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DYNOTECH

THE SNOWMOBILE PERFORMANCE PUBLICATION

ARCTIC CAT 1993 EXT-Z 580 STOCK EVALUATION

OWNER: Marilyn Mullen
WEIGHT WITH THREE GALLONS OF GAS: 514 lbs.

The 1993 EXT Z 580cc engine is more than just an overbored EXT Special 550. If that were the case, we would be happy to see the percentage horsepower increase that we might expect with a five percent dispacement increase.

But compared to the 550 stocker, the new 580cc Z engine is substantially stronger than the displacement increase would suggest. The reason for the higher airflow and torque and horsepower is that in addition to the larger bore size, the Z cylinders' port timing has been improved as follows:

INTAKE PORT- 2 mm. *lower* and 2mm *wider*

TRANSFER PORTS- 1 mm. *lower*

EXHAUST PORT- 2 mm. *higher*

Compression and squish clearance appear to be unchanged.

The EXT Z's 38mm Mikuni round slide carbs have all new deeper, high volume float bowls. This would make it less likely that any vibration-induced leanouts would occur. Also, for 1993 the EXT motor mounts have been stiffened. When running under load on the dyno, the 580 Z engine exibited little of the visible shaking that plagued the earlier EXT Specials. Now, fuel delivery is much smoother and more predictable.

Like most other Cats, the EXT Z draws its carburetor air from ducting behind the cowl. There are, however, some louvers behind the driven clutch that may allow hot air to enter the airbox at high speed. For our dyno evaluation, we installed 280 main jets to compensate for the air temperature (CAT). The following data was generated.

1993 ARCTIC CAT EXT Z 580 STOCK
38MM CARBS--280MJ
Data for 29.92 inches Hg, 60 F dry air
Test: 200 RPM/Sec Acceleration
Fuel Specific Gravity: .747
Vapor Pressure: .68
Barometer: 29.71

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5500	41.1	43.0	33.1	115.8	16.1	.80	69
5750	42.1	46.1	38.4	117.8	14.1	.87	70
6000	44.4	50.7	40.4	121.7	13.8	.84	71
6250	48.3	57.5	43.3	126.9	13.5	.79	70
6500	52.8	65.3	49.1	132.2	12.4	.79	70
6750	57.6	74.0	50.6	138.1	12.5	.71	69
7000	58.7	78.2	48.0	140.3	13.4	.64	69
7250	60.9	84.1	59.1	143.6	11.2	.74	70
7500	61.9	88.4	58.9	146.4	11.4	.70	70
7750	61.6	90.9	62.1	148.3	11.0	.72	71
8000	60.3	91.9	65.1	150.2	10.6	.74	70
8250	57.5	90.3	63.3	151.1	11.0	.74	71
8500	52.6	85.1	57.5	150.5	12.0	.71	71
8750	34.7	57.8	56.2	145.5	11.9	1.03	71

In Vol.3 #1, we found that the stock 550 EXT Special engine made no more horsepower with a gutted airbox. However, as the result of its higher flowing cylinders, the stock 580 Z engine did benefit from an open airbox. Removing the sound-deadening baffle from the airbox opening resulted in an airflow increase, fuel flow decrease, and the torque and horsepower were higher. The BSFC was still in the mid .60's.

EXTZ 580
CONTINUED

1993 ARCTIC CAT EXT Z 580 STOCK
GUT AIRBOX--38MM CARBS--280MJ

Data for 29.92 inches Hg, 60 F dry air
Test: 200 RPM/Sec Acceleration
Fuel Specific Gravity: .747
Vapor Pressure: .68
Barometer: 29.71

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5500	41.7	43.7	40.7	132.1	14.9	.98	70
5750	42.2	46.2	40.2	133.3	15.2	.91	70
6000	45.8	52.3	41.0	137.1	15.4	.82	70
6250	50.3	59.9	43.8	140.8	14.7	.77	70
6500	54.4	67.3	48.1	142.1	13.6	.75	71
6750	58.4	75.1	51.6	144.3	12.8	.72	71
7000	60.0	80.0	51.8	147.3	13.1	.68	70
7250	62.2	85.9	54.2	152.0	12.9	.66	70
7500	62.5	89.3	57.2	154.7	12.4	.67	71
7750	62.3	91.9	57.6	156.4	12.5	.66	70
8000	61.3	93.4	63.9	156.5	11.2	.72	71
8250	58.1	91.3	56.9	157.1	12.7	.65	72
8500	52.8	85.5	54.1	157.6	13.4	.66	70
8750	41.2	68.6	55.0	156.1	13.0	.84	70
9000	28.1	48.2	51.5	148.6	13.2	1.13	69

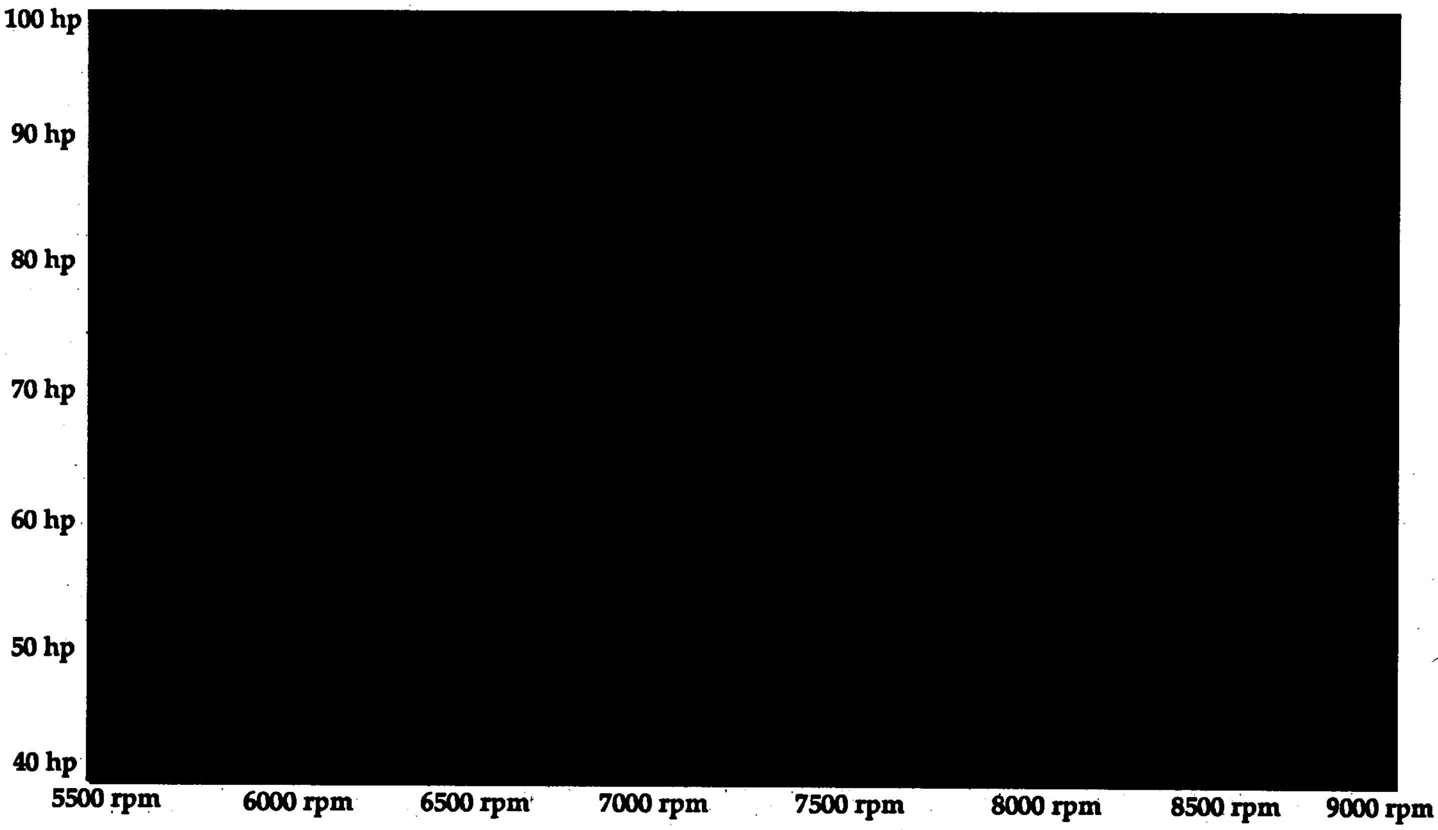
We next leaned the jetting down to 250 mains, and obtained the following data. **Note that this is a 100 octane drag spec for 70 deg. F air.**

