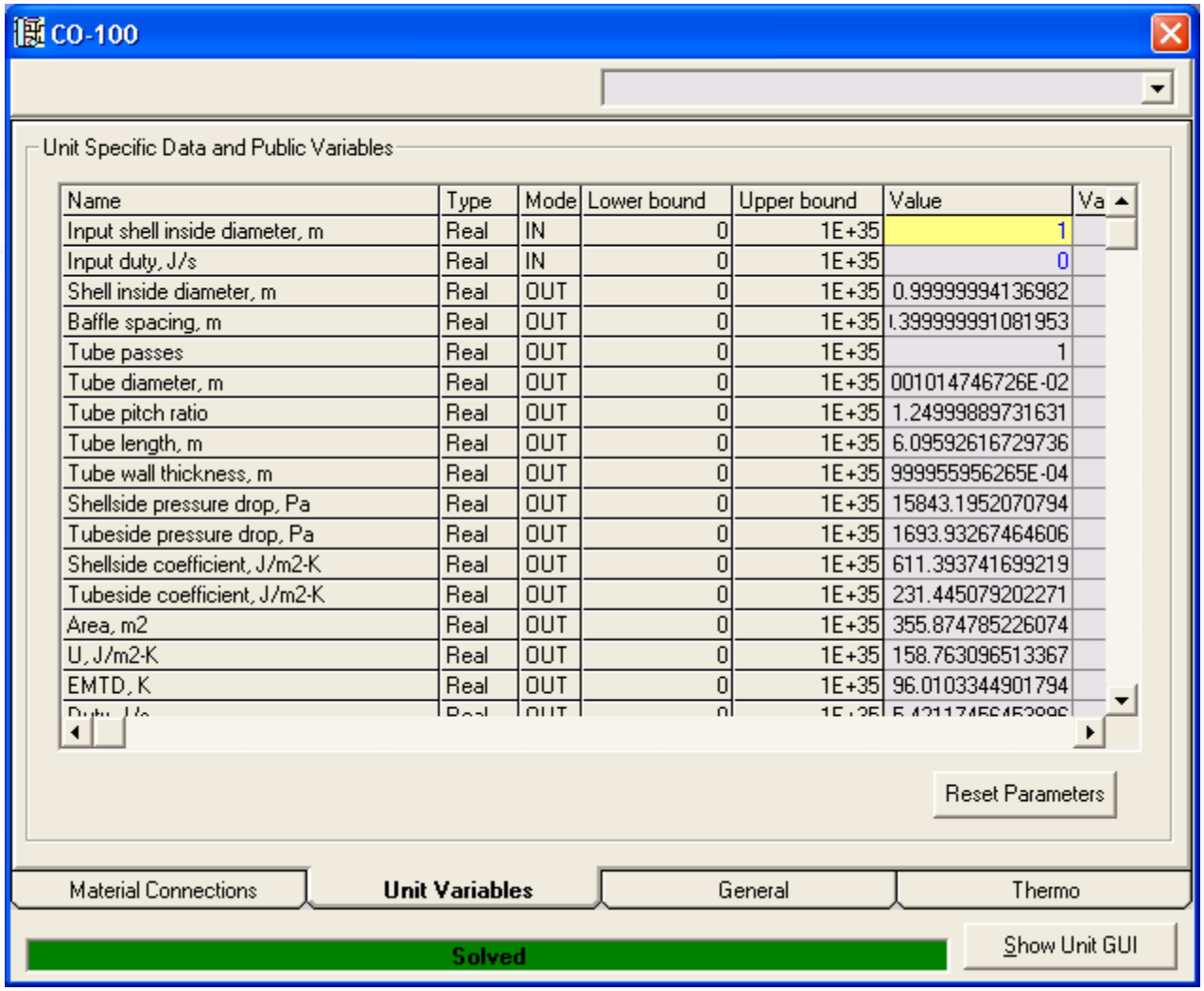
(No Datasheets exist for this unit operation)

Can CAPE-OPEN access the native reporting mechanisms?

