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DYNOTECH

JOURNAL OF SNOWMOBILE PERFORMANCE AND TWO STROKE TECHNOLOGY

1996 Polaris 680 Ultra

1996 Polaris 680 Ultra	
Bore X Stroke	66.6mm X 65mm
Induction	Case Reed
Carburetion	(3) 38mm Mikuni

Here we have an ultra-modern, three cylinder, case reed inducted Fuji engine, with triple exhaust ports, nickasil lined cylinders, billet-style combustion chambers, digital ignition, fiber reeds, and a well designed hi-flow airbox and carb venting system.

During our test session, we dissected the restrictive-looking airbox, and dyno tested the engine. Even those two tiny-looking rubber airbox inlet openings are adequate for this engine at 140 HP. Removing the rubber inlet grommets in the top of the box, and/ or the three rubber air horns in the bottom shelf actually reduced airflow very slightly. The time honored tradition of "gutting" the Polaris airbox for extra trail performance is not desirable in this case.

The carb vent hoses are connected to the airbox bottom, where we measured a mere 1.0" of negative water pressure (equal only to a 60 foot altitude change) even with the high flowing triple pipes. While this slight negative pressure has no measurable effect on HP, it dramatically alters fuel flow (see "Effects of Underhood Pressure on the V-Max 4" in Vol. 4 #3). The fact that Polaris connected the vent hoses to the airbox ensures a constant A/F ratio regardless of vehicle speed, wind, or snow conditions. Powder riders will appreciate the fact that as inlet foam becomes restricted by snow, the carbs are not likely to enrichen as in previous models; the increased negative pressure in the float bowls will properly lean out the fuel flow.

Unfortunately, with all of this great new engine technology and intake air management, Polaris opted to use a vintage 1979 single pipe that effectively negates the potential performance advantage of the new 680 triple.

It has proven to be extremely difficult to obtain much power from any three cylinder engine with a single expansion chamber exhaust system. Over the years, we've never been able to get much more than 105 HP out of any Polaris triple, regardless of size or state of tune, with a W pipe and single tuned pipe. Several years ago, Tim Bender spent several days on our dyno trying to develop a single pipe for the "Avalanche" Exciter triple engine, with no success. As I recall, 110 HP was all they found with 854cc, and the project was scrapped.

Why a low performance single pipe on an ultra-performance three cylinder engine?

Cost is the most obvious consideration. It would cost Polaris, say, another $100 per machine to add the extra two pipes (and thirty or so more HP in this case). Because HP is such an early season mystery as opposed to selling price, could the higher selling price of the triple-piped Ultra cost market share?

Weight is another factor. Heavy factory stamped pipes weigh a bit more than some lightweight aftermarket units. The SLP triples can weigh about the same as the stock exhaust. Even the most weight-conscious mountain rider would gladly add 10 pounds for 30 HP!

It is most likely that detuning the Ultra with a single pipe was a marketing decision, just as Yamaha reportedly made when it detuned the new, powerful (for then) 65 HP Phazer engine to 52 HP with a "soft" pipe, ostensibly to maintain SRV sales.

Is it possible that this new engine turned out too good, and the "prototype" factory triple piped 135 HP, lightweight 680 Ultra outperformed the 800 Storm? Who would pay more for a slower, heavier Storm? And, who would want a new 600SP that weighs more (!) with "only" 125 HP? Imagine Polaris dealers being able to charge over list price, like Harley dealers do, for this limited supply 140 HP 680cc factory lightweight speedster that every Polaris rider would want to own, while the dust-covered, crated Storms lan-

680 Ultra

continued

guished in the warehouse with unread below-cost price tags. That would not be acceptable to the beancounters.

What we have here is the aftermarket guys' dream. Like the Phazer, which has provided zillions of dollars of profits for aftermarket suppliers, the Ultra will undoubtedly pay for new Fountain powerboats and Lamborghinis for sharp pipe builders, and deservedly so. Starting Line Products has the jump on the other guys this fall with this low RPM pipe set (there is reportedly a destructive resonant frequency in the crankshaft at 8750 that must be avoided) that will probably be sold out for the season once this word is out. Any Ultra owner who reads this simply has no choice; 35 more HP with low noise and low revs for $500 is the performance bargain of the decade. The tinsmiths and dyno operators at the other pipe factories are working overtime to be in a position to cash in on this great market. HTG racing is currently making nearly 170 HP at high RPM, improved stock racing only, trim. It is probable that 180+ HP is lurking in this engine for improved stock dragracers. The piston port 650 triple, sadly, will soon be put to rest.

Stay tuned for an Ultra trail pipe shootout, aftermarket reed/ reed cage evaluation, and other possible performance improvements.

Here is our data, as dyno tested on a 65 degree day. Our jetting is safe at 65 degrees F for 93 octane gasoline, which is what we used for all of our tests.

1995 Stock Polaris 680 Ultra
300 MJ 90dB

Data for 29.92 in. Hg, 60 deg. F dry air
Test: 100 RPM/sec Acceleration
Fuel Specific Gravity: .740
Vapor Pressure: .21
Barometric Pressure: 30.32

RPM	CBT	CBHP	Fuel	Air	A/F	BSFC	CAT
6750	62.6	80.5	59.9	142.5	10.9	.74	67
7000	67.3	89.7	64.7	149.7	10.7	.72	66
7250	70.3	97.0	66.2	155.2	10.8	.68	66
7500	70.4	100.5	65.2	157.7	11.1	.65	67
7750	69.9	103.1	66.8	160.4	11.1	.65	67
8000	69.2	105.4	71.0	164.1	10.7	.67	65
8250	67.3	105.7	67.6	166.1	11.3	.64	66
8500	63.0	102.0	65.4	167.1	11.7	.64	66
8750	59.4	99.0	65.9	165.8	11.6	.66	66
9000	54.6	93.6	65.6	161.9	11.3	.70	66

1995 Stock Polaris 680 Ultra
340 MJ SLP Pipe (Warm)

Data for 29.92 in. Hg, 60 deg. F dry air
Test: 100 RPM/sec Acceleration
Fuel Specific Gravity: .740
Vapor Pressure: .21 Barometric Pressure: 30.29

RPM	CBT	CBHP	Fuel	Air	A/F	BSFC	CAT
6500	68.2	84.4	57.9	160.2	12.7	.69	66
6750	71.9	92.4	59.2	163.5	12.7	.64	67
7000	76.7	102.2	61.4	172.6	12.9	.60	67
7250	78.6	108.5	64.9	180.2	12.7	.60	66
7500	81.1	115.8	70.1	185.8	12.2	.61	66
7750	85.5	126.2	88.3	195.5	10.1	.70	65
8000	88.5	134.8	80.1	202.0	11.6	.59	66
8250	88.7	139.3	80.6	209.6	12.0	.58	63
8500	82.6	133.7	98.6	209.4	9.8	.74	66

1995 Stock Polaris 680 Ultra
340/290 MJ SLP Pipe (Hot)

Data for 29.92 in. Hg, 60 deg. F dry air
Test: 100 RPM/sec Acceleration
Fuel Specific Gravity: .740
Vapor Pressure: .21 Barometric Pressure: 30.28

RPM	CBT	CBHP	Fuel	Air	A/F	BSFC	CAT
6500	65.3	80.8	55.8	154.1	12.7	.69	66
6750	67.7	87.0	55.9	160.0	13.1	.64	65
7000	72.1	96.1	59.9	167.3	12.9	.62	64
7250	77.4	106.8	63.4	174.9	12.6	.59	66
7500	78.0	111.4	66.0	181.2	12.6	.59	66
7750	80.3	118.5	73.9	185.4	11.6	.63	67
8000	84.4	128.6	76.5	194.9	11.7	.59	66
8250	86.9	136.5	78.2	203.2	12.0	.57	65
8500	86.5	140.0	79.7	208.0	12.0	.57	65
8750	75.5	125.8	88.0	203.3	10.9	.70	65

Here's a high compression mod with .025" removed from the head sealing surfaces. This surely requires 93++ octane fuel to prevent detonation at sea level, and is inadvisable for those who can't be absolutely sure about their fuel. High compression domes are reportedly available from Polaris for high altitude riders or low altitude high octane riders. Because they utilize reusable o-ring sealing, having two sets of chambers seems like a practical option for those who like to occasionally have 100 octane fun on the lake with their trail machines.

1995 Stock Polaris 680 Ultra
340/290 MJ High Comp. SLP Pipe

Data for 29.92 in. Hg, 60 deg. F dry air
Test: 100 RPM/sec Acceleration
Fuel Specific Gravity: .740
Vapor Pressure: .24
Barometric Pressure: 30.11

RPM	CBT	CBHP	Fuel	Air	A/F	BSFC	CAT
6500	70.2	86.9	54.6	154.3	13.0	.63	63
6750	74.9	96.3	56.5	164.0	13.3	.59	63
7000	79.1	105.4	58.4	172.0	13.5	.56	64
7250	80.0	110.4	63.3	178.0	12.9	.58	64
7500	83.3	119.0	74.0	184.3	11.4	.63	64
7750	86.5	127.6	87.2	190.3	10.0	.69	64
8000	91.4	139.2	89.0	209.3	10.4	.64	64
8250	91.0	142.9	79.1	207.1	12.0	.56	63
8500	77.2	124.9	80.6	204.6	11.7	.65	63

PIPE SHOOTOUT #32

1995 Polaris XCR 600

Present During Test: Steve McQuillen John T. Cowie Dan Cross
Owner of Sled: Jim Pixley

Is it possible for the "outdated" but lighter weight piston port 600 triple to compete with the new 120-something horsepower triple-piped reed valve triples from Cat, SkiDoo and now Polaris? Compared to the new 600 triples, the XCR 600 starts out with a 50+ pound weight advantage, a fact that has not gone unnoticed by many XCR 600 owners who aren't quite ready to trade. The stock XCR600 also has a 30 HP power deficit, which is mostly the result of the single tuned pipe. Much of that deficit, however, can be made up with the addition of any of these aftermarket triple pipes that are currently available.

