Yamaha Nytro Turbo vs Supercharger boost

TURBO CONNECTION TURBO NYTRO
Allen Ulmer of Ulmer Performance in South Dakota (srxspec@gwtc.net) is marketing Nytro turbocharger systems designed and built by Turbo Connection in Rapid City SD. Allen and his dad Gary brought this stock Nytro to DTR for final tuning of the PCIII fuel management system, and assess boosted Nytro HP on pump gas. This turbo system uses a custom pump/ adjustable fuel regulator to increase fuel pressure as boost rises. The mid-mount turbo is mounted under the seat, and uses a small custom stainless muffler exiting out the stock location. Filtered air is compressed, and then delivered to a front mounted intercooler. Stock injectors are used.

The Ulmer/ Turbo Connection Nytro kit uses self-lubricating Aerocharger turbos, with the largest 53 series model. The Aerocharger's small airflow capacity and self-lubricating ball bearing system lends itself well to the design and intended use of this Yamaha Nytro turbo system. The exhaust exits out the back of the engine, and the three into one stock header merges under the rear of the seat, which provides an ideal space for the Aerocharger turbo. There's no need for oil feed lines and oil pump/ return to sump system. And that small Aerocharger compressor lends itself well for a pump gas high power turbo system for the Yamaha triple—small turbo sizing = quick building boost which is most critical for quick throttle response and midrange HP, as the following dyno test data shows. Also note that on this efficient four-stroke the 53 turbo makes 209 HP with safe turbine speed at only 250 CFM, allowing for perhaps 20% more HP capacity if octane and boost were increased before turbo overspeed might occur, far greater than the 210 HP the most turbo friendly (ie: low exhaust port Vmax 800) two-stroke could ever achieve with a 53. South Dakota pump gas was used for this test.

Also note that the Nytro turbo engine made peak torque of 140.4 lb/ft at 6200 RPM, with 165.7 HP. Just another example that shows you can't create maximum acceleration by clutching to the torque peak.

EngSpd RPM	STPTrq Clb-ft	STPPwr CHp	Fuel A Lb/hr	BSFC A lb/hph	AirTmp degF	FuelP psig	A/F A Ratio	BOOST IN HG	Air1+2 scfm
5667	134.6	145.2	67.8	0.48	62	67.3	11.05	13.9	164
5800	134.4	148.5	70.2	0.49	63	67.5	11.17	14.7	171
5900	134.6	151.2	71.6	0.49	63	67.6	11.27	15.6	176
6000	136.6	156.1	73.3	0.49	63	67.8	11.35	16.2	182
6100	139.0	161.5	74.2	0.48	63	68.1	11.42	16.5	185
6200	140.4	165.7	75.4	0.47	63	68.1	11.44	16.6	188
6300	139.1	166.9	76.6	0.48	63	68.0	11.30	16.7	189
6400	138.2	168.4	79.1	0.49	63	67.9	11.06	16.7	191
6500	137.7	170.4	82.5	0.50	63	68.0	10.73	16.8	193
6600	135.8	170.7	89.9	0.55	63	68.0	10.01	17.1	197
6700	133.5	170.3	97.1	0.59	63	68.3	9.37	17.4	199
6800	132.7	171.9	96.8	0.59	63	68.7	9.54	17.6	202
6900	136.2	179.0	92.1	0.53	62	68.8	10.19	17.6	205
7000	138.9	185.1	88.4	0.49	61	68.6	10.82	17.5	209
7100	139.0	188.0	91.2	0.50	60	68.2	10.60	17.4	211

7200	137.2	188.1	94.0	0.52	60	68.0	10.36	17.3	213
7300	137.0	190.4	95.9	0.52	60	68.1	10.29	17.3	215
7400	137.1	193.2	96.3	0.52	60	68.1	10.39	17.3	218
7500	136.9	195.5	96.1	0.51	60	68.2	10.53	17.5	221
7600	135.2	195.6	94.1	0.50	60	68.2	10.87	17.5	223
7700	134.8	197.7	93.1	0.49	60	68.2	11.08	17.6	225
7800	135.5	201.3	91.3	0.47	61	68.4	11.49	17.6	229
7900	135.8	204.3	91.0	0.46	61	68.5	11.72	17.7	233
8000	134.7	205.1	89.9	0.45	60	68.6	12.04	17.8	236
8100	133.2	205.5	90.1	0.45	60	68.6	12.10	17.8	238
8200	131.4	205.2	90.9	0.46	59	68.5	12.04	17.8	239
8300	129.9	205.3	92.1	0.46	59	68.4	11.90	17.8	239
8400	127.9	204.5	93.8	0.48	60	68.3	11.68	17.8	239
8500	126.9	205.3	94.9	0.48	60	68.3	11.61	17.8	241
8600	126.5	207.1	96.8	0.48	60	68.3	11.51	17.9	243
8700	126.3	209.1	97.4	0.48	60	68.4	11.63	17.9	247
8800	124.8	209.1	97.1	0.48	60	68.6	11.75	17.8	249
8900	122.0	206.8	95.9	0.48	60	68.7	11.94	17.5	250
9033	116.7	200.7	93.8	0.48	60	68.6	12.20	17.3	250