Unit Operation Interface

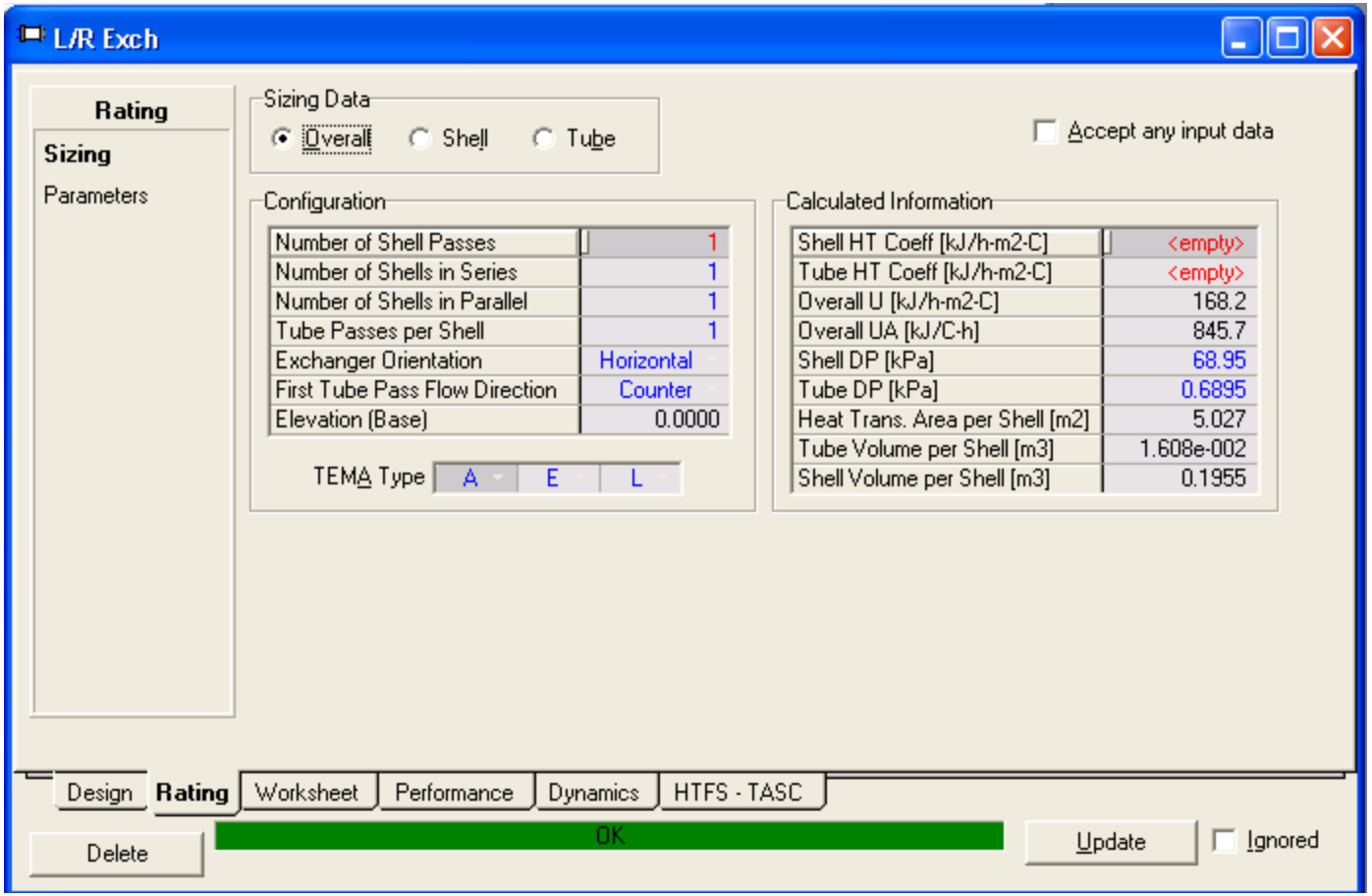
- Access allowed to native unit operation interface
  - Required for complete control of unit operation
- Allows population of parameters in PME
  - Necessary for PME access to unit operation parameters

