```
clc;
format long

%% Part 1
manometar_hieght = [0.5 0.78 1.12 1.39 1.74 2.03 2.29]; %[m]
pressure_gauge = [0.3 0.5 0.8 1.1 1.45 1.75 2]; % [V]
g = 9.81; % [m/s^2]
rho = 997; % [Kg/m^3]
delta_p = rho*g*manometar_hieght; % [pa]
delta_p_as_a_func_of_pressure_gauge_poly = [1.0040e+04, 2.4314e+03];
delta_p_as_a_func_of_pressure_gauge = delta_p_as_a_func_of_pressure_gauge_poly(1)*pressure_gauge+delta_p_as_a_func_of_pressure_gauge_poly(2);

% delta_FR_calib = (((1.418*10^(-4))./t).^2+(1.418*10^(-3).*h_calib./t.^2 ).^2 ).^0.5;

fig1 = figure ("Name","Delta P as a Function of Voltage",'Position',[100 350 900 500]);
hold all
plot (pressure_gauge, delta_p_as_a_func_of_pressure_gauge,'LineWidth',2,'Color',[0 0.4470 0.7410])

e1 = errorbar(pressure_gauge,delta_p,zeros(1,length(delta_p)), 'LineStyle','none');
e1.Color = [0 0 0];
e1.Marker = '.';
e1.MarkerSize = 15;

e1.XNegativeDelta = zeros(1,length(delta_p))+0.05;
e1.XPositiveDelta = zeros(1,length(delta_p))+0.05;
e1.YNegativeDelta = zeros(1,length(delta_p))+502;
```

```
 27 e1.YPositiveDelta = zeros(1,length(delta_p))+502;
 28
 29 title ("Delta P as a Function of Voltage")
 30 ylabel("Delta P [Pa]")
 31 xlabel("Voltage [V]")
 32 grid on
 33 grid minor
 34 legend({'y = 1.0040e+04*x + 2.4314e+03'},'FontSize',11↙
,'Location','northwest')
 35 %exportgraphics(fig1, 'P1-graph1.png','Resolution',1200);
 36
 37 %% Part 2 - 1
 38 true_flow_rate = [56.71 174.8 359.1 482.0 595.4]*10^(-6);↙
% [m^3/sec]
 39 rotmeter_flow_rate = [83.33 200.0 366.7 500.0 633.3]*10^↙
(-6); % [m^3/sec]
 40 h_calib = [0.06 0.185 0.38 0.51 0.63]; % [m]
 41 t = [30 30 30 30 30]; % [sec]
 42
 43 true_flow_rate_as_a_func_of_rotmeter_flow_rate_poly =↙
[0.9902 -1.958e-05];
 44 true_flow_rate_as_a_func_of_rotmeter_flow_rate =↙
true_flow_rate_as_a_func_of_rotmeter_flow_rate_poly(1)↙
*rotmeter_flow_rate+true_flow_rate_as_a_func_of_rotmeter_flow_↙
rate_poly(2);
 45
 46 delta_FR_calib = (((1.418*10^(-4))./t).^2+(1.418*10^(-3).↙
*h_calib./t.^2 ).^2 ).^0.5;
 47 dleta_FR_real_from_rotmeter = 16.51*10^(-6);
 48 delta_FR_real = (delta_FR_calib.^2.↙
+dleta_FR_real_from_rotmeter.^2).^0.5;
 49
 50 fig2 = figure ("Name","True Flow Rate as a Fuction of↙
Rotmeter Flow Rate",'Position',[300 350 900 500]);
 51 hold all
```

```
 52 plot (rotmeter_flow_rate,↙
true_flow_rate_as_a_func_of_rotmeter_flow_rate,'LineWidth',↙
2,'Color',[0 0.4470 0.7410])
 53
 54 e1 = errorbar(rotmeter_flow_rate,true_flow_rate,zeros(1,↙
length(rotmeter_flow_rate)), 'LineStyle','none');
 55 e1.Color = [0 0 0];
 56 e1.Marker = '.';
 57 e1.MarkerSize = 15;
 58
 59 e1.XNegativeDelta = zeros(1,length(rotmeter_flow_rate))↙
+16.67*10^(-6);
 60 e1.XPositiveDelta = zeros(1,length(rotmeter_flow_rate))↙
+16.67*10^(-6);
 61 e1.YNegativeDelta = delta_FR_real;
 62 e1.YPositiveDelta = delta_FR_real;
 63
 64 title ("True Flow Rate as a Fuction of Rotmeter Flow↙
Rate")
 65 ylabel("True Flow Rate [m^3/sec]")
 66 xlabel("Rotmeter Flow Rate [m^3/sec]")
 67 grid on
 68 grid minor
 69 legend({'y = 0.9902*x - 1.958e-05'},'FontSize',11↙
,'Location','northwest')
 70 %exportgraphics(fig2, 'P2-graph1.png','Resolution',1200);
 71
 72 %% Part 2 - 2
 73 true_flow_rate = [56.71 174.8 359.1 482.0 595.4]*10^(-6);↙
% [m^3/sec]
 74 h_rotmeter = [5 37.5 72 94 115]*10^(-3); % [m]
 75 h_calib = [0.06 0.185 0.38 0.51 0.63]; % [m]
 76 t = [30 30 30 30 30]; % [sec]
 77
 78 true_flow_rate_as_a_func_of_h_rotmeter_poly = [4.977e-3↙
```

```
1.158e-5];
 79 true_flow_rate_as_a_func_of_h_rotmeter =↙
true_flow_rate_as_a_func_of_h_rotmeter_poly(1)↙
*h_rotmeter+true_flow_rate_as_a_func_of_h_rotmeter_poly(2);
 80
 81 delta_FR_calib = (((1.418*10^(-4))./t).^2+(1.418*10^(-3).↙
*h_calib./t.^2 ).^2 ).^0.5;
 82 dleta_FR_real_from_h_rotmeter = 2.489*10^(-6);
 83 delta_FR_real = (delta_FR_calib.^2.↙
+dleta_FR_real_from_h_rotmeter.^2).^0.5;
 84
 85 fig3 = figure ("Name","True Flow Rate as a Fuction of↙
Rotmeter Hieght",'Position',[500 350 900 500]);
 86 hold all
 87 plot (h_rotmeter,↙
true_flow_rate_as_a_func_of_h_rotmeter,'LineWidth',2,'Color',↙
[0 0.4470 0.7410])
 88
 89 e1 = errorbar(h_rotmeter,true_flow_rate,zeros(1,length↙
(h_rotmeter)), 'LineStyle','none');
 90 e1.Color = [0 0 0];
 91 e1.Marker = '.';
 92 e1.MarkerSize = 5;
 93
 94 e1.XNegativeDelta = zeros(1,length(h_rotmeter))+0.5*10^↙
(-3);
 95 e1.XPositiveDelta = zeros(1,length(h_rotmeter))+0.5*10^↙
(-3);
 96 e1.YNegativeDelta = delta_FR_real;
