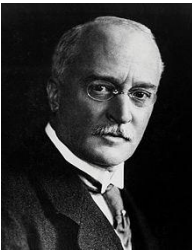


Diesel Cycle model

Dr A. French. September 2017



Rudolf Diesel
(1858-1913)

Input parameters

Temperature T1 of air draw into piston /Celsius	12
Low pressure state p1 /atm	1.00
Volume V1 of uncompressed gas /litres	1.000
Volume V2 of compressed gas /litres	0.320
Volume V3 of compressed gas after isobaric heating /litres	0.500
Degrees of freedom of molecular motion	3
Molar mass of gas /gmol^-1	28.966

Outputs

Heat input during isobaric heating /kJ	0.305
Heat output during isochoric cooling /kJ	0.168
Total work done by gas on surroundings /kJ	0.137
Efficiency (work done / heat input)	0.449

Theoretical efficiency

0.449

$$\eta = 1 - \frac{1}{r^{\gamma-1}} \left(\frac{s' - 1}{\gamma(s-1)} \right)$$
$$r = \frac{V_1}{V_2} \quad s = \frac{V_3}{V_2} \quad \gamma = \frac{c_p}{c_v}$$

Note all temperatures incorporated into calculations
will be converted to Kelvin first
- i.e. add 273 to Celsius number.

Pressure, volume, temperature coordinates of heat cycle

p1	1.0
V1	1
T1	285
p2	6.7
V2	0.3
T2	609
p3	6.7
V3	0.5
T3	952
p4	2.1
V4	1.0
T4	600