1993 ARCTIC CAT EXT Z 580 STOCK
GUT AIRBOX--38MM CARBS--250MJ--DRAG SPEC

Data for 29.92 inches Hg, 60 F dry air
Test: 200 RPM/Sec Acceleration
Fuel Specific Gravity: .747
Vapor Pressure: .68 Barometer: 29.73

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5500	42.1	44.1	36.5	122.6	15.41	.86	68
5750	43.1	47.2	33.6	131.9	18.0	.75	68
6000	46.1	52.7	35.2	136.8	17.8	.70	68
6250	50.8	60.5	37.3	140.7	17.3	.65	68
6500	55.1	68.2	42.9	142.3	15.2	.66	68
6750	57.9	74.4	44.3	144.2	14.9	.62	67
7000	60.5	80.6	43.7	147.8	15.5	.57	67
7250	62.1	85.7	50.7	151.5	13.7	.62	68
7500	63.2	90.3	53.1	155.7	13.5	.61	68
7750	63.6	93.8	51.7	158.1	14.0	.57	67
8000	63.4	96.6	53.8	158.6	13.5	.58	68
8250	61.3	96.3	54.5	159.0	13.4	.59	67
8500	58.3	94.4	52.0	158.9	14.0	.58	67

Comparing this new 580cc Z engine to the "trail ported" EXT Special 550 that we tested in Vol.4 #4, we can see that the two engines share very similar airflow and horsepower numbers. The modified 550 cylinders made a bit more horsepower than the stock 580 Z due mostly to the mod 550's higher compression. Next fall, when we "improve" the 580 Z engine we'll see what a bit higher compression alone will do. Also, "trail ported" 580 Z cylinders will be tested along with the available aftermarket pipes.



1993 EXCITER SX STOCK EVALUATION

WEIGHT W/ 3 GALS. GAS: 516 LBS.

I spoke to several non-Yamaha people who tried out the new Exciter SX at the Rode Reports last season. Everyone's reaction to the new chassis configuration was one of pleasant surprise at its compliance and high speed stability. Evidently the wider, adjustable front suspension (with V-Max 4-like struts) works much better than the standard Exciter's TSS.

Besides the better handling chassis, the Exciter SX engine has been improved as well. The obvious changes are as follows:

CYLINDERS: The intake flanges are now much closer to the cylinder, resulting in shorter intake runners. They continue to use Nikasil instead of cast iron liners, with approximate port timing changes as follows:

PISTON PORT INTAKE: narrower, lower, and taller by approximately two mm.

TRANSFER PORTS: much wider and about 2mm higher, with the back of the rear transfers hooking towards the exhaust port. The standard Exciter II rear transfers aim directly at one another.

EXHAUST PORT: no apparent change.

COMBUSTION CHAMBERS: 1.3cc smaller, with a thinner headgasket which raises the corrected compression ratio from 6.5 to 6.9-1.

CARBURETORS: All-new, racked, lever operated Mikuni 38mm flatslides are used. Looking very much like the racked V-Max 4 carbs, they have a similar pleasantly light throttle pull. They also use those difficult to change round main jets. Doesn't anyone have a tool for changing them yet?

The carbs have their float bowls vented under the hood. The airbox inlet at the rear of the hood allows hot underhood air (and air pressure) to feed into the airbox inlet at high vehicle speed. The hot air reduces power somewhat, but the air pressure at the floatbowls and airbox opening remains about the same.

Adding a Bender Cold Air Induction Kit will reduce the ingestion of hot underhood air, but may cause a pressure differential between the float bowls and airbox opening during field operation. Those who use the Bender kit probably should extend their float bowl vent lines, and run them up somewhere near the airbox inlet. This will prevent the carburetion from going rich if there is even a slight underhood pressure buildup or negative air intake pressure at high speed.

EXHAUST SYSTEM: The Y-pipe is shorter on the SX model. The stock single pipe appears to have been altered a bit only to allow the standard bellypan opening to be used with the shorter Y-pipe.

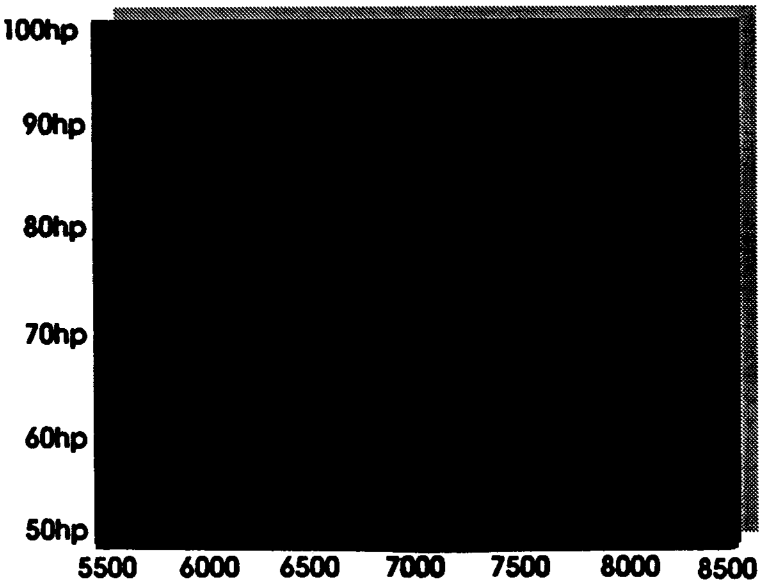
It is interesting to compare this SX engine to the "update ported" (Yamaha designed port modifications) Exciter engine we tested three years ago for our Pipe Shootout in V1 #4. With the shorter Y-pipe and stock pipe installed on the "update ported" Exciter, the peak airflow and horsepower were quite similar. But, even though we had the SX jetted more conservatively (.70 lb/hphr), it made considerably more torque and midrange horsepower.

While we had the SX on the dyno, we quickly ran through our inventory of Exciter II single pipes. Because of the new port timing and shorter Y-pipe, some aftermarket manufacturers may find it necessary or advantageous for their customers to make new model single pipes for the SX.

Some Exciter SX buyers still have their old Exciter II single pipes stored in the garage. For their information, all but one of the pipes that we tested on the stock Exciter II in V4#3 will add some horsepower to their new SX. The exception is the Decker single, which doesn't work at all with the SX Y-pipe (as was the case in V1#4). The high RPM Decker pipe needs a standard Exciter II pipe.

