

ANEXO A

Datos de operación e incertidumbre según fabricante

Tabla A.1 Rangos de operación e incertidumbre de equipos de medición

Instrumento	Marca	Rango de operación	Incertidumbre
AVL Indimicro	AVL	hasta 14.000 [Pc]	±0.01% FS
Sensor de presión del cilindro	AVL	[0 a 250] bar	±0.3% FS
Sensor de presión de admisión	AVL	[0 a 10] bar	±0.1% FS
Dinamómetro	Zollner	[0 a 500] N-m	±0.2% VM
Pinza amperimétrica	AVL	[50 mA a 100 A]	±0.5% FS
Sensor de coriolis	Micro Motion	caudal máximo 108 [l/h]	±0.05% VM
Temperatura de admisión		[0 a 1260] °C	±0.4% VM
Registrador de datos	Honeywell	250 ms todos los canales	±0.02% VM
Medidor de emisiones	Testo	[0 a 10,000] ppm, CO	±10% VM
		[1,000 a 40,000] ppm, HC	±10% VM
		[0 a 3,000] ppm, Nox	±5% VM

ANEXO B

Cálculo de Incertidumbres

Tabla B.1 Presión máxima al interior del cilindro y sus incertidumbres respectivas [bar]

Número de medición	Presión máxima al interior del cilindro [bar]								
	1000 RPM			1500 RPM			2000 RPM		
N°	40 Nm	80 Nm	120 Nm	40 Nm	80 Nm	120 Nm	40 Nm	80 Nm	120 Nm
1	50.678	51.712	52.997	49.313	49.881	51.116	55.440	56.865	59.935
2	52.180	51.382	52.826	49.294	49.870	51.081	54.796	56.869	59.920
3	51.476	52.280	53.059	49.321	49.868	51.188	55.180	56.914	59.932
4	51.970	52.145	51.276	49.254	49.811	51.096	55.165	56.766	60.020
5	50.896	52.526	52.755	49.315	49.785	51.080	54.452	56.765	60.055
6	51.314	53.066	52.797	49.263	49.929	51.18	55.423	56.893	60.139
7	51.440	51.899	52.538	49.399	49.920	51.191	55.008	56.677	59.908
8	51.083	51.944	51.79	49.279	49.861	51.116	55.074	56.857	60.149
9	51.481	51.084	53.822	49.234	49.905	51.134	55.088	56.945	59.901
10	51.153	52.128	51.629	49.357	49.775	51.205	55.142	56.812	60.160
11	51.478	52.638	52.889	49.240	49.818	51.117	54.489	56.865	60.011
12	50.311	52.632	52.613	49.296	49.845	50.999	55.038	56.875	60.073
13	50.601	52.294	52.926	49.243	49.901	51.136	55.033	56.883	60.252
14	50.986	53.431	52.798	49.253	49.848	51.028	54.393	56.934	60.068
15	50.744	52.943	53.868	49.317	49.908	51.082	55.067	56.775	60.288
16	51.848	51.598	52.403	49.225	49.934	51.015	54.775	57.054	60.017
17	51.593	52.205	53.539	50.225	49.920	51.137	54.470	56.725	60.004
18	51.067	52.322	51.503	49.247	49.920	51.139	55.427	56.896	60.022
19	51.118	51.320	54.049	49.988	49.840	51.067	54.512	57.036	60.195
20	52.612	52.129	52.454	49.353	49.920	51.177	54.465	56.968	60.170
21	51.019	51.699	52.646	49.213	49.907	51.120	54.938	57.091	60.251
22	51.744	52.030	53.522	49.202	49.828	51.156	54.581	57.032	60.107
23	50.979	52.305	51.601	49.193	49.746	51.118	54.719	56.956	60.191
24	51.587	52.768	53.473	49.176	49.864	51.112	55.181	56.941	60.144
25	51.172	52.959	52.211	49.164	49.957	51.138	54.747	57.001	60.059
26	51.741	52.976	52.566	49.272	49.956	51.159	54.540	57.049	60.059
27	50.471	52.203	51.785	49.319	49.866	51.064	55.123	56.876	60.046
28	50.647	52.682	53.494	49.244	49.827	51.119	54.826	56.922	59.955
29	50.804	52.461	52.881	49.304	49.896	51.208	54.841	56.784	60.024
30	51.743	52.205	52.611	49.210	49.881	51.104	55.414	56.958	59.981
31	50.677	52.883	53.124	49.364	49.783	51.192	55.410	56.961	60.132
32	51.188	52.421	51.953	49.144	49.889	51.093	54.615	56.732	60.120