Single cylinder power output

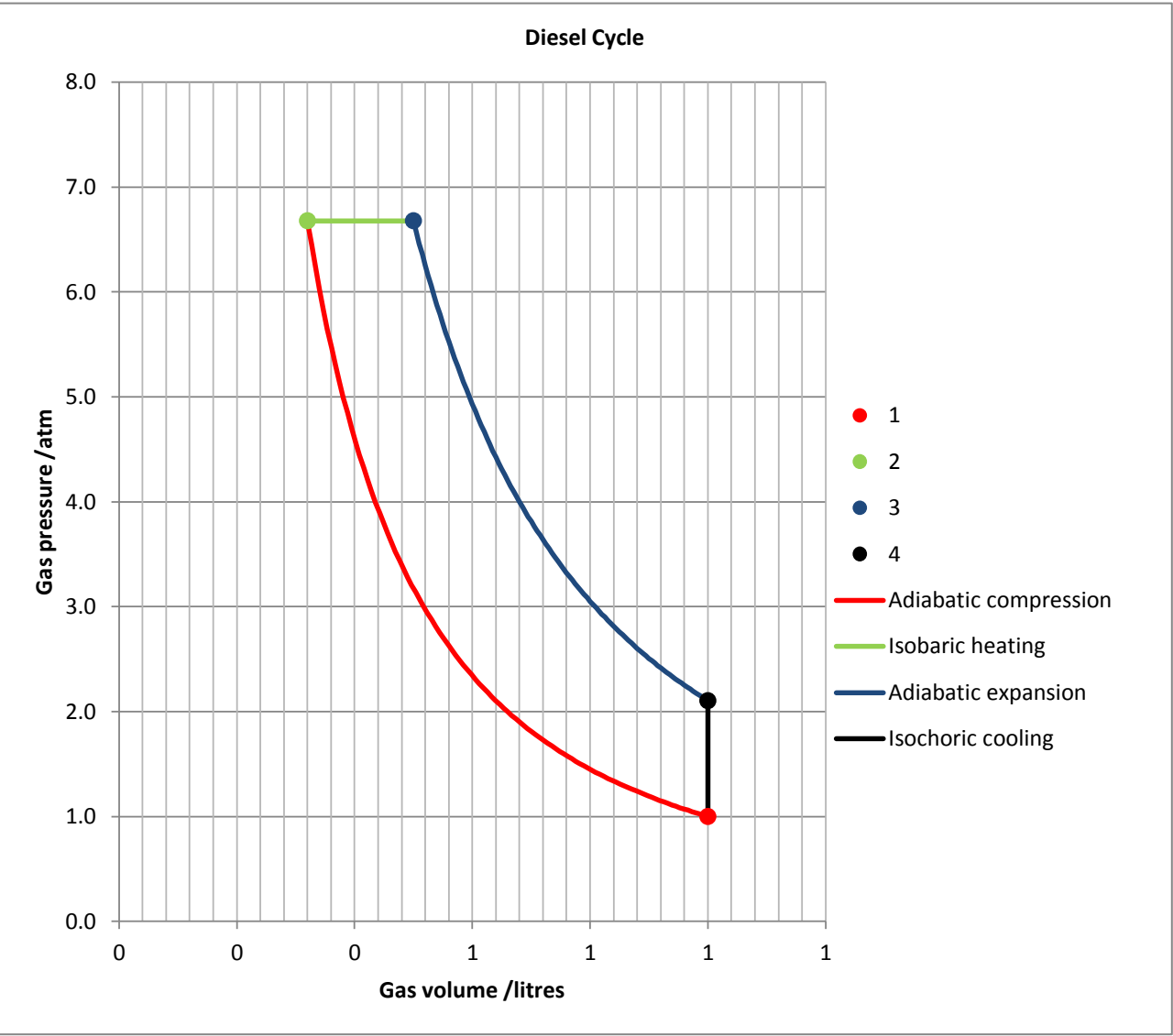
Engine RPM	84
Power output /kW	0

Number of cylinders	14
Total power output /kW	3

Note all pressures are quoted in atmospheres. 1atm = 101,325 Pa. Volumes in litres, T in K

Number of moles of gas in engine	0
Ratio of specific heats gamma	1.667
Constant volume specific heat capacity /Jkg^-1K^-1	431
Constant pressure specific heat capacity /Jkg^-1K^-1	718

Note real petrol engines have an efficiency of more like 20%, whereas diesels can be
up to 40%. In other words, significant losses!