We had Bender Racing's stamped prototype Exciter SX pipe, and it made over 100 CBHP, even with the same conservative jetting. When we receive production SX pipes, we will provide a thorough pipe evaluation for you.

We used our Mikuni Pocket Tuner to adjust the carbs from the standard 155 main jets to 147.5. On the new Exciter SX, Yamaha continues to use the oil pumps as a point to inject lubricating oil. To prevent "oil ratio lag", we did all of our testing with the oil pump locked in the wide-open position. 92 Octane gas was used.



1993 YAMAHA EXCITER SX STOCK
147.5 MJ
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .55
Barometer: 29.79

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	52.7	60.2	52.3	127.5	11.2	.90	68
6250	56.0	66.6	54.6	132.5	11.1	.85	69
6500	60.5	74.9	59.9	138.7	11.2	.79	68
6750	63.5	81.6	59.0	142.9	11.1	.75	68
7000	64.7	86.2	60.3	145.7	11.1	.72	68
7250	65.3	90.1	60.4	148.0	11.3	.69	68
7500	64.5	92.1	61.2	151.1	11.3	.69	69
7750	62.3	91.9	62.2	154.3	11.4	.70	70
8000	58.9	89.7	63.5	159.7	11.5	.74	71
8250	52.9	83.1	61.7	165.1	12.3	.77	70
8500	44.7	72.3	61.0	166.6	12.5	.88	70

EXCITER HP COMPARISON

88 EXCITER — EXCITER II — EXCITER SX

PRODUCT EVALUATION

CHAMPION QX PERFORMANCE FUEL ADDITIVE

Canadian fuel additive distributor Len Calvert (604-868-2063) flew all the way from British Columbia, Canada, to have us test the Champion QX fuel additive. Up until that date, no legally available non-toxic fuel additive or power enhancer that we have tested did anything noticable to improve horsepower.

The Independant Material Safety Data sheet that Len provided us showed nothing either illegal or any more hazardous to our health than the gasoline it would be mixed with. Independant M.S.D. documentation is required for any special chemical mixture or lubricant that we test from now on, to ensure our own safety while handling the material and breathing the exhaust.

As an aside, one dyno customer recently snookered me by secretly adding what he thought was Propylene Oxide to the gasoline in his SkiDoo 250 SnoPro engine while I was occupied in the head. He had purchased it in crudely labeled pint cans from a major supplier of racing two-stroke oils. It wasn't until he saw his engine lose one horsepower that he told me what he had done; he was at the time unaware of the house rule against testing toxic gasoline additives. Fortunately, the "Propylene Oxide" was fake--probably harmless, relabled cans of dry-gas. That particular test was typical of so-called "power enhancers".

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CHAMPION QX PRODUCT EVALUATION ...CONTINUED

Long term subscribers remember some of the horror stories of ring seal being permanently compromised by some of those highly advertised super-slippery lubricants. Len Calvert agreed that if the Champion QX hurt the modified Arctic Cat EXT Special 550 that was on the dyno that day, he would pay to rebuild it. Fair enough.

The Champion QX fuel additive is a dark, slightly slippery liquid with a viscosity and odor remarkably similar to diesel fuel. We mixed between four and five ounces of QX with each gallon of the VP C12 gasoline we were using in the engine.

To establish a baseline, we ran four or five tests which repeated within several tenths of a horsepower. Test #1 is typical.

1991 EXT SPECIAL MODIFIED
GASOLINE ONLY
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .742
Vapor Pressure: .18
Barometer: 30.23

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6500	47.2	58.4	48.6	140.8	13.3	.81	44
6750	51.1	65.7	50.0	148.7	13.7	.75	45
7000	53.8	71.7	53.6	151.9	13.0	.73	45
7250	56.4	77.9	54.8	155.4	13.0	.69	44
7500	57.9	82.7	61.2	157.9	11.8	.72	44
7750	59.1	87.2	62.1	161.1	11.9	.70	45
8000	61.1	93.1	64.6	165.0	11.7	.68	45
8250	64.1	100.7	67.9	171.0	11.6	.66	45
8500	64.9	105.0	76.4	175.6	10.6	.71	44
8750	63.9	106.5	71.2	175.9	11..3	.65	46

After adding the QX to the gasoline, it took perhaps three back to back dyno pulls before the effect of the additive became apparent. The engine's output gradually increased to the level that is shown in the second test. We ran a total of about 10 repeat tests, each within a few tenths of a horsepower.

1991 EXT SPECIAL MODIFIED
CHAMPION QX AND GASOLINE
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .742
Vapor Pressure: .18
Barometer: 30.23

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6500	46.9	58.0	50.2	140.3	12.8	.84	42
6750	50.4	64.8	49.3	148.0	13.8	.74	42
7000	53.9	71.8	50.4	152.4	13.9	.68	43
7250	56.1	77.4	56.0	155.0	12.7	.71	43
7500	58.4	83.4	60.7	157.7	11.9	.71	43
7750	59.9	88.4	73.8	161.9	10.1	.81	43
8000	62.4	95.0	61.7	166.6	12.4	.63	43
8250	64.9	101.9	69.0	172.9	11.5	.66	42
8500	65.5	106.0	70.7	177.2	11.5	.65	42
8750	64.4	107.3	72.4	177.3	11.2	.66	42

Then, we returned to straight VP C12 gasoline and the torque and horsepower gradually resumed its original level.

Since this test, we tried the Champion QX on five other snowmobile engines, and four times the results were similar (interestingly, there was no horsepower change on one of the engines). A 14,000 RPM Yamaha FZR400 motorcycle enjoyed an even greater increase in torque and horsepower--around three percent. We tried increasing the "dosage" and saw no further increase in power. It appears as though one to two percent is the average increase in torque and horsepower.

A boat racer friend of mine dyno tested some of our Champion QX in one of his big block Chevrolet race engines. He saw no horsepower increase or decrease, but the horsepower peaked 250 RPM higher.

A one to two percent increase in horsepower can't be felt in the handlebars--and may represent only a couple of sledlengths in a long dragrace. But, there are some who may find the continual expense of the fuel additive worthwhile.

RUNNING ON ALCOHOL

TIPS FOR ACHIEVING THE BEST (AND SAFEST) PEFORMANCE FROM ALCOHOL FUEL

BY MARK GIAMMATTEI

Methanol, more commonly known as alcohol or "alky" in high performance circles, presents us with a means by which we can significantly boost performance in two stroke engines. Gains of 10-15% are common--and I have seen as much as 22% gain in horsepower with very sharp improvements in low and midrange torque. Methanol carries half the thermal energy in BTU's as gasoline, but it is chemically superior as a power producing fuel when correctly applied.

The increase in power is due to several factors. First, the amount of heat absorbed with vaporization is much greater with methanol. Simply put, as methanol is introduced into the air stream, twice the normal amount of liquid is moving through the engine. This large amount of liquid must vaporize (turn from liquid to gas or vapor) before it can burn. Due to its chemical composition, the methanol/air mixture consumes a great deal of heat during the vaporization process. As a result, engine components remain unusually cool. In fact, it is common to see frost on the carburetor and intake manifold while running on methanol. (It is kind of reminiscent of those cold, crisp nights when the throttle response of your favorite sled brought a smile to your face).

This vaporization process improves the intake charge density. Higher intake charge density means higher volumetric efficiency, and since two stroke engines suffer greatly from poor volumetric efficiency, this increase in efficiency means more power!

