```
{Knowns}
 r_c = 10                                   {Compression Ratio}
$IFNOT parametric table
 alpha = 2                                  {Cut-Off Ratio}
$ENDIF
 r_p = 2                                    {Pressure Ratio During Constant Volume Heat Addition}
 RPM = 3000[1/min]                          {Speed of Engine}
 gamma = 1.4                                {Ratio Of Specific Heats}
 vol_cyl = 40*convert(in^3,m^3)             {Volume Per Cylinder}
 N_cyl = 6                                  {4 Cylinder Engine}
 N_r = 2                                    {Number of Revolutions Per Power Stroke}

{______________________________________________________________________________}

{Find}
{a.) Develop an arrays table for the dual cycle based on known parameters
 b.) Use your model to calculate heat transfer and work transfer for each process as well as the entire cycle
 c.) Compute the cycle efficiency and plot this for cut-off ratios between 1.5 and 2.5}

{______________________________________________________________________________}

{Pressure Ratio During Constant Volume Heat Addition}
 r_p = P[3]/P[2]
{Cut Off/Load Ratio}
 alpha = v[4]/v[3]
{Relating Compression Ratio To Cycle}
 r_c = v[1]/v[2]

{______________________________________________________________________________}

{Dual Cycle Operations}
 {States 1-->2  Adiabatic Compression
  States 2-->3  Addition of Heat At Constant Volume
  States 3-->4  Addition of Heat At Constant Pressure
  States 4-->5 Adiabatic Expansion
  States 5-->1 Rejection of Heat At Constant Volume}

{______________________________________________________________________________}

{Fluid Properties}
{State 1}
s[1]=Entropy(Air_ha,T=T[1],P=P[1])
P[1] = 101.3[kPa]
T[1] = 300[K]
v[1]=Volume(Air_ha,T=T[1],P=P[1])
u[1]=IntEnergy(Air_ha,T=T[1],P=P[1])

{State 2}
s[2]=s[1]
P[2] = pressure(Air_ha,v=v[2],s=s[2])
T[2] = temperature(Air_ha,v=v[2],s=s[2])
u[2] = intenergy(Air_ha,v=v[2],s=s[2])

{State 3}
s[3]=Entropy(Air_ha,T=T[3],P=P[3])
T[3] = temperature(Air_ha,v=v[3],P=P[3])
v[3] = v[2]
u[3] = intenergy(Air_ha,v=v[3],P=P[3])
h[3]=Enthalpy(Air_ha,T=T[3],P=P[3])

{State 4}
s[4]=Entropy(Air_ha,T=T[4],P=P[4])
```

```
T[4] = temperature(Air_ha,v=v[4],P=P[4])
P[4] = P[3]
u[4] = intenergy(Air_ha,v=v[4],P=P[4])
h[4]=Enthalpy(Air_ha,T=T[4],P=P[4])

{State 5}
s[5] = s[4]
P[5] = pressure(Air_ha,v=v[5],s=s[5])
T[5] = temperature(Air_ha,v=v[5],s=s[5])
u[5] = intenergy(Air_ha,v=v[5],s=s[5])
v[5]=v[1]

{Setting A "State 6" To Fill In Gaps On Cycle Plot}
P[6] = P[1]
T[6] = T[1]
v[6] = v[1]
s[6] = s[1]

{______________________________________________________________________________}

{Mass of Air In Cylinder}
m = vol_cyl/v[1]
{Developing Work/Heat Transfer Terms}
q_in = m*(u[3] - u[2])+ m*(h[4]-h[3])
q_out = m*(u[5]-u[1])
W_net = q_in - q_out
eta_TH = W_net/q_in
W_dot*convert(hp,kW) =  N_cyl*W_net*(RPM/N_r)*convert(kJ/min,kW)
```

