

LLY INDUCTION SPREADSHEET TUTORIAL...

This should help reduce the misuse of this calculator tool, and some widespread misunderstanding. If you still have questions, then you can always email me and ask.

The Induction Spreadsheet Calculator is a thermodynamic problem solver for Thermal Feedback issues, and was developed as a decision making tool. The first thing to understand is that it is not perfect. It was developed from a thermodynamic model that I compiled, and have since calibrated with some real world validated practical results. It is to help you decide if the conditions that you expect to encounter will justify the change to both an Induction Overhaul Kit, and an “effective” Cold Air Intake. The spreadsheet considers both items together. The IOH kit is responsible for 60% of the benefits, the True CAI is approx. 40%, real world numbers though the proportions vary by use. If only for dyno or track purposes, then use 90/10. There is little benefit to IAT dampening on a dyno, it simply does not happen without ambient air rushing by at 60 mph. In other words, if you want to understand the dyno only benefits, then multiply your HP results from the spreadsheet by about 60% or 70% +/- . Use this same factor to estimate IOH kit only benefits. I personally could care less about dyno benefits, but this may help you understand the disparity.

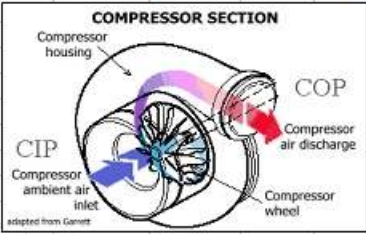
With lots of HP benefit numbers being thrown around (confusing speculation), I am doing this to show why one operator may show only 10 HP benefit, and little SOTP confirmation while another demonstrates 40 or more. To date, the spreadsheet has been revised 3 or 4 times, using real world results, and I consider it a nicely accurate prediction tool, but you have to know how to use it.

<http://members.cox.net/beekiller/GMC%20Light%20Duty/Turbo%20Calc%20spreadsheet.xls>

The difference in actual results among uses, is expected, and justified by the reality that we all have different uses, tunes, environments, etc. It also takes into account steady-state heat soak conditions, an important allowance when estimating real world situations. This is NOT what you get on a typical dyno run, PERIOD! I am not going to argue this point, except to say, that if you are on a grade, you will gradually feel the gradual power drop off. This is heat soak. Nuff said.

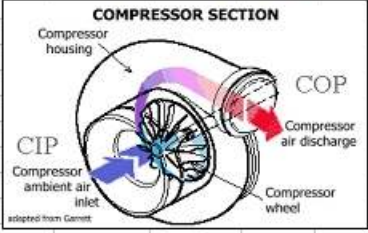
The following stereotypical examples should illustrate how “performance modification” benefits “performance vehicles”. If you feel hesitation every time you go to pass in the passing lane, you are not driving in a performance application. The more you demand from D. Maxx, the more valuable induction overhaul is. That is how it works. Same goes for mpg savings.

Operator A, Stock tune user, near sea level Grocery Getter: Usually warms it up in the driveway, changes the oil every 3000 miles, and has the DIC always set to “instant economy”, happily married with 2 college kids and a dog. Covets the warranty ☺ and maybe wants to exploit mpg benefits, longevity benefits, but is not usually towing anything heavy into high places.