In DYNOTECH Vol. 4 no. 3, Kevin Cameron discussed "cheater" additives that carry oxygen with them and their power increasing abilities. Methanol has an oxygen atom attached to it, and has often been used as a "cheater" additive in race gasoline. Ways in which to make gasoline and alcohol compatible have been discovered, so now we can take advantage of the heat of vaporization, and improved volumetric efficiency. Atmospheric conditions can not be changed with normally aspirated engines, but the fuel side of the fuel/air ratio can be altered to coincide with the weather conditions at a given moment. So, if we bring along oxygen bound with the liquid (methanol + gas), we can potentially increase the volume of oxygen to aid in combustion.

Our high school chemistry class taught us that liquid cannot be compressed, but gases can. The ideal situation for increased charge volume would be to keep the fuel/air mixture a liquid all the way to the combustion chamber, and induce vaporization just before ignition. The resulting explosion would rock the horsepower world! But, it doesn't happen that way. With methanol, which is somewhat resistant to vaporization, a reasonable fraction of the fuel/air mixture remains liquid. It continues to vaporize right up to the point of ignition. After ignition occurs, the flame duration is incredibly long. Fuel continues to burn out of the exhaust system, and can be seen as a blue/yellow flame pouring from the exhaust stinger--quite a pretty sight to see at night! This extension in flame duration, coupled with the higher compression caused by methanol's resistance to vaporization, pushes the piston harder and longer. This results in increased power.

Before I approach the specifics involved in the application of alcohol, I'd like to discuss the hazards associated with its use and handling. DO NOT confuse methanol with the grain alcohol (ethanol) we consume at the local bar. Methanol alcohol is extremely poisonous. According to its Material Safety Data Sheet, the oral ingestion of one teaspoon can cause blindness or death. Avoid inhaling the fumes from vaporization and burning. Methanol is very flammable, and in its purest state, burns without a visible flame. With the addition of two-cycle lubricating oil, the flame becomes visible, although you do not want to see it burn.

Methanol, by its nature, is much more corrosive than gasoline. A chemical reaction occurs in the presence of aluminum, forming a white powder which may clog the fuel filter and/or plug the jets in the carburetor. Many of the fuel system components and internal engine parts (cylinder, head, piston, etc.) used on modern two-cycle engines are manufactured from aluminum. This

ALCOHOL FUEL

CONTINUED

oxidation process will eventually damage these parts, but methanol can be used in a way that will reduce damage and extend the life of the parts. The bottom line is this; if you're not willing to pay close attention to details, methanol is not for you.

Fuel systems presently designed for use with gasoline are not adequate for delivering the volume of fuel necessary to keep sufficient feed on carburetor float bowls without aeration. Fuel tank pickup size must be increased along with fuel filter valve and pump inlet and outlet when using the Mikuni fuel pump. One pump per cylinder just barely gets the job done, so keep in mind that anything that can be done to increase volume is a plus. We have a complete kit designed to fuel up to 165 hp on multi-cylinder engines using Mikuni fuel pumps. Anything above 165 hp requires a special electric fuel pump and constant flow loop, which we can also supply. DO NOT try to use an electric fuel pump which is not designed for methanol, or a fuel fire could result. When fuel volume and pressure remain constant at all throttle positions, the metering circuits of a properly prepared Mikuni slide carburetor are adequate. Under extreme circumstances, it may become necessary to use a power jet for additional fuel supply at open throttle. The fuel inlet needle valve must be enlarged from the standard 1.5mm. We do not recommend drilling the needle and seat. Depending on engine displacement, inlet valve diameter requirements may differ. To aid in fuel control under all demand conditions, the rule of thumb is to use the smallest valve available to get the job done. Start out with Mikuni's 2.5 needle and seat assembly and work backward as you gain experience tuning.

One area many tuners fail to address is the ignition system. Again, factory fire is barely adequate, but can be made to work. One improvement is the addition of Mercury Outboard Engine coils. Very little difference can be seen by switching coils with gasoline, but alky comes alive! Ignition timing can be advanced a bit with further on methanol, but is dependent on geometric compression ratio, so advance timing slowly. Remember that more advance means more fuel. Be sure to track jetting with advanced timing.

DO NOT use extended tip spark plugs with methanol. Toyota did extensive research with methanol as part of their race car program and found that the hot porcelain of extended tip plugs holds enough heat to pre-ignite alcohol vapors. Use the coldest NGK EV spark plugs you can get away with. One other ignition option we should mention is the N-wire system. We can modify any cylinder head to accept twin spark plugs. When coupled with the N-wire system's hot long-duration spark, better ignition occurs. This significantly improves power and throttle response.

For lubrication, a diester base oil will mix with the methanol. One such oil is Klotz200, which works well. The oil we prefer is G&M Cart Shop Racing 2-Stroke Alky oil. It is more expensive, but works well and protects against rust and corrosion. Remember that the engine should be flushed with gasoline and the engine should be run on gasoline after each usa.

For those interested in alcohol applications, we have made it easy to put your motor on juice. We have everything needed to complete the task in kit form. We have developed a flat slide Mikuni carburetor which flows 186 CFM. This carburetor has an improved signal at the nozzle. We have designed special needles for use with methanol, and the result has been a crisp low and midrange and a strong top end. We also have fuel delivery components compatible with alky and can engineer components for special racing applications.

I hope I've maybe helped to take some of the mystery out of the use of alcohol as a performance fuel. There are many other techniques, such as cold weather set-ups, that will be addressed in a future article. Finally, if you really want to fly, try methanol, nitro methane and nitrous oxide. I have and it will amaze you!

If you would like further information about the products mentioned n this article call:

Jimetti Racing and Performance Center
518-756-7686
Klotz
219-749-0489
G&M Cart Shop
216-678-6437

ALCOHOL Vs. GASOLINE

A DYNO EVALUATION

Florida subscriber and midget car racer Fred Stutz traveled to Western N.Y. to the dyno to convert his mod Rotax 580cc (Mach 1) engine from gasoline to alcohol.

As a follow-up to the alcohol articles which Kevin Cameron and Mark Giammattei did for us, we thought it would be interesting to see how much horsepower could be actually be generated by switching fuels.

Initially, we spent several hours obtaining a good gasoline baseline on the engine. Compression was raised, and rotary valve and ignition timing were "rolled" (slang term for making many component adjustments between dyno runs until the horsepower curve was best) and optimized for maximum horsepower. All of the testing was performed using a long set of pipes designed to fit Fred's midget race car. These gave the engine decent bottom end horsepower (these cars run clutchless--direct drive), at the expense of maximum peak horsepower.

We used a set of standard 42.5mm Mikuni flatslide carbs. Note that with gasoline, maximum horsepower BSFC was over .60 lb/hphr. Fresh VP C14 gasoline was used.

SKI DOO 580 MACH I MOD TQ MIDGET
390-390MJ FAST PIPES
GASOLINE

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .730
Vapor Pressure: .23
Barometer: 29.91

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6250	60.7	72.2	66.4	172.2	11.9	.92	55
6500	64.1	79.3	64.1	172.5	12.4	.81	56
6750	66.4	85.3	57.1	175.3	14.1	.67	56
7000	67.7	90.2	55.7	180.2	14.9	.62	54
7250	67.1	92.6	54.8	188.3	15.8	.59	55
7500	66.8	95.4	58.5	191.3	15.0	.62	55
7750	69.0	101.8	61.9	196.9	14.6	.61	55
8000	70.5	107.4	65.9	201.9	14.1	.62	56
8250	69.9	109.8	67.4	205.0	14.1	.62	55
8500	69.2	112.0	69.3	209.1	13.9	.62	55
8750	66.3	110.5	71.4	212.0	13.6	.65	56
9000	57.9	99.2	71.7	213.4	13.7	.72	55

Converting the engine to alcohol involved changing to a set of 42.5mm Mikuni flatslide carbs that had been specially modified for alcohol by Mel Miller of Downey, Ca. There is a photo of Mel's own Wildcat 650 powered midget car in a recent Black Magic catolog.