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33	51.888	52.700	51.964	49.236	49.970	51.149	55.101	57.058	60.153
34	51.365	51.765	52.34	49.254	49.996	51.111	55.374	56.869	59.972
35	52.062	52.357	51.702	49.809	49.852	51.113	54.858	56.989	59.978
36	51.166	52.725	53.094	49.230	49.848	51.059	55.322	56.994	60.047
37	52.437	51.984	53.949	49.300	49.903	51.111	54.509	56.924	60.195
38	51.309	53.617	52.998	49.230	49.804	51.125	54.962	56.819	60.072
39	49.840	51.833	52.246	49.249	49.773	51.146	54.749	56.820	60.165
40	51.944	52.069	51.956	49.447	49.986	51.178	54.892	56.896	60.114
41	50.207	51.332	53.347	49.299	49.802	51.083	55.039	56.929	60.333
42	51.644	51.935	52.189	49.337	49.841	51.119	55.040	56.841	60.102
43	51.941	51.727	52.508	49.256	49.881	51.070	54.745	56.754	60.154
44	51.690	52.145	53.258	49.335	49.892	51.146	54.570	56.711	60.011
45	50.994	52.314	52.302	49.187	49.954	51.191	54.492	56.817	60.083
46	51.208	51.167	52.142	49.383	49.967	51.082	54.798	56.839	59.938
47	50.597	51.328	53.843	49.283	49.887	51.092	54.350	56.940	60.039
48	51.379	52.234	52.543	49.235	49.902	51.193	54.655	56.944	60.087
49	50.892	52.057	52.112	49.715	49.852	51.054	55.341	56.778	60.199
50	52.623	51.574	53.237	49.337	49.796	51.065	55.122	56.802	59.938
51	51.808	51.963	52.994	49.261	49.856	51.152	54.586	56.933	60.050
52	51.443	52.143	52.254	49.829	49.858	51.146	54.825	56.655	59.871
53	51.007	52.229	52.197	49.241	49.937	51.112	54.592	56.853	60.024
54	52.762	52.160	51.753	49.246	49.885	51.079	54.804	56.800	60.062
55	51.969	52.740	52.341	49.273	49.765	51.152	54.453	56.768	60.160
56	50.932	51.939	53.405	49.324	49.966	51.146	54.580	56.886	60.097
57	52.375	51.693	52.759	49.245	49.849	51.120	54.788	56.818	59.883
58	51.390	52.197	53.228	49.399	49.885	51.173	54.903	56.873	59.897
59	50.591	52.249	53.758	49.303	49.884	51.237	54.893	56.963	60.124
60	52.181	52.655	52.468	49.208	49.853	51.136	54.833	56.821	59.797
61	50.808	52.003	52.387	49.280	49.836	51.099	55.211	56.801	60.111
62	51.655	51.349	52.408	49.269	49.823	51.171	54.549	56.911	60.027
63	51.088	52.049	52.158	49.231	49.813	51.111	54.695	56.900	60.057
64	52.554	52.175	53.312	49.194	49.913	51.138	54.906	56.689	59.898
65	51.011	52.248	52.471	49.273	49.776	51.150	55.125	56.821	59.934
66	51.322	51.799	52.651	49.187	49.822	51.164	55.235	56.986	60.036
67	50.802	52.033	53.388	49.327	49.831	51.048	54.785	56.742	59.968
68	51.067	51.877	53.652	49.231	49.806	51.115	54.510	56.834	59.965
69	51.327	52.132	51.717	49.142	49.893	51.106	54.914	56.851	59.955
70	51.347	53.191	52.078	49.300	49.895	51.039	55.231	56.868	59.805
71	51.740	51.860	53.343	49.195	49.925	51.117	55.043	56.983	59.956
72	51.994	51.951	53.192	49.810	49.903	51.093	54.770	56.944	60.109
73	51.033	52.291	51.408	49.223	49.826	51.125	54.487	56.934	59.909
74	51.393	52.084	52.653	49.217	49.968	51.161	54.465	56.874	60.066

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75	51.437	51.602	52.926	49.366	49.868	51.155	55.446	57.022	60.068
76	52.302	52.136	53.021	49.207	49.850	51.065	54.968	56.898	60.077
77	52.296	52.276	53.14	49.220	49.864	51.171	54.669	56.891	60.116
78	51.484	52.231	52.563	49.260	49.812	51.115	54.925	56.819	59.939
79	50.812	52.009	51.66	49.287	49.813	51.170	55.170	56.771	60.217
80	51.221	52.017	53.753	49.218	49.978	51.048	54.521	56.787	60.071
81	51.294	52.406	53.985	49.204	49.888	51.082	54.592	56.875	59.992
82	51.145	51.746	53.533	49.336	49.927	51.114	54.771	56.931	59.977
83	52.016	52.720	52.795	49.166	49.846	51.066	54.493	56.989	60.051
84	51.274	51.469	51.833	49.343	49.842	51.069	54.567	56.798	60.064
85	50.479	52.108	52.545	49.146	49.918	51.094	54.672	56.931	60.044
86	52.180	51.878	52.215	49.186	49.799	50.973	54.631	56.755	59.928
87	51.939	51.512	52.256	49.261	49.845	51.014	55.683	56.957	59.846
88	51.015	51.741	53.668	49.282	49.848	51.070	55.039	56.792	59.894
89	51.218	51.621	53.321	49.286	49.941	50.980	54.660	56.883	60.010
90	51.361	51.566	51.804	49.407	49.868	51.061	55.155	56.998	60.038
91	51.007	52.140	52.073	49.262	49.803	51.001	54.377	56.904	60.036
92	51.008	51.900	51.555	49.209	49.943	51.096	54.801	56.956	59.759
93	50.963	51.842	53.64	49.265	49.874	50.980	54.938	56.936	60.099
94	50.220	51.891	52.509	49.892	49.945	51.100	54.404	56.872	60.141
95	50.947	51.092	52.847	49.367	49.827	51.166	54.978	56.879	60.121
96	51.535	51.829	52.392	49.331	49.712	51.063	55.174	56.902	60.167
97	51.331	51.941	52.948	49.285	49.779	51.071	54.672	56.874	60.192
98	52.047	52.792	52.518	49.243	49.963	51.075	54.607	56.826	59.983
99	50.730	51.543	52.193	49.203	49.867	51.037	55.341	57.017	60.021
100	51.487	52.236	53.887	49.269	49.929	51.186	55.163	56.953	59.973
101	51.233	51.482	53.503	49.262	49.970	51.129	54.633	56.890	60.015
102	51.586	52.111	52.221	49.425	49.803	51.199	55.083	56.675	60.163
103	51.815	51.539	53.516	49.256	49.962	51.011	54.713	56.820	59.951
104	50.771	50.877	51.007	49.220	49.785	51.109	54.774	56.895	60.027
105	51.417	53.355	52.341	49.572	49.944	51.107	55.086	56.845	59.938
106	51.541	51.952	52.913	49.317	49.832	51.143	54.828	56.919	59.974
107	50.961	51.647	53.37	49.268	49.839	51.151	54.618	56.702	60.127
108	50.478	51.558	52.164	49.320	49.817	51.095	54.579	56.754	59.971
109	51.576	52.768	53.594	49.179	49.839	51.210	54.678	56.709	59.926
110	50.888	51.482	52.76	49.169	49.830	51.105	54.744	56.857	60.011
111	50.927	52.136	52.208	49.194	49.763	51.075	54.717	56.812	59.988
112	50.944	52.118	51.332	49.269	49.975	51.147	54.709	56.982	60.136
113	51.139	51.671	52.581	49.276	50.000	51.171	54.942	56.797	60.054
114	51.017	52.356	52.758	49.246	49.900	51.190	54.515	56.960	60.085
115	52.188	51.672	53.516	49.245	49.863	51.069	55.150	56.712	60.012
116	50.704	51.264	51.842	49.217	49.750	51.119	54.681	56.891	59.889