At, say, 115 HP, the triple-piped XCR600 with a 175lb rider has a power to weight ratio of about 5.8 lb/hp. A new 125 HP case-reed triple with the same rider has a nearly identical power to weight ratio! Adding the $500 tuned triple aftermarket pipes to the stock XCR600 seems like a good investment compared to the cost of trading up for a "modern" 600.

We used Jim Pixley's stock 1995 XCR600 engine, removed from the sled and mounted on our engine plate for a dyno mule. With 3000 miles of trail riding on the engine, it was quite typical of other XCR600 engines we have dyno tested. Oil injection was retained, and 93 octane (we hoped) unleaded gas was used, with a "splash" (5-1 ratio) of 100LL av gas added to be safe. The stock airbox had the foam and shelf removed during all tests.

We fine-tuned the carbs to allow each set of pipes to achieve a similar A/F ratio and BSFC. The BSFC of the stock single pipe, however, was left a bit higher. Due to its relative inefficiency, the stock single pipe gave us a higher BSFC at leaner A/F ratios than that achieved by the triple pipes. Though some savvy XCR600 tuners run one size larger on the PTO carb (that cylinder receives the least coolant flow), we jetted the engine evenly. Note that the air temp (CAT) was in the mid 60's for most of the session (two days), and the Mikuni slide rule should be used to determine winter jetting.

1995 Stock Polaris XCR
260 MJ Gut Airbox–Stock Pipe
Data for 29.92 in. Hg, 60 deg. F dry air
Test: 100 RPM/sec Acceleration
Fuel Specific Gravity: .744
Vapor Pressure: .30
Barometric Pressure: 30.21

RPM	CBT	CBHP	Fuel	Air	A/F	BSFC	CAT
6500	49.4	61.1	55.1	134.2	11.2	.91	72
6750	51.0	65.5	57.6	136.3	10.9	.89	71
7000	53.4	71.2	60.7	148.1	11.2	.86	71
7250	56.3	77.7	66.8	158.0	10.9	.87	71
7500	59.2	84.5	69.5	164.7	10.9	.83	70
7750	60.3	89.0	69.0	171.6	11.4	.78	70
8000	60.1	91.5	70.0	174.0	11.4	.77	70
8250	60.9	95.7	65.2	173.5	12.2	.69	71
8500	58.8	95.2	65.5	175.0	12.3	.70	71
8750	56.4	94.0	65.2	172.8	12.2	.70	70
9000	53.2	91.2	65.6	173.0	12.1	.73	71

The pipes tested here were all that were available as of late September. We also tested a lightweight, but louder than stock Precision Performance Products replacement cannister muffler. Noticeably absent are the Aaen pipes which we were not able to obtain from them in time for the test. We tried.

Because the engine was out of the chassis, pipe fit could not be compared. It should be noted, however, that using Decker pipes will require two new exit holes be punched in the bellypan to accommodate the individual silencers. All others had either a stock-like cannister muffler or individual glasspack mufflers manifolded together to exit the stock bellypan opening.

1995 Stock Polaris XCR
260 MJ Gut Airbox–Decker Pipes 92 dB
Data for 29.92 in. Hg, 60 deg. F dry air
Test: 100 RPM/sec Acceleration
Fuel Specific Gravity: .744
Vapor Pressure: .30 Barometric Pressure: 30.21

RPM	CBT	CBHP	Fuel	Air	A/F	BSFC	CAT
6500	54.6	67.6	58.5	147.3	11.6	.87	64
6750	58.2	74.8	64.6	151.8	10.8	.87	63
7000	61.0	81.3	66.9	159.2	10.9	.83	63
7250	63.0	87.0	64.9	161.6	11.4	.75	65
7500	65.7	93.8	72.4	162.5	10.3	.78	64
7750	66.8	98.6	75.8	164.7	10.0	.77	64
8000	66.7	101.6	73.5	165.3	10.3	.73	64
8250	68.2	107.1	70.9	170.0	11.0	.66	64
8500	69.2	112.0	72.9	173.9	11.0	.65	64
8750	69.7	116.1	74.6	179.1	11.0	.65	64
9000	68.7	117.7	72.8	180.2	11.4	.62	63
9250	64.6	113.8	70.4	181.1	11.8	.62	64

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The SLP pipes we used in this test were early-style individual glasspack silencers that exited the stock hole. According to SLP, new versions of this pipe set will have a single cannister muffler that is "a bit" quieter with no change in airflow or HP.

1995 Stock Polaris XCR
250 MJ Gut Airbox--Starting Line Pipes 92 dB
Data for 29.92 in. Hg, 60 deg. F dry air
Test: 100 RPM/sec Acceleration
Fuel Specific Gravity: .744
Vapor Pressure: .30
Barometric Pressure: 30.20

RPM	CBT	CBHP	Fuel	Air	A/F	BSFC	CAT
6500	56.5	69.9	58.7	154.5	12.1	.84	62
6750	58.8	75.6	62.5	159.1	11.7	.83	63
7000	61.3	81.7	68.4	164.5	11.0	.84	63
7250	63.0	87.0	72.9	167.5	10.6	.84	63
7500	65.8	94.0	73.9	172.6	10.7	.79	62
7750	66.2	97.7	74.6	170.4	10.5	.77	62
8000	66.3	101.0	73.8	169.1	10.5	.73	62
8250	67.6	106.2	72.2	178.0	11.3	.68	62
8500	68.8	111.3	72.2	184.8	11.8	.65	61
8750	69.7	116.1	73.2	185.8	11.7	.63	62
9000	68.4	117.2	73.6	188.7	11.8	.63	61
9250	64.8	114.1	73.8	186.6	11.6	.65	61

SLP and PSI utilize steel sealing rings on the exhaust flange. These newer versions now have bell-mouthed header pipes to facilitate installation (as opposed to the old-style sharp machined header pipes that sometimes act like a Popiel Vegematic fingertip slicer when compressing the rings to install the pipes).

1995 Stock Polaris XCR
260 MJ Gut Airbox--PSI Pipes 94 dB
Data for 29.92 in. Hg, 60 deg. F dry air
Test: 100 RPM/sec Acceleration
Fuel Specific Gravity: .744
Vapor Pressure: .30
Barometric Pressure: 30.21

RPM	CBT	CBHP	Fuel	Air	A/F	BSFC	CAT
6500	57.7	71.4	61.8	158.3	11.8	.87	63
6750	60.1	77.2	66.8	159.9	11.0	.87	66
7000	59.9	79.8	66.1	161.0	11.2	.83	64
7250	62.7	86.6	68.4	162.8	10.9	.79	64
7500	64.4	92.0	74.6	168.3	10.4	.82	65
7750	66.0	97.4	75.5	174.2	10.6	.78	64
8000	67.6	103.0	72.1	176.4	11.2	.70	65
8250	68.9	108.2	71.0	178.6	11.6	.66	67
8500	71.3	115.4	74.4	184.1	11.4	.65	66
8750	70.7	117.8	76.6	187.5	11.2	.65	65
9000	68.2	116.9	76.1	188.8	11.4	.65	65
9250	46.6	82.1	73.5	183.6	11.5	.90	64

The Pro-5 pipes reminded us of the old Pro-5 Indy 600/650 stampings, with a newer and quieter-than-stock cannister silencer. The Pro-5 cannister also uses a stock-like perforated glass-pack silencer in the cannister outlet pipe. Also, each pipes' center section has a one inch wide strip of heat resistant header wrap banded around its circumference, most likely to eliminate the "tinney" sound that thin stampings sometimes emit.

1995 Stock Polaris XCR
260 MJ Gut Airbox--Pro 5 Pipes 88dB
Data for 29.92 in. Hg, 60 deg. F dry air
Test: 100 RPM/sec Acceleration
Fuel Specific Gravity: .744
Vapor Pressure: .30
Barometric Pressure: 30.22

RPM	CBT	CBHP	Fuel	Air	A/F	BSFC	CAT
7000	59.7	79.6	60.8	156.3	11.8	.77	69
7250	62.3	86.0	67.7	160.6	10.9	.80	70
7500	64.1	91.5	68.7	164.4	11.0	.76	71
7750	65.4	96.5	67.1	169.6	11.6	.70	69
8000	66.4	101.1	69.0	170.6	11.4	.69	70
8250	66.4	104.3	65.4	174.0	12.2	.63	70
8500	67.3	108.9	67.1	175.6	12.0	.62	71
8750	67.6	112.6	66.4	179.3	12.4	.60	71
9000	67.3	115.3	68.1	183.5	12.4	.60	70
9250	63.7	112.2	68.7	186.5	12.5	.62	69
9500	58.2	105.3	72.4	184.3	11.7	.69	70

The LRM (owned by Larry Rugland) pipes' configuration and cannister was very much like the Pro-5 design, including the sound-deadening strips banded to the center sections. Though sound levels were close, the power output was the lowest of the triple pipes tested (though still a respectable 15+ over stock).

