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DYNOTECH

THE SNOWMOBILE PERFORMANCE PUBLICATION

1993 POLARIS INDY XLT PROTOTYPE

Weight of preproduction unit with three gallons of gas: 521 lbs.
Sled owner: Gail Barber of Bliss Garage Polaris, Bliss, N.Y.

When we tested the XLT this winter, it was well broken in with 400 lake and trail miles. Just prior to this session, Gail had run 1/2 mile on bare ice, 100 MPH on radar at zero degrees F, with 200 main jets.

For those of you who haven't seen or read about the XLT powerplant, the **X**tra **L**ight **T**riple engine is completely new. Bore and stroke measurements are 64 mm and 60 mm, respectively.

Previous Indy triples have utilized individual cast cylinders and heads. The new Fuji-built 583 has a lighter weight, one pièce cast aluminum cylinder block assembly. The head assembly is comprised of a long, single aluminum diecasting which supports and directs coolant around three individual combustion chambers. Neoprene O-rings provide sealing.

Piston port induction is used with Mikuni 34mm roundslide carburetors.

The cold air induction system incorporates the traditional foam lined airbox, with a new perforated shelf baffle inside. During our dyno session, we tried removing the foam and baffle from the airbox, and found no increase in airflow or horsepower.

The exhaust system includes a three-into-one header pipe manifold, with a single expansion chamber and silencer. While the exhaust note seems milder than that of the 650's, it retains that unmistakeable three-cylinder Indy sound. The XLT's stock pipe provides a flat, easy to clutch power curve (varying only two horsepower from 7750 RPM to 8500 RPM).

We tested the engine with 200, 190, and 180 main jets and found that 190's were ideal for the 40 degree F dyno room carburetor air temperature (CAT). 92 octane pump gas was used during the test.

1993 INDY 583 PROTOTYPE 190MJ
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .748
Vapor Pressure: .14
Barometer: 30.13

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6250	54.0	64.3	53.3	134.1	11.6	.81	41
6500	55.9	69.2	52.8	137.9	12.0	.74	41
6750	59.1	76.0	51.3	145.4	13.0	.66	41
7000	60.6	80.8	50.1	152.0	13.9	.61	41
7250	60.2	83.1	53.6	155.3	13.3	.63	41
7500	61.2	87.4	56.8	157.0	12.7	.63	41
7750	61.4	90.6	59.1	156.7	12.2	.64	40
8000	60.9	92.8	60.2	156.6	11.9	.63	41
8250	59.0	92.7	60.7	155.1	11.7	.64	41
8500	56.4	91.3	60.5	155.4	11.8	.65	41
8750	53.4	89.0	60.0	154.0	11.8	.66	41
9000	50.3	86.2	58.1	153.9	12.2	.66	41

PIPE SHOOTOUT # 22

1991 EXCITER II UPDATE

Present during test: Jim Czekala, Dave Curran (owner of the sled and race director of the annual N.Y.S. Grass Drag Championships), Ron Pearl, Maynard Troyer, Tom Petit, John Cowie, John Peca.

This is an update of the two previous stock Exciter and Exciter II pipe shootouts. Since then, we have seen several new single pipes come on the market. Bewildered Exciter pipe shoppers have flooded our Friday tech line looking for the "best" pipe.

The Bender Racing single pipe is new to their product line this year. This new pipe has high midrange and peak torqe and horsepower, but like som of the other pipes, it drops off quite rapidly ebyond thee power peak. This type of power cuurve requires more clutching diligence than the stock pipe.

Last year, DG created controversy by reportedly unabashedly copying the PSI Phazer and Exciter single pipes (right down to the hidden angled steel bracket supporting the internal stinger). This year, the DG Exciter pipe is shaped differently. The rear cone is sealed off at the end, and the pipe outlet is on the side of the center section, with a separate cannister silencer running parallel to the center section. Our DG pipe had the optional chrome plating.

PSI has added about an inch to the center section of their old single pipe. This adds some midrange torque, but sacrifices some horsepower in the process.