 97 e1.YPositiveDelta = delta_FR_real;
 98
 99 title ("True Flow Rate as a Fuction of Rotmeter Hieght")
100 ylabel("True Flow Rate [m^3/sec]")
101 xlabel("Rotmeter Hieght [m]")
102 grid on
```

```
103 grid minor
104 legend({'y = 4.977e-3*x + 1.158e-5'},'FontSize',11↙
,'Location','northwest')
105 %exportgraphics(fig3, 'P2-graph2.png','Resolution',1200);
106
107 %% Part 2 - 3
108 true_flow_rate = [56.71 174.8 359.1 482.0 595.4]*10^(-6);↙
% [m^3/sec]
109 frequency = [2.9 16.6 29.6 39.2 48.4]; % [Hz]
110 h_calib = [0.06 0.185 0.38 0.51 0.63]; % [m]
111 t = [30 30 30 30 30]; % [sec]
112
113 true_flow_rate_as_a_func_of_frequency_poly = [1.214e-5↙
1.733e-6];
114 true_flow_rate_as_a_func_of_frequency =↙
true_flow_rate_as_a_func_of_frequency_poly(1)↙
*frequency+true_flow_rate_as_a_func_of_frequency_poly(2);
115
116 delta_FR_calib = (((1.418*10^(-4))./t).^2+(1.418*10^(-3).↙
*h_calib./t.^2 ).^2 ).^0.5;
117 dleta_FR_real_from_frequency = 0.607e-6;
118 delta_FR_real = (delta_FR_calib.^2.↙
+dleta_FR_real_from_frequency.^2).^0.5;
119
120 fig4 = figure ("Name","True Flow Rate as a Fuction of↙
Frequency",'Position',[700 350 900 500]);
121 hold all
122 plot (frequency,↙
true_flow_rate_as_a_func_of_frequency,'LineWidth',2,'Color',[0↙
0.4470 0.7410])
123
124 e1 = errorbar(frequency,true_flow_rate,zeros(1,length↙
(frequency)), 'LineStyle','none');
125 e1.Color = [0 0 0];
126 e1.Marker = '.';
```

```
127 e1.MarkerSize = 5;
128
129 e1.XNegativeDelta = zeros(1,length(frequency))+0.05;
130 e1.XPositiveDelta = zeros(1,length(frequency))+0.05;
131 e1.YNegativeDelta = delta_FR_real;
132 e1.YPositiveDelta = delta_FR_real;
133
134 title ("True Flow Rate as a Fuction of Frequency")
135 ylabel("True Flow Rate [m^3/sec]")
136 xlabel("Frequency [Hz]")
137 grid on
138 grid minor
139 legend({'y = 1.214e-5*x + 1.733e-6'},'FontSize',11↙
,'Location','northwest')
140 %exportgraphics(fig4, 'P2-graph3.png','Resolution',1200);
141
142 %% Part 2 - 4 - 1 - 1
143 h_calib = [0.095 0.2 0.37 0.485 0.625]; % [m]
144 t = [30 30 30 30 30]; % [sec]
145 x = 58*10^(-3); % [m]
146 L = (58+263.5)*10^(-3); % [m]
147 d_calib = 0.19; % [m]
148 d_entrenc = 0.024; % [m]
149 d_exit = 0.024; % [m]
150 d_disturbance = 0.0115; % [m]
151 rho = 997; % [Kg/m^3]
152
153 A_entrenc = pi*(0.5*d_entrenc)^2;
154 A_exit = pi*(0.5*d_exit)^2;
155 A_disturbance = pi*(0.5*d_disturbance)^2;
156 FR_real = (pi*(0.5*d_calib)^2.*h_calib)./(t);
157 dp_E_D_V = [0.6 0.7 1.15 1.55 2.1];
158 dp_E_D_Pa = 1.004e4*dp_E_D_V+2.431e3;
159 FR_ideal = ((A_disturbance)./(1-(A_disturbance/A_entrenc).↙
^2).^0.5)*((2*dp_E_D_Pa)/(rho)).^0.5;
```

```
160
161 FR_ideal_as_a_func_of_FR_real_poly = [0.6023 3.666e-4];
162 R_sqr_FR_ideal_as_a_func_of_FR_real = 0.9856;
163 FR_ideal_as_a_func_of_FR_real =↙
FR_ideal_as_a_func_of_FR_real_poly(1)↙
*FR_real+FR_ideal_as_a_func_of_FR_real_poly(2);
164
165 delta_FR_real = (((1.418*10^(-4))./t).^2+(1.418*10^(-3).↙
*h_calib./t.^2 ).^2 ).^0.5;
166 delta_FR_ideal = ((A_disturbance)./(1-↙
(A_disturbance/A_entrenc).^2).^0.5).*(502./(rho.*((2.↙
*dp_E_D_Pa)./rho).^0.5));
167 %
168 v_entrenc_real = FR_real/A_entrenc;
169 v_disturbance = FR_real/A_disturbance;
170 v_avg_venturi = (v_entrenc_real+v_disturbance)/2;
171 Reinolds_venturi = (v_avg_venturi.*d_disturbance)./(0.801↙
*10^(-6));
172 c = [0.94 0.96 0.967 0.97 0.971];
173 FR_fixed_c = c.*FR_ideal;
174
175 FR_fixed_c_as_a_func_of_FR_real_poly = [0.6094 3.434e-4];
176 R_FR_fixed_c_as_a_func_of_FR_real = 0.9910;
177 FR_fixed_c_as_a_func_of_FR_real =↙
FR_fixed_c_as_a_func_of_FR_real_poly(1)↙
*FR_real+FR_fixed_c_as_a_func_of_FR_real_poly(2);
178
179 delta_FR_fixed_c = c.*delta_FR_ideal;
180 %
181 dp_E_E_V = [0.55 0.6 0.6 0.7 0.75];
182 dp_E_E_Pa = 1.004e4*dp_E_E_V+2.431e3;
183 dp_loss_Pa = (x/L)*dp_E_E_Pa;
184 dp_E_D_fixed_Pa = dp_E_D_Pa - dp_loss_Pa;
185 FR_fixed_pressurefall = ((A_disturbance)./(1-↙
(A_disturbance/A_entrenc).^2).^0.5)*((2*dp_E_D_fixed_Pa)/↙
```

```
(rho)).^0.5;
186
187 FR_fixed_pressurefall_as_a_func_of_FR_real_poly = [0.6254↙
3.25e-4];
188 R_FR_fixed_pressurefall_as_a_func_of_FR_real = 0.9862;
189 FR_fixed_pressurefall_as_a_func_of_FR_real =↙
FR_fixed_pressurefall_as_a_func_of_FR_real_poly(1)↙
*FR_real+FR_fixed_pressurefall_as_a_func_of_FR_real_poly(2);
190
191 delta_dp_loss_Pa = (x/L)*502;
192 delta_dp_E_D_fixed_Pa = (delta_dp_loss_Pa^2+502^2)^0.5;
193 delta_FR_fixed_pressurefall = ((A_disturbance)./(1-↙