1995 Stock Polaris XCR
260 MJ Gut Airbox--LRM Pipes 90 dB
Data for 29.92 in. Hg, 60 deg. F dry air
Test: 100 RPM/sec Acceleration
Fuel Specific Gravity: .744
Vapor Pressure: .30
Barometric Pressure: 30.21

RPM	CBT	CBHP	Fuel	Air	A/F	BSFC	CAT
6750	55.8	71.7	64.6	153.6	10.9	.91	70
7000	59.9	79.8	65.3	159.2	11.2	.83	70
7250	62.2	85.9	70.7	164.4	10.7	.83	70
7500	65.1	93.0	72.3	169.0	10.7	.79	71
7750	65.8	97.1	71.1	172.4	11.1	.74	70
8000	65.4	99.6	70.8	173.9	11.3	.72	70
8250	65.6	103.0	65.9	177.8	12.4	.65	70
8500	66.5	107.6	68.3	181.0	12.2	.64	70
8750	66.5	110.8	70.4	184.7	12.0	.64	70
9000	64.5	110.5	70.9	187.3	12.1	.65	69
9250	60.1	105.9	70.6	187.1	12.2	.67	70

DynoPort pipes use individual glasspack mufflers like Decker and PSI, and exit out the stock opening. The DynoPort and Decker pipes were the "tightest" of the bunch, showing lower airflow than the others.

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1995 Stock Polaris XCR
270 MJ Gut Airbox–Dyno Port Pipes 92 dB
Data for 29.92 in. Hg, 60 deg. F dry air
Test: 100 RPM/sec Acceleration
Fuel Specific Gravity: .744
Vapor Pressure: .30 Barometric Pressure: 30.22

RPM	CBT	CBHP	Fuel	Air	A/F	BSFC	CAT
6750	53.6	68.9	53.7	141.2	12.1	.79	69
7000	58.1	77.4	62.4	157.1	11.6	.81	70
7250	59.8	82.5	65.7	161.2	11.3	.80	70
7500	61.6	88.0	67.3	164.3	11.2	.77	70
7750	63.6	93.8	67.1	162.4	11.1	.72	69
8000	65.1	99.2	66.1	163.0	11.3	.67	68
8250	65.6	103.0	66.0	169.4	11.8	.65	68
8500	66.4	107.5	67.5	171.0	11.6	.63	70
8750	67.6	112.6	68.1	174.7	11.8	.61	70
9000	67.9	116.4	69.8	178.6	11.7	.61	70
9250	65.2	114.8	71.1	180.2	11.6	.63	71

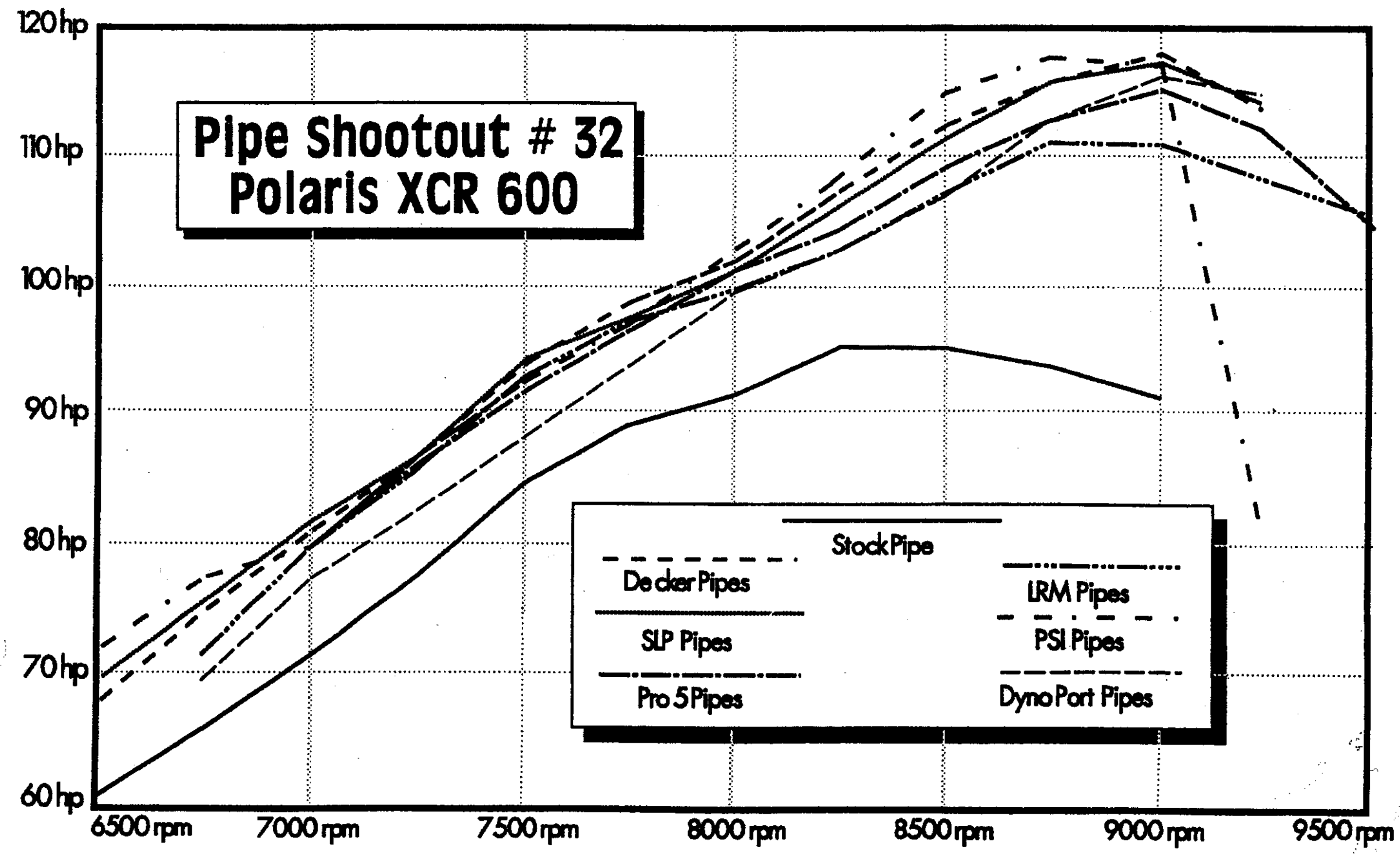
1995 Stock Polaris XCR
250 MJ Precision Products Muffler 94 dB
Data for 29.92 in. Hg, 60 deg. F dry air
Test: 100 RPM/sec Acceleration
Fuel Specific Gravity: .744
Vapor Pressure: .30 Barometric Pressure: 30.21

RPM	CBT	CBHP	Fuel	Air	A/F	BSFC	CAT
6500	48.2	59.7	54.1	132.6	11.3	.92	73
6750	48.0	61.7	54.8	134.2	11.2	.90	72
7000	52.5	70.1	59.9	147.8	11.3	.87	73
7250	55.3	76.3	65.3	153.3	10.8	.87	73
7500	59.2	84.5	69.0	165.1	11.0	.83	73
7750	60.7	89.6	69.2	169.1	11.2	.78	73
8000	60.9	92.8	69.3	173.5	11.5	.76	74
8250	60.4	94.9	64.8	175.7	12.5	.69	73
8500	59.1	95.6	65.2	175.3	12.3	.69	74
8750	56.7	94.5	63.4	173.9	12.6	.68	74
9000	53.3	91.3	63.1	171.9	12.5	.70	75
9250	49.8	87.7	65.8	169.1	11.8	.76	73

After all triple pipes were tested, we reinstalled the stock single pipe to ensure that the engine had the same power as when we began. It repeated within two tenths of a HP, and we installed a set of higher compression billet heads acquired from HTG racing. These had one cc less volume than stock, and raised the cranking compression on our gauge from 140psi to 155psi. This would be considered very marginal on today's pump gas, but we show this as an example of what it takes to achieve more power with different combustion chambers (see Feedback). Jim Pixley purchased these chambers for use exclusively for high octane lake racing.

1995 Stock Polaris XCR
250 MJ Gut Airbox–HTG Heads
Data for 29.92 in. Hg, 60 deg. F dry air
Test: 100 RPM/sec Acceleration
Fuel Specific Gravity: .744
Vapor Pressure: .30
Barometric Pressure: 29.87

RPM	CBT	CBHP	Fuel	Air	A/F	BSFC	CAT
6500	50.4	62.4	53.0	130.0	11.3	.87	70
6750	51.7	66.4	53.0	136.0	11.8	.82	69
7000	53.7	71.6	56.5	146.6	11.9	.81	68
7250	58.2	80.3	62.6	156.5	11.5	.80	69
7500	60.3	86.1	62.3	160.9	11.9	.74	70
7750	62.6	92.4	62.6	169.0	12.4	.69	71
8000	62.5	95.2	62.4	171.0	12.6	.67	70
8250	62.1	97.5	64.2	172.5	12.3	.67	70
8500	60.4	97.8	63.8	173.7	12.5	.67	71
8750	57.5	95.8	64.2	173.4	12.4	.69	70
9000	54.7	93.7	64.7	170.8	12.1	.71	70



1996 Ski Doo Formula SLS

Ed Sedlemeier brough us his new SkiDoo for break-in and evaluation. At press time there weren't any technical specs available on this new middleweight twin, so all we can do is show these dyno results. SkiDoo rep Gary Potyok didn't have any info that he could share with us, but comparing this engine to the 1987 521cc Formula Plus in Vol. 1 #2, we can see the subtle advances that have been made over the past decade in the Rotax two cylinder engine and pipe design.

We removed the standard (typically safe to zero F) 320 mains, and installed 290's that would correctly compensate for the 70 degree F air temperature on the day of the test. 93 octane unleaded gas with a splash of leaded race gas was used in all phases of this test.

This combo gave us a marginally safe mid .60's lb/h-phr BSFC that might be too lean for oxygenated gas. However, there probably is some high speed enrichening from the combination of underhood venting of the carbs and the cold air intake behind the windshield that should make the fuel flow higher and safer than shown here.

The airflow readings are for some reason lower than actual, but consistant from test to test.