The new Decker single pipe appears the same as before, with less torque and better top end horsepower than most of the other pipes. Only the new Bender pipe makes more horsepower. Decker also has the nicest looking high temperature paint of the lot, with their unique semi-gloss finish that seems to take the heat of the dyno with ease.

The new Reichard pipe looks like the DG pipe, with the separate parallel cannister silencer, but the stinger outlet is in the usual position. Prior to our test session, I spoke to Reichard's Jeff Simon, who worked on the design of their new Exciter pipe at Midwest Dyno Service. He told me to expect more horsepower than we actually got on the dyno with the pipe that we bought. I suspect that the design that they came up with at Midwest Dyno is not quite like the production pipe that we received. We'll be doing a trail ported Exciter II shortly, and perhaps Reichard (or anyone else, for that matter) will send us a different pipe to try then.

The Aaen pipe is also unchanged for this year. It remains low on horsepower and flows just a bit more air than the other pipes. The higher airflow readings generally result from lower backpressure (ie: larger exhaust outlet inner diameter) than the other pipes, including the stock pipe.

Because this Exciter II had the stock oil injection, we did all of the dyno testing with the oil pump locked wide open, assuring equally "rich" oiling during each of our tests. 94 octane unleaded gas was used. Although leaner than recommended by the manufacturer, 280 main jets gave us a pump gas trail safe A/F ratio and BSFC in the mid thirties F dyno air temperature (CAT).

1990 YAMAHA EXCITER II
STOCK PIPE BASELINE 280 MJ

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .20 Barometer: 29.58

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5500	48.8	51.1	34.2	123.3	16.6	.67	38
5750	50.8	55.6	43.1	130.8	13.9	.77	35
6000	55.8	63.7	50.3	139.8	12.8	.78	37
6250	58.4	69.5	53.5	146.7	12.6	.77	38
6500	60.8	75.2	54.3	155.8	13.2	.72	38
6750	61.4	78.9	55.2	161.7	13.5	.70	37
7000	61.2	81.6	55.6	166.6	13.8	.68	38
7250	60.8	83.9	58.0	164.6	13.0	.69	38
7500	58.0	82.8	57.4	157.5	12.6	.69	39
7750	53.6	79.1	57.5	151.7	12.1	.73	39
8000	46.6	71.0	57.7	144.5	11.5	.81	39
8250	38.9	61.1	57.3	141.7	11.4	.93	40

YAMAHA EXCITER II
280 MJ--1992 AAEN PIPE 88dB
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .20
Barometer: 29.60

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5500	51.3	53.7	41.9	131.0	14.4	.78	37
5750	53.1	58.1	46.9	136.7	13.4	.80	38
6000	57.0	65.1	53.3	145.4	12.5	.81	38
6250	60.2	71.6	55.1	154.8	12.9	.77	38
6500	63.0	78.0	56.0	163.2	13.4	.72	39
6750	63.6	81.7	56.4	169.9	13.8	.69	38
7000	62.7	83.6	56.9	173.7	14.0	.68	38
7250	61.8	85.3	60.3	173.2	13.2	.70	38
7500	58.8	84.0	60.4	168.3	12.8	.72	38
7750	49.3	72.7	60.7	159.2	12.0	.83	39
8000	36.1	55.0	59.5	147.3	11.4	1.08	40

YAMAHA EXCITER II
280 MJ--1992 BENDER PIPE 88dB
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .20
Barometer: 29.60

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5500	55.6	58.2	43.2	129.7	13.8	.74	37
5750	56.8	62.2	48.0	134.7	12.9	.77	36
6000	59.2	67.6	48.4	142.2	13.5	.71	37
6250	62.1	73.9	53.1	150.1	13.0	.71	37
6500	62.9	77.8	53.2	156.2	13.5	.68	37
6750	63.8	82.0	54.6	164.3	13.8	.66	37
7000	64.9	86.5	55.2	168.7	14.0	.64	38
7250	64.7	89.3	56.8	168.2	13.6	.63	38
7500	62.7	89.5	59.4	163.8	12.7	.66	38
7750	47.8	70.5	58.0	148.9	11.8	.82	38
8000	36.9	56.2	57.4	143.4	11.5	1.02	38