With the engine running on methanol, we again "rolled" the timing, and maximum horsepower was obtained with approximately two additional degrees of ignition timing.

It is interesting to note the air flow and fuel flow differences between the two fuels. Even though the cooling effect of the alcohol results in a colder, denser intake charge, less air is consumed by the engine; the huge volume of vaporizing alcohol carries some of its own oxygen, and displaces some of the air which the 580 was capable of consuming on gasoline. The resulting BSAC (lb. of AIR per horsepower/ hour) is much lower.

SKI DOO 580 MACH I MOD TQ MIDGET
390-390MJ 109-109PJ FAST PIPES
METHANOL

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .790
Vapor Pressure: .23
Barometer: 29.79

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6500	66.8	82.7	112.3	149.6	6.1	1.38	61
6750	63.4	81.5	121.8	156.6	5.9	1.52	61
7000	70.6	94.1	125.7	169.4	6.2	1.35	58
7250	72.1	99.5	131.9	173.8	6.1	1.35	62
7500	73.8	105.4	135.0	178.2	6.1	1.30	61
7750	76.1	112.3	137.3	181.1	6.1	1.24	61
8000	77.6	118.2	138.7	183.2	6.1	1.19	61
8250	78.1	122.7	139.0	184.1	6.1	1.15	61
8500	78.5	127.0	144.3	189.1	6.0	1.15	62
8750	78.2	130.3	144.8	192.3	6.1	1.13	63
9000	75.0	128.5	144.4	191.7	6.1	1.14	61

STROKED INDY 650

750 cc POLARIS STROKER

by PETE WEBB 516-546-8062

When dyno testing at C&H Dyno Service, almost as much time is spent dreaming up future projects as working on the one at hand. On one such occasion Billy Mathes, of Performance Engines in Torrington, Ct. and I were discussing the idea of building a 750 cc stroker Polaris engine using basic off-the-shelf parts. Nothing overly complicated--but an engine that a Polaris 650 owner could build himself starting with his own stock engine. We were primarily thinking of the guy looking for some significant power increases without buying a new $7000 or $8000 musclesled.

Though a lot of ideas get tossed around while at the dyno, this one seemed practical, and an ideal Dynotech project. Billy and I decided to start with a stock 1991 650 02 engine, and build our 750 stroker in five stages, from a basic trail version, to an all-out full mod version.

STAGE I

The crankshaft wheels were stroked from 60mm to 64mm, using all stock parts. The bore was increased to 70.5mm and the existing ports were matched to the 64mm stroke. The head was also reshaped for the bigger bore size. The compression ratio was 11:1; lower than the stock 650 at 11.3:1, and pump gas safe.

Stage I testing was done with the stock exhaust and 39.2 X 40.2 oval bored carbs.

1991 INDY 650 STROKER STOCK PIPE
39MM X 40MM CARBS--350 MJ--Q4NJ
Data for 29.92 inches Hg, 60 F dry air
Test: 200 RPM/Sec Acceleration
Fuel Specific Gravity: .710
Vapor Pressure: .26
Barometer: 30.54

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
7250	64.5	89.0	74.4	211.4	13.0	.81	44
7500	65.0	95.8	78.1	213.8	12.6	.82	45
7750	69.0	101.8	76.3	222.2	13.4	.73	45
8000	70.2	106.9	77.5	224.9	13.3	.70	44
8250	69.4	109.0	77.9	223.2	13.2	.69	42
8500	65.8	106.5	80.9	222.2	12.6	.73	43

The horsepower was not what we hoped. We suspected that poor flow in the stock exhaust was to blame. Removing just the muffler, we picked up 4 hp.

1991 INDY 650 STROKER STOCK PIPE W/O MUFFLER
39MM X 40MM CARBS--350 MJ--Q4NJ
Data for 29.92 inches Hg, 60 F dry air
Test: 200 RPM/Sec Acceleration
Fuel Specific Gravity: .710
Vapor Pressure: .26
Barometer: 30.54

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
7250	74.7	103.1	71.1	231.9	15.0	.66	39
7500	74.9	107.0	73.0	240.6	15.1	.66	39
7750	75.6	111.6	76.9	248.2	14.8	.66	40
8000	73.5	112.0	78.1	253.0	14.9	.67	39
8250	72.0	113.1	81.0	249.5	14.1	.69	39
8500	69.3	112.2	83.5	248.2	13.6	.72	38

We next installed a set of SLP ported 650 pipes with the same carbs and jetting and power increased 40% over the stock exhaust system.

1991 INDY 650 STROKER SLP 650 PIPES
39MM X 40MM CARBS--350 MJ--Q4NJ
Data for 29.92 inches Hg, 60 F dry air
Test: 200 RPM/Sec Acceleration
Fuel Specific Gravity: .710
Vapor Pressure: .26
Barometer: 30.55

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
7250	75.3	103.9	74.4	236.6	14.6	.69	37
7500	77.5	110.7	76.0	240.9	14.6	.66	39
7750	80.8	119.2	77.3	247.8	14.7	.62	40
8000	83.5	127.2	81.1	257.1	14.6	.61	39
8250	84.9	133.4	82.7	261.2	14.5	.60	39
8500	85.0	137.6	85.5	261.1	14.0	.60	39
8750	87.1	125.1	87.6	262.8	13.8	.58	39
9000	87.3	149.6	91.8	264.5	13.2	.59	40
9250	81.7	143.9	92.4	265.2	13.2	.62	40

STAGE II

Stage II consisted of trail porting with a slightly higher compression ratio of 12.1:1; still pump gas safe. We installed a set of SLP Mod 4 pipes and mufflers and with the same oval bored carbs and jetting, the following resulted.

STROKED INDY 650

CONTINUED

1991 INDY 650 STROKER SLP 707 MOD PIPES
39MM X 40MM CARBS--350 MJ--Q4NJ
Data for 29.92 inches Hg, 60 F dry air
Test: 200 RPM/Sec Acceleration
Fuel Specific Gravity: .728
Vapor Pressure: .26 Barometer: 30.38

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
7250	71.0	98.0	78.0	223.9	13.2	.78	46
7500	74.4	106.2	77.4	230.4	13.7	.71	46
7750	77.2	113.9	81.4	235.5	13.3	.70	46
8000	81.2	123.7	80.2	240.9	13.8	.63	47
8250	83.7	131.5	81.7	245.3	13.8	.61	46
8500	89.0	144.0	87.1	251.6	13.3	.59	45
8750	91.2	151.9	90.6	257.2	13.0	.58	46
9000	91.1	156.1	94.1	262.4	12.8	.59	46
9250	89.6	157.8	97.8	265.6	12.5	.61	46
9500	79.7	144.2	98.4	265.5	12.4	.67	47

STAGE III

This stage was for fast trail riding. We replaced the headgasket with one .040" thick, and an increased compression ratio of 13.8:1. We retained the the SLP Mod 4 pipes, with a long pipe flange. Carbs and jetting remained the same. This set-up lowered the power peak 250 RPM, and increased the low and midrange torque and horsepower.