1996 Ski Doo Formula SLS 500
290 MJ
Data for 29.92 in. Hg, 60 deg. F dry air
Test: 100 RPM/sec Acceleration
Fuel Specific Gravity: .750
Vapor Pressure: .30
Barometric Pressure: 29.86

RPM	CBT	CBHP	Fuel	Air	A/F	BSFC	CAT
5250	41.5	41.5	40.6	81.6	9.2	1.00	71
5500	44.7	46.8	42.3	85.3	9.3	.92	67
5750	48.8	53.4	43.0	89.8	9.6	.83	70
6000	48.7	55.6	41.6	93.3	10.3	.77	72
6250	52.4	62.4	51.2	100.7	9.0	.84	71
6500	53.9	66.7	55.5	103.9	8.6	.85	71
6750	56.4	72.5	61.2	108.0	8.1	.87	71
7000	58.0	77.3	56.1	112.9	9.2	.74	70
7250	60.0	82.8	53.5	117.6	10.1	.66	69
7500	61.6	88.0	56.1	123.0	10.1	.65	69
7750	60.3	89.0	62.4	125.3	9.2	.72	71
8000	56.5	86.1	65.2	127.0	8.9	.78	72
8250	40.6	63.8	62.8	125.8	9.2	1.01	70

Ed had purchased a second airbox which he had modified prior to coming to the dyno. This one had the shelf pretty much removed from the box, allowing the engine to breath a little better, even at low revs. Some of the increase in midrange power can be associated with the pipe being a bit cooler during this particular test (observing the difference in the peak power RPM from run to run where compression and timing are unchanged). Because of the slight increase in carb venturi pressure with the gutted box, the main jets had to be increased FIVE SIZES to 340 to maintain adequate fuel flow for 70 degrees F.

1996 Ski Doo Formula SLS 500
340 MJ
Data for 29.92 in. Hg, 60 deg. F dry air
Test: 100 RPM/sec Acceleration
Fuel Specific Gravity: .750
Vapor Pressure: .30
Barometric Pressure: 29.86

RPM	CBT	CBHP	Fuel	Air	A/F	BSFC	CAT
5250	46.5	46.5	42.5	89.5	9.7	.94	70
5500	50.5	52.9	44.5	94.4	9.7	.86	69
5750	50.7	55.5	43.3	99.5	10.6	.80	69
6000	54.4	62.1	47.0	106.5	10.4	.77	69
6250	57.0	67.8	50.4	111.1	10.1	.76	70
6500	58.9	72.9	55.1	115.3	9.6	.77	69
6750	60.4	77.6	55.4	118.9	9.9	.73	69
7000	62.4	83.2	54.0	123.2	10.5	.67	70
7250	63.5	87.7	54.8	128.3	10.8	.64	69
7500	63.6	90.8	56.3	132.2	10.8	.63	69
7750	60.7	89.6	61.2	134.3	10.1	.70	70
8000	50.6	77.1	62.7	135.3	9.9	.83	70

On the new engine, timing changes are easily effected by moving the ignition pickup, accessible on the top half of the crankcase. We advanced the timing two degrees and picked up maybe one HP, but we opted to return the timing back to stock. Having the ignition timing cranked up to absolute maximium HP is sometimes beneficial for short drag runs. But, max HP timing makes operation on pump gas of questionable octane and formulation precarious at best.

1996 Arctic Cat ZRT 600

Arctic Cat ZRT 600	>>>>>>>>>>>>>>>>>>
Displacement	594 cc
Carburetion	(3) VM 36 Mikuni
Induction	Case Reed

D&D Cycles Arctic Cat had dyno tested their 1995 ZRT600 at their own new dyno testing facility (a Huff Technology instrumented and computerized hydraulic unit) and found it necessary to spend time hand-fitting the pipes to the exhaust flanges to obtain the power level shown here. They reported that their header pipe to exhaust flange fit was poor, causing exhaust leakage and affecting the actual length of the pipes. With the pipes fit and sealed properly, and 260 main jets installed to compensate for the 80+ degree humid temperature of the dyno on that August day, this data resulted.

1995 Stock Arctic Cat ZRT 600
260 Main Jets
Data for 29.92 in. Hg, 60 deg. F dry air
Test: 100 RPM/sec Acceleration
Fuel Specific Gravity: .741
Vapor Pressure: .82
Barometric Pressure: 29.93

RPM	CBT	CBHP	Fuel	BSFC	CAT
6500	62.6	77.5	55.8	.76	87
6750	64.2	82.5	61.7	.79	86
7000	70.5	94.0	71.4	.81	87
7250	72.6	100.2	73.8	.78	87
7500	75.0	107.1	74.6	.74	86
7750	77.9	115.0	72.8	.67	86
8000	78.2	119.1	73.7	.66	88
8250	77.7	122.1	75.0	.65	87
8500	71.0	114.9	73.2	.68	87

This 1996 machine is an early unit, which was purchased by Larry Bartlett from Norton Enterprises in E. Bethany, NY.

As suggested by the Mikuni slide rule, Larry removed the stock 360 main jets and installed 320 mains to compensate for the 65 degree October air. We used 93 octane unleaded gas-with 15% 100LL av gas added to be sure. After a short breakin period on the dyno it was apparent that the pipe fit was still a problem; large amounts of two-stroke oil was finding its way out of the flange/ pipe sealing area onto the outside of the header pipes and into the belly pan.

This is how the out-of-the-crate ZRT600 engine performed, suffering from the loss of backpressure from the leaking pipes and the uneven tuned lengths.

1996 Stock Arctic Cat ZRT 600
Stock 360, 320 Main Jets
Data for 29.92 in. Hg, 60 deg. F dry air
Test: 200 RPM/sec Acceleration
Fuel Specific Gravity: .750
Vapor Pressure: .24
Barometric Pressure: 29.77

RPM	CBT	CBHP	Fuel	BSFC	CAT
6500	61.4	76.0	56.9	.76	63
6750	62.3	80.1	60.9	.78	64
7000	67.4	89.8	65.0	.74	64
7250	74.1	102.3	69.0	.69	65
7500	75.4	107.7	68.5	.65	64
7750	75.6	111.6	72.7	.67	65
8000	72.7	110.7	68.7	.63	63
8250	65.3	102.6	75.4	.75	63

Next, Larry spent several hours refitting the pipes to the flanges. Upon removal of the pipes, it was apparent that Cat's 600 pipe welding fixtures need some attention; the center pipe was wedged into the flange at an angle so that was effectively 1/4" longer than it would be had it fitted properly. Repairing this required angle grinding the header pipes, as well as some hand filing. Once the pipes were fit reasonably to the flanges, the exhaust cannister had to be unbolted and moved forward a little. This necessitated modifying the cannister mounts a bit.

With the work Larry did on the pipes, the exhaust leakage at the flanges persisted. This would require sealing with silicone, something we didn't have time to do (silicone should be left to cure 12 hours prior to running). So, this is what we came up with. Not bad for a couple of hours work. Note that the horsepower peak slid up to 8000 RPM.

1996 Stock Arctic Cat ZRT 600
360, 320 Main Jets–Pipe Fitted
Data for 29.92 in. Hg, 60 deg. F dry air
Test: 100 RPM/sec Acceleration
Fuel Specific Gravity: .744
Vapor Pressure: .38 Barometric Pressure: 29.75

RPM	CBT	CBHP	Fuel	BSFC	CAT
6500	64.5	79.8	59.7	.75	65
6750	69.1	88.8	69.7	.81	65
7000	72.1	96.1	72.1	.77	65
7250	74.4	102.7	69.0	.69	65
7500	78.6	112.2	88.7	.81	64
7750	78.9	116.4	85.4	.75	65
8000	77.8	118.5	90.2	.78	65
8250	74.9	117.7	90.0	.77	65
8500	66.6	107.8	92.2	.88	64

Dropping the jet size to 280, which would equate to the '95 ZRT600's jetting as shown earlier in this evaluation, we picked up a bit of power, but not enough to match the '95. This would be a 93 octane safe jet for 1/4 mile runs at 65 degrees F, but might be too lean for reformulated gas (see TCD in this edition). Note that the peak was 250 RPM higher.

1996 Stock Arctic Cat ZRT 600
Stock 360, 280 Main Jets
Data for 29.92 in. Hg, 60 deg. F dry air
Test: 100 RPM/sec Acceleration
Fuel Specific Gravity: .748
Vapor Pressure: .27
Barometric Pressure: 30.07

RPM	CBT	CBHP	Fuel	BSFC	CAT
6500	64.7	80.1	59.7	.81	68
6750	66.4	85.3	68.8	.80	66
7000	71.3	95.0	70.1	.74	66
7250	75.2	103.8	67.8	.70	67
7500	78.0	111.4	79.0	.72	68
7750	78.6	116.0	83.2	.73	68
8000	77.8	118.5	79.1	.68	68
8250	76.3	119.9	76.8	.65	67
8500	71.9	116.4	77.2	.67	69

We were surprised to find our 1996 ZRT600 case-reed inducted engine was afflicted by the same poor pipe fit that caused difficulty for the limited production 1995 ZRT600. The performance capabilities of this exotic new Eagle River-winning Suzuki engine with its short 57 mm stroke (high rev capabilities) and nickasil lined cylinders are, for the time being, hampered a bit by poor quality control in Arctco's pipe welding department. We don't know how typical this problem is, but any ZRT600 owner should check the fit of the pipes. Do yours leak oil all over themselves and the belly pan? Do the pipes have to be wrenched partially out of the exhaust port flanges to fit the stinger to the cannister? If so, your performance is likely suffering.