YAMAHA EXCITER II
280 MJ--DECKER PIPE 90dB
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .20
Barometer: 29.59

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5500	49.2	51.5	37.2	118.9	14.7	.72	40
5750	51.6	56.5	43.5	124.6	13.2	.77	40
6000	54.0	61.7	48.1	131.4	12.5	.78	40
6250	55.2	65.7	50.3	136.8	12.5	.76	39
6500	57.2	70.8	50.2	144.8	13.2	.71	39
6750	58.7	75.4	50.9	151.7	13.7	.67	40
7000	61.2	81.6	52.5	159.0	13.9	.64	40
7250	61.7	85.2	54.8	159.9	13.4	.64	40
7500	61.8	88.3	56.7	157.1	12.7	.64	39
7750	58.5	86.3	58.8	151.9	11.9	.68	39
8000	55.7	84.8	60.4	149.0	11.3	.71	39
8250	44.7	70.2	58.9	143.5	11.1	.84	39

YAMAHA EXCITER II
280 MJ--1991 DG PIPE 88dB
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .20
Barometer: 29.60

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5500	50.8	53.2	41.1	127.5	14.2	.77	36
5750	54.4	59.6	48.6	135.4	12.8	.81	37
6000	57.2	65.3	53.0	143.6	12.4	.81	36
6250	58.6	69.7	54.3	149.3	12.6	.77	37
6500	61.3	75.9	55.7	158.2	13.0	.73	36
6750	61.7	79.3	56.1	164.3	13.4	.70	37
7000	61.1	81.4	57.1	168.5	13.5	.70	37
7250	60.7	83.8	58.7	166.8	13.0	.70	37
7500	60.7	86.7	59.1	162.3	12.6	.68	36
7750	52.6	77.6	59.8	153.8	11.8	.77	36
8000	39.7	60.5	58.8	146.3	11.4	.97	36

YAMAHA EXCITER II
280 MJ--1992 DG PIPE 88dB
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .20
Barometer: 29.58

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5500	51.6	54.0	37.8	117.2	14.2	.69	36
5750	52.5	57.5	41.9	122.2	13.4	.72	36
6000	54.7	62.5	47.4	130.3	12.6	.75	37
6250	56.5	67.2	48.4	137.5	13.0	.72	37
6500	59.1	73.1	51.0	144.3	13.0	.69	37
6750	60.9	78.3	51.3	150.6	13.5	.65	37
7000	62.5	83.3	51.7	156.3	13.9	.62	37
7250	62.4	86.1	53.1	155.4	13.4	.61	36
7500	60.1	85.8	55.4	152.8	12.7	.64	36
7750	54.9	81.0	54.7	145.2	12.2	.67	34
8000	43.2	65.8	54.3	134.6	11.4	.82	35
8250	31.1	48.9	52.8	127.1	11.1	1.07	35

YAMAHA EXCITER II
280 MJ--1990 PSI PIPE 90dB
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .20
Barometer: 29.59

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5500	54.3	56.9	44.9	129.1	13.2	.79	40
5750	56.3	61.6	51.1	134.1	12.1	.83	40
6000	58.4	66.7	52.4	141.1	12.4	.78	40
6250	61.0	72.6	56.5	149.7	12.2	.78	40
6500	63.2	78.2	56.1	157.7	12.9	.72	40
6750	64.0	82.3	56.4	164.8	13.4	.68	40
7000	64.6	86.1	56.3	170.2	13.9	.65	38
7250	64.3	88.8	57.2	168.3	13.5	.64	40
7500	58.7	83.8	59.5	162.2	12.5	.71	39
7750	39.8	58.7	58.2	147.2	11.6	.99	39
8000	33.5	51.0	57.8	141.8	11.3	1.13	39