(A_disturbance/A_entrenc).^2).^0.5).*(502./(rho.*((2.↙
*delta_dp_E_D_fixed_Pa)./rho).^0.5));
194
195 %
196 fig5 = figure ("Name","Flow Rate as a Fuction of Measured↙
Flow Rate",'Position',[100 250 900 500]);
197 hold all
198 plot (FR_real,FR_ideal_as_a_func_of_FR_real,'LineStyle','-↙
.','LineWidth',2,'Color',[0 0.4470 0.7410])
199 plot (FR_real,↙
FR_fixed_c_as_a_func_of_FR_real,'LineStyle','-.','LineWidth',↙
2,'Color',[0.4940 0.1840 0.5560])
200 plot (FR_real,↙
FR_fixed_pressurefall_as_a_func_of_FR_real,'LineStyle','-↙
.','LineWidth',2,'Color',[0.8500 0.3250 0.0980])
201
202 e1 = errorbar(FR_real,FR_ideal,zeros(1,length(FR_real)),↙
'LineStyle','none');
203 e1.Color = [0 0.4470 0.7410];
204 e1.Marker = '.';
205 e1.MarkerSize = 15;
206
207 e1.XNegativeDelta = delta_FR_real;
```

```
208 e1.XPositiveDelta = delta_FR_real;
209 e1.YNegativeDelta = delta_FR_ideal;
210 e1.YPositiveDelta = delta_FR_ideal;
211
212 e2 = errorbar(FR_real,FR_fixed_c,zeros(1,length(FR_real)),↙
'LineStyle','none');
213 e2.Color = [0.4940 0.1840 0.5560];
214 e2.Marker = '.';
215 e2.MarkerSize = 15;
216
217 e2.XNegativeDelta = delta_FR_real;
218 e2.XPositiveDelta = delta_FR_real;
219 e2.YNegativeDelta = delta_FR_fixed_c;
220 e2.YPositiveDelta = delta_FR_fixed_c;
221
222 e3 = errorbar(FR_real,FR_fixed_pressurefall,zeros(1,length↙
(FR_real)), 'LineStyle','none');
223 e3.Color = [0.8500 0.3250 0.0980];
224 e3.Marker = '.';
225 e3.MarkerSize = 15;
226
227 e3.XNegativeDelta = delta_FR_real;
228 e3.XPositiveDelta = delta_FR_real;
229 e3.YNegativeDelta = zeros(1,length(FR_real))↙
+delta_FR_fixed_pressurefall;
230 e3.YPositiveDelta = zeros(1,length(FR_real))↙
+delta_FR_fixed_pressurefall;
231
232 title ("Venturi - Flow Rate as a Fuction of Measured Flow↙
Rate")
233 ylabel("Flow Rate [m^3/sec]")
234 xlabel("Measured Flow Rate [m^3/sec]")
235 grid on
236 grid minor
237 legend({'Ideal - y = 0.6023*x + 3.666e-4','Fixed C - y =↙
```

```
0.6094*x + 3.434e-4','Fixed Pressurefall - y = 0.6254*x + 3.25↙
e-4'},'FontSize',11 ,'Location','northwest')
238 %exportgraphics(fig5, 'P2-graph4-1-1.png','Resolution',↙
1200);
239
240 %% Part 2 - 4 - 1 - 2
241 h_calib = [0.095 0.2 0.37 0.485 0.625]; % [m]
242 t = [30 30 30 30 30]; % [sec]
243 x = 58*10^(-3); % [m]
244 L = (58+263.5)*10^(-3); % [m]
245 d_calib = 0.19; % [m]
246 d_entrenc = 0.024; % [m]
247 d_exit = 0.024; % [m]
248 d_disturbance = 0.0115; % [m]
249 rho = 997; % [Kg/m^3]
250
251 FR_real = (pi*(0.5*d_calib)^2.*h_calib)./(t);
252 dp_E_D_V = [0.6 0.7 1.15 1.55 2.1];
253 dp_E_D_Pa = 1.004e4*dp_E_D_V+2.431e3;
254 sqrt_dp_E_D_Pa = (dp_E_D_Pa).^0.5;
255
256 FR_real_as_a_func_of_sqrt_dp_E_D_Pa_poly = [7.822e-6↙
-5.952e-4];
257 R_FR_real_as_a_func_of_sqrt_dp_E_D_Pa = 0.9856;
258 FR_real_as_a_func_of_sqrt_dp_E_D_Pa =↙
FR_real_as_a_func_of_sqrt_dp_E_D_Pa_poly(1)↙
*sqrt_dp_E_D_Pa+FR_real_as_a_func_of_sqrt_dp_E_D_Pa_poly(2);
259
260 delta_FR_calib = (((1.418*10^(-4))./t).^2+(1.418*10^(-3).↙
*h_calib./t.^2 ).^2 ).^0.5;
261 delta_FR_from_sqrt_delta_dp_E_D_Pa = (7.822e-6*502)./(2.*↙
(dp_E_D_Pa).^0.5);
262 delta_FR_real = ((delta_FR_calib).^2.+↙
(delta_FR_from_sqrt_delta_dp_E_D_Pa).^2).^0.5;
263
```

```
264 fig6 = figure ("Name","Venturi - True Flow Rate as a↙
Fuction of √Δp",'Position',[300 250 900 500]);
265 hold all
266 plot (sqrt_dp_E_D_Pa,↙
FR_real_as_a_func_of_sqrt_dp_E_D_Pa,'LineWidth',2,'Color',[0↙
0.4470 0.7410])
267
268 e1 = errorbar(sqrt_dp_E_D_Pa,FR_real,zeros(1,length↙
(sqrt_dp_E_D_Pa)), 'LineStyle','none');
269 e1.Color = [0 0 0];
270 e1.Marker = '.';
271 e1.MarkerSize = 15;
272
273 e1.XNegativeDelta = 502./(2.*(dp_E_D_Pa).^0.5);
274 e1.XPositiveDelta = 502./(2.*(dp_E_D_Pa).^0.5);
275 e1.YNegativeDelta = delta_FR_real;
276 e1.YPositiveDelta = delta_FR_real;
277
278 title ("Venturi - True Flow Rate as a Fuction of √Δp")
279 ylabel("True Flow Rate [m^3/sec]")
280 xlabel("√Δp [Hz]")
281 grid on
282 grid minor
283 legend({'y = 7.822e-6 *x - 5.952e-4'},'FontSize',11↙
,'Location','northwest')
284 %exportgraphics(fig6, 'P2-graph4-1-2.png','Resolution',↙
1200);
285
286 %% Part 2 - 4 - 2 - 1
287 h_calib = [0.08 0.2 0.385 0.51 0.595]; % [m]
288 t = [30 30 30 30 30]; % [sec]
289 x = 47*10^(-3); % [m]
290 L = (47+228.5)*10^(-3); % [m]
291 d_calib = 0.19; % [m]
292 d_entrenc = 0.024; % [m]
```

```
293 d_exit = 0.024; % [m]
294 d_disturbance = 0.0115; % [m]
295 beta = d_disturbance/d_entrenc;
296 rho = 997; % [Kg/m^3]
297
298 A_entrenc = pi*(0.5*d_entrenc)^2;