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117	52.159	51.819	53.082	49.231	49.987	51.060	55.115	56.789	59.933
118	50.647	51.303	52.143	49.320	49.795	51.172	55.275	56.808	60.044
119	50.648	52.410	53.719	49.320	49.833	51.063	54.507	56.905	60.138
120	50.390	51.237	52.219	49.301	49.977	51.093	54.688	56.792	59.986
121	50.956	51.999	52.975	49.559	49.897	51.231	54.462	56.923	59.801
122	51.732	51.813	53.93	49.342	49.859	51.113	54.843	56.814	60.103
123	51.476	52.122	53.072	49.734	49.857	51.077	54.419	56.795	60.193
124	51.343	52.424	52.106	49.423	49.836	51.161	54.642	56.721	60.033
125	50.730	52.369	51.604	49.298	49.931	50.924	54.608	56.836	60.077
126	50.521	51.928	53.68	49.202	49.840	51.181	55.298	56.813	60.013
127	50.647	51.460	52.714	49.196	49.796	51.084	54.836	56.926	59.910
128	50.722	52.585	53.267	49.184	49.852	50.979	54.445	56.849	59.971
129	52.781	51.797	53.055	49.203	49.835	51.058	54.617	56.762	60.106
130	51.280	51.763	52.865	49.179	49.984	51.111	54.758	56.998	60.192
131	51.386	51.773	53.702	49.144	49.906	51.035	54.534	56.910	60.088
132	51.375	51.537	52.244	49.161	49.845	51.173	54.755	56.839	60.092
133	51.709	51.120	52.946	49.134	49.884	51.122	54.511	56.940	60.110
134	50.897	52.122	53.613	49.190	49.903	51.069	54.789	56.863	60.053
135	51.070	51.474	51.778	49.207	49.858	51.231	54.775	56.837	60.100
136	52.493	52.835	52.118	49.256	49.900	51.156	55.035	56.869	60.141
137	52.742	52.100	51.739	49.970	49.851	51.176	54.426	56.750	60.102
138	50.494	52.746	51.908	49.857	49.886	51.137	55.290	56.908	60.270
139	50.652	52.248	51.698	50.055	49.840	51.261	54.507	56.851	60.087
140	50.947	52.342	52.191	49.367	49.776	51.239	54.413	56.739	60.021
141	50.677	52.482	52.777	49.269	49.831	51.079	54.980	56.886	60.041
142	50.426	51.787	51.573	49.148	49.880	51.042	55.336	56.756	60.116
143	50.742	52.284	52.911	49.194	49.898	51.209	54.471	56.724	59.897
144	50.967	52.487	52.99	49.191	49.948	51.092	55.089	56.860	59.913
145	50.299	51.613	54.053	50.343	49.889	51.165	54.477	56.882	60.105
146	52.608	51.569	51.672	49.100	49.960	51.035	55.246	56.838	60.001
147	52.144	51.970	53.739	49.160	49.912	51.131	54.882	56.961	59.992
148	50.896	51.757	52.877	49.239	49.850	51.171	54.610	56.877	60.135
149	51.776	51.990	53.011	49.667	49.879	51.164	54.273	56.740	60.008
150	52.392	52.202	52.272	49.172	49.798	51.165	55.133	56.897	59.899
151	51.266	52.688	51.952	49.204	49.821	51.078	55.360	56.854	60.070
152	52.645	52.045	53.363	49.472	49.806	51.154	55.358	56.865	59.972
153	49.878	52.243	53.617	49.252	49.822	51.141	54.970	56.910	59.967
154	51.358	52.066	52.091	49.691	49.777	51.183	54.332	56.906	59.988
155	50.692	51.189	53.368	49.175	49.925	51.183	54.534	56.851	60.015
156	50.775	52.635	51.443	49.200	49.919	51.106	55.240	56.641	59.964
157	51.683	51.574	53.58	49.076	49.937	50.982	55.142	56.750	60.103
158	51.280	52.434	53.312	49.187	49.817	51.101	54.542	56.916	59.959