1991 INDY 650 STROKER--.040" HEADGASKET
SLP 707 MOD PIPES LONG FLANGE
39MM X 40MM CARBS--350 MJ--Q4NJ
Data for 29.92 inches Hg, 60 F dry air
Test: 200 RPM/Sec Acceleration
Fuel Specific Gravity: .728
Vapor Pressure: .26 Barometer: 30.34

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
7000	73.2	97.6	77.7	225.7	13.3	.78	43
7250	74.9	103.4	78.1	230.1	13.5	.74	43
7500	76.3	109.0	80.8	235.7	13.4	.72	42
7750	79.4	117.2	81.8	236.4	13.3	.68	43
8000	84.0	128.0	83.2	243.9	13.5	.63	42
8250	88.1	138.4	81.0	249.8	14.2	.57	42
8500	90.4	146.3	88.0	255.5	13.3	.59	43
8750	93.7	156.1	92.1	260.2	13.0	.58	43
9000	91.6	157.0	95.9	265.5	12.7	.60	43
9250	78.2	137.7	98.7	265.3	12.3	.70	43

STAGE IV

For lake racing, we changed to larger, 45.5mm X 48mm ovalbored carbs, and compensated with 390 main jets. Compression ratio, porting and pipes were the same as Stage III. Part of the horsepower increase resulted from the slightly lower fuel flow. Note that the smaller carbs gave us better midrange airflow and horsepower.

1991 INDY 650 STROKER--.040" HEADGASKET
SLP 707 MOD PIPES LONG FLANGE--
46MM X 48MM CARBS--390 MJ--BB5NJ
Data for 29.92 inches Hg, 60 F dry air
Test: 200 RPM/Sec Acceleration
Fuel Specific Gravity: .728
Vapor Pressure: .26 Barometer: 30.32

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
7000	71.1	94.8	73.1	209.4	13.2	.76	46
7250	71.3	98.4	74.0	213.7	13.3	.74	46
7500	75.3	107.5	79.3	223.5	12.9	.72	46
7750	80.0	118.1	79.1	230.2	13.4	.66	46
8000	86.0	131.0	80.6	242.9	13.8	.60	46
8250	90.0	141.4	81.1	253.7	14.4	.56	45
8500	93.9	152.0	89.5	260.3	13.4	.58	46
8750	95.3	158.8	91.6	265.5	13.3	.57	46
9000	95.6	163.8	92.6	266.3	13.2	.56	47
9250	93.3	164.3	91.0	267.4	13.5	.54	47
9500	74.1	134.0	96.8	265.9	12.6	.71	46

By Stage IV, we had increased the torque and horsepower by some 65% over the stock engine, using fairly basic, off-the-shelf parts. All three stages have been field tested, with no failures. (Expect some bent handlebars from trying to hold on, though).

STAGE V

Full mod, with all the full mod tricks. We haven't divulged them yet (even to Jim) but the compression ratio is 15:1 and cylinder bore was reduced to 70mm for 738cc displacement. This set-up took three trips to the dyno to dial in. Full mod porting with an increased stroke is probably not a job that the part-time engine builder should attempt. Our late hours developing and testing paid off, though, with a hefty 173 CBHP and 99+ CBT.

EDITOR'S NOTE FOR FULL MOD VERSION

The accompanying dyno test result is a cold dragrace run, just the way it will be run at the track. Engine water temperature was at 60 degrees F at the beginning of the test. Had we anticipated the public comparison of this engine with the trail versions, we would have done a hot engine test. With the engine at the same hot temperature as the trail version, it would probably have been in the 168+ CBHP range.

1991 INDY 650 STROKER SLP 707 MOD 4 STINGER PIPES
46MM X 48MM CARBS--320 MJ--CC0NJ
Data for 29.92 inches Hg, 60 F dry air
Test: 200 RPM/Sec Acceleration
Fuel Specific Gravity: .720
Vapor Pressure: .60 Barometer: 29.77

RPM	CBT	CBHP	FUEL	BSFC	CAT
7500	72.9	104.1	126.8	1.28	75
7750	77.8	114.8	126.1	1.15	74
8000	84.3	128.4	114.3	.93	73
8250	90.5	142.2	108.4	.80	75
8500	92.6	149.9	108.1	.76	76
8750	97.8	162.9	102.7	.66	75
9000	99.2	170.0	96.1	.59	75
9250	98.1	172.8	95.7	.57	74
9500	93.6	169.3	90.8	.56	76

Stay tuned--we're planning a 520cc twin strokers, and stroked versions of the new Storm and 580XLT's this fall.

...SOME ADVICE FOR WOULD-BE STROKERS

STROKING SHOULDN'T BE UNDERTAKEN LIGHTLY... BUT CAREFUL CONSIDERATION AND A LOT OF TIME AND WORK CAN IMPROVE THE CHANCES OF SUCCESS.

Please re-read Rodney Champagne's article "Machining a Stroked Two-Cycle Motor" in Vol. 3 #4 and then my article "Boring and Stroking" in the same issue.

In the past two years, problems created by some companies like Legend Peformance altering snowmobile engine strokes have given these modifications in general a black eye.

Frank Mungo, (whose stroked motor was featured in "Boring and Stroking" recently had his Polaris/PSI Genesis triple modified again--this time with an all-new billet crank from Legend Performance. The engine made good horsepower, but the crankshaft broke in half after 300 miles of trail riding last winter.

Even if a particular "stroked" engine makes good horsepower, and is properly machined, moving the rod pins outward usually alters the resonant frequencies of a crankshaft.

If the operating RPM of the newly stroked engine happens to fall in the resonant frequency range of the crankshaft, disaster will eventually befall the engine. Clutches will beat themselves to dust, tapers will fret and gall, crankcases and studs may mysteriously break, and the crankshafts will fail. There are similar explainable unexplainable horror stories from all over North America. I hate to say "I told you so", but "I told you so".

Altering the stroke of a production engine can be successful on the dyno, as Pete Webb's engine article shows. It takes a lot of work, R & D, thrashing, dyno testing, rework, more dyno testing, more reworking, more dyno testing, then field testing, etc, etc. Pete was willing to do all of this.

In addition, and as important for success, is the accuracy of workmanship on stroked motors. The company that does Pete's crank work uses a jig boring machine that is accurate to .0001 inch. Comparatively crude equipment such as standard shop milling machines (like the one reportedly used by Legend Performance) cannot provide the accuracy necessary for proper crankshaft machining.

What about Pete's stroker's resonant frequencies? No one can guarantee what the real long term durability will be. Pete and Billy field tested the pump gas trail version of the big engine over1500 hard miles last winter, with no apparent problems. I rode the sled in March at Big Moose Lake and it was very, very impressive---especially in midrange acceleration where its high midrange torque and horsepower really shine. I will provide a long term test update.

If you want 160+ CBHP pump gas horsepower for your Polaris "02" engine, you have the choice of either a PSI Genesis 800 cylinder kit or this particular stroker combination with Pete's Polaris top end. Neither is inexpensive, but that is the price of having new musclesled beating, FIII horsepower on pump gas.

FEEDBACK Jim Czekala BACKFEED

SUBSCRIBER SURVEYS
Of the surveys that were returned, the majority of respondants were in favor of "whatever it takes to ensure continuation" of our publication. I didn't mean to have sounded like evangelist Oral Roberts who threatened that God would "call him home" if his congregation didn't ante up a bunch of money. I really enjoy this project; most of you would agree that DynoTech has made an important impact on the snowmobile performance industry, and that alone is enough of a recompense to make our efforts worthwhile. But the bills have to be paid.