299 A_exit = pi*(0.5*d_exit)^2;
300 A_disturbance = pi*(0.5*d_disturbance)^2;
301 FR_real = (pi*(0.5*d_calib)^2.*h_calib)./(t);
302 dp_E_D_V = [0.6 0.7 1.15 1.55 2.05];
303 dp_E_D_Pa = 1.004e4*dp_E_D_V+2.431e3;
304 FR_ideal = ((A_disturbance)./(1-(A_disturbance/A_entrenc).↙
^2).^0.5)*((2*dp_E_D_Pa)/(rho)).^0.5;
305
306 FR_ideal_as_a_func_of_FR_real_poly = [0.5824 3.723e-4];
307 R_sqr_FR_ideal_as_a_func_of_FR_real = 0.9652;
308 FR_ideal_as_a_func_of_FR_real =↙
FR_ideal_as_a_func_of_FR_real_poly(1)↙
*FR_real+FR_ideal_as_a_func_of_FR_real_poly(2);
309
310 delta_FR_real = (((1.418*10^(-4))./t).^2+(1.418*10^(-3).↙
*h_calib./t.^2 ).^2 ).^0.5;
311 delta_FR_ideal = ((A_disturbance)./(1-↙
(A_disturbance/A_entrenc).^2).^0.5).*(502./(rho.*((2.↙
*dp_E_D_Pa)./rho).^0.5));
312 %
313 v_entrenc_real = FR_real/A_entrenc;
314 v_disturbance = FR_real/A_disturbance;
315 v_avg_nozzle = (v_entrenc_real+v_disturbance)/2;
316 Reinolds_nozzle = (v_avg_nozzle.*d_entrenc)./(0.801*10^↙
(-6));
317 c = [0.95 0.96 0.97 0.975 0.98];
318 FR_fixed_c = c.*FR_ideal;
319
320 FR_fixed_c_as_a_func_of_FR_real_poly = [0.5961 3.501e-4];
```

```
321 R_FR_fixed_c_as_a_func_of_FR_real = 0.9679;
322 FR_fixed_c_as_a_func_of_FR_real =↙
FR_fixed_c_as_a_func_of_FR_real_poly(1)↙
*FR_real+FR_fixed_c_as_a_func_of_FR_real_poly(2);
323
324 delta_FR_fixed_c = c.*delta_FR_ideal;
325 %
326 dp_E_E_V = [0.6 0.6 0.9 1.2 1.5];
327 dp_E_E_Pa = 1.004e4*dp_E_E_V+2.431e3;
328 dp_loss_Pa = (x/L)*dp_E_E_Pa;
329 dp_E_D_fixed_Pa = dp_E_D_Pa - dp_loss_Pa;
330 FR_fixed_pressurefall = ((A_disturbance)./(1-↙
(A_disturbance/A_entrenc).^2).^0.5)*((2*dp_E_D_fixed_Pa)/↙
(rho)).^0.5;
331
332 FR_fixed_pressurefall_as_a_func_of_FR_real_poly = [0.561↙
3.371e-4];
333 R_FR_fixed_pressurefall_as_a_func_of_FR_real = 0.9684;
334 FR_fixed_pressurefall_as_a_func_of_FR_real =↙
FR_fixed_pressurefall_as_a_func_of_FR_real_poly(1)↙
*FR_real+FR_fixed_pressurefall_as_a_func_of_FR_real_poly(2);
335
336 delta_dp_loss_Pa = (x/L)*502;
337 delta_dp_E_D_fixed_Pa = (delta_dp_loss_Pa^2+502^2)^0.5;
338 delta_FR_fixed_pressurefall = ((A_disturbance)./(1-↙
(A_disturbance/A_entrenc).^2).^0.5).*(502./(rho.*((2.↙
*delta_dp_E_D_fixed_Pa)./rho).^0.5));
339
340 %
341 fig7 = figure ("Name","Nozzle - Flow Rate as a Fuction of↙
Measured Flow Rate",'Position',[500 250 900 500]);
342 hold all
343 plot (FR_real,FR_ideal_as_a_func_of_FR_real,'LineStyle','-↙
.','LineWidth',2,'Color',[0 0.4470 0.7410])
344 plot (FR_real,↙
```

```
FR_fixed_c_as_a_func_of_FR_real,'LineStyle','-.','LineWidth',↙
2,'Color',[0.4940 0.1840 0.5560])
345 plot (FR_real,↙
FR_fixed_pressurefall_as_a_func_of_FR_real,'LineStyle','-↙
.','LineWidth',2,'Color',[0.8500 0.3250 0.0980])
346
347 e1 = errorbar(FR_real,FR_ideal,zeros(1,length(FR_real)),↙
'LineStyle','none');
348 e1.Color = [0 0.4470 0.7410];
349 e1.Marker = '.';
350 e1.MarkerSize = 15;
351
352 e1.XNegativeDelta = delta_FR_real;
353 e1.XPositiveDelta = delta_FR_real;
354 e1.YNegativeDelta = delta_FR_ideal;
355 e1.YPositiveDelta = delta_FR_ideal;
356
357 e2 = errorbar(FR_real,FR_fixed_c,zeros(1,length(FR_real)),↙
'LineStyle','none');
358 e2.Color = [0.4940 0.1840 0.5560];
359 e2.Marker = '.';
360 e2.MarkerSize = 15;
361
362 e2.XNegativeDelta = delta_FR_real;
363 e2.XPositiveDelta = delta_FR_real;
364 e2.YNegativeDelta = delta_FR_fixed_c;
365 e2.YPositiveDelta = delta_FR_fixed_c;
366
367 e3 = errorbar(FR_real,FR_fixed_pressurefall,zeros(1,length↙
(FR_real)), 'LineStyle','none');
368 e3.Color = [0.8500 0.3250 0.0980];
369 e3.Marker = '.';
370 e3.MarkerSize = 15;
371
372 e3.XNegativeDelta = delta_FR_real;
```

```
373 e3.XPositiveDelta = delta_FR_real;
374 e3.YNegativeDelta = zeros(1,length(FR_real))↙
+delta_FR_fixed_pressurefall;
375 e3.YPositiveDelta = zeros(1,length(FR_real))↙
+delta_FR_fixed_pressurefall;
376
377 title ("Nozzle - Flow Rate as a Fuction of Measured Flow↙
Rate")
378 ylabel("Flow Rate [m^3/sec]")
379 xlabel("Measured Flow Rate [m^3/sec]")
380 grid on
381 grid minor
382 legend({'Ideal - y = 0.5824*x + 3.723e-4','Fixed C - y =↙
0.5961*x + 3.501e-4','Fixed Pressurefall - y = 0.561*x + 3.371↙
e-4'},'FontSize',11 ,'Location','northwest')
383 %exportgraphics(fig7, 'P2-graph4-2-1.png','Resolution',↙
1200);
384
385 %% Part 2 - 4 - 2 - 2
386 h_calib = [0.08 0.2 0.385 0.51 0.595]; % [m]
387 t = [30 30 30 30 30]; % [sec]
388 x = 47*10^(-3); % [m]
389 L = (47+228.5)*10^(-3); % [m]
390 d_calib = 0.19; % [m]