Arctco is now preparing a program to remunerate Cat dealers for two hours to remedy leaking exhaust flanges. What about stock-class dragracers, who might experience difficulty in "tech" with hand fitted pipes? What about our Old Forge Shootout this year?

Larry is spending more time fitting his pipes to his sled, paying close attention to the lengths of the individual header pipes and sealing the flanges properly with silicone. When some aftermarket pipes become available to us, we'll put Larry's sled back on the dyno to see if we're making the 122+ HP that the new engine should be capable of in stock trim. And, as we'll be doing with the other new 600 class engines, we'll see what sort of power is available to lake racers

With its ultra short 57 mm stroke, piston speed of the ZRT600 engine at 10,000 RPM is the same as a Polaris XCR600 engine engine at 8800 RPM or a VMax600 engine at 8400 RPM! That should give pipe designers and engine modifiers leeway for sliding power peaks reliably up to new, higher RPM levels. Ultra-short stroke 500cc two-stroke case reed inducted racing motorcycles now can make 190+ HP at 13-14000 RPM . Can snowmobile engines be far behind?

TURBO V MAX 800 XCR 600

XCR 600

Radical port timing that works so well on high RPM naturally aspirated engines can often be somewhat of a detriment with turbocharging. One example is the Polaris XCR 600, that makes about ten more HP than a standard XLT 600 when fitted with high RPM triple pipes.

When fitted with a turbocharger, however, the additional port timing contributes to excessive short-circuiting of the intake charge, lowering power and raising BSFC. Excessive short-circuiting with a turbocharger, however, may increase the engine's resistance to detonation on low octane gas, as there is less preheating of the intake charge returned from the tuned pipe prior to exhaust port closing.

Here is our stock XCR600 fitted with a First Choice turbo system which uses the self-lubed variable geometry Aerocharger, blow through carbs, and oil injection. 100LL Av gas was used.

Comparing this data with that of the XLT580 turbo tested in Vol. 5 # 1., we see that with turbos and port timing, more is not necessarily better.

1995 600 XCR TURBO
300 MJ 8.0 lbs Boost
Data for 29.92 in. Hg, 60 deg. F dry air
Test: 200 RPM/sec Acceleration
Fuel Specific Gravity: .740
Vapor Pressure:.36
Barometric Pressure: 30.19

RPM	CBT	CBHP	Fuel	Air	A/F	BSFC	CAT
7250	83.7	115.5	78.6	235.1	13.7	.68	57
7500	85.7	122.4	83.8	242.2	13.3	.68	56
7750	86.2	127.2	86.9	246.8	13.0	.68	57
8000	87.3	133.0	90.3	251.5	12.8	.68	56
8250	88.2	138.5	92.8	253.2	12.5	.67	56
8500	88.2	142.7	94.5	255.9	12.4	.66	55
8750	86.9	144.8	98.7	255.5	11.9	.68	57
9000	85.2	146.0	99.1	256.8	11.9	.68	56
9250	82.7	145.7	98.5	256.8	12.0	.68	55
9500	80.7	146.0	99.4	256.7	11.9	.68	56

An interesting comparison can be made between our stock XCR600 turbo with one put together by Cooper Sales and Service Polaris in Waterport, N.Y. Jimmy and Lynn Cooper utilized an XLT600 cylinder block to optimize the performance of their XCR600 turbo system, and here's their machine tested at the same 100 LL AVgas only, boost. Though clutching would be quite effective shifting between 8000 and 9000 RPM, the power peak occurs at 8500 RPM with the stock XCR600 single pipe.

1995 600 XCR TURBO
300 MJ--XLT 600 Cyls.
Data for 29.92 in. Hg, 60 deg. F dry air
Test: 200 RPM/sec Acceleration
Fuel Specific Gravity: .744
Vapor Pressure:.22
Barometric Pressure: 29.58

RPM	CBT	CBHP	Fuel	Air	A/F	BSFC	CAT
7000	89.4	119.2	101.9	221.9	10.0	.85	49
7250	91.6	126.4	102.1	229.8	10.3	.81	49
7500	94.0	134.2	100.5	239.8	11.0	.75	48
7750	96.5	142.4	107.5	249.5	10.7	.75	48
8000	98.1	149.4	102.4	261.4	11.7	.69	48
8250	97.0	152.4	100.8	264.6	12.1	.66	48
8500	94.6	153.1	103.9	265.9	11.8	.68	49
8750	91.7	152.8	104.0	266.1	11.7	.68	48
9000	87.9	150.6	101.6	265.7	12.0	.67	48

V MAX 800

Here's another case of "less is better". The more moderate port timing of the '92 V-Max 4 always made a bit more power, boost for boost, than did the '93 or '94 versions of the 750 quad.

The 1995 and 1996 V-Max 800 combines moderate port timing, larger displacement, and improved Y-pipe/tuned pipe design to create an ideal situation for the turbo.

The largest modern series 53 Aerocharger, the 143N300 will efficiently pump enough intake air to make 210 HP at sea level, whether it's mounted on a 670 Rotax, V-Max 4, or small block Chevy. Beyond that, the turbo spins too fast for efficient operation, causing additional preheating of the intake charge and excessive backpressure in the exhaust, causing additional preheating of the intake charge returned through the exhaust port by the exhaust header pipes. Aero-

→

dyne Dallas is planning to build a larger compressor wheel and housing next year that should be capable of delivering 235-240 HP worth of intake air, but until that time we will have to "live" with 210 as the practical max.

This is an Aerocharged stock V-Max 800 engine, shown with only 2.75, 6.5, and 8psi of boost respectively. Raising boost pressure higher than 8psi on this engine will possibly make more power, but at elevated intake temperature and exhaust backpressure. These tests were all performed with a 50/50 mix of Sunoco 94 and 100LL AvGas.

1995 V MAX 800 TURBO
165 MJ 2.75 lbs Boost
Data for 29.92 In. Hg, 60 deg. F dry air
Test: 100 RPM/sec Acceleration
Fuel Specific Gravity: .750
Vapor Pressure: .20
Barometric Pressure: 30.30

RPM	CBT	CBHP	Fuel	Air	A/F	BSFC	CAT
7000	98.7	131.5	142.7	429.6	13.8	1.09	33
7250	100.0	138.0	129.3	440.6	15.6	.94	35
7500	104.6	149.4	129.6	462.2	16.4	.87	37
7750	106.7	157.4	126.9	478.0	17.2	.81	32
8000	108.8	165.7	126.8	486.4	17.6	.77	35
8250	107.0	168.1	130.0	490.0	17.4	.77	37
8500	102.7	166.2	132.1	494.0	17.2	.79	37
8750	94.3	157.1	133.1	498.2	17.2	.85	36

1995 V MAX 800 TURBO

165 MJ 6.5 lbs Boost
Data for 29.92 In. Hg, 60 deg. F dry air
Test: 200 RPM/sec Acceleration
Fuel Specific Gravity: .750
Vapor Pressure: .20 Barometric Pressure: 30.30

RPM	CBT	CBHP	Fuel	Air	A/F	BSFC	CAT
7000	109.5	145.9	141.8	255.7	12.5	.97	46
7250	115.3	159.2	147.3	268.3	12.5	.93	46
7500	121.0	172.8	145.3	283.1	12.5	.84	46
7750	124.3	183.4	145.3	293.8	12.5	.79	46
8000	126.7	193.0	146.2	300.3	12.5	.76	46
8250	125.3	196.8	149.2	304.9	12.6	.76	46
8500	121.9	197.3	151.0	306.7	12.8	.77	47
8750	113.8	189.6	150.4	306.3	13.2	.79	48
9000	101.6	174.1	155.6	300.2	13.6	.89	48

1995 V MAX 800 TURBO
165 MJ 8.5 lbs Boost
Data for 29.92 In. Hg, 60 deg. F dry air
Test: 300 RPM/sec Acceleration
Fuel Specific Gravity: .750
Vapor Pressure:.20 Barometric Pressure: 30.30

RPM	CBT	CBHP	Fuel	Air	A/F	BSFC	CAT
7000	110.3	147.0	139.4	279.0	9.2	.93	49
7250	115.1	158.9	140.2	284.5	9.3	.87	49
7500	123.5	176.4	142.7	306.6	9.9	.79	51
7750	129.2	190.7	140.2	311.8	10.2	.72	50
8000	134.0	204.1	143.5	320.7	10.3	.69	49
8250	132.6	208.3	145.8	327.3	10.3	.69	49
8500	130.0	210.4	150.5	331.6	10.1	.70	49
8750	125.9	209.8	152.4	334.3	10.1	.71	49
9000	115.1	197.2	158.0	333.3	9.7	.79	49

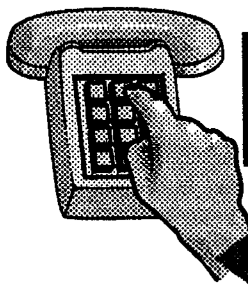
EXCELLENT ENGINE

We've dyno tested several PSI Genesis Storm engines- some better than others due possibly to differences in pipes and/or port angles. The "worst" one was 185 HP, "only" 50 HP higher than the stock Storm engine.

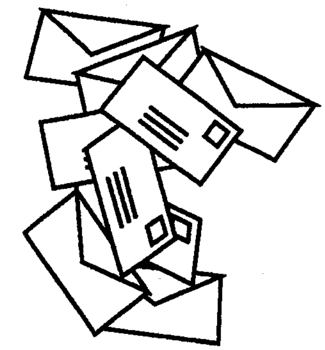
This one is a recent and dandy 1000cc "lake race" engine belonging to Roy Smith of Freeport, Maine. It built peak power at a moderate 8400 RPM, with Boswell modded TMX38 flatslides as supplied by PSI. Cranking compression was a reasonable 160psi, and VPC12 gas was used for the test. This was not "cold shot" cold water power, but hot engine, hot water (100 degree F+) temp with repeatable, long pulls on the dyno.

