

An Introduction to SolidWorks® Flow Simulation 2012

John E. Matsson, Ph.D.



Visit the following websites to learn more about this book:



Table of Contents

Chapter 1: Introduction	1-1-
SolidWorks Flow Simulation Introduction	1-1-
Setting Up a SolidWorks Flow Simulation Project	1-2-
Meshering in SolidWorks Flow Simulation	1-2-
Calculation Control Options.....	1-4-
Inserting Boundary Conditions	1-4-
Choosing Goals	1-5-
Viewing Results	1-7-
Limitations of SolidWorks Flow Simulation	1-7-
References	1-7-
Chapter 2: Flat Plate Boundary Layer.....	2-1-
Objectives.....	2-1-
Problem Description.....	2-1-
Creating the SolidWorks Part	2-2-
Setting Up the Flow Simulation Project.....	2-8-
Selecting Boundary Conditions.....	2-10-
Inserting Global Goals.....	2-14-
Running the Calculations	2-16-
Using Cut Plots to Visualize the Flow Field	2-17-
Using XY Plots with Templates	2-18-
Comparison of Flow Simulation Results with Theory and Empirical Data	2-20-
Cloning of the Project.....	2-27-
References	2-35-
Exercises.....	2-35-

Table of Contents

Chapter 3: Analysis of the Flow past a Sphere and a Cylinder	3-1-
Objectives	3-1-
Problem Description	3-1-
Creating the SolidWorks Part for the Sphere	3-1-
Setting Up the Flow Simulation Project for the Sphere	3-9-
Inserting Global Goal for Calculations.....	3-12-
Running the Calculations.....	3-13-
Using Cut Plots.....	3-15-
Inserting Surface Parameters	3-16-
Theory	3-17-
Cloning of the Project	3-17-
Time-Dependent Calculations	3-18-
Creating the SolidWorks Part for the Cylinder.....	3-20-
Setting Up the Flow Simulation Project for the Cylinder.....	3-21-
Inserting Global Goals for Calculations and selecting 2D Flow	3-22-
Tabular Saving.....	3-23-
Running Calculations for the Cylinder.....	3-24-
Using Excel for Frequency Analysis	3-25-
Inserting XY Plots	3-25-
Strouhal number	3-27-
Inserting Cut Plots	3-27-
Animating the Cut Plots	3-30-
References	3-32-
Exercises.....	3-32-
Chapter 4: Analysis of the Flow past an Airfoil	4-1-
Objectives	4-1-
Problem Description	4-1-

Table of Contents

Creating the SolidWorks Part	4-1-
Setting Up the Flow Simulation Project.....	4-5-
Inserting Global Goals for Calculations	4-8-
Running the Calculations	4-10-
Using Cut Plots	4-11-
Theory	4-12-
Creating a Custom Visualization Parameter	4-13-
Inserting Equation Goal for Calculations	4-16-
Cloning of the Project	4-17-
Creating a Batch Run	4-18-
References	4-19-
Exercises.....	4-20-

Chapter 5: Rayleigh-Bénard Convection and Taylor-Couette Flow	5-1-
Objectives.....	5-1-
Problem Description.....	5-1-
Creating the SolidWorks Part for Rayleigh-Bénard Convection.....	5-2-
Setting up the Flow Simulation Project for Rayleigh-Bénard Convection.....	5-4-
Creating Lids	5-6-
Inserting Boundary Conditions for Rayleigh-Bénard Convection	5-7-
Setting up 2D Flow	5-9-
Inserting Global Goal for Rayleigh-Bénard Convection.....	5-10-
Running the Calculations	5-10-
Inserting Cut Plots	5-11-
Comparison with Neutral Stability Theory	5-14-
Creating the SolidWorks Part for Taylor-Couette Flow.....	5-15-
Setting up the Flow Simulation Project for Taylor-Couette Flow	5-18-

Table of Contents

Inserting Boundary Conditions for Taylor-Couette Cell	5-20-
Inserting Global Goal and Running the Calculations for Taylor-Couette Flow	5-21-
Inserting Surface Plots.....	5-21-
Comparison with Neutral Stability Theory.....	5-25-
References	5-26-
Exercises.....	5-26-

Chapter 6: Pipe Flow	6-1-
Objectives	6-1-
Problem Description	6-1-
Creating the SolidWorks Part	6-1-
Setting up the Flow Simulation Project	6-5-
Creating Lids for the Pipe.....	6-8-
Modifying the Computational Domain and Mesh.....	6-9-
Inserting Boundary Conditions.....	6-11-
Inserting a Global Goal.....	6-14-
Running the Calculations for Laminar Pipe Flow	6-14-
Inserting Cut Plots	6-15-
Inserting XY Plots for Laminar Pipe Flow using Templates.....	6-16-
Theory for Laminar Pipe Flow	6-18-
Running Calculations for Turbulent Pipe Flow.....	6-20-
Theory for Turbulent Pipe Flow	6-20-
Inserting XY Plots for Turbulent Pipe Flow using Templates	6-21-
Reference	6-25-
Exercises.....	6-25-