391 d_entrenc = 0.024; % [m]
392 d_exit = 0.024; % [m]
393 d_disturbance = 0.0115; % [m]
394 beta = d_disturbance/d_entrenc;
395 rho = 997; % [Kg/m^3]
396
397
398 FR_real = (pi*(0.5*d_calib)^2.*h_calib)./(t);
399 dp_E_D_V = [0.6 0.7 1.15 1.55 2.05];
400 dp_E_D_Pa = 1.004e4*dp_E_D_V+2.431e3;
401 sqrt_dp_E_D_Pa = (dp_E_D_Pa).^0.5;
```

```
402
403 FR_real_as_a_func_of_sqrt_dp_E_D_Pa_poly = [7.921e-6↙
-6.053e-4];
404 R_FR_real_as_a_func_of_sqrt_dp_E_D_Pa = 0.9652;
405 FR_real_as_a_func_of_sqrt_dp_E_D_Pa =↙
FR_real_as_a_func_of_sqrt_dp_E_D_Pa_poly(1)↙
*sqrt_dp_E_D_Pa+FR_real_as_a_func_of_sqrt_dp_E_D_Pa_poly(2);
406 %
407 delta_FR_calib = (((1.418*10^(-4))./t).^2+(1.418*10^(-3).↙
*h_calib./t.^2 ).^2 ).^0.5;
408 delta_FR_from_sqrt_delta_dp_E_D_Pa = (7.921e-6*502)./(2.*↙
(dp_E_D_Pa).^0.5);
409 delta_FR_real = ((delta_FR_calib).^2.+↙
(delta_FR_from_sqrt_delta_dp_E_D_Pa).^2).^0.5;
410
411 fig8 = figure ("Name","Nozzle - True Flow Rate as a↙
Fuction of √Δp",'Position',[700 250 900 500]);
412 hold all
413 plot (sqrt_dp_E_D_Pa,↙
FR_real_as_a_func_of_sqrt_dp_E_D_Pa,'LineWidth',2,'Color',[0↙
0.4470 0.7410])
414
415 e1 = errorbar(sqrt_dp_E_D_Pa,FR_real,zeros(1,length↙
(sqrt_dp_E_D_Pa)), 'LineStyle','none');
416 e1.Color = [0 0 0];
417 e1.Marker = '.';
418 e1.MarkerSize = 15;
419
420 e1.XNegativeDelta = 502./(2.*(dp_E_D_Pa).^0.5);
421 e1.XPositiveDelta = 502./(2.*(dp_E_D_Pa).^0.5);
422 e1.YNegativeDelta = delta_FR_real;
423 e1.YPositiveDelta = delta_FR_real;
424
425 title ("Nozzle - True Flow Rate as a Fuction of √Δp")
426 ylabel("True Flow Rate [m^3/sec]")
```

```
427 xlabel("√Δp [Hz]")
428 grid on
429 grid minor
430 legend({'y = 7.921e-6 *x - 6.053e-4'},'FontSize',11↙
,'Location','northwest')
431 %exportgraphics(fig8, 'P2-graph4-2-2.png','Resolution',↙
1200);
432
433 %% Part 2 - 4 - 3 - 1
434 h_calib = [0.06 0.185 0.38 0.51 0.63]; % [m]
435 t = [30 30 30 30 30]; % [sec]
436 x = 36*10^(-3); % [m]
437 L = (36+236.5)*10^(-3); % [m]
438 d_calib = 0.19; % [m]
439 d_entrenc = 0.024; % [m]
440 d_exit = 0.024; % [m]
441 d_disturbance = 0.0115; % [m]
442 beta = d_disturbance/d_entrenc;
443 rho = 997; % [Kg/m^3]
444
445 A_entrenc = pi*(0.5*d_entrenc)^2;
446 A_exit = pi*(0.5*d_exit)^2;
447 A_disturbance = pi*(0.5*d_disturbance)^2;
448 M = 1/(1-(A_disturbance/A_entrenc)^2)^0.5;
449 FR_real = (pi*(0.5*d_calib)^2.*h_calib)./(t);
450 dp_E_D_V = [0.6 0.85 1.6 2.4 3.45];
451 dp_E_D_Pa = 1.004e4*dp_E_D_V+2.431e3;
452 FR_ideal = ((A_disturbance)./(1-(A_disturbance/A_entrenc).↙
^2).^0.5)*((2*dp_E_D_Pa)/(rho)).^0.5;
453
454 FR_ideal_as_a_func_of_FR_real_poly = [0.89 3.609e-4];
455 R_sqr_FR_ideal_as_a_func_of_FR_real = 9809;
456 FR_ideal_as_a_func_of_FR_real =↙
FR_ideal_as_a_func_of_FR_real_poly(1)↙
*FR_real+FR_ideal_as_a_func_of_FR_real_poly(2);
```

```
457
458 delta_FR_real = (((1.418*10^(-4))./t).^2+(1.418*10^(-3).↙
*h_calib./t.^2 ).^2 ).^0.5;
459 delta_FR_ideal = ((A_disturbance)./(1-↙
(A_disturbance/A_entrenc).^2).^0.5).*(502./(rho.*((2.↙
*dp_E_D_Pa)./rho).^0.5));
460 %
461 v_entrenc_real = FR_real/A_entrenc;
462 v_disturbance = FR_real/A_disturbance;
463 v_avg_orifice = (v_entrenc_real+v_disturbance)/2;
464 Reinolds_orifice = (v_avg_orifice.*d_entrenc)./(0.801*10^↙
(-6));
465 c = [0.6132 0.6132 0.6035 0.6035 0.6035];
466 FR_fixed_c = c.*FR_ideal;
467
468 FR_fixed_c_as_a_func_of_FR_real_poly = [0.527 2.23e-4];
469 R_FR_fixed_c_as_a_func_of_FR_real = 0.9792;
470 FR_fixed_c_as_a_func_of_FR_real =↙
FR_fixed_c_as_a_func_of_FR_real_poly(1)↙
*FR_real+FR_fixed_c_as_a_func_of_FR_real_poly(2);
471
472 delta_FR_fixed_c = c.*delta_FR_ideal;
473 %
474 dp_E_E_V = [0.55 0.75 1.3 1.9 2.6];
475 dp_E_E_Pa = 1.004e4*dp_E_E_V+2.431e3;
476 dp_loss_Pa = (x/L)*dp_E_E_Pa;
477 dp_E_D_fixed_Pa = dp_E_D_Pa - dp_loss_Pa;
478 FR_fixed_pressurefall = ((A_disturbance)./(1-↙
(A_disturbance/A_entrenc).^2).^0.5)*((2*dp_E_D_fixed_Pa)/↙
(rho)).^0.5;
479
480 FR_fixed_pressurefall_as_a_func_of_FR_real_poly = [0.8529↙
3.358e-4];
481 R_FR_fixed_pressurefall_as_a_func_of_FR_real = 0.9807;
482 FR_fixed_pressurefall_as_a_func_of_FR_real =↙
```

```
FR_fixed_pressurefall_as_a_func_of_FR_real_poly(1)↙
*FR_real+FR_fixed_pressurefall_as_a_func_of_FR_real_poly(2);
483
484 delta_dp_loss_Pa = (x/L)*502;
485 delta_dp_E_D_fixed_Pa = (delta_dp_loss_Pa^2+502^2)^0.5;
486 delta_FR_fixed_pressurefall = ((A_disturbance)./(1-↙
(A_disturbance/A_entrenc).^2).^0.5).*(502./(rho.*((2.↙