Parametric Table: Table 1

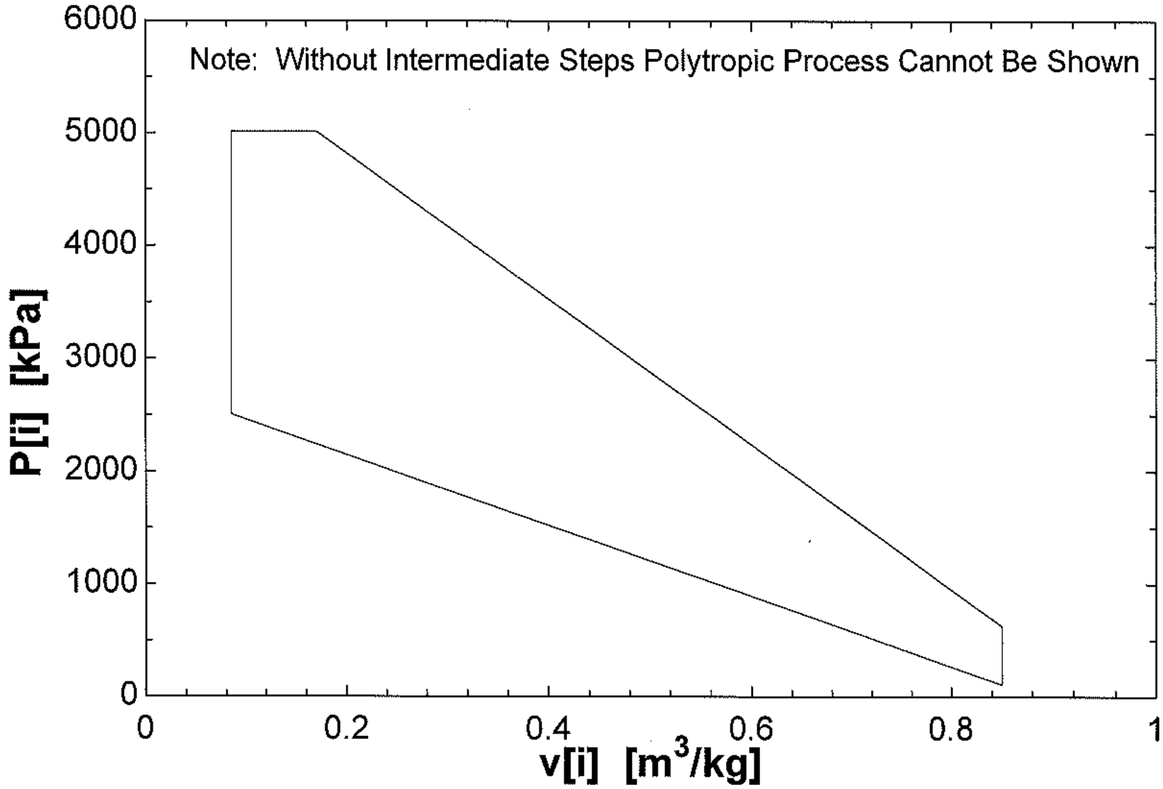
	α	η_{TH}
Run 1	1.5	*0.5193*
Run 2	1.51	*0.5184*
Run 3	1.52	*0.5175*
Run 4	1.53	*0.5165*
Run 5	1.54	*0.5156*
Run 6	1.551	*0.5147*
Run 7	1.561	*0.5138*
Run 8	1.571	*0.5129*
Run 9	1.581	*0.5119*
Run 10	1.591	*0.511*
Run 11	1.601	*0.5101*
Run 12	1.611	*0.5092*
Run 13	1.621	*0.5083*
Run 14	1.631	*0.5074*
Run 15	1.641	*0.5065*
Run 16	1.652	*0.5056*
Run 17	1.662	*0.5048*
Run 18	1.672	*0.5039*
Run 19	1.682	*0.503*
Run 20	1.692	*0.5021*
Run 21	1.702	*0.5012*
Run 22	1.712	*0.5004*
Run 23	1.722	*0.4995*

