

# Reply to thread 135-344488

Given: Gas Turbine Fuel consumption @  $132 \times 10^6$  Btu/hr  
 flow rate @ 362,000 lbs/hr  
 exhaust gas (EG) temp @  $500^\circ\text{C} \approx 932^\circ\text{F}$

Daya Heat output @ 7,500,000 kcal/hr  $\approx 29,762,405$  Btu/hr  
 Temp. ratings  $600^\circ\text{C}$

Assumptions: Flow rate to be assumed to be Air & Fuel combined  
 Lean burning mixture @ 200% excess air (EA)  
 (gas turbines are known to be "lean" burning machines up to 300% EA)  
 A portion of compressed air will be diverted to cool down  
 products of combustion (P.O.C) before expanding thru turbine  
 assume 50% for combustion air (C.A.) & 50% to cool down P.O.C  
 fuel gas (FG) assumed propane ( $\text{C}_3\text{H}_8$ ) with gross heating  
 value @ 2590 Btu/lb  
 propane and air as perfect gases; air as perfect gas not atmospheric air

Details: Fuel consumption  $\dot{V}_{FG} = 132 \times 10^6 / 2590 = 50915 \text{ ft}^3/\text{hr} = 134.19 \text{ lb mole/hr}$   
 $= 5916.69 \text{ lb/hr}$

From stoichiometry

with 0% EA:  $\text{C}_3\text{H}_8 + 5\text{O}_2 + 5(3.761)\text{N}_2 = 3\text{CO}_2 + 4\text{H}_2\text{O} + 5(3.761)\text{N}_2$

with 200% EA:  $\text{C}_3\text{H}_8 + (2)5\text{O}_2 + (2)(5)(3.761)\text{N}_2 = 3\text{CO}_2 + 4\text{H}_2\text{O} + 5\text{O}_2 + 37.61\text{N}_2$

		Moles	x	Mol. Wts	=	Weights	Mole $\dot{V}$	$\dot{m}$ (lbs/hr)
FG - $\text{C}_3\text{H}_8$		1		44.092		44.092	379.99	5916.69
C.A. - $\text{O}_2$		10		32.000		320.00	3999.9	$(5916.69)(1373.18) / 44.092 =$
$\text{N}_2$		37.61		28.011		1053.68	14283.9	184,333.63
$\Sigma$		47.61				1373.68	18,081.80	
P.O.C	$\text{CO}_2$	3		44.01		132.03	1139.37	$(5916.69)(1417.77) / 44.092 =$
	$\text{H}_2\text{O}$	4		18.016		72.064	1519.16	190,250.6
	$\text{O}_2$	5		32.00		160.00	1898.95	
	$\text{N}_2$	37.61		28.01		1053.68	14283.90	
$\Sigma$		49.61				1417.77	18,841.38	

Conclusion: mass flow rate of C.A. = 184,333.63 lb/hr

mass flow rate of total air (T.A.) = 2 x C.A. = 368,667.3 lbs/hr

total mass flow rate (EG = T.A + FG) = 374,584 lbs/hr  $\approx 187.3$  tons/hr

$C_{p,EG} \approx 0.245 \text{ Btu/lbm} \cdot ^\circ\text{R} \rightarrow Q_{EG} = 374,584 \times 0.25 \times (932 - 60)$

$= 81.66 \times 10^6 \text{ Btu/hr}$  from turbine exhaust

Will require additional heat to boost temperature requirement.