*delta_dp_E_D_fixed_Pa)./rho).^0.5));
487
488
489 fig9 = figure ("Name","Orifice - Flow Rate as a Fuction of↙
Measured Flow Rate",'Position',[100 150 900 500]);
490 hold all
491 plot (FR_real,FR_ideal_as_a_func_of_FR_real,'LineStyle','-↙
.','LineWidth',2,'Color',[0 0.4470 0.7410])
492 plot (FR_real,↙
FR_fixed_c_as_a_func_of_FR_real,'LineStyle','-.','LineWidth',↙
2,'Color',[0.4940 0.1840 0.5560])
493 plot (FR_real,↙
FR_fixed_pressurefall_as_a_func_of_FR_real,'LineStyle','-↙
.','LineWidth',2,'Color',[0.8500 0.3250 0.0980])
494
495 e1 = errorbar(FR_real,FR_ideal,zeros(1,length(FR_real)),↙
'LineStyle','none');
496 e1.Color = [0 0.4470 0.7410];
497 e1.Marker = '.';
498 e1.MarkerSize = 15;
499
500 e1.XNegativeDelta = delta_FR_real;
501 e1.XPositiveDelta = delta_FR_real;
502 e1.YNegativeDelta = delta_FR_ideal;
503 e1.YPositiveDelta = delta_FR_ideal;
504
505 e2 = errorbar(FR_real,FR_fixed_c,zeros(1,length(FR_real)),↙
'LineStyle','none');
```

```
506 e2.Color = [0.4940 0.1840 0.5560];
507 e2.Marker = '.';
508 e2.MarkerSize = 15;
509
510 e2.XNegativeDelta = delta_FR_real;
511 e2.XPositiveDelta = delta_FR_real;
512 e2.YNegativeDelta = delta_FR_fixed_c;
513 e2.YPositiveDelta = delta_FR_fixed_c;
514
515 e3 = errorbar(FR_real,FR_fixed_pressurefall,zeros(1,length↙
(FR_real)), 'LineStyle','none');
516 e3.Color = [0.8500 0.3250 0.0980];
517 e3.Marker = '.';
518 e3.MarkerSize = 15;
519
520 e3.XNegativeDelta = delta_FR_real;
521 e3.XPositiveDelta = delta_FR_real;
522 e3.YNegativeDelta = zeros(1,length(FR_real))↙
+delta_FR_fixed_pressurefall;
523 e3.YPositiveDelta = zeros(1,length(FR_real))↙
+delta_FR_fixed_pressurefall;
524
525 title ("Orifice - Flow Rate as a Fuction of Measured Flow↙
Rate")
526 ylabel("Flow Rate [m^3/sec]")
527 xlabel("Measured Flow Rate [m^3/sec]")
528 grid on
529 grid minor
530 legend({'Ideal - y = 0.89*x + 3.609e-4','Fixed C - y =↙
0.527*x + 2.23e-4','Fixed Pressurefall - y = 0.8529*x + 3.358↙
e-4'},'FontSize',11 ,'Location','northwest')
531 %exportgraphics(fig9, 'P2-graph4-3-1.png','Resolution',↙
1200);
532
533 %% Part 2 - 4 - 3 - 2
```

```
534 h_calib = [0.06 0.185 0.38 0.51 0.63]; % [m]
535 t = [30 30 30 30 30]; % [sec]
536 x = 47*10^(-3); % [m]
537 L = (47+228.5)*10^(-3); % [m]
538 d_calib = 0.19; % [m]
539 d_entrenc = 0.024; % [m]
540 d_exit = 0.024; % [m]
541 d_disturbance = 0.0115; % [m]
542 beta = d_disturbance/d_entrenc;
543 rho = 997; % [Kg/m^3]
544
545
546 FR_real = (pi*(0.5*d_calib)^2.*h_calib)./(t);
547 dp_E_D_V = [0.6 0.85 1.6 2.4 3.45];
548 dp_E_D_Pa = 1.004e4*dp_E_D_V+2.431e3;
549 sqrt_dp_E_D_Pa = (dp_E_D_Pa).^0.5;
550
551 FR_real_as_a_func_of_sqrt_dp_E_D_Pa_poly = [5.268e-6↙
-3.914e-4];
552 R_FR_real_as_a_func_of_sqrt_dp_E_D_Pa = 0.9809;
553 FR_real_as_a_func_of_sqrt_dp_E_D_Pa =↙
FR_real_as_a_func_of_sqrt_dp_E_D_Pa_poly(1)↙
*sqrt_dp_E_D_Pa+FR_real_as_a_func_of_sqrt_dp_E_D_Pa_poly(2);
554 %
555 delta_FR_calib = (((1.418*10^(-4))./t).^2+(1.418*10^(-3).↙
*h_calib./t.^2 ).^2 ).^0.5;
556 delta_FR_from_sqrt_delta_dp_E_D_Pa = (5.268e-6*502)./(2.*↙
(dp_E_D_Pa).^0.5);
557 delta_FR_real = ((delta_FR_calib).^2.+↙
(delta_FR_from_sqrt_delta_dp_E_D_Pa).^2).^0.5;
558
559 fig10 = figure ("Name","Orifice - True Flow Rate as a↙
Fuction of √Δp",'Position',[300 150 900 500]);
560 hold all
561 plot (sqrt_dp_E_D_Pa,↙
```

```
FR_real_as_a_func_of_sqrt_dp_E_D_Pa,'LineWidth',2,'Color',[0↙
0.4470 0.7410])
562
563 e1 = errorbar(sqrt_dp_E_D_Pa,FR_real,zeros(1,length↙
(sqrt_dp_E_D_Pa)), 'LineStyle','none');
564 e1.Color = [0 0 0];
565 e1.Marker = '.';
566 e1.MarkerSize = 15;
567
568 e1.XNegativeDelta = 502./(2.*(dp_E_D_Pa).^0.5);
569 e1.XPositiveDelta = 502./(2.*(dp_E_D_Pa).^0.5);
570 e1.YNegativeDelta = delta_FR_real;
571 e1.YPositiveDelta = delta_FR_real;
572
573 title ("Orifice - True Flow Rate as a Fuction of √Δp")
574 ylabel("True Flow Rate [m^3/sec]")
575 xlabel("√Δp [Hz]")
576 grid on
577 grid minor
578 legend({'y = 5.268e-6*x - 3.914e-4'},'FontSize',11↙
,'Location','northwest')
579 %exportgraphics(fig10, 'P2-graph4-3-2.png','Resolution',↙
1200);
580
581 %% Part 2 - 4 - 4 - 1
582 h_calib1 = [0.095 0.2 0.37 0.485 0.625]; % [m]
583 h_calib2 = [0.08 0.2 0.385 0.51 0.595]; % [m]
584 h_calib3 = [0.06 0.185 0.38 0.51 0.63]; % [m]
585 t = [30 30 30 30 30]; % [sec]
586 x = 58*10^(-3); % [m]
587 L = (58+263.5)*10^(-3); % [m]
588 d_calib = 0.19; % [m]
589 d_entrenc = 0.024; % [m]
590 d_exit = 0.024; % [m]
591 d_disturbance = 0.0115; % [m]