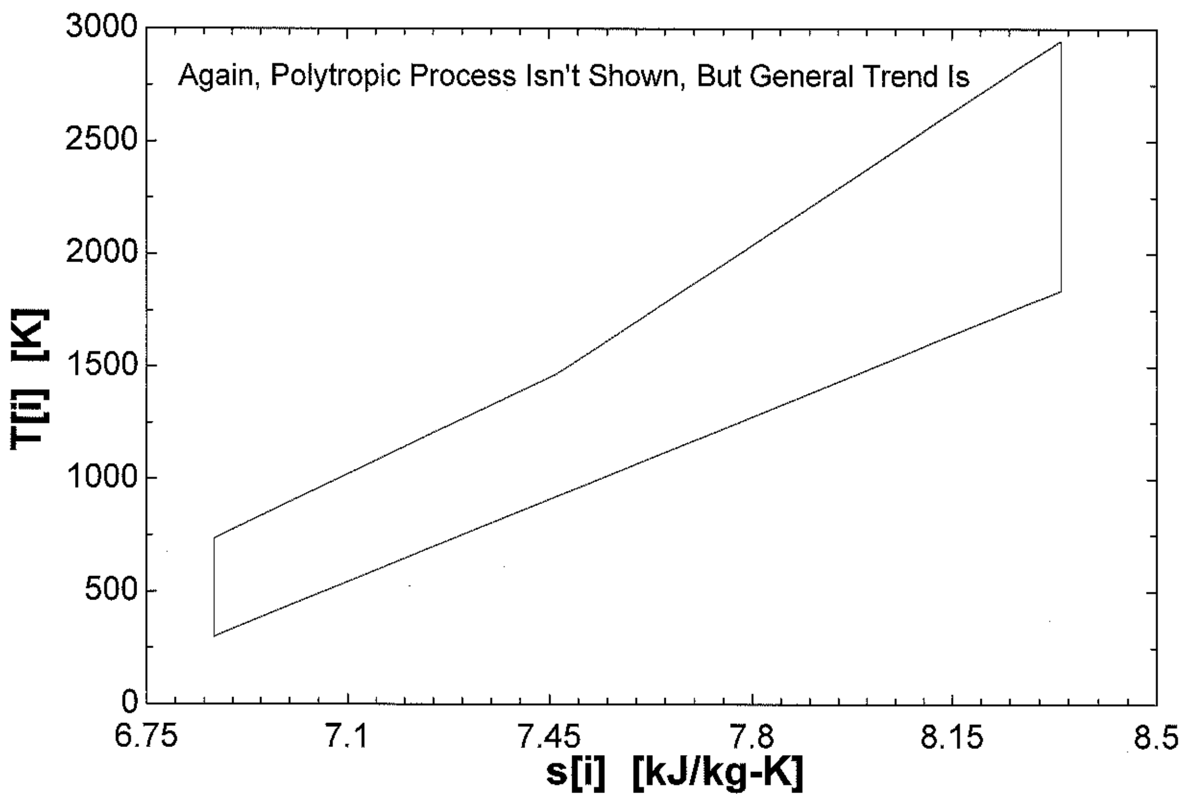
Parametric Table: Table 1

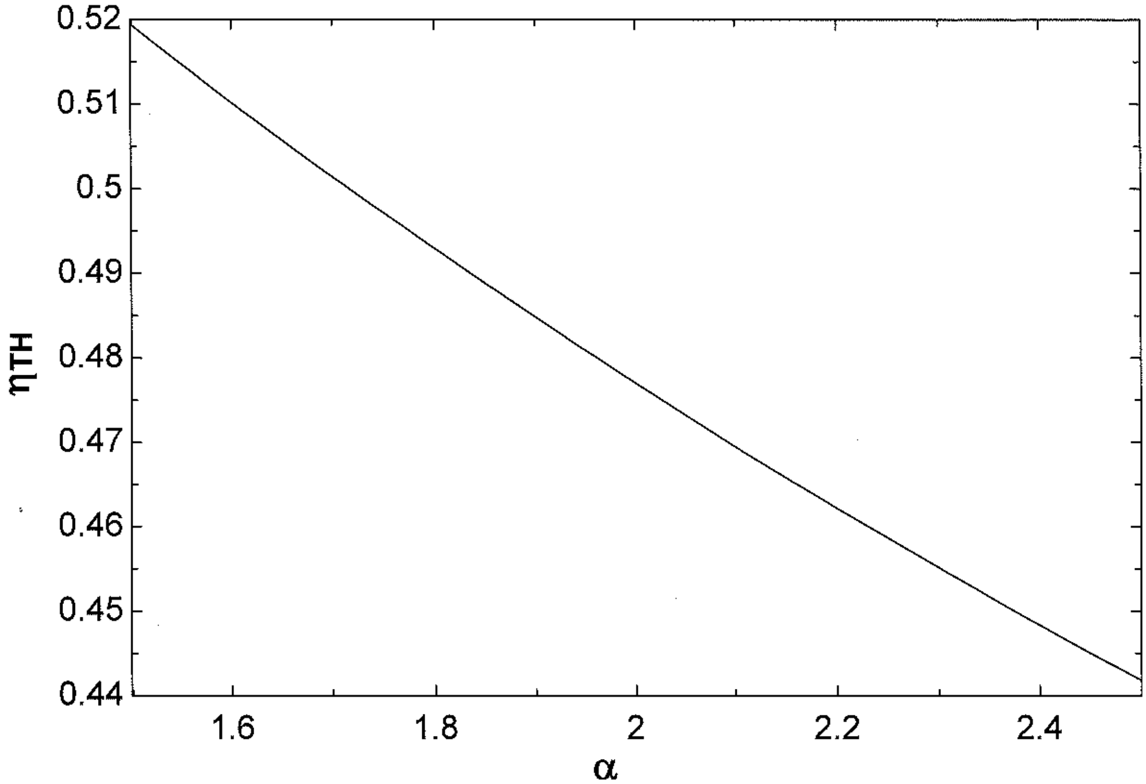
	α	η_{TH}
Run 24	1.732	*0.4986*
Run 25	1.742	*0.4978*
Run 26	1.753	*0.4969*
Run 27	1.763	*0.4961*
Run 28	1.773	*0.4952*
Run 29	1.783	*0.4944*
Run 30	1.793	*0.4935*
Run 31	1.803	*0.4927*
Run 32	1.813	*0.4919*
Run 33	1.823	*0.491*
Run 34	1.833	*0.4902*
Run 35	1.843	*0.4894*
Run 36	1.854	*0.4886*
Run 37	1.864	*0.4877*
Run 38	1.874	*0.4869*
Run 39	1.884	*0.4861*
Run 40	1.894	*0.4853*
Run 41	1.904	*0.4845*
Run 42	1.914	*0.4837*
Run 43	1.924	*0.4829*
Run 44	1.934	*0.4821*
Run 45	1.944	*0.4813*
Run 46	1.955	*0.4805*
Run 47	1.965	*0.4797*
Run 48	1.975	*0.4789*
Run 49	1.985	*0.4781*
Run 50	1.995	*0.4774*
Run 51	2.005	*0.4766*
Run 52	2.015	*0.4758*
Run 53	2.025	*0.475*
Run 54	2.035	*0.4743*
Run 55	2.045	*0.4735*
Run 56	2.056	*0.4727*
Run 57	2.066	*0.472*
Run 58	2.076	*0.4712*
Run 59	2.086	*0.4705*
Run 60	2.096	*0.4697*
Run 61	2.106	*0.469*
Run 62	2.116	*0.4682*
Run 63	2.126	*0.4675*
Run 64	2.136	*0.4667*
Run 65	2.146	*0.466*
Run 66	2.157	*0.4653*
Run 67	2.167	*0.4645*
Run 68	2.177	*0.4638*