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159	51.594	52.929	53.414	49.103	49.836	51.155	54.543	56.872	60.134
160	50.619	51.760	51.972	49.104	49.870	51.115	54.810	56.805	60.160
161	52.404	52.369	53.701	49.144	49.885	51.008	54.606	56.891	59.959
162	50.816	51.939	51.909	49.383	49.847	51.079	54.923	56.926	59.952
163	51.754	52.862	51.839	49.257	49.902	51.141	54.702	56.847	60.040
164	51.088	51.241	53.617	49.148	49.859	51.133	54.478	56.934	60.192
165	51.153	52.404	52.79	49.231	49.962	51.160	54.779	56.975	60.118
166	51.468	52.976	53.014	49.018	49.878	51.217	55.099	56.979	60.263
167	51.051	53.160	53.157	49.307	49.861	50.996	54.774	56.893	60.014
168	52.999	52.514	51.921	49.237	49.821	51.155	54.923	56.844	60.035
169	53.430	52.275	52.132	49.279	49.830	51.088	54.393	56.678	60.266
170	50.604	51.740	53.955	49.234	49.851	51.151	55.301	56.920	60.099
171	51.592	52.049	52.014	49.209	49.844	51.136	55.207	56.956	60.017
172	51.200	51.653	52.993	49.160	49.816	51.052	54.606	56.910	60.257
173	51.579	52.956	51.929	49.374	49.869	51.048	54.725	56.783	60.012
174	51.074	52.434	54.149	49.166	49.825	51.079	54.612	56.923	60.124
175	51.331	52.242	52.676	49.699	49.863	51.114	54.566	56.924	60.259
176	51.169	52.924	53.942	49.274	49.863	51.103	54.511	56.828	60.010
177	51.831	51.449	52.6	49.106	49.866	51.118	55.198	56.857	60.159
178	51.627	51.329	51.349	49.156	49.896	51.012	54.856	57.046	60.144
179	50.556	52.511	52.453	49.205	49.877	51.208	54.421	56.790	59.994
180	50.523	52.025	52.812	49.234	49.928	51.174	54.947	56.947	60.110
181	51.358	51.703	52.812	49.174	49.944	51.159	54.435	56.827	60.164
182	50.670	51.663	51.582	49.239	49.744	51.085	54.804	56.784	60.131
183	52.544	52.182	53.214	49.158	49.830	51.208	54.516	56.856	60.212
184	50.821	51.441	51.989	49.116	49.865	51.186	54.829	56.748	60.144
185	50.724	51.311	54.271	49.151	49.855	51.163	54.597	56.941	59.993
186	51.980	51.288	51.812	49.336	49.823	51.052	54.390	56.840	60.110
187	50.896	51.444	52.812	49.191	49.863	51.174	55.391	56.724	60.144
188	51.045	51.655	52.708	49.117	49.814	51.156	55.769	56.870	60.220
189	50.474	52.477	53.233	49.413	49.808	51.178	54.316	56.834	60.304

Continúa...

190	51.462	51.879	52.741	50.254	49.738	51.203	54.611	56.725	60.004	
191	51.622	52.425	52.528	49.190	49.992	51.235	54.586	56.811	60.149	
192	51.359	52.446	53.01	49.217	49.926	51.126	54.475	56.817	60.235	
193	52.557	52.202	51.733	49.202	49.801	51.148	54.480	56.826	60.062	
194	51.892	52.379	52.997	49.490	49.892	51.096	54.472	56.851	59.968	
195	51.985	51.000	51.073	49.216	49.847	51.128	54.612	56.737	60.226	
196	51.338	51.538	52.611	49.174	49.873	51.099	54.404	56.785	60.062	
197	51.562	51.334	51.827	49.148	49.958	51.115	54.965	56.728	60.094	
198	51.519	52.858	52.578	49.287	49.878	51.072	54.413	57.018	60.244	
199	50.805	51.638	53.705	49.199	49.820	51.134	54.534	56.890	60.159	
200	51.218	52.177	51.916	49.224	49.856	51.193	54.320	56.633	60.069	
σ	0.629	0.510	0.726	0.205	0.058	0.059	0.312	0.090	0.105	
\bar{M}	51.331	52.062	52.689	49.303	49.869	51.118	54.814	56.862	60.057	
<i>Incertidumbres</i>	I_A	0.044	0.036	0.051	0.015	0.004	0.004	0.022	0.006	0.007
	I_{AVL}	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	I_{Sensor}	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	I_B	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	I_C	0.751	0.751	0.752	0.750	0.750	0.750	0.750	0.750	0.750
	k	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
	I_E	1.503	1.502	1.504	1.500	1.500	1.500	1.501	1.500	1.500



Tabla B.2 Flujo másico de combustible y sus incertidumbres respectivas [Kg/h]