So, we've opted to go with the purple ink background on heavy paper, first class mail for now.

Reading the new darker format seems easier when flourescent lighting is used. Try it, and if you still think it's too difficult to read, give us a call!

New members will have to pay $40 for next season's subscription. Our current subscribers can re-up for $38, if renewed before September 15. This will enable Debbie to get that raise I promised her!

MORE ON GASOLINE OCTANE CHEATING
We reported some time ago that the AAA estimates that you have no better than a 50/50 chance of receiving the high octane gasoline you pay for at the pumps! Cheating by wholesalers and station owners costs us millions of dollars (including needlessly detonated pistons) each year. The problem has become so widespread that Congress has recently commisioned a study of the feasability of requiring refineries to add red dye to low octane grades of gasoline. This would prevent unscrupulous wholesalers and retailers from switching regular and premium grades of gasoline. Let's hope that something like this happens.

CORRECTION
We published the wrong phone number for D&D Cycle with our EXT hop-up last issue. The correct number is 315-376-8013.

THE TRUE HORSEPOWER CURVE...
ALLOW ME TO GLOAT JUST A BIT
For four years, DynoTech has provided accurate engine tuning data and product evaluations to previously less informed performance snowmobilers, (like we used to be). It has been, and will continue to be great fun.

We have also provided an invaluable public testing and tuning facility for trail riders and racers. In this region of the country one must use our dyno to be competitive. One new dyno customer was tired of losing every time he came up against a sled with a DynoTech decal. Now he is properly tuned and clutched and has a decal--and he's getting his share of victories again.

Because of the success that we and our customers are having, there are many similar new testing facilities operating or currently under construction. I will compile a listing of new public computerized dyno tuning facilities for our subscribers before next winter.

I'm always amused by ignorant people who whine and complain about our method of testing or what brand or type of dynamometer system we or others in this business have elected to use.

What's the difference?

We are the pioneers of doing rapid, accurate, computerized acceleration testing of snowmobile engines. Our SuperFlow dyno is quite capable of doing the steady-state, step and hold testing that those with less sophisticated equipment must use. If we wish, we can turn off the computer, run our (or our customers') engines wide open throttle, manually apply the correct load to the engine to hold it at approximately 7,000 RPM (no dyno can hold exactly 7,000 RPM, but it's probably close). Then we can observe our torque gauge, and write that on a piece of paper. Then we can look at our fuel flowmeters, and write the pounds per hour of fuel flow on that same piece of paper. Meanwhile, the engine is howling wide open against the dyno brake at 7,000 RPM. Next, we should look at the airflow readings, and write those down. How about Carb Air and water Temperature? We'd better write those down, too.

Next, we adjust the dyno load to allow the engine to run wide open, at 7,250 RPM. Or, is it 7,298 or 7,193? It does make a difference, but it's probably close enough. We'll write the torque reading down now. And the airflow and fuel flow, too. Forget the temperatures- they're not changing too much.

Now, we have to see what the engine will do at around 7,500 RPM. Our water temperature is getting a bit hot--and the paint is peeling off the pipes--we have to do this all the way to 10,000 RPM? The owner of the engine is getting nervous-but I'm having fun! Will the three gallons of gas be enough for this run?

So, we manually record these dyno readings 13 times, all the way to 10,000 RPM. The owner of the engine is passed out in the corner now. He fainted two steps ago at 9,500 RPM. What a wimp!

Now we shut off the engine, and do our math computations. While the engine crackles and pops as it cools down from the tortuous procedure, we multiply each torque reading by the engine RPM. Then, we divide that number by 5252. That was our horsepower at that RPM. Now, we divide the fuel flow by the horsepower to get our BSFC in lb/hphr. Twelve more sets of computations. We finally determine that the peak power BSFC is .79; too safe for decent horsepower. Let's jet down, refill the dyno fuel tank and do it again! Wake up the wimp--it's his turn to pull the recoil rope! (Just kidding--every modern dyno has electric start).

Sound like fun? Not hardly. But, that's the way some factories and aftermarket companies do it! They typically trash an engine in a day on the dyno. Engines are expendable. That's the way it has been done since the early 1900's.

But, in this age of computerization, why not gradually accelerate the engine, and let the computer take readings of the necessary information? What's wrong with an exact engine speed "snapshot" of the desired data as the engine accelerates slowly through its power band? Who cares if the "factories" can't do it that way? They never let you know what their dyno readings are anyway!

Our SuperFlow system does give us the option of doing "step and hold" testing. The computer controlled servo stabilizes the engine every 250 RPM for several seconds--as close as possible to each point--records the data and computes the horsepower and brake specifics--then continues on to the next "step". A thirteen step test might take a minute or more of WOT engine run time. Certainly faster, however, than the three minutes it would take on a manual system.

During a typical computer controlled acceleration test, the same thirteen point test from 7,000 to 10,000 RPM takes less than ten seconds. And, with our system it is at least as repeatable--usually within one or two tenths of a horsepower at each point--and definitely more accurate for two-stroke snowmobile engines than the step and hold test. I've done thousands of tests each way. I say, and our dyno customers say, that acceleration testing is much more desirable. The 1,000+ dyno tests that Bender Racing performed here during porting and pipe development on their V-Max 4 engine required *less than three hours of full load WOT testing*. If that same amount of data had been obtained on a manually controlled dyno, with data recorded by *a* Bic pen, the "mule" engine would have to have spent *40 hours screaming at full throttle against the dyno brake!*

Besides being infinitely easier on engines, acceleration testing allows us to see more realistic horsepower peaks. In the field, snowmobiles are typically run with comparatively cool pipes. Cool pipes cause horsepower peaks to be at lower RPM (see The Cellar Dwellar in Vol 2 #6 and Feedback Vol 2 #5). Steady-state testing in hot dyno rooms promotes overheated pipes and inaccurately high horsepower peaks; this may be fine after two miles at WOT but useless for clutching for acceleration. On the contrary, acceleration testing doesn't allow false heating of the pipes; clutching for maximum sled acceleration works best when cool-pipe data is used as a guideline.

Remember the first 650 Wildcats that were delivered with 8500-8750 RPM clutch shifting? Our acceleration dyno testing revealed that 7750-8000 RPM was stronger, to the tune of some 18 horsepower! Wildcat owners who opted for our clutching recommendations instead of the factory's were rewarded with much improved performance.

Over the past four years, there have been dozens of similar situations where our method of testing has revealed more accurate, lower RPM horsepower peaks. For acceleration in the field, our acceleration tested horsepower peaks are always more accurate than any steady-state testing manufacturer's.

One aftermarket company which uses a semi-instrumented electric eddycurrent dyno devotes several of their catalog pages to ridiculing our "type" or other suppliers' "types" of dyno system. This same catalog is full of strange, atypical horsepower curves handwritten in black crayon, and shaped like toenail clippings.

I agree that eddycurrent dynamometers are excellent tools for controlling engine speed and measuring torque. I used one when we mapped our EFI engine at Injection Research Services several years ago (it was fully instrumented by SuperFlow). Because of the huge flywheel mass of the eddycurrent absorption unit, the engines are held beautifully at steady-state, usually holding within 50 RPM of the desired engine speed. This is excellent for mapping EFI systems- especially at the engine speeds where the the engine is just coming "on the pipe", and many different throttle positions used. But, that same huge flywheel mass prevents the eddycurrent dynamometer from lending itself well to modern "transient", or acceleration testing. Imagine hanging a large diameter 80 lb. flywheel on the end of your snowmobile crankshaft, and trying to accelerate the engine. There is so much energy lost to accelerating the mass of the heavy eddycurrent absorption units that there is little left to show accurate torque on the manual gauge or electronic torque link! It just doesn't work well. I've used them both; low inertia, high torque capability water brakes are much better suited for accurate, repeatable, rapid data aquisition on small engines.