INPUTS: BLUE items change most		Imperial	Metric convy	D-MAX VGT INDUCTION ANALYSIS-LLY	
OAT, AMBIENT TEMP (F)	70		21 C	 <p>See previous tab for ins Created by: Michael Patton ENERVATIVE Product Engineer baskiller@cox.net The Complete INDUC</p>	
RELATIVE HUMIDITY (%)	50				
STOCK IAT, AIR BOX TEMP (F) typical fan	80		27 C		
ELEVATION (ft)	500		152.5 M		
DESIRED GAUGE BOOST (psig)	18.0		124.2 Kpa		
RPM	2800				
AIR CONDITIONING (on/off)	on				
ENGINE DISPLACEMENT (L)	6.6				
VOLUMETRIC EFF	0.85				
CAC EFFICIENCY (%)	75				
OUTPUTS:		RESULTS-STOCK VEHICLE		WITH INDUCTION OVERHAUL KIT* AND TRUE	
		Imperial	Metric Conv	Imperial	Metric Conv
ATMOSPHERIC PRESSURE (baro)		14.4	psia 99.4 Kpa	14.4	psia 99 kpa
LOW PRESSURE LOSSES (psi)		2.9	psi 20.1 Kpa	0.9	psi 6 kpa
CIP, Compressor Inlet Pressure (psia)		11.5	psia 79.3 Kpa	13.5	psia 93 kpa
HIGH PRESSURE LOSSES (psi)		1.6	psi 10.7 Kpa	1.1	psi 7 kpa
COP, Compressor Outlet Pressure (psia)		34.0	psia 234.4 Kpa	33.5	psia 231 kpa
PR, Compressor Pressure Ratio		2.95		2.49	
CIT, Absolute Inlet Temp@80F IAT		540	deg R 300 Kelvin	535	deg R 75 F new IAT, a 5 F improve
COMPRESSOR EFF. η (%)		70.3		72.5	2.2% efficiency improvement
COT, Compressor Discharge Temp		335	deg F 168 C	276	deg F 135 C
CFM		624	cfm	647	cfm
SCFM		609	cfm	631	cfm
Compressor mouthpiece (stock LLY) velocity		226	mph	132	mph 94 mph slower (improved)
MAF		45.0	lb/min	46.7	lb/min 1.7 lb/min (4%) air increase
Compressor Heat Created/ HP consumed		172,305	BTU/hr 67.7 HP	140,819	BTU/hr 55 HP 31000 BTU's/hr reduction (19
Rejected CAC heat (into the radiator)		134,294	BTU/hr 52.8 HP	108,109	BTU/hr 42 HP 26000 less BTU's/hr rejected
Turbo Shaft HP req'd to drive compressor		67.7	HP	55.0	HP 19% less turbo shaft HP
Post CAC, Intake Charge Temperature		140	F	125	F 15 F improved charge temp
Power Penalty From Charge Heatup		-3	%	-6	% A 3% improvement
Radiator Capacity Remaining		88.7	%	92.4	% 4% more radiator effectiveness
Components of Radiator Reduction		before	after	10.2 More HP than stock vehicle	
Reduction due to ambient temperature>85F		-10.3 %	-10.3 %	49 Deg F Peak EGT reduction	
Reduction due to CAC and AC heat		24.3 %	20.6 %		
Reduction from thin air-mass flow decrease		-2.6 %	-2.6 %		
**Of the improvements noted, 60-70% come from the IOH kit, 30-40% from the CAI				NOTE: a 40-80% fan reduction is observed 35.0 HP total improvement if fan is kept off	

Benefits: there is a 10 HP increase, a 49 degree peak EGT reduction, 19% less turbo shaft rpm, and a 4% MAF increase. There are other benefits as well, as you can see. If you just want mpg benefits, there is a little, 0.5-1.0 mpg, but not if you drive 60 mph in the right lane 24/7. If this describes you, I just saved you some money, buy custom tuning instead.

Operator B, Stock Tune User, Work Vehicle: Likes to go places with the toy hauler, heading North of 6000 ft elevation. Wants to exploit mpg benefits, longevity and power benefits while putting the vehicle to its intended use. Note that CAC efficiency has dropped, a real world observation when you mash the pedal for more than 12 seconds. IAT is through the roof as well. This is a typical value for around here when the fan comes on, observed as high as 232 F.