MPI SUPERCHARGED NYTRO

This stock Yamaha Nytro is owned by New Yorker Mike Martin. This particular Mountain Performance Supercharger kit, set to deliver 9-10 psi boost at peak revs, was professionally installed by Woodie's Yamaha in Topsham, Maine (woodiesyamaha@hotmail.com). (SC specialist Woodie is the asphalt madman who brought us that violent methanol fueled SC 400+ HP Apex seen on this website). The centrifugal supercharger is attached in front of the engine block, and belt driven via a jackshaft from the right side of the engine. A nicely fabbed custom tig welded aluminum oil tank provides clearance for the belt drive, but is devoid of a drain plug. A front mounted intercooler feeds the throttle bodies, and creates a tent-shaped area, boxed in by frame rails, that the supercharger and air intake filter fits into. We can to criticize the location of the air intake next to the hot engine block, and right behind the intercooler—any outside air forced through the intercooler fins will be preheated by the exchange of heat from the hot compressed boosted air inside, which causes air entering the SC to be preheated, causing compressed air to be even hotter, creating much hotter intake air in a vicious cycle at extended periods at WOT. But the nature of this system for trail riding is momentary use of WOT for accelerating, where the intercooler is more of a heat sink, gradually cooling back to ambient while normal riding resumes, and having little effect on air temp entering the filter. That intake location is likely more of a performance reducer for mountain climbers who run WOT uphill for minutes at low vehicle speed.

But more of an issue with this application/ boost level is that it appears that either the stock fuel pump, or the stock injectors max out at around 175 observed HP. During this session we tuned the MP fuel controller using the dyno's Innovate wide band A/F measuring device. Since we weren't connected to the sled's fuel system, we don't know if, when A/F begins to lean out at around 7800 RPM (175 observed HP), the fuel pressure is dropping from insufficient pump size, or if pressure is maintaining but injectors are just maxed out. As the result of this tuning session, Mike is returning to DTR on 12/4/08 with a Mountain Performance supplied higher capacity fuel pump and boost-sensing regulator to alleviate this problem. Remember, I implore pump gas TC and SC riders to tune to around 11/1 to try to achieve safe operation on the 87 octane fuel that will surely be encountered (see the DTR blog “Hosed at the pump”). Note that as boost and airflow rises to max HP at the rev limiter, air/fuel ratio is leaning out to 13/1 which is probably maximum HP. Included on the right side of the data is observed (actual) HP, so high altitude riders of this combo can see that the stock injectors/ pump should be fine at up to 22.5 psia or 45 inhga (absolute pressure = baro pressure plus boost pressure) especially since the intake air temp is likely to be 50 degrees F or even 100 degrees F or higher while on boost.