There are cases of dyno tuners going with too little inertia--trying to perform computerized acceleration testing without a good balance of dyno mass that allows the engine a constant acceleration rate without surging. A surging or vibrating engine and dyno causes errors in torque readings. During a surge, as the engine accelerates too quickly, low torque readings result (horsepower energy is absorbed by the accelerating mass). Then, as the dyno "grabs" the accelerating engine and brake to slow the rate of acceleration, a high "torque spike" occurs. The false "torque spikes" that occur at the end of each surge result in an inaccurate computerized horsepower curve that is jagged, shaped like the back of a stegosaurus dinosaur. High performance snowmobile horsepower curves are shaped smoothly, like a parabola, peaking at a single point, then dropping quickly beyond the peak.

Toenail clippings and stegosaurus backs are not accurate representations of snowmobile engine horsepower curves. Our curves are right, theirs are wrong.

ANOTHER EXCELLENT SAE BOOK

SAE number R-104 is a hardcover book, "The Basic Design of Two-Stroke Engines" ($70.00). It's written by Gordon Blair, of the Queens University in Belfast, Ireland, and is the most comprehensive two-stroke technical book I've seen.

In conjunction with the book, a five disc IBM compatible program, SAE number R-104SW-IBM, is available (also $70.00). The program crunches all of the formulas in the book, and makes pipe and port modification recommendations, as well as displaying a cutaway of your engine and pipes on the screen. I haven't used the program yet, but those who have say it's interesting and informative. This material is available from the SAE, at 412-776-4841.

I recently spoke to Gordon Jennings about the book and program, and he cautioned me not to go madly hacking at my ports based solely upon one of these computer models. The models should be helpful as a guideline, for gradual modifications in conjunction with continual dyno testing to verify the results.

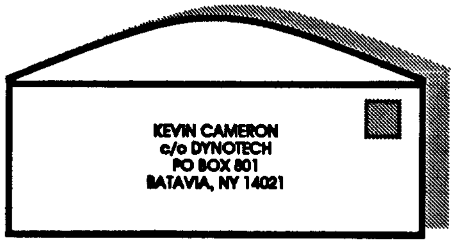
HANDWRITING ON THE WALL

In this issue, the EXT Z and Exciter SX both have "improved porting" compared to previous EXT and Exciter engines. That means that there is no longer an easy 10 horsepower increase that can be expected from either engine with aftermarket port changes.

Arctco and Yamaha have done it for you. All that is left is maybe an inexpensive (it should be, anyway) general cleanup that may at best yield a few horsepower.

We'll be testing "trail modified" versions of all these engines this year. But, don't expect the vast improvements that we've become accustomed to; the factories realize that "educated" snowmobile consumers demand the "good" porting and they are providing it. And because of their newly improved port timing, both of these engines will respond especially well to inexpensive compression increases. The factories understandably go easy on compression for the benefit of those who won't change jets at -20 degrees F, run the frozen rivers and lakes mile after mile at WOT, then scream for warranty repairs when they "squeek". But, aside from that, the work is done. The aftermarket guys will have less to do this year.

How about the new musclesleds? You can bet that the factories won't leave a whole lot of room for improvement. Trail performance aficionados are the bread and butter of most of the aftermarket companies. What will happen if Yamaha, Bombardier, Polaris and Arctco achieve performance perfection?



ASK KEVIN

Kevin's column this issue is in response to a question submitted by a subscriber who signs his name "Father Ed", and who claims to receive DYNOTECH at his monastery in New Hampshire "Father Ed inquires as to whether knife-edged or rounded transfer port dividers are preferable. Kevin also discusses a related matter, that of a power drop which resulted when we installed bored carbs with a knife-edge machined bellmouth on Pete Webb's stroked 650 Polaris engine in this issue.

There are two related matters to discuss this month. One has to do with a power drop, seen on the dyno, when a carburetor bellmouth on a 46.5 mm Mikuni was machined to a knife-edge. The other has to do with what might happen as a result of the tuner's decision; to run transfer entry dividers round-nosed, or cut them to knife-edges as well.

First the carburetor. When the piston rises, a low pressure causes air in the carburetor to accelerate inward. That, in turn, produces a low pressure at the mouth of the carb, causing air to flow towards that low-pressure region from all directions. The air directly in front of the carb is already moving in the right direction - down the hole - but air coming from large angles off the carb centerline must turn to enter the intake.

However, this air coming from the sides has momentum, and it doesn't turn unless something turns it. The something that turns it is the pressure difference between inside the carb and outside - not a tremendous force. If the carburetor had no bell-mouth, but was just a piece of pipe, all that turning would have to take place inside the mouth of the carb. The flow would not be able to suddenly zip around the tiny sharp radius of the pipe's edge, but would coast onward towards the center before making its turn. In the process, it would separate from the sharp edge. Looked at in cross section, the momentum of the inward flow contracts the flow cross-section momentarily to a diameter significantly less than the ID of the pipe. It is this contraction of the flow (called the "vena contracta" by the fluid mechanics people) that causes power loss; we've paid good money to have our 44s bored to paper-thin 46.5s, but in leaving the bellmouth edge sharp, we have shrunk the actual flowing diameter - the vena contracta - back to 45 or less. The sharper the edge, the less the bellmouth resembles a 360-degree roller-coaster, and the more the flow is reduced.

It is to allow the air to make its turn early that we provide a smoothly-contoured bellmouth. Its job is to collect the intake flows from all angles and give them opportunity to get turned parallel to the bore before they reach it. This avoids the inward rush that separates the flow from the carb edge and produces the vena contracta - an "invisible choke" that reduces power.

I've heard a lot of noise about whether 'tis nobler in the mind to knife-edge or to round-nose the dividers in the bottoms of the transfer ducts. On engines designed with little tiny secondary ducts, I have knife-edged the dividers to favor flow into the smaller ports, and with good results. I believe Yamaha did the same thing on factory road race engines in the 1970s. I could imagine, depending upon the geometry of the transfer entries, a situation in which flow would pour across the divider edges rather as side-flow approaches a carburetor across a too-sharp bellmouth edge. In that case, if there were flow separation, there might also be flow loss. On the other hand, if the flow

Kevin, center, Jim and Debbie waiting for a dyno printout from the ExciterSX. Kevin is holding a cylinder from a V-Max 4.

ASK KEVIN continued

approaches straight-on, knife-edging would certainly not be harmful.

A parallel contrast controls aircraft wing design. A subsonic wing must have a round leading edge so the flow over it at high angles of attack (analogous to side-flow approaching a carb bellmouth) will not separate and cause stall. A supersonic wing must have a knife edge to avoid speeding up the flow too much, leading to sonic velocity being reached over the regions of high curvature at too low a speed, making transonic acceleration require too much power. Lift at low speed is provided by gadgets--by trick wing flaps or by sucking or blowing away stagnant boundary layer that leads to flow separation and stall.

Therefore the rule; if flow can occur across the port dividers, rather than straight at them, they ought to be rounded just as are the leading edges of airplane wings. Otherwise, please yourself. I doubt it makes a lot of difference either way.

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