```

```
592 rho = 997; % [Kg/m^3]
593
594 FR_real1 = (pi*(0.5*d_calib)^2.*h_calib1)./(t);
595 dp_E_D_V1 = [0.6 0.7 1.15 1.55 2.1];
596 dp_E_D_Pa1 = 1.004e4*dp_E_D_V1+2.431e3;
597 sqrt_dp_E_D_Pa1 = (dp_E_D_Pa1).^0.5;
598
599 FR_real2 = (pi*(0.5*d_calib)^2.*h_calib2)./(t);
600 dp_E_D_V2 = [0.6 0.7 1.15 1.55 2.05];
601 dp_E_D_Pa2 = 1.004e4*dp_E_D_V2+2.431e3;
602 sqrt_dp_E_D_Pa2 = (dp_E_D_Pa2).^0.5;
603
604 FR_real3 = (pi*(0.5*d_calib)^2.*h_calib3)./(t);
605 dp_E_D_V3 = [0.6 0.85 1.6 2.4 3.45];
606 dp_E_D_Pa3 = 1.004e4*dp_E_D_V3+2.431e3;
607 sqrt_dp_E_D_Pa3 = (dp_E_D_Pa3).^0.5;
608
609
610 FR_real_as_a_func_of_sqrt_dp_E_D_Pa_poly1 = [7.822e-6↙
-5.952e-4];
611 R_FR_real_as_a_func_of_sqrt_dp_E_D_Pa1 = 0.9856;
612 FR_real_as_a_func_of_sqrt_dp_E_D_Pa1 =↙
FR_real_as_a_func_of_sqrt_dp_E_D_Pa_poly1(1)↙
*sqrt_dp_E_D_Pa1+FR_real_as_a_func_of_sqrt_dp_E_D_Pa_poly1(2);
613
614 FR_real_as_a_func_of_sqrt_dp_E_D_Pa_poly2 = [7.921e-6↙
-6.053e-4];
615 R_FR_real_as_a_func_of_sqrt_dp_E_D_Pa2 = 0.9652;
616 FR_real_as_a_func_of_sqrt_dp_E_D_Pa2 =↙
FR_real_as_a_func_of_sqrt_dp_E_D_Pa_poly2(1)↙
*sqrt_dp_E_D_Pa2+FR_real_as_a_func_of_sqrt_dp_E_D_Pa_poly2(2);
617
618 FR_real_as_a_func_of_sqrt_dp_E_D_Pa_poly3 = [5.268e-6↙
-3.914e-4];
619 R_FR_real_as_a_func_of_sqrt_dp_E_D_Pa3 = 0.9809;
```

```
620 FR_real_as_a_func_of_sqrt_dp_E_D_Pa3 =↙
FR_real_as_a_func_of_sqrt_dp_E_D_Pa_poly3(1)↙
*sqrt_dp_E_D_Pa3+FR_real_as_a_func_of_sqrt_dp_E_D_Pa_poly3(2);
621
622
623 delta_FR_calib1 = (((1.418*10^(-4))./t).^2+(1.418*10^(-3).↙
*h_calib1./t.^2 ).^2 ).^0.5;
624 delta_FR_from_sqrt_delta_dp_E_D_Pa1 = (7.822e-6*502)./(2.*↙
(dp_E_D_Pa1).^0.5);
625 delta_FR_real1 = ((delta_FR_calib1).^2.+↙
(delta_FR_from_sqrt_delta_dp_E_D_Pa1).^2).^0.5;
626
627 delta_FR_calib2 = (((1.418*10^(-4))./t).^2+(1.418*10^(-3).↙
*h_calib2./t.^2 ).^2 ).^0.5;
628 delta_FR_from_sqrt_delta_dp_E_D_Pa2 = (7.921e-6*502)./(2.*↙
(dp_E_D_Pa2).^0.5);
629 delta_FR_real2 = ((delta_FR_calib2).^2.+↙
(delta_FR_from_sqrt_delta_dp_E_D_Pa2).^2).^0.5;
630
631 delta_FR_calib3 = (((1.418*10^(-4))./t).^2+(1.418*10^(-3).↙
*h_calib3./t.^2 ).^2 ).^0.5;
632 delta_FR_from_sqrt_delta_dp_E_D_Pa3 = (5.268e-6*502)./(2.*↙
(dp_E_D_Pa3).^0.5);
633 delta_FR_real3 = ((delta_FR_calib3).^2.+↙
(delta_FR_from_sqrt_delta_dp_E_D_Pa3).^2).^0.5;
634
635
636 fig11 = figure ("Name","Calibration  - True Flow Rate as a↙
Fuction of √Δp",'Position',[500 150 900 500]);
637 hold all
638 plot (sqrt_dp_E_D_Pa1,↙
FR_real_as_a_func_of_sqrt_dp_E_D_Pa1,'LineWidth',2,'Color',[0↙
0.4470 0.7410])
639 plot (sqrt_dp_E_D_Pa2,↙
FR_real_as_a_func_of_sqrt_dp_E_D_Pa2,'LineWidth',2,'Color',↙
```

```
[0.4940 0.1840 0.5560])
640 plot (sqrt_dp_E_D_Pa3,↙
FR_real_as_a_func_of_sqrt_dp_E_D_Pa3,'LineWidth',2,'Color',↙
[0.8500 0.3250 0.0980])
641
642 e1 = errorbar(sqrt_dp_E_D_Pa1,FR_real1,zeros(1,length↙
(sqrt_dp_E_D_Pa1)), 'LineStyle','none');
643 e1.Color = [0 0.4470 0.7410];
644 e1.Marker = '.';
645 e1.MarkerSize = 15;
646
647 e1.XNegativeDelta = 502./(2.*(dp_E_D_Pa1).^0.5);
648 e1.XPositiveDelta = 502./(2.*(dp_E_D_Pa1).^0.5);
649 e1.YNegativeDelta = delta_FR_real1;
650 e1.YPositiveDelta = delta_FR_real1;
651
652 e2 = errorbar(sqrt_dp_E_D_Pa2,FR_real2,zeros(1,length↙
(sqrt_dp_E_D_Pa2)), 'LineStyle','none');
653 e2.Color = [0.4940 0.1840 0.5560];
654 e2.Marker = '.';
655 e2.MarkerSize = 15;
656
657 e2.XNegativeDelta = 502./(2.*(dp_E_D_Pa2).^0.5);
658 e2.XPositiveDelta = 502./(2.*(dp_E_D_Pa2).^0.5);
659 e2.YNegativeDelta = delta_FR_real2;
660 e2.YPositiveDelta = delta_FR_real2;
661
662 e3 = errorbar(sqrt_dp_E_D_Pa3,FR_real3,zeros(1,length↙
(sqrt_dp_E_D_Pa3)), 'LineStyle','none');
663 e3.Color = [0.8500 0.3250 0.0980];
664 e3.Marker = '.';
665 e3.MarkerSize = 15;
666
667 e3.XNegativeDelta = 502./(2.*(dp_E_D_Pa3).^0.5);
668 e3.XPositiveDelta = 502./(2.*(dp_E_D_Pa3).^0.5);
```

```
669 e3.YNegativeDelta = delta_FR_real3;
670 e3.YPositiveDelta = delta_FR_real3;
671
672 title ("Calibration  - True Flow Rate as a Fuction of↙
√Δp")
673 ylabel("True Flow Rate [m^3/sec]")
674 xlabel("√Δp [Hz]")
675 grid on
676 grid minor
677 legend({'Venturi - y = 7.822e-6 *x - 5.952e-4', 'Nozzle -↙
y = 7.921e-6 *x - 6.053e-4', 'Orifice - y = 5.268e-6*x - 3.914↙
e-4'},'FontSize',11 ,'Location','northwest')
678 %exportgraphics(fig11, 'P2-graph4-4-1.png','Resolution',↙
1200);
679
680 %% Part 2 - 4 - 4 - 2
681 h_calib1 = [0.095 0.2 0.37 0.485 0.625]; % [m]
682 h_calib2 = [0.08 0.2 0.385 0.51 0.595]; % [m]