Unit Operation Interface (CAPE-OPEN)

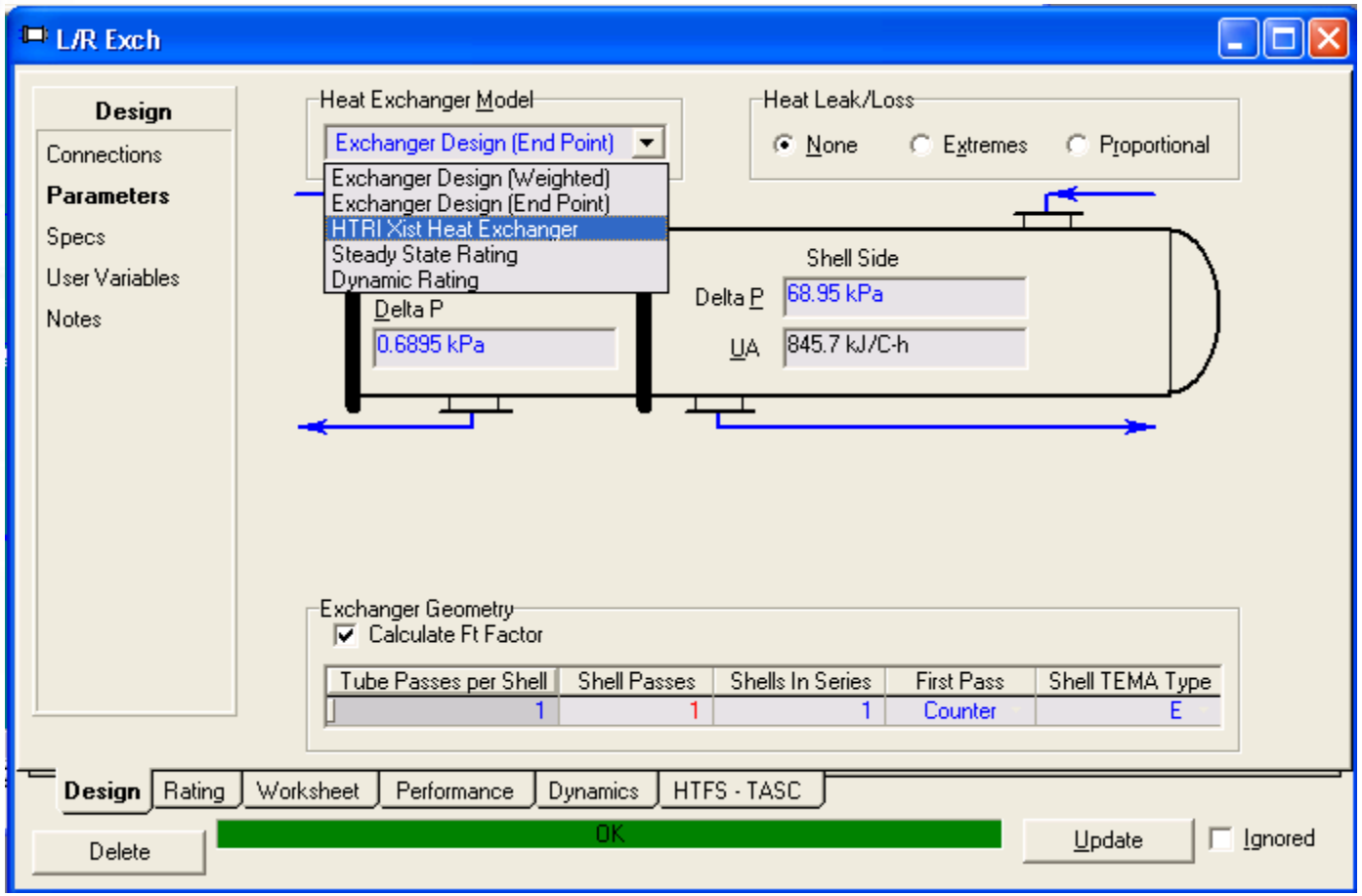


Name	Type	Mode	Lower bound	Upper bound	Value	Va
Input shell inside diameter, m	Real	IN	0	1E+35	1	
Input duty, J/s	Real	IN	0	1E+35	0	
Shell inside diameter, m	Real	OUT	0	1E+35	0.99999994136982	
Baffle spacing, m	Real	OUT	0	1E+35	1.399999991081953	
Tube passes	Real	OUT	0	1E+35	1	
Tube diameter, m	Real	OUT	0	1E+35	001014746726E-02	
Tube pitch ratio	Real	OUT	0	1E+35	1.24999889731631	
Tube length, m	Real	OUT	0	1E+35	6.09592616729736	
Tube wall thickness, m	Real	OUT	0	1E+35	999955956265E-04	
Shellside pressure drop, Pa	Real	OUT	0	1E+35	15843.1952070794	
Tubeside pressure drop, Pa	Real	OUT	0	1E+35	1693.93267464606	
Shellside coefficient, J/m2-K	Real	OUT	0	1E+35	611.393741699219	
Tubeside coefficient, J/m2-K	Real	OUT	0	1E+35	231.445079202271	
Area, m2	Real	OUT	0	1E+35	355.874785226074	
U, J/m2-K	Real	OUT	0	1E+35	158.763096513367	
EMTD, K	Real	OUT	0	1E+35	96.0103344901794	

Unit Operation Interface (Native)



Unit Operation Interface (Extension)



Can CAPE-OPEN allow access to native unit operation interface?

Interface Experience

- Unit Operation interface tested against HYSYS, ASPEN Plus, PRO/II, and UniSim Design
- Property package interface tested against ASPEN Plus, PPDS, Simulis, and UniSim Design

Interface Experience

- Successful interface with one software package does not guarantee it will work with other packages
- Interface required modification for each new package tested
- Requires software packages to be available for testing and interaction between companies

Overall experience was successful in that common code used for all packages!

Interface Experience

- Most problems have been related to properties
- For example overall enthalpy:
  - Software A: Calculated automatically via CalcFlash
  - Software B: Must be specified in the CalcFlash property list
  - Software C: Due to a bug CalcFlash throws an exception when property list supplied
  - Software D: Not calculated by CalcFlash, must be determined from phase properties
- Makes code more complex than necessary

Interface Experience

- Examples of some other problems
  - Volume property calculated instead of Density. Modified HTRI software to detect this and use the available property.
  - IDispatch Invoke method not supported. Modified HTRI software to never use Invoke.
  - IPersistStorage interface not supported. Other vendors implemented IPersistStorage.

Interface Experience

- Improved documentation
  - Flexibility interferes with standardization. Allowing both Volume or Density makes things more difficult not less
  - More specific mechanisms (e.g., overall enthalpy)
  - Required/recommended properties
- Better testing software

Testing Software

- Vendors could supply
  - Program specific testers
    - Allows testing of compatibility with particular software without requiring access to vendor software
    - Could be available to CAPE-OPEN members on website
  - Sample code
    - Provides additional examples beyond Mixer/Splitter block
    - Jump start for new members
- CAPE-OPEN could supply
  - Reference implementation
    - Would require multi-vendor support
    - Substantial amount of work

Summary and Conclusions

- Simply providing technically correct interfaces is not sufficient
- Vendors should optimize software for use in PME
- Additional work in PME could enhance adoption
- CAPE-OPEN could enhance documentation in some areas
  - Details of physical property handling
- Vendor specific testing tools/example code would be useful