POLARIS STORM PSI GENESIS 1000
BOSWELL FS 420-410-410
Data for 29.92 In. Hg, 60 deg. F dry air
Test: 200 RPM/sec Acceleration
Fuel Specific Gravity: .735
Vapor Pressure:.10 Barometric Pressure: 30.00

RPM	CBT	CBHP	Fuel	BSFC	CAT
6250	95.5	113.6	99.9	.85	30
6500	100.8	124.8	101.4	.79	30
6750	110.1	141.5	107.8	.74	30
7000	112.9	150.5	113.6	.73	30
7250	117.8	162.6	115.4	.69	29
7500	128.9	184.1	120.8	.64	30
7750	135.9	200.5	126.1	.61	30
8000	138.8	211.4	136.9	.63	29
8250	135.8	213.3	141.6	.64	29
8500	131.7	213.1	138.4	.63	28
8750	125.2	208.6	136.9	.63	29
9000	109.7	188.0	131.3	.68	30



FEEDBACK



Examining the information in this issue confirms what we have been predicting for years: snowmobile manufacturers would eventually provide us consumers with out-of-the-box performance that is difficult, even unnecessary for all but a mad few, to improve upon by modifiers and engine parts vendors. It has been enjoyable for all of us observing the snowmobile engine transformation from golf-cart to GP motorcycle engine technology in just a few short years! Competition for market share and increased consumer awareness are the primary reasons for this great phenomenon, and the best may be yet to come. Performance sells, and consumers have voted for this modern technology revolution with their checkbooks.

Our dyno analyses of pipes, reeds, etc. are becoming less critical for performance-minded consumers. We used to devote great volumes to "stock pipe shootouts" and then "trail ported pipe shootouts" when the best factory musclesleds were 75 to 100 HP, and could be perked up to a rocket-like 125 HP or so. Now, bone-stock "middleweight" sleds have that kind of engine performance because of this technological revolution. Besides analyzing higher RPM pipes or perhaps complex reed evaluations that might lose or gain one or two HP, there's not much for us to do. The manufacturers are even accurately determining at what RPM their engines' typically warm pipe horsepower peaks occur.

We are considering the possibility of expanding the scope of DynoTech to include clutch and chassis tuning. While this may be a bit more subjective than the hard data from our SuperFlow dyno, it is most important in determining the sled's final performance. Joe DiSpirito of CycleDyne in Clinton, NY has done several engine mod articles for us in the past, and is intrigued by the possibility of being involved with us in future issues. Joe's clutch and chassis tuning expertise, as well as his understanding of dyno tuning and two-stroke theory should be a great benefit to our subscribers.

STORM TRANSFER PORT ANALYSIS

Recently, we published a dyno test we did on a mod Storm engine built by Larry Audette, owner of the CrankShop that made revolutionary HP. Storm modifiers had been frustrated by low HP, regardless of engine size and state of tune.

As I understand it, the stock Storm's main transfer ports are sharply aimed to the rear of the cylinder. The cylinders were altered substantially by Larry so that the main transfers were aimed more toward the center of the cylinder. This required extensive welding on the outside of the cylinders. Besides the 800 engine we tested for DynoTech, Larry built several 950 size Storm engines that made even more power. Since the CrankShop specializes in Rotax engines, Larry has turned the Storm engine modification program over to Polaris maven Rob Schooping at HTG racing. Rob uses the CrankShop stamped pipes, and has since ground out another ten HP to give the 800 Mod Storm 200+ HP, and the larger 900 and 950 versions are also competitive in mod dragracing (with as much as 220+ coldshot HP!).

PSI makes dandy 1000cc Storm replacement cylinder castings that are now capable of making similar power on race gas, but are high-buck and not legal for most classes. Because of the heavy demand for the labor intensive but highly effective modification, the Crankshop is duplicating the welded transfer Storm cylinders with a new cylinder casting of their own that they and HTG will be offering soon.

To attempt to analyze just the transfer port modification, Joe DiSpirito has taken stock, unported 1995 800 Storm cylinders, and modified the main transfers only in the Crank Shop/HTG style. We will test a stock engine, then change cylinders to see what happens on the dyno.

Is it possible that the rear-swept main transfers is what has hindered the maximum performance of this engine all along? If so, will the new 1996 nickasil production cylinders have the CS/HTG style main transfers?

The effects of transfer port angles on performance were addressed by Kevin Cameron in TCD "Colliding Streams" in Vol. 5 #1 & #2.

BOSWELL/ MIKUNI/ LECTRON CARB ANALYSIS

Joe DiSpirito's second assignment (after the Storm transfer project) is to bring along his single cylinder Fuji 217cc piston port dyno mule engine that he carved out of a 650 triple. We intend to run 38mm Mikuni flatslide TMX and roundslide carbs, both standard and "Boswell-ized" and 38mm Lectron carbs. This will require almost a visual interpretation of the fuel as it enters the air stream, using a strobe light to freeze the action.

With all of the dyno testing we've done, I have to generalize that all identically sized slide carbs make the same HP at Wide Open Throttle, on an engine at normal operating temperature, with fresh pump or racing gasoline. This is an ideal condition, where high velocity air entering the heated engine easily vaporizes gasoline into a nice, burnable, homogenized vapor. Whether or not the engine would be more or less detonation prone with any one carb is difficult to say. When Yamaha engineer Greg Marier was here last winter dyno testing the Gyt Kit pipe, he taught me about what is called a "fish-hook" curve, where fuel flow or A/F ratio is represented by the X axis and HP is represented by the Y axis.

If maximum power is made at, say, 13-1, it is possible that well vaporized fuel at 17-1 would run fine, albeit lower on power, with one carb but result in even lower power or detonation in another carb if vaporization is not as complete.

What about running on the rich side of the "fish-hook"? I suspect that, where well vaporized fuel rich-misfires at around 10-1 and lean-misfires at 20-1, poorly vaporized fuel can misfire on the dyno at a 12-1 reading.

Is that a rich or lean misfire? Does the misfire come from the large unvaporized droplets of gas and oil hitting the plug? Or, is the actual vaporized portion of fuel equal to 21-1? I must ask Kevin Cameron about that one.

With Joe's single cylinder engine and our remote vacuum/ pressure pump and magnahelic gauge controlling float bowl pressure and fuel flow, it will be practical to create a "fish-hook" graph of each carb at several throttle openings. The dyno computer will easily create the graph, which may show some fish-hooks wider or broader, possibly even higher than others. A carb with a broad fishook curve may not necessarily make more peak power than one with a narrow curve, but will be easier to tune for crisp, max performance.

The most common of all snowmobile carbs, a Mikuni VM round slide, when perfectly calibrated, is hard to improve upon. But who amongst us, in the field, can achieve 13.0-1 from the slide cutaway to the mains? My pal Long Islander Frank Mungo is a fanatic about that, often spending hours tuning on our dyno at all throttle positions, delightfully achieving perfection with his roundslide Mikunis. Frank's touring mileage with his big trail mod engines is invariably better than that of the stockers he rides with. When roundslides are that closely dialed in, it's hard to imagine anything being better.

And, the bigger (more oversized) the carbs are for an engine, the trickier the tuning becomes.

Prior to our upcoming fish-hook analysis, here are some generalizations about these carbs that I can offer from many dyno test sessions we've done:

LECTRONS

The snowmobile version of the Lectrons is called Megatron Snow-Carbs. these are flatslide carbs that have precision-ground D-shaped needles (with the flat toward the intake port) that do the tuning normally done by the pilot, needle, needle jet, and main jet. There is also a power jet for fine tuning at WOT. The Megatrons have the most amazing cold engine throttle response; a brief touch of the electric starter button on the dyno fires up a fresh cold engine with no choke, and it immediately idles happily. A Megatron carbed cold engine responds better to throttle on the dyno than one with Mikunis. We can make more power with cold engines- ice cold, in fact. Cold seizures? Not if the fuel is vaporizing.

Many dragracers are going to the Megatrons for that cold performance advantage. Did you ever see a dragracer "cleaning out" his engine on a jackstand prior to a race? This is mainly putting heat into the engine so that the fuel will vaporize. Don't believe it? Start a cold Mikuni carbed engine, and just drive around very slowly until the water temp is 100 degrees F or so. Then, stab the throttle and it will run burble free. "Cleaning out" is a hard habit for dragracers to break, but I believe that the Lectrons are able to run crisply and cleanly off the line with an colder, hence more powerful engine.

Modified piston port 750 H2 Kawasaki motorcycles that we dyno tuned with old-style 38 Lectrons suffered from power reducing lean midrange WOT then suffered again at high RPM WOT where the carbs would go too rich. Lean the needles, top end power would go up, and midrange would lean out more and power would drop or deto. There was no way of making the A/F curve correct for differing velocities on these engines.

New Megatron 38's appear to have a fuel delivery curve close to ideal for the piston port engines we've tested them on; we installed Lectron 38's on our XCR600 tested in this issue, and they provided a flat 12-1 A/F ratio from 6500 to 9000 WOT, and made very similar HP, albeit with slightly reduced airflow, compared to the standard 38mm Mikunis. The 38 Megatrons, however, may be a bit lean in the midrange WOT for engines that have less reversion or "multiple carburetion" at low RPM.

The new 44 Lectrons (Megatrons) appear to have similar midrange WOT leanness on reed engines. D&D Cycles dyno tested 44 Lectrons on a big Cat engine, but they were too lean in the midrange WOT to run properly on the dyno. When they richened the needles enough to run well there, the top end was too rich. I don't believe they've tried them in the field, but they are still competitive with the trusty 39.2mm straight-bored Mikuni roundslides on their 1000 T-Cats.