INPUTS: BLUE items change most		Imperial	Metric conv	D-MAX VGT INDUCTION ANALYSIS-LLY	
OAT, AMBIENT TEMP (F)	80		27 C	 <p>See previous tab for inst Created By: Michael Patton & ENERVative Product Engine</p> <p>baekiller@cox.net The Complete INDUCT</p>	
RELATIVE HUMIDITY (%)	30		82 C		
STOCK IAT, AIR BOX TEMP (F) typical fan	180		1830 M		
ELEVATION (ft)	6000		124.2 Kpa		
DESIRED GAUGE BOOST (psig)	18.0				
RPM	3000				
AIR CONDITIONING (on/off)	on				
ENGINE DISPLACEMENT (L)	6.6				
VOLUMETRIC EFF	0.85				
CAC EFFICIENCY (%)	65				
OUTPUTS:		RESULTS-STOCK VEHICLE		WITH INDUCTION OVERHAUL KIT** AND TRUE I	
		Imperial	Metric Conv	Imperial	Metric Conv
ATMOSPHERIC PRESSURE (baro)		11.5 psia	79.6 Kpa	11.5 psia	80 kpa
LOW PRESSURE LOSSES (psi)		3.5 psi	24.0 Kpa	1.1 psi	8 kpa
CIP, Compressor Inlet Pressure (psia)		8.1 psia	55.6 Kpa	10.4 psia	72 kpa
HIGH PRESSURE LOSSES (psi)		2.6 psi	17.8 Kpa	1.8 psi	12 kpa
COP, Compressor Outlet Pressure (psia)		32.1 psia	221.6 Kpa	31.3 psia	216 kpa
PR, Compressor Pressure Ratio		3.98		3.02	
CIT, Absolute Inlet Temp@180F IAT		640 deg R	355 Kelvin	584 deg R	124 F new IAT, a 56 F improv
COMPRESSOR EFF, η (%)		68.5		71.5	3% efficiency improvement
COT, Compressor Discharge Temp		609 deg F	320 C	411 deg F	211 C
CFM		761 cfm		797 cfm	
SCFM		501 cfm		569 cfm	
Compressor mouthpiece (stock LLY) velocity		276 mph		162 mph	113 mph slower (improved)
MAF		37.1 lb/min		42.1 lb/min	5 lb/min (14%) air increase
Compressor Heat Created/ HP consumed		238,485 BTU/hr	93.7 HP	181,533 BTU/hr	71 HP 57000 BTU/s/hr reduction (24
Rejected CAC heat (into the radiator)		191,184 BTU/hr	75.1 HP	135,957 BTU/hr	53 HP 55000 less BTU/s/hr rejected
Turbo Shaft HP req'd to drive compressor		93.7 HP		71.0 HP	24% less turbo shaft HP
Post CAC, Intake Charge Temperature		270 F	132 C	201 F	94C 69 F improved charge temp
Power Penalty From Charge Heatup		15 %		6 %	A 9% improvement
Radiator Capacity Remaining		55.2 %		63.0 %	8% more radiator effectiveness
Components of Radiator Reduction		before	after	29.6 More HP than stock vehicle	
Reduction due to ambient temperature>85F		-3.4 %	-3.4 %	137 Deg F Peak EGT reduction	
Reduction due to CAC and AC heat		32.5 %	24.6 %		
Reduction from thin air-mass flow decrease		15.8 %	15.8 %		
**Of the improvements noted, 60-70% come from the IOH kit, 30-40% from the CAI				NOTE: a 40-80% fan reduction is observed 50.8 HP total improvement if fan is kept off	

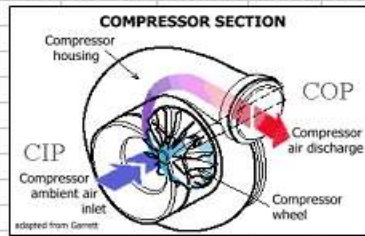
Benefits: A 29 HP increase, a 137 degree peak EGT reduction, 24% less turbo shaft rpm, and a 14% MAF increase. With it, you will get an easy 10% economy boost.

Operator C, Tow Tune User, plus boost enhancement, work vehicle: Likes to tow north of 6000 ft elevation. Wants to exploit mpg benefits, longevity and power benefits while putting the vehicle to its intended use, but does so with a mixture of ECM modifications, and as a result, experiences more CAC heat soak, and still lower CAC efficiency.