V or p diff fraction	1 to 2		2 to 3		3 to 4		4 to 1	
	Adiabatic compression		Isobaric heating		Adiabatic expansion		Isochoric cooling	
	p	V	p	V	p	V	p	V
0	1.000	1.000	6.680	0.320	6.680	0.500	2.104	1.000
0.01	1.011	0.993	6.680	0.322	6.570	0.505	2.093	1.000
0.02	1.023	0.986	6.680	0.324	6.463	0.510	2.082	1.000
0.03	1.035	0.980	6.680	0.325	6.358	0.515	2.071	1.000
0.04	1.047	0.973	6.680	0.327	6.257	0.520	2.060	1.000
0.05	1.059	0.966	6.680	0.329	6.158	0.525	2.049	1.000
0.06	1.072	0.959	6.680	0.331	6.061	0.530	2.038	1.000
0.07	1.085	0.952	6.680	0.333	5.967	0.535	2.027	1.000
0.08	1.098	0.946	6.680	0.334	5.875	0.540	2.016	1.000
0.09	1.111	0.939	6.680	0.336	5.786	0.545	2.005	1.000
0.1	1.125	0.932	6.680	0.338	5.699	0.550	1.994	1.000
0.11	1.138	0.925	6.680	0.340	5.613	0.555	1.983	1.000
0.12	1.152	0.918	6.680	0.342	5.530	0.560	1.971	1.000
0.13	1.167	0.912	6.680	0.343	5.449	0.565	1.960	1.000
0.14	1.181	0.905	6.680	0.345	5.369	0.570	1.949	1.000
0.15	1.196	0.898	6.680	0.347	5.292	0.575	1.938	1.000
0.16	1.212	0.891	6.680	0.349	5.216	0.580	1.927	1.000
0.17	1.227	0.884	6.680	0.351	5.142	0.585	1.916	1.000
0.18	1.243	0.878	6.680	0.352	5.069	0.590	1.905	1.000
0.19	1.259	0.871	6.680	0.354	4.998	0.595	1.894	1.000
0.2	1.276	0.864	6.680	0.356	4.929	0.600	1.883	1.000
0.21	1.293	0.857	6.680	0.358	4.862	0.605	1.872	1.000
0.22	1.310	0.850	6.680	0.360	4.795	0.610	1.861	1.000
0.23	1.328	0.844	6.680	0.361	4.731	0.615	1.850	1.000
0.24	1.346	0.837	6.680	0.363	4.667	0.620	1.839	1.000
0.25	1.364	0.830	6.680	0.365	4.605	0.625	1.828	1.000
0.26	1.383	0.823	6.680	0.367	4.544	0.630	1.817	1.000
0.27	1.402	0.816	6.680	0.369	4.485	0.635	1.806	1.000
0.28	1.422	0.810	6.680	0.370	4.427	0.640	1.795	1.000
0.29	1.442	0.803	6.680	0.372	4.370	0.645	1.784	1.000
0.3	1.463	0.796	6.680	0.374	4.314	0.650	1.773	1.000
0.31	1.484	0.789	6.680	0.376	4.259	0.655	1.762	1.000
0.32	1.505	0.782	6.680	0.378	4.205	0.660	1.751	1.000
0.33	1.527	0.776	6.680	0.379	4.153	0.665	1.740	1.000
0.34	1.550	0.769	6.680	0.381	4.101	0.670	1.729	1.000
0.35	1.573	0.762	6.680	0.383	4.051	0.675	1.718	1.000
0.36	1.597	0.755	6.680	0.385	4.001	0.680	1.707	1.000
0.37	1.621	0.748	6.680	0.387	3.953	0.685	1.695	1.000
0.38	1.646	0.742	6.680	0.388	3.905	0.690	1.684	1.000
0.39	1.671	0.735	6.680	0.390	3.858	0.695	1.673	1.000
0.4	1.697	0.728	6.680	0.392	3.812	0.700	1.662	1.000
0.41	1.724	0.721	6.680	0.394	3.767	0.705	1.651	1.000
0.42	1.752	0.714	6.680	0.396	3.723	0.710	1.640	1.000
0.43	1.780	0.708	6.680	0.397	3.680	0.715	1.629	1.000
0.44	1.809	0.701	6.680	0.399	3.638	0.720	1.618	1.000
0.45	1.838	0.694	6.680	0.401	3.596	0.725	1.607	1.000
0.46	1.869	0.687	6.680	0.403	3.555	0.730	1.596	1.000
0.47	1.900	0.680	6.680	0.405	3.515	0.735	1.585	1.000
0.48	1.932	0.674	6.680	0.406	3.475	0.740	1.574	1.000
0.49	1.965	0.667	6.680	0.408	3.436	0.745	1.563	1.000
0.5	1.999	0.660	6.680	0.410	3.398	0.750	1.552	1.000
0.51	2.034	0.653	6.680	0.412	3.361	0.755	1.541	1.000
0.52	2.069	0.646	6.680	0.414	3.324	0.760	1.530	1.000
0.53	2.106	0.640	6.680	0.415	3.288	0.765	1.519	1.000
0.54	2.144	0.633	6.680	0.417	3.252	0.770	1.508	1.000

Note the Wärtsilä-Sulzer RTA96-C engine is perhaps more powerful, producing 80,080kW from it's 14 cylinders, at 120RPM