PIPE SHOOTOUT

CONTINUED

YAMAHA EXCITER II
280 MJ--1992 PSI PIPE 90dB

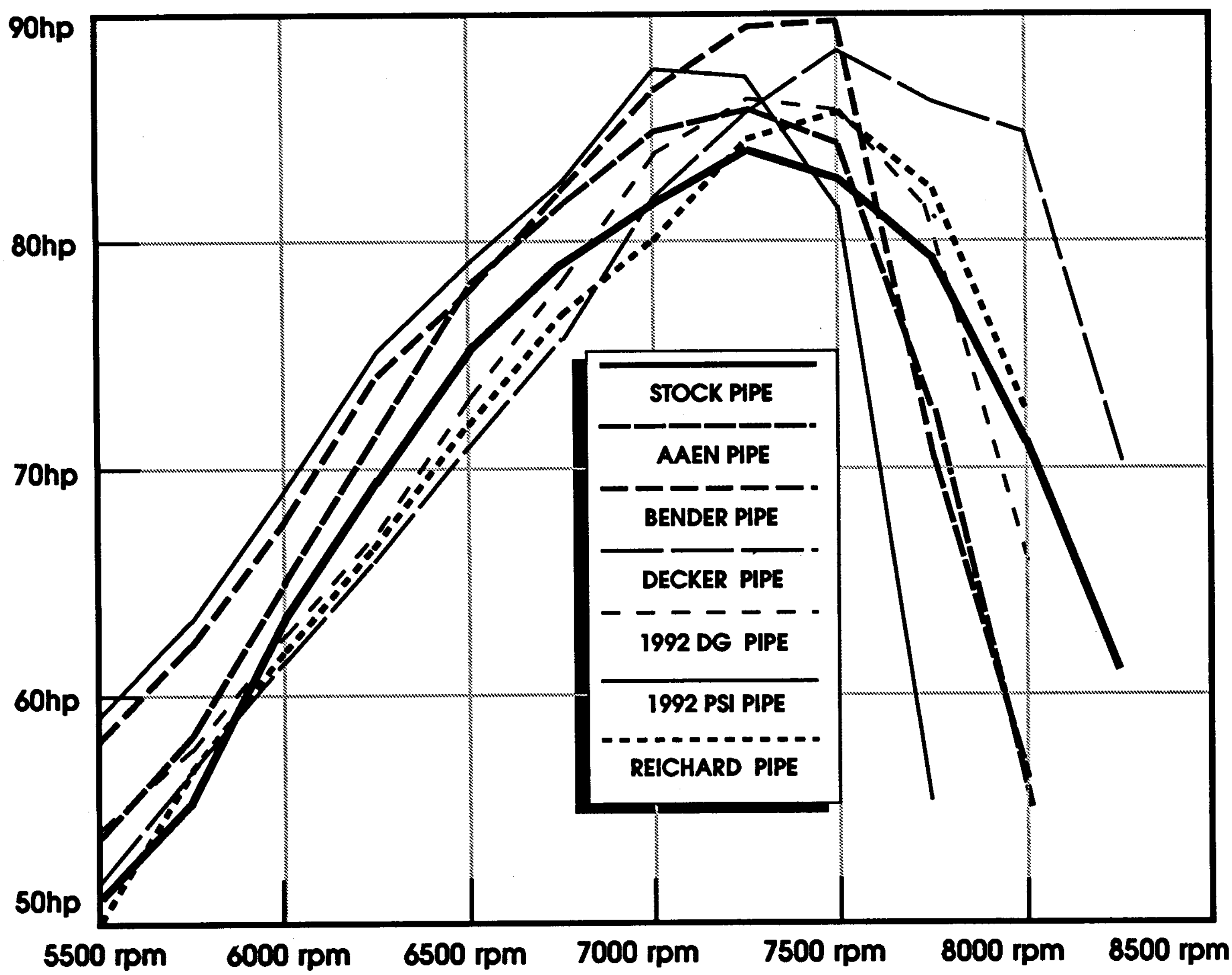
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .20 Barometer: 29.59

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5500	56.0	58.6	44.2	132.7	13.8	.75	37
5750	57.9	63.4	51.3	139.4	12.5	.80	36
6000	60.3	68.9	53.3	145.1	12.5	.77	36
6250	62.8	74.7	56.7	152.7	12.4	.75	36
6500	63.8	79.0	55.2	160.4	13.3	.69	36
6750	64.0	82.3	55.8	166.3	13.7	.67	37
7000	65.6	87.4	57.0	171.7	13.8	.65	37
7250	62.8	86.7	58.4	169.0	13.3	.67	37
7500	56.9	81.3	58.7	161.5	12.6	.72	37
7750	37.4	55.2	57.2	146.8	11.8	1.03	38
8000	31.1	47.4	56.8	138.8	11.2	1.19	37