Número de medición	Incertidumbre Flujo masico de combustible [Kg/h]									
	1000 RPM			1500 RPM			2000 RPM			
N°	40 Nm	80Nm	120 Nm	40 Nm	80Nm	120 Nm	40 Nm	80Nm	120 Nm	
1	2.337	2.9706	3.731	4.130	4.782	5.869	5.996	7.028	7.137	
2	2.337	2.9706	3.713	4.112	4.818	5.869	5.996	7.064	7.155	
3	2.319	2.9706	3.731	4.112	4.818	5.869	5.977	7.064	7.155	
4	2.319	2.9706	3.731	4.112	4.800	5.869	5.977	7.046	7.191	
5	2.319	2.9525	3.713	4.094	4.818	5.851	5.941	7.064	7.227	
6	2.282	2.9706	3.713	4.076	4.818	5.869	5.923	7.064	7.300	
7	2.282	2.9706	3.713	4.076	4.818	5.887	5.923	7.100	7.354	
8	2.282	2.9706	3.713	4.057	4.818	5.851	5.905	7.100	7.445	
9	2.282	2.9706	3.713	4.057	4.836	5.887	5.887	7.100	7.499	
10	2.282	2.9706	3.713	4.021	4.836	5.887	5.905	7.119	7.535	
11	2.282	2.9706	3.713	4.021	4.836	5.905	5.887	7.100	7.590	
12	2.264	2.9706	3.731	4.003	4.873	5.887	5.869	7.119	7.644	
13	2.264	2.9706	3.695	3.985	4.836	5.887	5.833	7.119	7.662	
14	2.282	2.9706	3.713	3.985	4.836	5.887	5.851	7.119	7.716	
15	2.264	2.9887	3.713	3.985	4.873	5.887	5.833	7.100	7.734	
16	2.264	2.9706	3.713	3.967	4.891	5.887		7.119	7.789	
17	2.264	2.9887	3.713	3.967	4.873	5.905		7.137		
18	2.264	2.9887	3.7133		4.873	5.905				
19	2.282	2.9887	3.7314		4.873	5.905				
20	2.282	2.9706	3.7314		4.873	5.905				
21	2.264	3.0068	3.7314		4.891	5.905				
22	2.246	2.9887	3.7133		4.873					
23	2.264	3.0068	3.7133		4.818					
24	2.228	2.9887	3.7495		4.818					
25	2.228	2.9887	3.7133							
26	2.246	2.9887	3.7314							
27	2.210	3.0068	3.7314							
28	2.246	3.0068	3.7314							
29	2.246	3.0068	3.7133							
30	2.228	3.0068	3.7314							
31	2.246	3.0068	3.7133							
32	2.228	2.9887								
33	2.228	3.0068								
34	2.210	3.0068								
35	2.228	3.0068								
36		3.0068								
37		3.0068								
38		3.0068								
σ	0.0333	0.0167	0.0111	0.0565	0.0304	0.0175	0.0556	0.0308	0.2308	
\bar{M}	2.2657	2.9868	3.7203	4.0446	4.8416	5.8843	5.9134	7.0919	7.4458	
Incertidumbres	I_A	0.0056	0.0027	0.0020	0.0137	0.0059	0.0036	0.0131	0.0069	0.0529
	$I_{Honeywell}$	0.0064	0.0064	0.0064	0.0064	0.0064	0.0064	0.0064	0.0064	0.0064
	$I_{Coriolis}$	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
	I_B	0.0504	0.0504	0.0504	0.0504	0.0504	0.0504	0.0504	0.0504	0.0504
	I_C	0.0507	0.0505	0.0504	0.0522	0.0507	0.0505	0.0521	0.0509	0.0731
	k	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000
I_E	0.1014	0.1010	0.1009	0.1045	0.1015	0.1011	0.1042	0.1018	0.1462	

Tabla B.3 Temperatura de admisión y sus incertidumbres respectivas [°C]

Número de medición	Incertidumbre Temperaturas de admisión [°C]									
	1000 RPM			1500 RPM			2000 RPM			
	40 Nm	80Nm	120 Nm	40 Nm	80Nm	120 Nm	40 Nm	80Nm	120 Nm	
1	27.156	25.327	24.984	28.721	27.613	28.882	34.106	33.540	33.551	
2	27.156	25.327	24.984	28.721	27.556	28.939	34.050	33.427	33.551	
3	27.156	25.327	24.984	28.721	27.613	28.882	34.106	33.427	33.540	
4	27.156	25.270	24.984	28.721	27.613	28.882	34.106	33.370	33.597	
5	27.156	25.327	24.984	28.778	27.613	28.824	34.106	33.370	33.653	
6	27.099	25.270	24.984	28.721	27.613	28.824	34.106	33.370	33.710	
7	27.099	25.270	24.984	28.778	27.613	28.824	34.050	33.314	33.767	
8	27.099	25.270	24.984	28.778	27.671	28.824	34.050	33.314	33.823	
9	27.099	25.270	24.984	28.778	27.671	28.767	34.050	33.314	33.880	
10	27.099	25.270	24.984	28.778	27.671	28.767	34.050	33.314	33.936	
11	27.042	25.270	24.984	28.778	27.671	28.642	34.050	33.314	33.993	
12	27.099	25.270	24.984	28.778	27.728	28.642	33.993	33.370	34.050	
13	27.099	25.270	24.984	28.778	27.728	28.642	33.993	33.370	34.050	
14	27.042	25.270	24.927	28.778	27.785	28.642	33.936	33.370	34.106	
15	27.042	25.270	24.984	28.778	27.785	28.767	33.936	33.370	34.106	
16	27.042	25.270	24.927	28.778	27.785	28.767		33.494	34.050	
17	27.042	25.270	24.927	28.721	27.785	28.767		33.551		
18	27.042	25.270	24.927		27.842	28.824				
19	27.042	25.270	24.927		27.842	28.767				
20	27.042	25.270	24.927		27.899	28.824				
21	26.917	25.270	24.927		27.899	28.767				
22	26.917	25.270	24.927		27.899					
23	26.860	25.270	24.927		27.899					
24	26.860	25.327	24.927		27.956					
25	26.985	25.327	24.927							
26	26.985	25.327	24.927							
27	26.927	25.327	24.927							
28	26.927	25.327	24.927							
29	26.927	25.327	24.927							
30	26.870	25.327	24.927							
31	26.870	25.384	24.927							
32	26.813	25.384								
33	26.813	25.384								
34	26.813	25.384								
35	26.813	25.384								
36		25.441								
37		25.441								
38		25.441								
σ	0.1146	0.0550	0.0289	0.0282	0.1192	0.0850	0.0585	0.0765	0.2131	
\bar{M}	27.0030	25.3151	24.9529	28.7576	27.7396	28.7842	34.0459	33.3884	33.8352	
Incertidumbres	I_A	0.0194	0.0089	0.0052	0.0068	0.0229	0.0174	0.0138	0.0171	0.0489
	$I_{Honeywell}$	0.0064	0.0064	0.0064	0.0064	0.0064	0.0064	0.0064	0.0064	0.0064
	$I_{termopar}$	0.0794	0.0794	0.0794	0.0794	0.0794	0.0794	0.0794	0.0794	0.0794
	I_B	0.0796	0.0796	0.0796	0.0796	0.0796	0.0796	0.0796	0.0796	0.0796
	I_C	0.0819	0.0801	0.0798	0.0799	0.0829	0.0815	0.0808	0.0814	0.0934
	k	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000
	I_E	0.1639	0.1602	0.1596	0.1598	0.1657	0.1630	0.1616	0.1629	0.1869