Table of Contents

Chapter 7: Flow across a Tube Bank	7-1-
Objectives.....	7-1-
Problem Description.....	7-1-
Creating the SolidWorks Part	7-2-
Setting up the Flow Simulation Project	7-4-
Modifying the Computational Domain and Mesh.....	7-6-
Inserting Boundary Conditions	7-7-
Inserting Global Goals.....	7-8-
Running the Calculations for Tube Bank Flow	7-8-
Inserting Cut Plots.....	7-9-
Creating Sketch for XY Plots.....	7-11-
Theory and Empirical Data	7-13-
Reference.....	7-16-
Exercises.....	7-16-
Chapter 8: Heat Exchanger	8-1-
Objectives.....	8-1-
Problem Description.....	8-1-
Creating the SolidWorks Part	8-2-
Setting up the Flow Simulation Project	8-10-
Creating Lids	8-12-
Inserting Boundary Conditions	8-14-
Inserting Goals	8-16-
Running the Calculations for Heat Exchanger	8-17-
Inserting Surface Parameters	8-18-
Inserting Cut Plots.....	8-18-
Effectiveness – NTU Method.....	8-20-

Table of Contents

Reference	8-22-
Exercises.....	8-23-

Chapter 9: Ball Valve..... 9-1-

Objectives	9-1-
Problem Description	9-1-
Creating the Ball Valve	9-2-
Creating the Ball Valve Housing and Pipe Sections	9-7-
Creating the Ball Valve and Pipe Assembly.....	9-11-
Setting up the Flow Simulation Project for the Ball Valve	9-14-
Creating Lids and Setting the Minimum Gap Size and Number of Cells.....	9-15-
Inserting Boundary Conditions.....	9-16-
Inserting Goals	9-18-
Running the Calculations for Ball Valve.....	9-18-
Inserting Cut Plots	9-19-
Determining Hydraulic Resistance.....	9-20-
Reference	9-22-
Exercises.....	9-23-

Chapter 10: Orifice Plate and Flow Nozzle 10-1-

Objectives	10-1-
Problem Description	10-1-
Creating the Orifice Plate in a Pipe	10-2-
Setting up the Flow Simulation Project for the Orifice Plate	10-6-
Inserting Boundary Conditions.....	10-7-
Inserting Goals.....	10-9-
Running the Calculations for Orifice Plate.....	10-9-

Table of Contents

Inserting Cut Plots	10-11-
Determining Discharge Coefficient for Orifice Plate.....	10-12-
Inserting XY Plots	10-14-
Creating Sketch for XY Plots.....	10-16-
Flow Trajectories.....	10-17-
Running the Calculations for Long Radius Nozzle	10-18-
Determining Discharge Coefficient for Long Radius Nozzle	10-19-
Reference.....	10-20-
Exercises.....	10-20-

Chapter 11: Thermal Boundary Layer	11-1-
Objectives.....	11-1-
Problem Description.....	11-1-
Setting up the Flow Simulation Project.....	11-1-
Inserting Boundary Conditions	11-4-
Inserting Goals	11-7-
Running the Calculations for Low Reynolds Number	11-7-
Inserting Cut Plots	11-8-
Plotting Temperature Profiles using Template.....	11-9-
Theory	11-11-
Plotting Non-dimensional Temperature Profiles using Template	11-11-
Plotting Local Nusselt Number using Template	11-13-
Running the Calculations for High Reynolds Number.....	11-14-
References	11-17-
Exercise	11-17-

Table of Contents

Chapter 12: Free-Convection on a Vertical Plate and from a Horizontal Cylinder	12-1-
Objectives	12-1-
Problem Description	12-1-
Setting up the Flow Simulation Project.....	12-2-
Inserting Goals.....	12-6-
Running Calculations	12-6-
Inserting Cut Plots	12-7-
Plotting Temperature and Velocity Profiles using Templates	12-8-
Theory.....	12-11-
Plotting Non-dimensional Temperature and Velocity Profiles using Templates	12-11-
Plotting Local Nusselt Number using Template	12-14-
Creating the SolidWorks Part for Free Convection from a Horizontal Cylinder	12-15-
Setting up the Flow Simulation Project for Free Convection from a Horizontal Cylinder	12-16-
Inserting Global Goal and Selecting 2D Flow for Free Convection from a Horizontal Cylinder	12-17-
Tabular Savings for Free Convection from Horizontal Cylinder	12-18-
Inserting Boundary Condition for Free Convection from Horizontal Cylinder	12-18-
Running Calculations for Free Convection from Horizontal Cylinder.....	12-19-
Inserting Cut Plots for Free Convection from Horizontal Cylinder	12-20-
Animating the Temperature Field for Free Convection from a Horizontal Cylinder	12-21-
References	12-22-
Exercises	12-22-
Chapter 13: Swirling Flow in a Closed Cylindrical Container	13-1-
Objectives	13-1-
Problem Description	13-1-
Creating the SolidWorks Part for Swirling Flow in a Closed Cylindrical Container	13-2-
Setting up the Flow Simulation Project for Swirling Flow in a Closed Cylindrical Container	13-3-

Table of Contents

Creating Lids	13-5-
Inserting Boundary Condition for Swirling Flow in a Closed Cylindrical Container	13-6-
Inserting Global Goal for Swirling Flow in a Closed Cylindrical Container	13-7-
Running the Calculations	13-8-
Inserting Flow Trajectories	13-9-
Reference	13-11-
Exercise	13-11-