0.55	2.183	0.626	6.680	0.419	3.218	0.775	1.497	1.000
0.56	2.223	0.619	6.680	0.421	3.183	0.780	1.486	1.000
0.57	2.264	0.612	6.680	0.423	3.150	0.785	1.475	1.000
0.58	2.307	0.606	6.680	0.424	3.116	0.790	1.464	1.000
0.59	2.351	0.599	6.680	0.426	3.084	0.795	1.453	1.000
0.6	2.396	0.592	6.680	0.428	3.052	0.800	1.442	1.000
0.61	2.442	0.585	6.680	0.430	3.020	0.805	1.431	1.000
0.62	2.490	0.578	6.680	0.432	2.989	0.810	1.419	1.000
0.63	2.540	0.572	6.680	0.433	2.959	0.815	1.408	1.000
0.64	2.591	0.565	6.680	0.435	2.929	0.820	1.397	1.000
0.65	2.644	0.558	6.680	0.437	2.899	0.825	1.386	1.000
0.66	2.699	0.551	6.680	0.439	2.870	0.830	1.375	1.000
0.67	2.755	0.544	6.680	0.441	2.842	0.835	1.364	1.000
0.68	2.813	0.538	6.680	0.442	2.813	0.840	1.353	1.000
0.69	2.874	0.531	6.680	0.444	2.786	0.845	1.342	1.000
0.7	2.936	0.524	6.680	0.446	2.758	0.850	1.331	1.000
0.71	3.001	0.517	6.680	0.448	2.732	0.855	1.320	1.000
0.72	3.068	0.510	6.680	0.450	2.705	0.860	1.309	1.000
0.73	3.137	0.504	6.680	0.451	2.679	0.865	1.298	1.000
0.74	3.209	0.497	6.680	0.453	2.654	0.870	1.287	1.000
0.75	3.284	0.490	6.680	0.455	2.628	0.875	1.276	1.000
0.76	3.361	0.483	6.680	0.457	2.604	0.880	1.265	1.000
0.77	3.441	0.476	6.680	0.459	2.579	0.885	1.254	1.000
0.78	3.525	0.470	6.680	0.460	2.555	0.890	1.243	1.000
0.79	3.611	0.463	6.680	0.462	2.531	0.895	1.232	1.000
0.8	3.702	0.456	6.680	0.464	2.508	0.900	1.221	1.000
0.81	3.795	0.449	6.680	0.466	2.485	0.905	1.210	1.000
0.82	3.893	0.442	6.680	0.468	2.462	0.910	1.199	1.000
0.83	3.995	0.436	6.680	0.469	2.440	0.915	1.188	1.000
0.84	4.101	0.429	6.680	0.471	2.418	0.920	1.177	1.000
0.85	4.212	0.422	6.680	0.473	2.396	0.925	1.166	1.000
0.86	4.328	0.415	6.680	0.475	2.374	0.930	1.155	1.000
0.87	4.448	0.408	6.680	0.477	2.353	0.935	1.144	1.000
0.88	4.575	0.402	6.680	0.478	2.332	0.940	1.132	1.000
0.89	4.707	0.395	6.680	0.480	2.312	0.945	1.121	1.000
0.9	4.845	0.388	6.680	0.482	2.292	0.950	1.110	1.000
0.91	4.990	0.381	6.680	0.484	2.272	0.955	1.099	1.000
0.92	5.142	0.374	6.680	0.486	2.252	0.960	1.088	1.000
0.93	5.301	0.368	6.680	0.487	2.233	0.965	1.077	1.000
0.94	5.469	0.361	6.680	0.489	2.214	0.970	1.066	1.000
0.95	5.645	0.354	6.680	0.491	2.195	0.975	1.055	1.000
0.96	5.830	0.347	6.680	0.493	2.176	0.980	1.044	1.000
0.97	6.026	0.340	6.680	0.495	2.158	0.985	1.033	1.000
0.98	6.232	0.334	6.680	0.496	2.139	0.990	1.022	1.000
0.99	6.450	0.327	6.680	0.498	2.122	0.995	1.011	1.000
1	6.680	0.320	6.680	0.500	2.104	1.000	1.000	1.000