ANEXO C

Especificaciones de calidad del Diesel comercializado en Perú

Tabla C.1 Especificaciones de calidad de Diesel comercializado en Perú (Fuente: D.S. N° 092-2009-EM)

CARACTERÍSTICAS	ESPECIFICACIONES		MÉTODOS DE ENSAYO		
	Mínimo	Máximo	ASTM	ISO	UNE EN
Densidad a 15 °C, Kg/m ³	Reportar		D 1298 D 4052	3675	
FLUIDEZ					
Viscosidad Cinemática a 40°C, cSt. (A)	1.9	4.1	D 445	3104	
Punto de Escurrimiento, °C (B)		4	D 97	3016	
COMPOSICIÓN					
Número de Cetano (C)	45		D 613	5165	
Índice de Cetano	45		D 4737 D 976 (**)	4264	
Cenizas, % masa		0.01	D 482	6245	
Residuo de Carbón Ramsbottom, 10%fondos, % masa (D)		0.35	D 524 D 189	4262 6615	
Azufre total, mg/Kg (ppm)		50	D 4294 D 5453 D 2622	14596 4260	
CORROSIVIDAD					
Corrosión a la lamina de Cobre, 3h, 50 °C, N°		3	D 130	2160	
CONTAMINANTES					
Agua y Sedimentos, % Vol.		0.05	D 1796 D 2709	3734	
LUBRICIDAD					
Lubricidad, diámetro rasgado de uso corregido, HFRR a 60 °C, micron		520	D 6079	12156	
REQUERIMIENTOS DE OPERATIVIDAD					
Punto Obstrucción del Filtro, Flujo en Frío, °C (CFPP) o (POFF)		-8	D 6371		116
CONDUCTIVIDAD					
Conductividad, pS/m (E)	25		D 2624 D 4308		
BIODIESEL 100 (B100)					
Contenido, % Vol.	2 (***)		D7371		14078