YAMAHA EXCITER II
280 MJ--REICHARD PIPE 88dB

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .20 Barometer: 29.60

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5750	51.6	56.5	43.3	124.9	13.2	.76	38
6000	54.4	62.1	46.8	132.2	13.0	.75	34
6250	55.9	66.5	49.7	139.0	12.8	.74	36
6500	58.3	72.2	51.0	146.3	13.2	.70	36
6750	59.8	76.9	51.5	153.5	13.7	.67	36
7000	60.0	80.0	50.8	156.9	14.2	.63	35
7250	61.1	84.3	53.4	155.1	13.3	.63	36
7500	60.0	85.7	54.5	150.2	12.7	.63	37
7750	55.9	82.5	54.3	143.2	12.1	.65	36
8000	47.8	72.8	53.2	136.5	11.8	.73	37
8250	30.4	47.8	52.8	125.8	10.9	1.10	37



EXAMINING THE EFFECTS OF UNDERHOOD PRESSURE UPON CARBURETION ON YAMAHA'S V-MAX4

In our last issue, I devoted some space to the placing of the V-Max 4 carburetor float bowl vent hoses.

Based upon the 800 dyno tests we have made on these engines, I felt that there was no way the engine could survive, much less make any horsepower in winter air with the 130 to 133.8 main jets that people were forced to run for decent top end performance.

There is some unseen force causing the fuel flow to change at high vehicle speed; the air pressure differential between the underhood area (where the float bowl vent hoses are) and the area behind the windshield (where the airbox intakes are located).

To accurately measure this phenomenon, I installed a Magnehelic pressure differential gauge on our V-Max 4. The Magnahelic gauge gives us air pressure readings in "inches of water" (one inch of water pressure is the air pressure necessary to lift a column of water one inch). I installed the high pressure probe beneath the hood, and the low pressure probe near the airbox openings. All of the cowl vents were open.

Field testing (my V-Max 4 has the float bowl vent hoses rerouted to the area of the airbox openings) showed a maximum differential of 2 to 2.5 inches of water at 100-110 MPH (actual, not speedometer reading) running into a slight headwind. When running with a tailwind at 105 MPH, the differential was between 1.5 and 1.75 inches of water. Cruising at 40-60 mph, the differential was 0 to 1 inch of water, depending on wind conditions.

With the pressures documented, Maynard Troyer (Troyer is the premier builder of dirt modified and Nascar asphalt modified race car chassis') brought us his stock V-Max 4 to see just what these pressures do on the dyno.

We set up the stock V-Max 4 on the dyno, and connected the four carbs' vent lines in series. We plugged the furthest left hose (PTO), and connected the furthest right hose to our Magnehelic gauge in the dyno control room. Using a delicately regulated pressure source, we were able to apply any desired pressure to the carbs' float bowls. Main jets were left at 133.8, which would prove to be marginally safe at 55 degrees F CAT.

When we first attempted to test our system, the engine was surging, as engines do on our dyno when overly lean, even when pressure was being applied to the float bowls. Examining the vent hoses individually, it was apparent that the furthest right vent hose (the last vent between the carbs and our pressure system) was plugged. We disconnected the right hand carb vent hoses from our pressure system, and allowed it to operate normally (later inspection by Maynard would show that one of the white plastic vent hose elbow fittings was not drilled! If you were unlucky enough to get a carb with two of these defective fittings, it might drive you crazy trying to track the source of the carb's leanness). ***So, our data is with pressure applied to only three carburetors.***

Also, bear in mind that the engine has 133.8 main jets, and our dyno air temperature (CAT) is 55 degrees F. If this were 20 degrees F, the baseline would surely be lean at least to the point of power loss. As it is, this is close to maximum horsepower jetting for this temperature. →

1992 V-MAX 4 BASELINE 133.8MJ
CARBURETOR VENTS OPEN TO ATMOSPHERE
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .20 Barometer: 30.12