Tim Bender dialed in Bender Racing's new 800 pro stock engine with four 44 Lectrons on the dyno, and ran into lean midrange detonation with top end fuel flow that was too safe. The fuel curve was corrected, much by accident, by changing the spacing between the reed cages and carbs (!). Like so many other cases, their engine picked up no power on the dyno, but accelerates well at the strip. Pat Pierce campaign's Bender's Pro Stock V-Max 500. He switched from Mikunis to Lectrons and improved his ETs.

Most of the HTG Racing engines are now 44 Megatron carbureted, except for those where class rules prohibit changing carb bodies. The Storm, Cat, and Rotax case reed mod engines sometimes appear lean and surgey on the dyno in the midrange, depending on what reeds are in the engine. Stiff reeds that snap shut instantly allow almost zero fuel-enrichening, multiple carburetion at low RPM. Loose, high flowing reeds often result in substantial reversion on the down-stroke at low RPM, looking more like wildly modified piston-port engines on the dyno because of the cloud of partially vaporized fuel that fogs the air in front of the carbs at WOT, low RPM.

Rob Schooping says that they now can add midrange WOT fuel to tight-reed engines without affecting top end fuel. This requires a new modification to the power jet, which supposedly makes it deliver less fuel as velocity increases. Dragracer Rick Murray, who was troubled on our dyno by the Megatrons' midrange leanness with his Rotax 700 Pro Stocker, reported great improvement in the field with this new modification. We haven't seen this new modification done on the dyno, however.

As Megatron-carbed drag sleds continue to do well at the track, more and more racers are beginning to use them.

Some mountain riders are also reporting good results with the Lectrons. If, as we surmise, the Megatrons have a wider "fish-hook" curve, they also can accommodate greater altitude changes without rich burble or lean misfire. This theory is supported by one mountain rider, who purchased a set of Megatrons from Olav Aaen that had previously been dialed in on a big-bore T-Cat in Wisconsin. With the same Lectrons installed on a similar T-Cat, the carbs only needed a slight needle drop to perform cleanly at 10,000 ft in spring conditions.

BOSWELL

I'm not sure about what changes they make to Mikuni carbs to improve vaporization, but they appear to do something. Mikuni TMS flatslides have similar Boswell-like fuel control circuits in the carbs. No horsepower improvement is measurable on the dyno. Calden Engineering in Jay, Maine has also dyno tested several sets of Boswell modded Mikunis with zero power increase. One of his customers was even promised "10-15 more HP", and of course was disappointed. The highly polished carb mouths are a bit hokey, and I don't "get" the optional "super-cycler" deal on the carb spigots, which also don't appear to affect HP. Calden Engineering reported that the super-cycler option actually reduced airflow measurably on their SuperFlow flowbench, but didn't lower HP.

Boswell modified carbs are tricky to tune for those used to conventional Mikunis; new air correction jets, pilot jets that control top end fuel flow, and main jets whose size numbers are no longer directly proportional to fuel flow make an instrumented dyno session quite helpful, and possibly even mandatory to establish a baseline.

Veteran Yamaha dragracers Pat Hauck and Craig Sessions both have had dismal results trying to dial in their Boswell modified Mikuni V-Max 600 & 800 flatslides in the field. Their Boswell carbs are currently on the bench. It's possible that we could straighten them out on the dyno, though.

Some improved stock dragracers have been trying Boswell modified Mikuni VMs, especially where stock carb bodies must be utilized. Quicker ET's with Boswell carbs are sometimes reported, but not always. Rob Schooping at HTG runs Boswell VM38s on his 800 Improved stock Storm, and he likes them. Rob and others, however, report that the Boswell modded carbs are more finicky than are stock Mikunis, requiring recalibration more often for changing air density.

Is it possible that they have a narrow fish-hook curve? We'll have to wait for Joe DiSpirito to find out for sure.

SPARKPLUG PERFORMANCE

Forget any magical performance bonus from changing sparkplug brand/ style/ index. Once, I watched from a distance as someone wrote down the names of the different brands of plugs I was running in each of the four cylinders of my old V-Max 4 that I'd left unattended on the lake with the hood up. As I recall, on that particular day there was a Champion, two NGKs and one rusty Autolite. Secret plug stagger? The tool tray at the dyno is littered with different styles and brands of plugs, and we often don't even look at what we've grabbed after a piston dome examination. It doesn't matter much what plug brand you run, as long as it's the correct heat range and makes a spark.

Ed Sedlemeier succumbed to the lure of the magazine ads, and couldn't resist buying a set of Split-Fire sparkplugs to try in his SkiDoo 500 engine. "Ten more horsepower merely by taking a full page ad in this magazine". As we've done too many times on other stock and mod engines, we installed the SplitFire plugs and saw no change in HP or fuel consumption. It's fortunate for Ed that he didn't spring for the new "split-wire" plug wires being hawked by the now-wealthy spark-plug vendors.

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We've also tried AC NASCAR spark plugs that have four heavy ground straps machined into the body of the plugs which are designed to trap the ceramic insulator should it crack from detonation. These $40 race plugs make the same power as $1 Champions or Autolites, but prevent engine damage that can result from broken insulators falling into the engine.

INDEXING To generalize we can say that sometimes, just sometimes, a one percent or less gain in power can be achieved from facing the opening of the ground electrode toward the exhaust port compared to having the opening toward the intake port.

GASOLINE WOES
Remember the Dateline NBC expose on octane cheating by gasoline wholesalers/retailers? Recently, we encountered severe pinging in our turbocharged Buell motorcycle after purchasing 93 octane gasoline from a gas station in town. The detonation disappeared as soon as we added three gallons of unleaded high test gas from a different vendor. It is fortunate that detonation is audible on our air cooled motorcycles, and we can ease off the throttle before damage occurs. How about a knock sensor for our liquid cooled sleds?

I also had an experience with oxygenated gasoline at Hempstead Harley Davidson on Long Island, NY. They had installed a turbo system on a new Road King, and it was low on power on the dyno (78 at the rear wheel instead of the usual 95-100 at 14 psi of boost). It wasn't pinging, it was just a little logey. Jetting the single Mikuni carb up from the standard 165 mains to 172.5 added 20 HP and it was back to normal.

I came home with four gallons of Long Island oxygenated Sunoco 94 octane gas to test with on the Superflow dyno. When we do our carb test on Joe DiSpirito's single cylinder 217 Polaris engine, we may attempt to analyze the effects of the oxygenated fuel on jetting and power.

WELD SLAG INSIDE TUNED PIPES
Mark Johnson of Gibbon, MN wrote to inquire about the effects of weld-slag inside pipes. We have seen differences in some pipes' internal finish, and it appears to us that the smoother the internal finish, the better. Rough goobers of oxidized weld metal may upset the sound waves as thay travel through the pipes, perhaps diminishing the intensity of the waves.

Some of the finest hand welded pipes we've seen are built by a French Canadian fellow named Gonyea who has done a lot of work for the Bombardier race shop. The inside finish of his pipes is even nicer than the outside, with each inside weld joint sanded smoothly.

Rob Schooping at HTG has concluded that, after dyno testing literally dozens of sets of otherwise identical 650 mod Polaris welded cone section race pipes that he's built, smoother is better.

Bender Racing's stamped pro-stock V-Max 800 pipes are made by a company in Detroit that stamps them in a three-dimensional manner so that they don't have to be cut and turned and rewelded to fit the chassis. It is possible that the minimal welding necessary to build these pipes contributes to the high power that the 800 race engines generate.

Decker Racing Enterprises stamped trail pipes have unbelievably beautiful inside gas welds connecting the seams of the stampings. Not sanded smooth (the welds are usually inaccessable on stamped pipes), just an amazing tig-weld like finish where you'd least expect it. It's as though the pipes are purged with argon gas as they're welded to eliminate the possibility of oxygen reaching the weld puddle from the inside. Has that been Decker's secret to obtaining the highest possible power from their triple pipes?

Blown pipes manufactured by Power, Inc. are laser welded on the outside seams prior to hydraulic inflation. These don't contain any weld slag at all, except where they may have to be cut and turned for chassis fit. Many engine builders use the blown pipes for short run manufacturing, and the absence of weld slag or roughness is likely a benefit.

For an experiment, it would be interesting to compare a tuned pipe with a smooth inside finish with an identical one loaded with weld oxidation and stalagtites. There's another project for Joe's single cylinder dyno engine. We have so much to do, and we keep thinking of more.

WE TRIED!
Don Emery, of DNE Performance in Orillia, Ontario, Canada, came to the dyno with a stock MachZ engine, a bunch of reeds and reed cages, many sets of aftermarket pipes, etc. But, as we completed our day-long test session it became apparent that we were losing power from run to run, and we could not repeat the first test of the day. It turned out that a piston had broken during testing, and was becoming increasingly worse as the testing went on. so, all of the dyno sheets we compiled during the day could only be used as spare paper in the head.

Whenever we do any one-step-at-a-time component comparison testing it is imperitive that we can repeat the first test of the day within 1/2% or less!

Don has promised a return trip to the dyno, with a fresh engine and even more sets of pipes.

NEXT ISSUE

I promise, cross my heart, ZR700 Pipe Shootout, 1996 SkiDoo Formula ZX, new twin pipes (including the GytKit) for the V-Max600, 1996 Storm, Larry's re-piped ZRT600 and more. ●

OXYGENATED FUELS

The Cellar Dweller Kevin Cameron

There is great debate about the value or harm of the so-called oxyfuels currently being added to gasoline. These include MTBE (Methyl Tertiary Butyl Ether), TAME (Tertiary Amyl Ethyl Ether), and ethyl and methyl alcohol.