INPUTS: BLUE items change most

	Imperial	Metric conv
OAT, AMBIENT TEMP (F)	80	27 C
RELATIVE HUMIDITY (%)	30	
STOCK IAT, AIR BOX TEMP (F) typical fan	180	82 C
ELEVATION (ft)	6000	1830 M
DESIRED GAUGE BOOST (psig)	24.0	165.6 Kpa
RPM	2800	
AIR CONDITIONING (on/off)	on	
ENGINE DISPLACEMENT (L)	6.6	
VOLUMETRIC EFF	0.85	
CAC EFFICIENCY (%)	60	

D-MAX VGT INDUCTION ANALYSIS-LLY



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OUTPUTS:

	RESULTS-STOCK VEHICLE		WITH INDUCTION OVERHAUL KIT* AND TRUE C	
	Imperial	Metric Conv	Imperial	Metric Conv
ATMOSPHERIC PRESSURE (baro)	11.5 psia	79.6 Kpa	11.5 psia	80 kpa
LOW PRESSURE LOSSES (psi)	4.4 psi	30.2 Kpa	1.4 psi	10 kpa
CIP, Compressor Inlet Pressure (psia)	7.2 psia	49.4 Kpa	10.1 psia	70 kpa
HIGH PRESSURE LOSSES (psi)	3.8 psi	26.4 Kpa	2.7 psi	18 kpa
COP, Compressor Outlet Pressure (psia)	39.4 psia	271.6 Kpa	38.2 psia	264 kpa
PR, Compressor Pressure Ratio	5.50		3.79	
CIT, Absolute Inlet Temp@180F IAT	640 deg R	355 Kelvin	588 deg R	128 F new IAT, a 53 F improv
COMPRESSOR EFF, η (%)	67.1		70.9	3.7% efficiency improvement
CDT, Compressor Discharge Temp	746 deg F	397 C	492 deg F	255 C
CFM	855 cfm		897 cfm	
SCFM	563 cfm		636 cfm	
Compressor mouthpiece (stock LLY) velocity	309 mph		183 mph	127 mph slower (improved)
MAF	41.7 lb/min		47.1 lb/min	5.4 lb/min (13%) air increase
Compressor Heat Created/ HP consumed	353,531 BTU/hr	138.9 HP	256,978 BTU/hr	101 HP 97000 BTU's/hr reduction (27%)
Rejected CAC heat (into the radiator)	249,610 BTU/hr	98.1 HP	174,304 BTU/hr	69 HP 75000 less BTU's/hr rejected
Turbo Shaft HP req'd to drive compressor	138.9 HP		101.0 HP	27% less turbo shaft HP
Post CAC, Intake Charge Temperature	352 F	178 C	251 F	121C 102 F improved charge temp
Power Penalty From Charge Heatup	24 %		13 %	A 11% improvement
Radiator Capacity Remaining	46.8 %		57.6 %	11% more radiator effectiveness

Components of Radiator Reduction

	before	after
Reduction due to ambient temperature > 85F	-3.4 %	-3.4 %
Reduction due to CAC and AC heat	40.8 %	30.0 %
Reduction from thin air-mass flow decrease	15.8 %	15.8 %

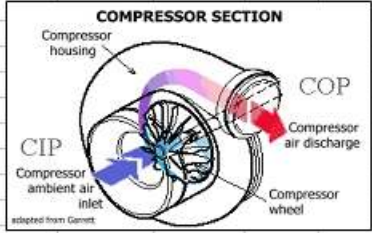
39.0 More HP than stock vehicle
204 Deg F Peak EGT reduction

NOTE: a 40-80% fan reduction is observed
58.7 HP total improvement if fan is kept off

**Of the improvements noted, 60-70% come from the IOH kit, 30-40% from the CAI

Benefits: A 39 HP increase, a 204 degree peak EGT reduction, 27% less turbo shaft rpm, and a 13% MAF increase. This all makes a significant difference to grade tow speed, and time to crest, while providing peace of mind on EGT's.

Operator D, Pubescent race tune user: Racer X likes to run 32 psi of boost on his gasket-challenged 8000 lb “race truck”.... He tunes for 4000 rpm, but can’t understand why he keeps popping stock turbo’s and topping off coolant... ☺ Usually rides a bicycle while the truck is down for repairs. Could care less about economy, loves black smokescreens, and has vision good enough to see 440 yards in front of him. You can usually spot him from the number of stickers on the highly tinted rear window. There is a reason for this: it helps cut down on the glare from those pesky cop strobes. Since this driver is running through shifts, boost and rpm are constantly changing, so an average value must be used, and I have done so here.