Run 69	2.187	*0.4631*
Run 70	2.197	*0.4624*
Run 71	2.207	*0.4616*
Run 72	2.217	*0.4609*
Run 73	2.227	*0.4602*
Run 74	2.237	*0.4595*

Parametric Table: Table 1

	α	η_{TH}
Run 75	2.247	*0.4588*
Run 76	2.258	*0.4581*
Run 77	2.268	*0.4574*
Run 78	2.278	*0.4567*
Run 79	2.288	*0.456*
Run 80	2.298	*0.4553*
Run 81	2.308	*0.4546*
Run 82	2.318	*0.4539*
Run 83	2.328	*0.4532*
Run 84	2.338	*0.4525*
Run 85	2.348	*0.4518*
Run 86	2.359	*0.4511*
Run 87	2.369	*0.4504*
Run 88	2.379	*0.4497*
Run 89	2.389	*0.4491*
Run 90	2.399	*0.4484*
Run 91	2.409	*0.4477*
Run 92	2.419	*0.447*
Run 93	2.429	*0.4464*
Run 94	2.439	*0.4457*
Run 95	2.449	*0.445*
Run 96	2.46	*0.4444*
Run 97	2.47	*0.4437*
Run 98	2.48	*0.4431*
Run 99	2.49	*0.4424*
Run 100	2.5	*0.4417*


Note: Without Intermediate Steps Polytropic Process Cannot Be Shown
P[i] [kPa]
v[i] [m^3/kg]
0
1000
2000
3000
4000
5000
6000
0
0.2
0.4
0.6
0.8
1


Again, Polytropic Process Isn't Shown, But General Trend Is
T[i] [K]
s[i] [kJ/kg-K]
0
500
1000
1500
2000
2500
3000
6.75
7.1
7.45
7.8
8.15
8.5


0.52
0.51
0.5
0.49
0.48
0.47
0.46
0.45
0.44
ηTH
1.6
1.8
2
2.2
2.4
α