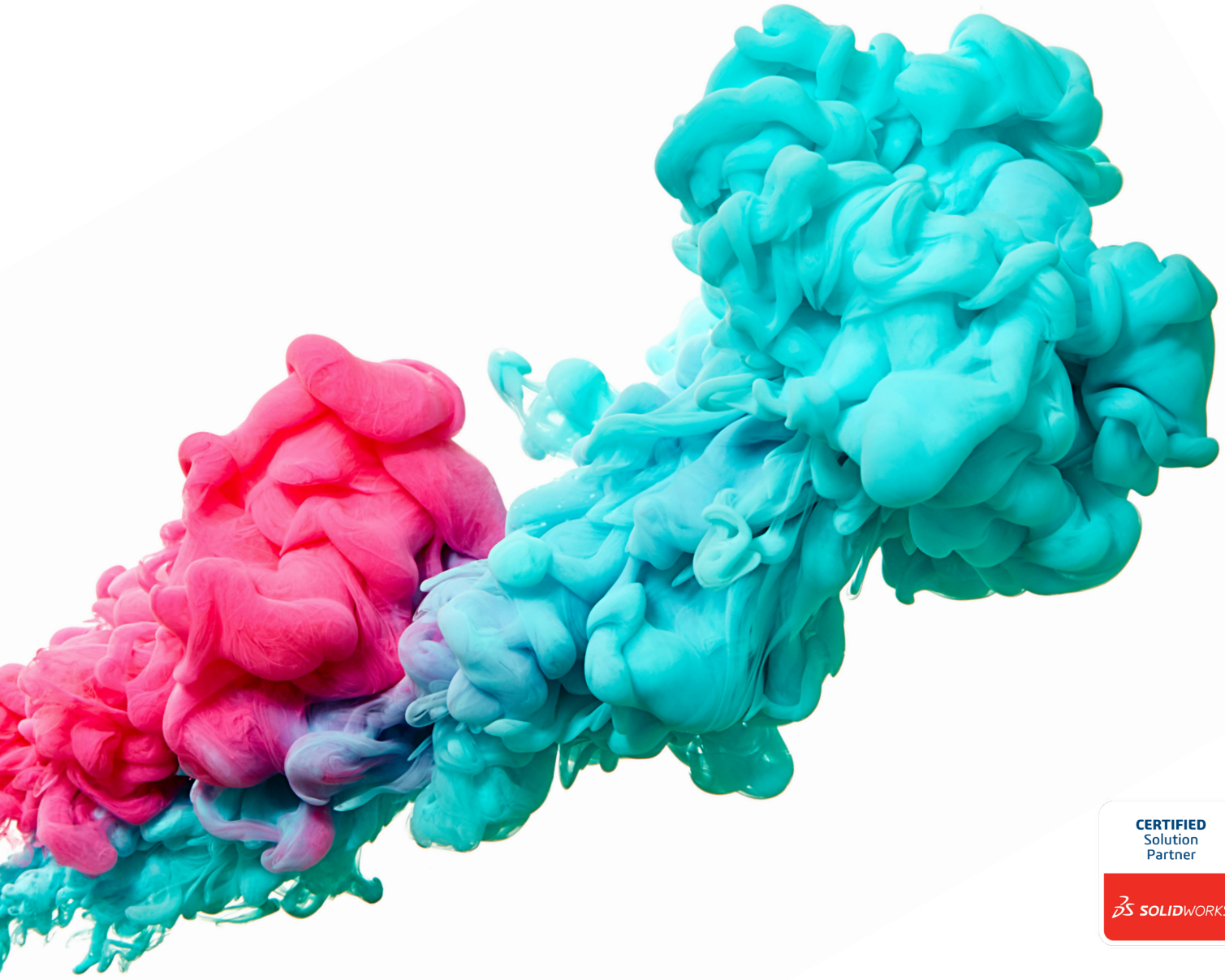
An Introduction to

SOLIDWORKS® Flow Simulation 2022



CERTIFIED Solution Partner

SOLIDWORKS

John E. Matsson, Ph.D., P.E.

SDC PUBLICATIONS

Better Textbooks. Lower Prices.

www.SDCpublications.com

Visit the following websites to learn more about this book:

TABLE OF CONTENTS

CHAPTER 1. INTRODUCTION 13
A. SOLIDWORKS® Flow Simulation 13
B. Project 14
C. Meshing 14
D. Calculation Control Options 16
E. Boundary Conditions 16
F. Goals 17
G. Results 19
H. Limitations 19
I. References 19
CHAPTER 2. FLAT PLATE BOUNDARY LAYER 21
A. Objectives 21
B. Problem Description 21
C. Creating the SOLIDWORKS Part 22
D. Setting Up the Flow Simulation Project 28
E. Selecting Boundary Conditions 30
F. Inserting Global Goals and Calculation Controls 34
G. Running the Calculations 36
H. Using Cut Plots to Visualize the Flow Field 38
I. Using XY Plots with Templates 39
J. Comparison of Flow Simulation Results with Theory and Empirical Data 41
K. Cloning of the Project 44
L. References 53
M. Exercises 53
CHAPTER 3. FLOW PAST A SPHERE AND A CYLINDER 57
A. Objectives 57
B. Problem Description 57
C. Creating the SOLIDWORKS Part for the Sphere 58
D. Setting Up the Flow Simulation Project for the Sphere 64
E. Inserting Global Goal for Calculations 66
F. Running the Calculations 68
G. Using Cut Plots 69
H. Inserting Surface Parameters 70
I. Theory 71