683 h_calib3 = [0.06 0.185 0.38 0.51 0.63]; % [m]
684 t = [30 30 30 30 30]; % [sec]
685 x = 58*10^(-3); % [m]
686 L = (58+263.5)*10^(-3); % [m]
687 d_calib = 0.19; % [m]
688 d_entrenc = 0.024; % [m]
689 d_exit = 0.024; % [m]
690 d_disturbance = 0.0115; % [m]
691 rho = 997; % [Kg/m^3]
692
693 FR_real1 = (pi*(0.5*d_calib)^2.*h_calib1)./(t);
694 dp_E_D_V1 = [0.6 0.7 1.15 1.55 2.1];
695 dp_E_D_Pa1 = 1.004e4*dp_E_D_V1+2.431e3;
696 sq_FR_real1 = FR_real1.^2;
697
698 FR_real2 = (pi*(0.5*d_calib)^2.*h_calib2)./(t);
699 dp_E_D_V2 = [0.6 0.7 1.15 1.55 2.05];
```

```
700 dp_E_D_Pa2 = 1.004e4*dp_E_D_V2+2.431e3;
701 sq_FR_real2 = FR_real2.^2;
702
703 FR_real3 = (pi*(0.5*d_calib)^2.*h_calib3)./(t);
704 dp_E_D_V3 = [0.6 0.85 1.6 2.4 3.45];
705 dp_E_D_Pa3 = 1.004e4*dp_E_D_V3+2.431e3;
706 sq_FR_real3 = FR_real3.^2;
707
708
709 dp_E_D_Pa_as_a_func_of_sq_FR_real_poly1 = [4.487e10 8173];
710 R_dp_E_D_Pa_as_a_func_of_sq_FR_real1 = 0.9970;
711 dp_E_D_Pa_as_a_func_of_sq_FR_real1 =↙
dp_E_D_Pa_as_a_func_of_sq_FR_real_poly1(1)↙
*sq_FR_real1+dp_E_D_Pa_as_a_func_of_sq_FR_real_poly1(2);
712
713 dp_E_D_Pa_as_a_func_of_sq_FR_real_poly2 = [4.621e10 7904];
714 R_dp_E_D_Pa_as_a_func_of_sq_FR_real2 = 0.9948;
715 dp_E_D_Pa_as_a_func_of_sq_FR_real2 =↙
dp_E_D_Pa_as_a_func_of_sq_FR_real_poly2(1)↙
*sq_FR_real2+dp_E_D_Pa_as_a_func_of_sq_FR_real_poly2(2);
716
717 dp_E_D_Pa_as_a_func_of_sq_FR_real_poly3 = [8.053e10 8229];
718 R_dp_E_D_Pa_as_a_func_of_sq_FR_real3 = 0.9994;
719 dp_E_D_Pa_as_a_func_of_sq_FR_real3 =↙
dp_E_D_Pa_as_a_func_of_sq_FR_real_poly3(1)↙
*sq_FR_real3+dp_E_D_Pa_as_a_func_of_sq_FR_real_poly3(2);
720
721
722 delta_FR_calib1 = (((1.418*10^(-4))./t).^2+(1.418*10^(-3).↙
*h_calib1./t.^2 ).^2 ).^0.5;
723 delta_dp_E_D_Pa_from_sq_FR_calib1 = 4.487e10*2*FR_real1.↙
*delta_FR_calib1;
724 delta_dp_E_D_Pa1 = ((502).^2.+↙
(delta_dp_E_D_Pa_from_sq_FR_calib1).^2).^0.5;
725
```

```
726 delta_FR_calib2 = (((1.418*10^(-4))./t).^2+(1.418*10^(-3).↙
*h_calib2./t.^2 ).^2 ).^0.5;
727 delta_dp_E_D_Pa_from_sq_FR_calib2 = 4.621e10*2*FR_real2.↙
*delta_FR_calib2;
728 delta_dp_E_D_Pa2 = ((502).^2.+↙
(delta_dp_E_D_Pa_from_sq_FR_calib2).^2).^0.5;
729
730 delta_FR_calib3 = (((1.418*10^(-4))./t).^2+(1.418*10^(-3).↙
*h_calib3./t.^2 ).^2 ).^0.5;
731 delta_dp_E_D_Pa_from_sq_FR_calib3 = 8.053e10*2*FR_real3.↙
*delta_FR_calib3;
732 delta_dp_E_D_Pa3 = ((502).^2.+↙
(delta_dp_E_D_Pa_from_sq_FR_calib3).^2).^0.5;
733
734
735 fig12 = figure ("Name","Calibration  - Δp as a Fuction of↙
True Flow Rate Square",'Position',[700 150 900 500]);
736 hold all
737 plot (sq_FR_real1,↙
dp_E_D_Pa_as_a_func_of_sq_FR_real1,'LineWidth',2,'Color',[0↙
0.4470 0.7410])
738 plot (sq_FR_real2,↙
dp_E_D_Pa_as_a_func_of_sq_FR_real2,'LineWidth',2,'Color',↙
[0.4940 0.1840 0.5560])
739 plot (sq_FR_real3,↙
dp_E_D_Pa_as_a_func_of_sq_FR_real3,'LineWidth',2,'Color',↙
[0.8500 0.3250 0.0980])
740
741 e1 = errorbar(sq_FR_real1,dp_E_D_Pa1,zeros(1,length↙
(sq_FR_real1)), 'LineStyle','none');
742 e1.Color = [0 0.4470 0.7410];
743 e1.Marker = '.';
744 e1.MarkerSize = 15;
745
746 e1.XNegativeDelta = 2*FR_real1.*delta_FR_calib1;
```

```
747 e1.XPositiveDelta = 2*FR_real1.*delta_FR_calib1;
748 e1.YNegativeDelta = delta_dp_E_D_Pa1;
749 e1.YPositiveDelta = delta_dp_E_D_Pa1;
750
751 e2 = errorbar(sq_FR_real2,dp_E_D_Pa2,zeros(1,length↙
(sq_FR_real2)), 'LineStyle','none');
752 e2.Color = [0.4940 0.1840 0.5560];
753 e2.Marker = '.';
754 e2.MarkerSize = 15;
755
756 e2.XNegativeDelta = 2*FR_real2.*delta_FR_calib2;
757 e2.XPositiveDelta = 2*FR_real2.*delta_FR_calib2;
758 e2.YNegativeDelta = delta_dp_E_D_Pa2;
759 e2.YPositiveDelta = delta_dp_E_D_Pa2;
760
761 e3 = errorbar(sq_FR_real3,dp_E_D_Pa3,zeros(1,length↙
(sq_FR_real3)), 'LineStyle','none');
762 e3.Color = [0.8500 0.3250 0.0980];
763 e3.Marker = '.';
764 e3.MarkerSize = 15;
765
766 e3.XNegativeDelta = 2*FR_real3.*delta_FR_calib3;
767 e3.XPositiveDelta = 2*FR_real3.*delta_FR_calib3;
768 e3.YNegativeDelta = delta_dp_E_D_Pa3;
769 e3.YPositiveDelta = delta_dp_E_D_Pa3;
770
771 title ("Calibration  - Δp as a Fuction of True Flow Rate↙
Square")
772 ylabel("Δp [Pa]")
773 xlabel("True Flow Rate Square [m^6/sec^2]")
774 grid on
775 grid minor
776 legend({'Venturi - y = 4.487e10*x + 8173', 'Nozzle - y =↙
4.621e10*x + 7904', 'Orifice - y = 8.053e10*x +↙
8229'},'FontSize',11 ,'Location','northwest')
```

```
777 %exportgraphics(fig12, 'P2-graph4-4-2.png','Resolution',↙
1200);
778
```