EngSpd RPM	STPTrq Clb-ft	STPPwr CHp	LAMAF1 Ratio	BOOST IN HG	AirTmp degF	BaroP in/Hg	VapPrs InHg	STPCor Factor	EngPwr Hp
6200	113.7	134.3	10.7	10.1	51	28.83	0.2	1.036	129.0
6300	112.7	135.2	10.7	10.3	50	28.82	0.2	1.035	130.0
6400	112.9	137.6	10.6	10.7	50	28.82	0.2	1.035	132.3
6500	113.3	140.2	10.6	11.1	50	28.82	0.2	1.035	134.8
6600	114.8	144.2	10.6	11.3	50	28.83	0.2	1.035	138.7
6700	114.8	146.5	10.5	11.5	50	28.82	0.2	1.035	140.8
6800	114.1	147.7	10.5	11.4	50	28.83	0.2	1.035	142.0
6900	116.7	153.4	10.6	12.0	50	28.83	0.2	1.035	147.5
7000	116.3	155.1	10.6	12.2	50	28.83	0.2	1.035	149.1
7100	118.8	160.6	10.7	12.8	50	28.83	0.2	1.035	154.5
7200	119.5	163.9	10.8	13.2	49	28.83	0.2	1.034	157.8
7300	119.0	165.4	10.8	13.4	49	28.83	0.2	1.034	159.3
7400	120.1	169.2	10.9	13.7	49	28.83	0.2	1.034	162.9
7500	119.2	170.3	10.8	13.8	49	28.83	0.2	1.034	163.9
7600	118.5	171.5	10.9	13.9	49	28.83	0.2	1.034	165.1
7700	122.9	180.1	10.9	14.7	49	28.83	0.2	1.034	173.4
7800	122.0	181.3	11.0	14.9	49	28.83	0.2	1.034	174.5
7900	121.9	183.4	11.1	15.2	48	28.83	0.2	1.033	176.7
8000	124.3	189.3	11.3	15.8	48	28.83	0.2	1.033	182.5
8100	123.7	190.8	11.4	16.3	48	28.83	0.2	1.033	183.8
8200	125.3	195.7	11.6	16.6	48	28.83	0.2	1.033	188.6
8300	126.0	199.1	11.8	17.0	49	28.83	0.2	1.034	191.7
8400	125.2	200.2	12.0	17.4	49	28.83	0.2	1.034	192.7
8500	125.0	202.3	12.1	17.7	49	28.83	0.2	1.034	194.7
8600	123.6	202.3	12.2	18.2	49	28.83	0.2	1.034	194.7
8700	125.2	207.3	12.5	19.0	50	28.83	0.2	1.035	199.3
8800	125.4	210.1	12.7	19.0	50	28.83	0.2	1.035	201.9
8900	124.0	210.1	13.0	19.5	51	28.83	0.2	1.036	201.7
9000	123.1	211.0	13.1	19.9	51	28.83	0.2	1.036	202.5

Performance comparison of a turbocharger and centrifugal supercharger
The centrifugal supercharger used by the Mountain Performance Nytro kit is belt driven from the right side of the crankshaft—compressor wheel speed is directly proportional to crank speed. The airflow and boost created by the centrifugal supercharger turbine wheel increases as the square of engine/ compressor speed, causing midrange boost and HP to be much lower than turbo boosted engines. As the dyno test graph shows, the rise in boost pressure from this centrifugal supercharger appears flatter than exponential due to the boost pressure being measured *after* the intercooler ahead of the throttle bodies. The intercooler's restriction is greater at high airflow causing a greater pressure drop at high revs. If a properly sized turbo's boost controller device diaphragm is connected after the intercooler, that boost curve will be fairly flat because the turbo will try to create whatever boost is necessary ahead of the intercooler to create the desired boost pressure at the engine. If the boost controller in connected before the intercooler, then boost pressure might *drop* as revs (and airflow) climb. The top end boost may be lower than midrange boost pressure, a feature that can be desirable in some applications that might benefit from maximized low and midrange RPM HP. However, if a turbo is oversize to be able to create very high boost/ high airflow/ high top end HP the low RPM boost may be lower than high RPM boost. In the case of this Aerocharged Nytro, the turbo sizing is optimal for its desired use, thus the flat boost curve/ high midrange torque and HP.

Properly sized turbochargers deliver the desired boost pressure regardless of engine speed, creating high midrange torque and HP. Low friction ball bearings allow that boost to occur quickly at low revs.

Plain bearing turbochargers, however, have much greater shaft friction and cause the turbine wheels to accelerate more slowly than ball bearing turbos like the Aerocharger and GT series Garretts, which creates more "lag"—the time it takes after applying throttle, for meaningful boost pressure and HP increase to occur. The ball bearings used by the Turbo Connection Aerocharger are mist-lubricating, creating minimal friction and minimal lag.

During cruise at light throttle opening, the turbocharger is often cool, with the exhaust turbine idling slowly. Even with low friction ball bearings, upon throttle opening it requires a short period of time to create the turbocharger heat and turbine speed necessary to create added HP. But the centrifugal supercharger, being directly linked to the crankshaft, creates minimal but instant intake pressure as soon as the throttle is opened. No lag for sure, and throttle response is instant. But big power arrives only at high revs whereas the turbo creates bigger midrange torque and HP a fraction of a second later, and even more at peak revs. The higher HP per pound of boost by the turbo is due to the fact that the turbocharger uses waste heat energy to create turbine speed, and a supercharger requires some crankshaft power to drive the compressor.

But proponents of supercharged sleds will argue that, unlike gear transmission bikes and cars, the snowmobile clutches allow revs to climb quickly to peak HP, partially negating the higher midrange TQ/ HP advantage of turbocharged engines. The only real negative, then, is the HP required to drive the blower. Eaton publishes the HP required to drive their 200 HP roots-type supercharger at 25 HP. Centrifugal SC's are said to be more efficient at peak revs, so the MPI blower may rob less, but still significant HP.

Here is the comparison of these two stock Nytros, boost rise and horsepower.