J. Cloning of the Project 71
K. Time-Dependent Calculations 72
L. Creating SOLIDWORKS Part for Cylinder 74
M. Setting Up Flow Simulation Project for Cylinder 75
N. Inserting Global Goals for Calculations and Selecting 2D Flow 76
O. Tabular Saving 77
P. Running Calculations for Cylinder 78
Q. Using Excel for Frequency Analysis 79
R. Inserting XY Plots 80
S. Strouhal number 82
T. Inserting Cut Plots 82
U. References 84
V. Exercises 84
CHAPTER 4. FLOW PAST AN AIRFOIL 87
A. Objectives 87
B. Problem Description 87
C. Creating the SOLIDWORKS Part 88
D. Setting Up Flow Simulation Project 92
E. Inserting Global Goals 95
F. Inserting Equation Goals 95
G. Global and Local Mesh 96
H. Running Simulations 97
I. Using Cut Plots 100
J. Theory 102
K. Creating a Custom Visualization Parameter 103
L. Cloning of Project 107
M. Creating a Batch Run 108
N. Reference 112
O. Exercises 112
CHAPTER 5. RAYLEIGH-BENARD CONVECTION & TAYLOR-COUETTE FLOW 113
A. Objectives 113
B. Problem Description 113
C. Creating the SOLIDWORKS Part for Rayleigh-Benard Convection 114
D. Setting Up Flow Simulation Project for Rayleigh-Benard Convection 116
E. Creating Lids 118
F. Boundary Conditions for Rayleigh-Benard Convection 119

G. Setting Up 2D Flow 121
H. Global Goal for Rayleigh-Benard Convection 122
I. Running Calculations 122
J. Inserting Cut-Plots 124
K. Comparison with Neutral Stability Theory 126
L. Creating SOLIDWORKS Part for Taylor-Couette Flow 127
M. Flow Simulation Project for Taylor-Couette Flow 129
N. Boundary Conditions for Taylor-Couette Flow 131
O. Global Goal and Simulations for Taylor-Couette Flow 132
P. Inserting Surface Plots 133
Q. Comparison with Neutral-Stability Theory 135
R. References 136
S. Exercises 136
CHAPTER 6. PIPE FLOW 139
A. Objectives 139
B. Problem Description 139
C. Creating the SOLIDWORKS Part 140
D. Flow Simulation Project 143
E. Lids for the Pipe 145
F. Computational Domain and Mesh 146
G. Boundary Conditions 148
H. Global Goal and Calculation Control Options 151
I. Flow Simulations for Laminar Pipe Flow 152
J. Inserting Cut Plots 153
K. Inserting XY Plots for Laminar Pipe Flow Using Templates 154
L. Theory for Laminar Pipe flow 157
M. Flow Simulations for Turbulent Pipe Flow 158
N. Theory for Turbulent Pipe Flow 159
O. XY Plots for Turbulent Pipe Flow Using Templates 160
P. References 163
Q. Exercises 163
CHAPTER 7. FLOW ACROSS A TUBE BANK 165
A. Objectives 165
B. Problem Description 165
C. Creating a SOLIDWORKS Part 166
D. Flow Simulation Project 167

E. Computational Domain and Mesh 169
F. Boundary Conditions 170
G. Global Goals 171
H. Flow Simulations for Tube Bank Flow 171
I. Inserting Cut Plots 172
J. Sketches for XY Plots 174
K. Theory and Empirical Data 176
L. References 179
M. Exercises 179
CHAPTER 8. HEAT EXCHANGER 181
A. Objectives 181
B. Problem Description 181
C. Creating the SOLIDWORKS Part 182
D. Flow Simulation Project 190
E. Creating Lids 192
F. Boundary Conditions 193
G. Inserting Goals 195
H. Simulations for Heat Exchanger 196
I. Surface Parameters 197
J. Cut-Plots 198
K. Theory for Effectiveness-NTU Method 199
L. References 201
M. Exercises 202
CHAPTER 9. BALL VALVE 203
A. Objectives 203
B. Problem Description 203
C. Creating the Ball Valve 204
D. Ball Valve Housing and Pipe Sections 210
E. Ball Valve and Pipe Assembly 214
F. Flow Simulation Project for Ball Valve 217
G. Creating Lids, Maximum Gap Size and Number of Cells 218
H. Boundary Conditions 219
I. Goals 220
J. Simulation for Ball Valve 221
K. Cut-Plots 221
L. Hydraulic Resistance 222