We are told that use of these compounds will, in critical areas of the country, reduce emissions of carbon monoxide, a poisonous product of incomplete combustion. With considerable arm-waving, we have been told that, in some mysterious way, oxyfuels will "make combustion more complete". We, who are not chemical engineers, are being told by the administrators and their chemists, "Trust me".

Weigh against that the large volume of complaint, coming from the areas of MTBE use, about such things as poor throttle response, longer warm-up times, and in the case of some small engines, outright lean operation and seizure. Are the complaints just the usual panic reaction of those who seek to blame their problems on anything new? Or is there substance here?

Oxyfuels are being added to gasoline based on the well-worn concept of doing the greatest good for the greatest number, and never mind what happens at the edges. The intention of oxyfuel use is to lean out the operation of high-polluting older cars and light trucks, thereby cutting their considerable emissions of CO and unburned hydrocarbons. Such high emissions occur because fuel metering parts wear, leading to richer mixtures (the worn needle jet effect). What happens at the edges is that small, high performance engines, jetted to run on gasoline, naturally run lean on MTBE laced fuel. The result is, variously, hard starting, poor warm-up, poor throttle response, and in some cases, detonation and seizure.

The oxyfuel used is mainly MTBE (Methyl Tertiary Butyl Ether) so let's call it that from here on. MTBE is what gives doctored gasolines their sharp, unfamiliar new smell. Fuel blenders are using MTBE instead of the previously-used alcohols because alcohols absorb water from any source (from the air, from the bottom of storage tanks, etc.), leading to problems with separation and corrosion. Although more expensive, MTBE has no such problems, and so is preferred.

How does adding MTBE lean out fuel/air mixtures? It does it by being already partly burned (the fancy term is "oxygenated"). When normal gasoline hydrocarbons burn in a chemically correct mixture with the oxygen in the air, the result is full "oxygenation" (that is, burning). Every pair of hydrogen atoms gets joined to a single oxygen atom to form water, and every carbon atom gets joined to a pair of oxygen atoms to form carbon dioxide. The water and carbon dioxide that result from "complete oxygenation" are no longer fuels because their ability to burn is completely used up by combination with oxygen. Oxyfuels are simply fuels that are "slightly burned", containing an oxygen atom or so in their molecules. The presence of this oxygen somewhat reduces the number of hydrogen and carbon atoms freely available in the fuel to combine with the oxygen of the air. The result is less fuel in relation to air--a leaner mixture. The chemically correct mixture for normal gasoline and air is about 14.5 parts air to one part fuel. For 100% MTBE it is 11.7 parts air to one part fuel. For the typical 85% gasoline hydrocarbons, 15% MTBE mixtures, the lean-out effect is small but real.

BUT I THOUGHT...

Don't confuse this situation with that of power-boosting oxygenated fuels such as nitromethane, or nitropropane, or nitrobenzene. Fuels containing a nitro group are actually explosives, and can react even without air. In them, the fuel and the oxidizer are contained in the same molecule just as they are in MTBE, but they are held out of reach of each other by inert nitrogen atoms. When heated, this arrangement breaks down, allowing the oxygen and the fuel (carbon and hydrogen) to fall violently into each other's arms--an explosion. In MTBE, the oxygen is not out of reach of the fuel atoms--it is bonded to them just as it is in water or carbon dioxide. Nitromethane is an explosive. MTBE is a partially burned fuel.

When government sponsored research revealed that a poorly maintained older car could emit as much nasty stuff as 300 late-model cars, there was pressure to force these old cars out of service. Moses did not carry a plaque down out of the mountains with the inscribed words, "Thou shalt Be Rich", so the move to eliminate older cars can be seen as discrimination against low-income (and I might add, middle-income) drivers. Oxyfuels, it was hoped, would be less controversial.

I drive one of those older, high-emitting cars, and on MTBE laced fuel, it now starts poorly and warms up slowly, with plenty of throttle refusing and bucking. I'm sorry about the unburned hydrocarbons, but I am even sorrier about the price of an equivalent new car, which equals what I paid for my house.

Official commentators claim that use of MTBE reduces emissions of CO even from computer fuel-injected cars whose mixtures are automatically adjusted to ensure chemically-correct combustion. How can this be? There is no mysterious chemical secret here. It happens during warm-up or rapid acceleration, when the closed-loop system that, in steady warmed-up operation measures exhaust oxygen content and then corrects the fuel mixture, is shut off. It is shut off because the mixture has to be rich during warm-up, when there is not enough heat in the engine's intake path to fully evaporate the fuel. During warm up the engine operates on the open-loop system that makes assumptions about the "fuel content" of the fuel. The open-loop warm-up fuel control doesn't know there is MTBE in the fuel and so this phase of operation is leaned-out just as it is in a carburetor equipped car, resulting in a measurable decrease in the CO emitted during warm-up. And a measurable increase in warm-up time, throttle fussiness, stumble, and so on. Even for computer cars.

Exactly how much decrease in CO and unburned hydrocarbon emissions is found in computer-controlled autos run on oxyfuels is a function of the procedure used in the measurement of emissions during warm-up. You choose your procedure depending on just what you'd like your data to prove. Politics always finds a way in!

No automobile uses a closed-loop system, so all are leaned out by MTBE in pump gasolines. They are leaned out during starting, warm-up, and normal hot operation. Therefore they experience the full range of potential problems.

The simplest one to fix is steady-state mixture; just increase main jet size slightly, to obtain best power and whatever margin of safety you prefer. This will eliminate the steady-state lean-mixture problem that has resulted in engine's seizing during long blasts of full throttle, when run on the new gasolines.

The more complicated part of the current fuel problem is caused by a second, emissions motivated desire to alter pump fuel properties; vapor pressure. As fuel sits in a container at a given temperature, statistical thermodynamics tells us that a few molecules will chance to have energy enough to overcome the surface attraction of the liquid fuel. They burst through the surface barrier, up into the air above the fuel, forming a vapor. Vapor pressure simply measures the strength of this effect. Aircraft fuels, for example, must have rather low vapor pressures because at high altitudes, significant gallonage can evaporate during flight, resulting in shortened range or stopped engines. Automotive fuels for winter use require higher vapor pressure because this improves vaporization during cold-starting.

The EPA knows there are zillions of autos out there, each with gas in its tank, generating vapor. Most cars carry charcoal canisters to absorb evolved fuel fuel vapor from the tank. This fuel is burned during operation by bleeding vacuum from the carburetor to the canister to carry away the absorbed fuel. But nothing we humans do ever works 100%, so vapor does escape despite these devices. Therefore we should be able to reduce this significant source of unburned hydrocarbons by reducing fuel volatility.

Unfortunately, running on reduced volatility fuel is something like trying to start your engine without the choke. If you prime the daylights out of it, it will fire, and you may then be able to keep it running by holding the RPM up at ridiculous levels, and by jazzing the throttle like a teenager. Many people have, therefore, encountered poor starting and deteriorated throttle response using fuels whose volatility has been readjusted to cut evaporation loss. This is not the fault of MTBE use, just an associated change. If you have poor throttle response, it is because the mixture leans out so much during rapid throttle opening that the engine cannot ignite and burn that mixture. So you jet richer to compensate, and the throttle reponse improves. But now the engine is richer everywhere and therefore gives less power. What to do? A little enrichment on the needle may help throttle response. An increase in engine temperature may help, too; snowmobilers often seek higher power through reduced coolant temperature or measures such as running cold in drag racing, or packing snow around the crankcase. But use of today's lower volatility pump fuels may require putting some heat back in the engine, to evaporate this sluggish fuel and restore the rapid throttle response we want. As an extreme, some may wish to experiment with Mikuni's optional accelerator pump kits, which enrich the mixture only when needed--during rapid throttle opening. And beyond that, there is always race gas--expensive but delightful.

A fix for cold starting is to enrich the starter jet, or downsize the starting system's air port, located in the side of the choke piston housing. Heated fuel bowls have already appeared on some snowmobiles, reminiscent of what Honda did on its Formula One turbo racecars. Faced with the need to use toluene as a fuel, (low volatility, but high anti-knock value), Honda used a fuel heater. The hotter the fuel, the more easily it evaporated to form an ignitable mixture.

WHY IS THERE MTBE IN SOME RACE FUELS?

Gasoline with MTBE is still a fuel, it's just that you have to use more of it. For example, oxyfuels are commonly added to some racing gasolines as a means of boosting power. You can smell MTBE in use at Daytona (four-stroke) and GPs (two-stroke). Why?

The answer is that the partial inertness of MTBE can be used as an advantage. Fuel--including the MTBE in it--requires heat to evaporate as it is carried into an engine by the intake airflow. This heat of evaporation is supplied by the intake air, which cools in the process. This cooling shrinks the air, enabling more of it to fit into the engine. It is partly to get more of this cooling that we run race engines nearer a 12:1 air/fuel ratio, rather than on the 14.5:1 chemically correct ratio. The extra fuel helps cool the charge, making a bit more of it fit in the engine.

By partially "inerting" the fuel with a little oxygen, more fuel must then be used to react a given mass of air, and this greater amount of fuel takes even more heat to evaporate. Therefore the air charge is cooled even more, more air is taken into the engine and power rises slightly.

This charge cooling process works best of all with alcohol, which contains only 9000 BTU of combustion heat release per pound as compared with 18-19,000 BTU/lb for gasoline. Alcohol has a high heat of evaporation, so combining this with the much larger amount of it that must be used to obtain a correct mixture, there is a huge amount of charge cooling. The power boost you get with alcohol arises from this fact alone.

The other oxyfuels produce this same effect, but in lesser degree--and only when all carburetor systems have been re-jetted appropriately to compensate for the reduced energy content of the fuel.

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