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	62.1	70.9	56.3	161.8	13.2	.79	55
6250	62.6	74.5	55.7	163.8	13.6	.74	55
6500	70.8	87.6	60.2	176.8	13.4	.68	55
6750	75.6	97.2	64.1	185.4	13.2	.66	54
7000	80.3	107.0	68.7	195.2	13.0	.64	55
7250	83.7	115.5	71.0	204.4	13.2	.61	55
7500	86.1	123.0	76.6	212.8	12.8	.62	55
7750	88.0	129.9	79.2	220.2	12.8	.61	55
8000	88.1	134.2	80.0	223.0	12.8	.59	56
8250	86.6	136.0	79.5	227.2	13.2	.58	56
8500	82.7	133.8	80.5	230.4	13.2	.60	52
8750	75.9	126.5	81.2	237.8	13.4	.64	54

1" OF WATER PRESSURE APPLIED TO FLOAT BOWLS
1992 V-MAX 4 133.8MJ
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .20
Barometer: 30.13

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	60.8	69.5	57.9	165.0	13.0	.83	55
6250	64.0	76.2	58.5	167.2	13.2	.76	55
6500	68.6	84.9	61.4	175.2	13.2	.72	54
6750	73.1	93.9	64.3	181.4	13.0	.68	56
7000	78.7	104.9	70.1	194.0	12.8	.67	55
7250	82.5	113.9	71.2	202.4	13.0	.62	55
7500	84.8	121.1	74.9	210.8	13.0	.61	55
7750	86.2	127.2	77.9	219.6	13.0	.61	53
8000	86.4	131.6	79.5	223.4	13.0	.60	55
8250	84.8	133.2	82.5	226.4	12.6	.62	55
8500	81.5	131.9	83.3	229.4	12.6	.63	54
8750	74.5	124.1	83.6	233.0	12.8	.67	53

2" OF WATER PRESSURE APPLIED TO FLOAT BOWLS
1992 V-MAX 4 133.8MJ
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .20 Barometer: 30.13

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	59.3	67.7	61.3	155.8	11.6	.90	55
6250	63.5	75.6	64.0	164.8	11.8	.84	56
6500	68.1	84.3	66.3	174.0	12.0	.78	55
6750	73.9	95.0	70.0	184.8	12.2	.73	55
7000	78.6	104.8	73.4	195.0	12.2	.70	54
7250	82.3	113.6	75.9	204.2	12.4	.66	55
7500	84.7	121.0	79.0	213.0	12.4	.65	55
7750	85.2	125.7	82.3	219.2	12.2	.65	55
8000	85.1	129.6	85.5	223.8	12.0	.66	55
8250	82.5	129.6	87.7	226.4	11.8	.67	55
8500	78.0	126.2	88.0	228.4	12.0	.69	55
8750	69.2	115.3	89.6	236.2	12.2	.77	54

2.5" OF WATER PRESSURE APPLIED TO FLOAT BOWLS
1992 V-MAX 4 133.8MJ
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .20 Barometer: 30.12

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	60.6	69.2	55.5	163.2	13.6	.80	55
6250	61.4	73.1	59.6	166.0	12.8	.81	55
6500	65.0	80.4	67.0	176.0	12.0	.83	54
6750	69.5	89.3	70.1	181.8	12.0	.78	54
7000	76.3	101.7	74.6	192.4	11.8	.73	55
7250	80.8	111.5	78.5	203.8	12.0	.70	53
7500	82.3	117.5	82.3	212.8	11.8	.69	53
7750	83.3	122.9	86.2	218.2	11.6	.70	54
8000	83.1	126.6	87.8	223.8	11.8	.69	53
8250	80.6	126.6	89.9	226.6	11.6	.70	53
8500	75.6	122.4	90.6	229.0	11.6	.74	55
8750	65.5	109.1	91.1	232.6	11.8	.83	55

We tried applying 3" of water pressure to the three float bowls, and the engine lost so much power that it wouldn't even pull the dyno. With 3" of water pressure at 6000 RPM, the engine was blubbering on 67 lb/hr of fuel!