M. References 224
N. Exercises 224
CHAPTER 10. ORIFICE PLATE AND FLOW NOZZLE 225
A. Objectives 225
B. Problem Description 225
C. Modeling an Orifice Plate in a Pipe 226
D. Flow Simulation Project for Orifice Plate 230
E. Boundary Conditions 231
F. Goals 233
G. Flow Simulation for Orifice Plate 234
H. Cut-Plots for Orifice Plate 235
I. Discharge Coefficient, XY Plots and Flow Trajectories for Orifice Plate 236
J. Simulation and Discharge Coefficient for Long Radius Nozzle 241
K. References 243
L. Exercises 244
CHAPTER 11. THERMAL BOUNDARY LAYER 245
A. Objectives 245
B. Problem Description 245
C. Flow Simulation Project 245
D. Boundary Conditions 248
E. Goals and Calculation Controls 251
F. Simulation for Low Reynolds Number 252
G. Cut-Plots 253
H. Plotting Temperature Profiles Using Templates 254
I. Theory 256
J. Plotting Non-Dimensional Temperature Profiles Using Templates 256
K. Plotting Local Nusselt Number Using Templates 257
L. Simulations at a Higher Reynolds Number 258
M. References 261
N. Exercise 261
CHAPTER 12. FREE CONVECTION ON A VERTICAL PLATE AND A HORIZONTAL CYLINDER 263
A. Objectives 263
B. Problem Description 263
C. Flow Simulation Project 264
D. Goals and Calculation Controls 267
E. Running Simulations for Vertical Plate 267

F. Cut-Plots for Vertical Wall 268
G. Plotting Temperature and Velocity Profiles Using Templates 269
H. Theory 271
I. Plotting Non-Dimensional Temperature and Velocity Profiles Using Templates 272
J. Plotting Local Nusselt Number Using Templates 274
K. Creating SOLIDWORKS Part for Free Convection from Horizontal Cylinder 274
L. Flow Simulation Project for Free Convection from Horizontal Cylinder 275
M. Global Goal and 2D Flow for Free Convection from Horizontal Cylinder 276
N. Tabular Saving for Free Convection from Horizontal Cylinder 277
O. Boundary Condition for Free Convection from Horizontal Cylinder 278
P. Simulations for Free Convection from Horizontal Cylinder 279
Q. Cut-Plots for Free Convection from Horizontal Cylinder 280
R. References 280
S. Exercises 281
CHAPTER 13. SWIRLING FLOW IN A CLOSED CYLINDRICAL CONTAINER. 283
A. Objectives 283
B. Problem Description 283
C. Modeling SOLIDWORKS Part 284
D. Flow Simulation Project 285
E. Modeling Lids 287
F. Boundary Conditions 288
G. Global Goals 289
H. Running Simulations 289
I. Flow Trajectories 291
J. Theory 292
K. References 292
L. Exercise 292
CHAPTER 14. FLOW PAST A MODEL ROCKET 293
A. Objectives 293
B. Problem Description 293
C. Modeling SOLIDWORKS Parts 293
D. Flow Simulation Project 299
E. Computational Domain 300
F. Goals 301
G. Global Mesh 301
H. Local Mesh 302

TABLE OF CONTENTS

I. Running Simulations 303
J. Cut-Plots 306
K. Theory 306
L. References 309
M. Exercises 309
CHAPTER 15. DRAINING OF A CYLINDRICAL TANK 311
A. Objectives 311
B. Problem Description 311
C. Modeling SOLIDWORKS Part 312
D. Flow Simulation Project 315
E. Computational Domain, Initial Condition and Boundary Conditions 317
F. Goal, Global Mesh and Calculation Control Options 319
G. Running the Flow Simulation 320
H. Goals Plots 321
I. Transient Explorer 322
J. Theory 323
K. References 324
L. Exercises 325
CHAPTER 16. AHMED BODY 327
A. Objectives 327
B. Problem Description 327
C. Modeling SOLIDWORKS Part 328
D. Flow Simulation Project 331
E. Computational Domain 332
F. Goals 333
G. Global Mesh 333
H. Local Mesh 334
I. Running Simulations 335
J. Cut-Plots and Flow Trajectories 337
K. Cloning of Project 339
L. Creating a Batch Run 339
M. Theory 341
N. References 341
O. Exercises 342
CHAPTER 17. SAVONIUS WIND TURBINE 343
A. Objectives 343

TABLE OF CONTENTS

B. Problem Description 343
C. Modeling SOLIDWORKS Part and Rotating Domain 343
D. Flow Simulation Project 351
E. Computational Domain 352
F. Goals 353
G. Rotating Region 354
H. Global Mesh 355
I. Local Mesh 355
J. Running Simulations 356
K. Cut-Plots, Flow Trajectories and Goals Plot 358
L. Cloning of Project 360
M. Creating a Batch Run 362
N. Theory 364
O. References 365
P. Exercises 365
INDEX 367