

Accuracy of An In-House Heat Transfer and Fluid Flow Modeler

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Importance Of Heat Transfer Coefficient (HTC)

- Measures Heat Transfer Effectiveness Of A Surface
 - Large HTC = Large Amount Of Heat Transfer
 - Combined With Cooling Flow Properties For Temperature Calculation
 - Allows For Temperature Predictions Of A Material In Hot Flow
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Predicting Heat Transfer Coefficient

- ❑ Extremely Difficult Without Numerical Methods
 - ❑ Mechanism Behind Complicated Geometry Is Not Fully Understood
 - ❑ Usually Solve Experimentally-Derived Formulas Iteratively
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K1D Background

- Siemens In-House Heat Transfer Tool

 - Specific Formulas Correspond To Different Physical Features
 - i.e. Smooth Duct, Ribbed Pipe
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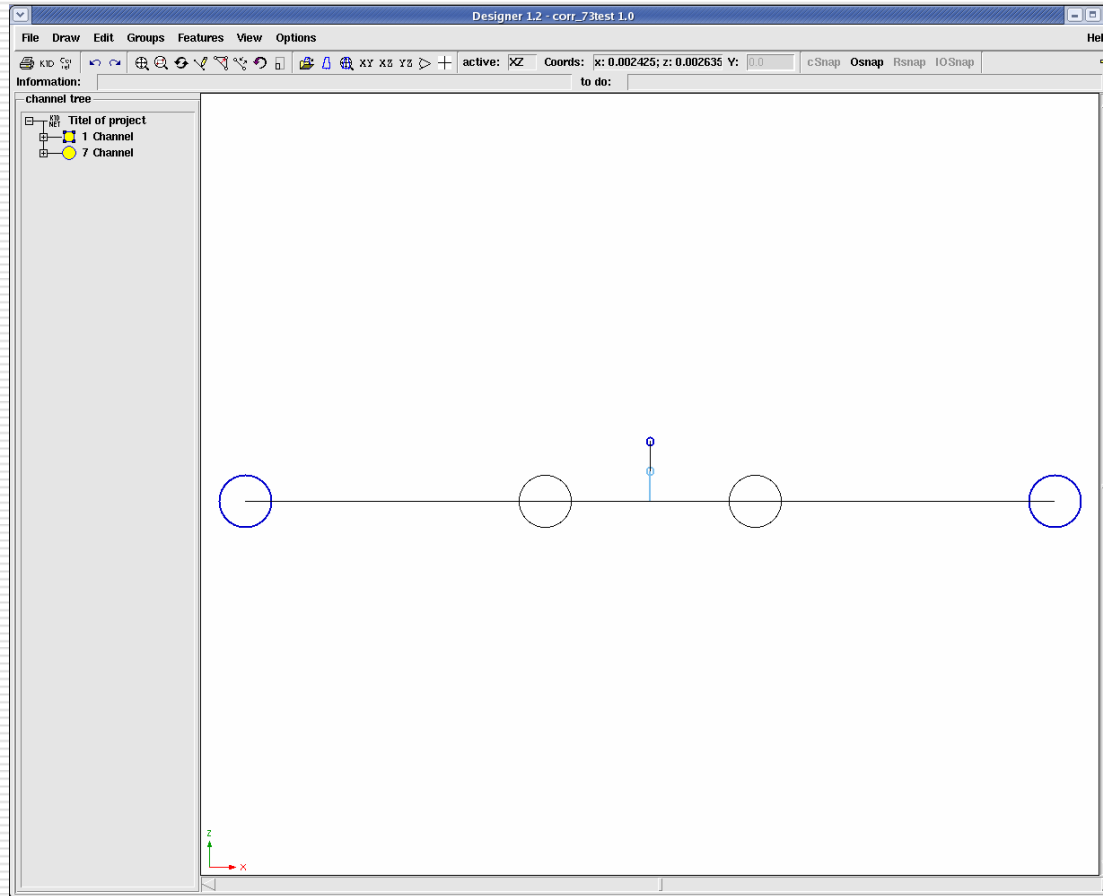
Using K1D

- Basic Building Block: Cell
 - Represents A Physical Feature
 - Contains Cell Length, Cross-Sectional Area, Side Lengths
 - Cells Connect Into Channels
 - Series Of Cells
 - Flow Starts At One End, Passes Through All Cells
 - Channels Combine Into Flow Network
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K1D Input

- Cell Geometry For Each Cell
 - Length, Cross-Sectional Area, Wall Temperature
 - Physical Feature Each Cell Represents
 - Starting And Ending Flow Conditions
 - Total Temperature
 - Total Inlet Pressure
 - Static Outlet Pressure
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An Example K1D Model



Accuracy Of K1D

- My Project: To Create A Tool Similar To K1D
 - Microsoft Excel
 - Visual Basic
 - Using Same Experimentally-Derived Formulas
 - Is K1D A Good Modeling Tool?
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Excel/VB Models

- Each Spreadsheet Corresponds To A Specific Physical Feature
 - User Enters Basic Geometry And Flow Conditions Similar To K1D
 - Fields In Yellow (next slide) Are User-Input Parameters
 - Results Organized/Displayed Immediately
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Excel/VB Model User Input

The screenshot shows a Microsoft Excel spreadsheet titled 'Microsoft Excel - testk.xls'. The active sheet is 'Correlation 20'. The spreadsheet is organized into sections for user input:

- Section 1: Correlation 20** (Rows 1-2)
- Section 2: Infinite Smooth Duct** (Rows 2-3)
- Section 3: Correlation Parameters** (Row 4)
- Section 4: Flow Input** (Row 8)
- Section 5: Geometry Input** (Row 18)

The following table represents the data entered in the spreadsheet:

Row	Parameter	Symbol	Units	Value
6	Slot Flow Flag (< 0 triggers slot treatment)	sff	[-]	0.0
10	Flow Temperature	T	[K]	673.15
11	Wall Temperature	T _w	[K]	673.15
12	Total Inlet Pressure	p _{t,in}	[Pa]	5.00E+05
13	Static Inlet Pressure	p _{s,in}	[Pa]	4.33E+05
14	Dynamic Inlet Pressure	p _{dyn,in}	[Pa]	6.75E+04
18	Number Of Sides	n	[-]	1
19	Sideface 1 Length	s ₁	[m]	3.55E-02
20	Sideface 2 Length (for pipe: 0)	s ₂	[m]	0.00E+00
21	Sideface 3 Length (for pipe: 0)	s ₃	[m]	0.00E+00
22	Sideface 4 Length (for pipe: 0)	s ₄	[m]	0.00E+00
23	Cross-Sectional Area	AA	[m ²]	1.00E-04
24	Channel Segment Length	Δx	[m]	0.3

Project Results

- ❑ Excel/VB Models Were Within 2% of K1D For Nearly All Cases
 - ❑ Need To Explore The Few Discrepancies

 - ❑ K1D Is A Good Modeling Tool!
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Conclusions

- ❑ Thanks to UTSR for giving me this incredible opportunity!
 - ❑ Thanks to everyone at Siemens who made my internship educational and enjoyable!
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