ANEXO D

Medida de emisiones

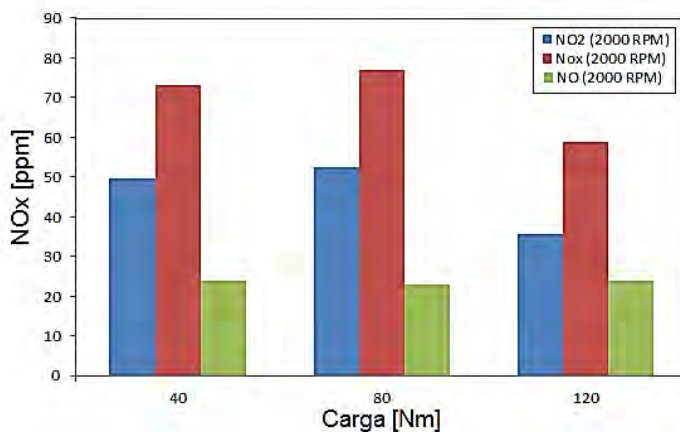


Figura D.1 - Concentración de NOx a 1000 RPM, cargas de 40, 80 y120 N-m

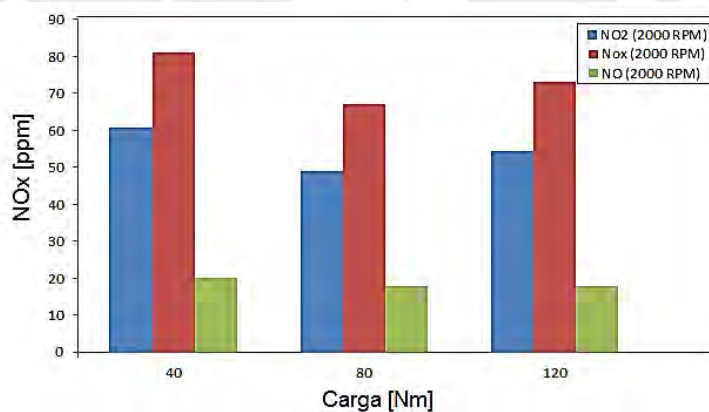


Figura D.2 - Concentración de NOx a 1500 RPM, cargas de 40, 80 y120 N-m

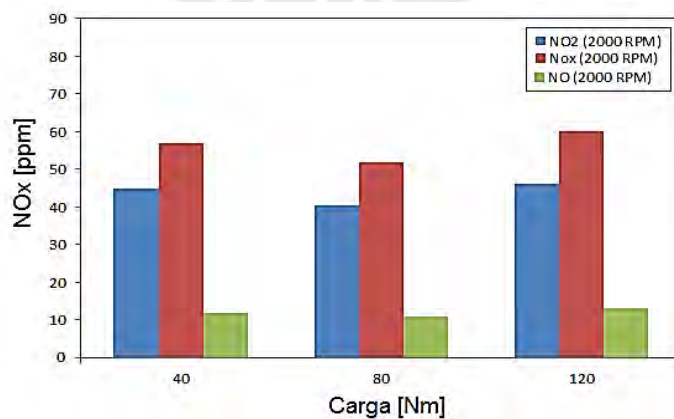


Figura D.3 - Concentración de NOx a 2000 RPM, cargas de 40, 80 y120 N-m

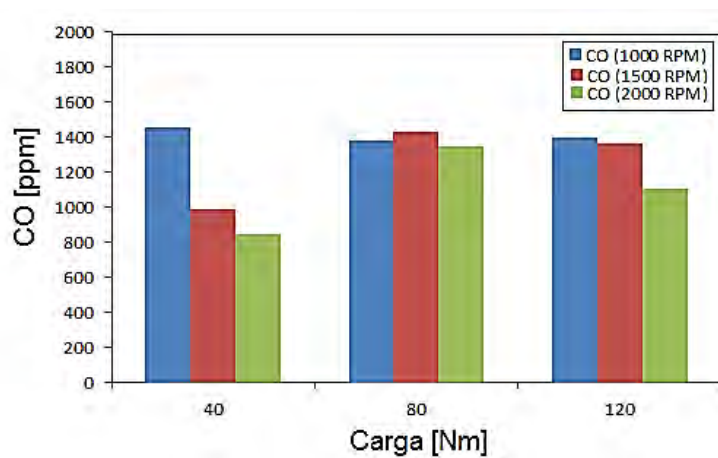


Figura D.4 - Concentración de CO a 1000, 1500 y 2000 RPM, cargas de 40, 80 y 120 N-m