INPUTS: BLUE items change most		Imperial	Metric conv	D-MAX VGT INDUCTION ANALYSIS-LLY	
OAT, AMBIENT TEMP (F)	70		21 C	 <p>COMPRESSOR SECTION</p> <p>Compressor housing</p> <p>CIP Compressor ambient air inlet</p> <p>COP Compressor air discharge</p> <p>Compressor wheel</p> <p><small>adapted from Garrett</small></p>	
RELATIVE HUMIDITY (%)	30				
STOCK IAT, AIR BOX TEMP (F) typical fan	70		21 C		
ELEVATION (ft)	500		152.5 M		
DESIRED GAUGE BOOST (psig)	30.0		207 Kpa		
RPM	3400				
AIR CONDITIONING (on/off)	on				
ENGINE DISPLACEMENT (L)	6.6				
VOLUMETRIC EFF	0.85				
CAC EFFICIENCY (%)	70				
OUTPUTS:		RESULTS-STOCK VEHICLE		WITH INDUCTION OVERHAUL KIT** AND TRUE	
		Imperial	Metric Conv	Imperial	Metric Conv
ATMOSPHERIC PRESSURE (baro)		14.4 psia	99.4 Kpa	14.4 psia	99 kpa
LOW PRESSURE LOSSES (psi)		8.1 psi	55.7 Kpa	2.8 psi	19 kpa
CIP, Compressor Inlet Pressure (psia)		6.3 psia	43.7 Kpa	11.6 psia	80 kpa
HIGH PRESSURE LOSSES (psi)		5.2 psi	35.7 Kpa	3.6 psi	25 kpa
COP, Compressor Outlet Pressure (psia)		49.6 psia	342.1 Kpa	48.0 psia	331 kpa
PR, Compressor Pressure Ratio		7.82		4.13	
CIT, Absolute Inlet Temp@70F IAT		530 deg R	294 Kelvin	530 deg R	70 F new IAT, a 0 F improvement
COMPRESSOR EFF, η (%)		62.7		69.2	6.5% efficiency improvement
COT, Compressor Discharge Temp		707 deg F	375 C	433 deg F	223 C
CFM		1038 cfm		1114 cfm	
SCFM		1032 cfm		1088 cfm	
Compressor mouthpiece (stock LLY) velocity		376 mph		227 mph	149 mph slower (improved)
MAF		76.3 lb/min		80.5 lb/min	4.2 lb/min (5%) air increase
Compressor Heat Created ¹ HP consumed		729.940 BTU/hr	286.9 HP	438.205 BTU/hr	172 HP 292000 BTU's/hr reduction (40% less turbo shaft HP)
Rejected CAC heat (into the radiator)		510.958 BTU/hr	200.8 HP	306.744 BTU/hr	121 HP 204000 less BTU's/hr rejected
Turbo Shaft HP req'd to drive compressor		286.9 HP		172.0 HP	
Post CAC, Intake Charge Temperature		266 F	130 C	183 F	84C 82 F improved charge temp
Power Penalty From Charge Heatup		15 %		4 %	A 11% improvement
Radiator Capacity Remaining		34.9 %		64.0 %	29% more radiator effectiveness
Components of Radiator Reduction		before	after	58.2 More HP than stock vehicle	
Reduction due to ambient temperature>85F		-10.3 %	-10.3 %	264 Deg F Peak EGT reduction	
Reduction due to CAC and AC heat		78.1 %	49.0 %		
Reduction from thin air-mass flow decrease		-2.6 %	-2.6 %		
**Of the improvements noted, 60-70% come from the IOH kit, 30-40% from the CAI				NOTE: a 40-80% fan reduction is observed	
				88.2 HP total improvement if fan is kept off	

Benefits: By now you can figure this out. Does it help explain some of the reports that the IOH kit has cut .3 sec off the quarter mile? BTW, don’t take this 32 psi tune to a 6000 ft track with the stock induction, unless it was towed there. You will need a way to get it home. Thanks for looking, happy hauling.

Michael