ANEXO E

Presiones con combustión y sin combustión al interior del cilindro

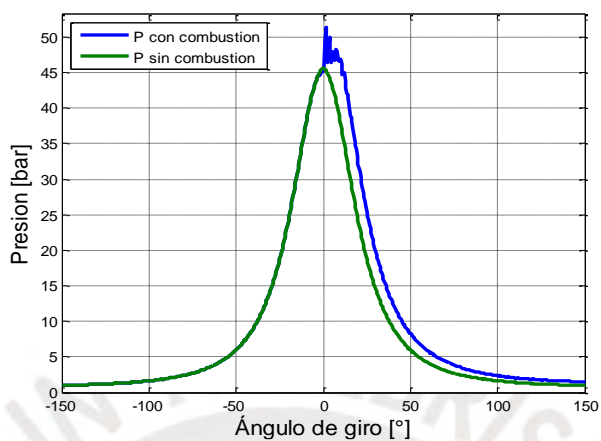


Figura E.1 - Presiones con y sin combustión a 1000 RPM y 40 N-m

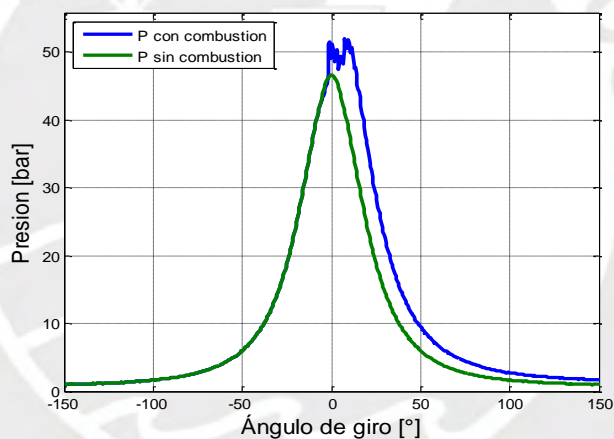


Figura E.2 - Presiones con y sin combustión a 1000 RPM y 80 N-m

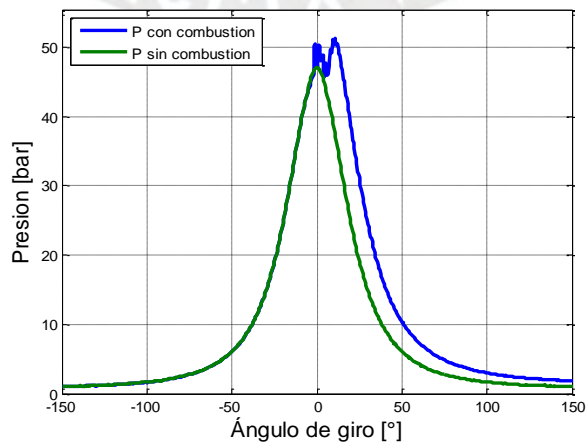


Figura E.3 - Presiones con y sin combustión a 1000 RPM y 1200 N-m

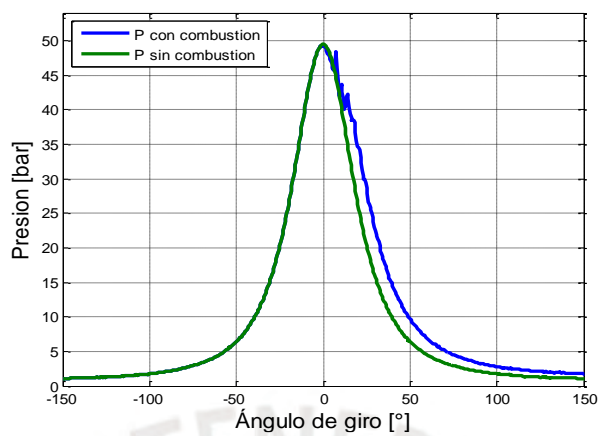


Figura E.4 - Presiones con y sin combustión a 1500 RPM y 40 N-m

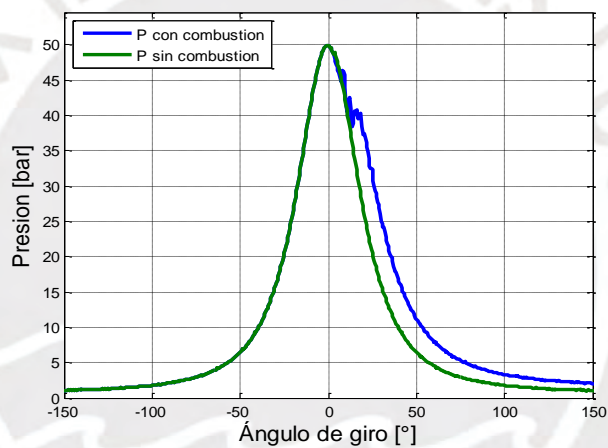


Figura E.5 - Presiones con y sin combustión a 1500 RPM y 80 N-m

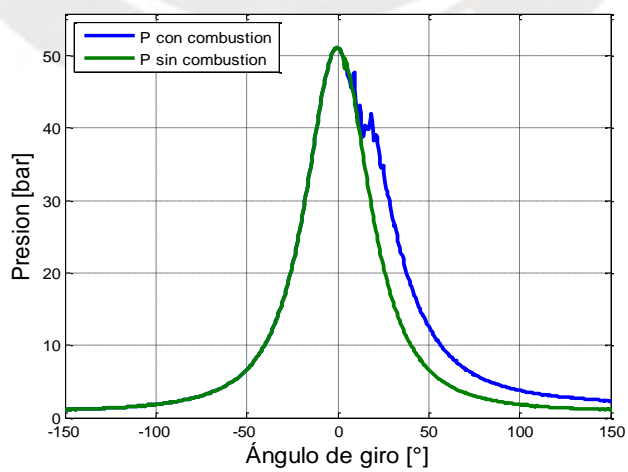


Figura E.6 - Presiones con y sin combustión a 1500 RPM y 120 N-m

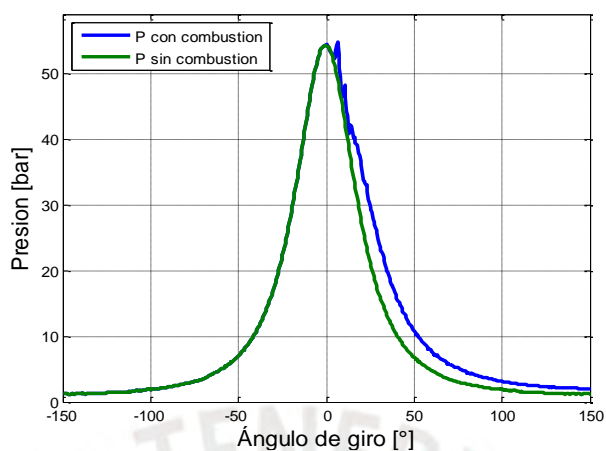


Figura E.7 - Presiones con y sin combustión a 2000 RPM y 40 N-m

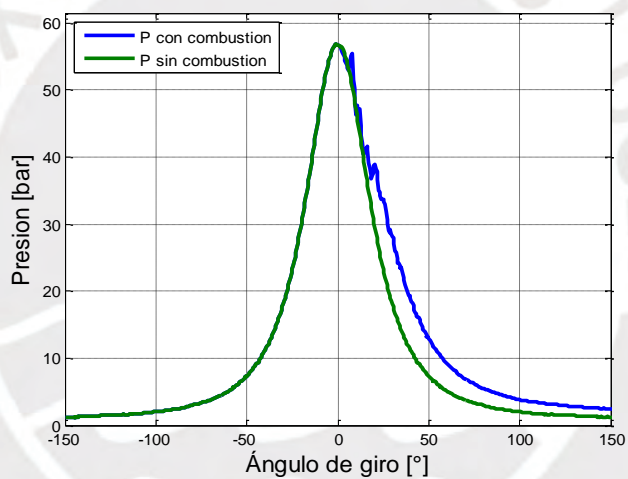


Figura E.8 - Presiones con y sin combustión a 2000 RPM y 80 N-m

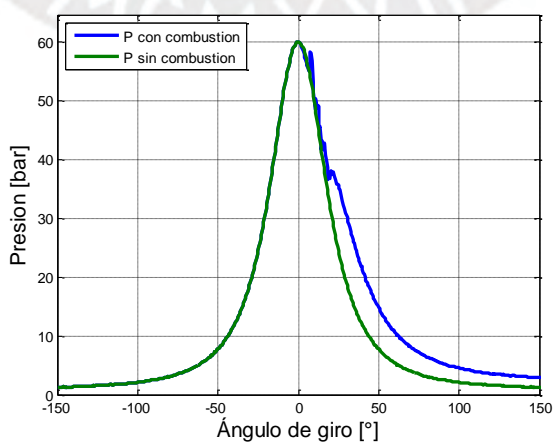


Figura E.9 - Presiones con y sin combustión a 2000 RPM y 120 N-m