At 2.5" of water pressure, the engine lost 10 horsepower. It probably would have lost 13 horsepower had all four carbs been pressurized! This was one reason why the V-Max 4 performance was off the mark with the standard 140 main jets. In winter air, the underhood pressure at 100 MPH allows the 133.8 main jets to deliver a proper amount of fuel. But what about from 10-70 MPH, as the sled accelerates at 8000-8250 RPM? The likely scenario is that, accelerating in still air, the engine probably begins lean to where power is down, then comes into proper tune around 70 MPH, then goes rich beyond 100 MPH. Then, the faster you go, the more horsepower you lose. You'll never burn down that way, but it's tough to go fast as the BSFC rises beyond .70 with a stock engine that will live all day at .60. Run into a headwind, and you will run even richer. A tailwind will lean you out. Is that any way to tune an engine?

Maynard reinstalled his 140 main jets. Then, using extra tubing and T fittings, he interconnected the four carbs' vent hoses and rerouted two long vent hoses up the steering column, terminating beneath the foam padding covering the handlebars.

1990 ARCTIC CAT PROWLER 440

PERFORMANCE IMPROVEMENTS & STOCK AND MODIFIED PIPE SHOOTOUT

Dale Roes of D&D Cycles Arctic Cat in Lowville, N.Y. (315-376-8013), does quite a few Prowler 440 perk-ups for his customers who desire to improve the trail performance of their machines. Compression increases, carb boring and port modifications are done to the machines with quite dramatic results.

Dale's standard "trail porting" specs are similar to the port timing specs of the Prowler Special. We noted that the trail ported Prowler, though ported similarly, makes more horsepower than the stock Prowler Special. Dale feels that the smaller crankcase volume of the standard Prowler engine may be the reason.

And, as we were to find out, the stock Prowler pipe is about as good, or better than any of the aftermarket trail pipes that we were able to purchase.

This was a multi-phase test session that we began last November. We had started that day with the stock engine, intending to step up to the larger carbs, higher compression, and then ported cylinders. But then our dyno failed due to a malfunction in the computer controlled servo valve, and we were forced to resume the test at a later date. This is the reason for the large change in Barometric Pressure and Carb Air Temperature. between Phases.

The aftermarket pipe testing, however, was all completed on the same day.

STOCK 1990 PROWLER 440--STOCK PIPE
4MM CARBS--230MJ--P4NJ
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .728
Vapor Pressure: .26 Barometer: 30.14

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5500	35.9	37.6	29.4	89.2	13.9	.78	51
5750	39.8	43.6	30.7	96.1	14.4	.70	51
6000	42.3	48.3	34.4	99.7	13.3	.71	51
6250	42.8	50.9	35.5	101.5	13.1	.69	50
6500	44.1	54.6	40.4	103.2	11.7	.73	51
6750	44.9	57.7	44.6	106.2	10.9	.77	50
7000	44.3	59.0	45.5	106.4	10.7	.76	50
7250	44.0	60.7	46.7	106.7	10.5	.76	50
7500	43.1	61.5	42.9	108.6	11.6	.69	50
7750	41.9	61.8	40.8	109.7	12.3	.65	50
8000	39.4	60.0	40.9	110.0	12.3	.67	50
8250	36.5	57.3	41.4	110.2	12.2	.71	50

PHASE 1:

We installed a set of carbs that had been bored out to 35.5mm. 250 main jets and P5 needle jets provided similar A/F ratio. The bored carbs gave us a slight airflow and horsepower increase.

1990 ARCTIC CAT PROWLER 440--STOCK PIPE
***35.5MM BORED CARBS*--250 MJ--P5 NJ**
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .728
Vapor Pressure: .26 Barometer: 30.13

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5500	38.0	39.8	33.8	95.4	13.0	.85	54
5750	42.0	46.0	32.7	99.7	14.0	.71	53
6000	42.6	48.7	35.0	101.2	13.3	.72	53
6250	44.0	52.4	41.0	104.9	11.7	.78	52
6500	45.2	55.9	43.6	106.9	11.3	.77	52
6750	45.7	58.7	45.0	108.5	11.1	.76	52
7000	45.4	60.5	43.7	108.3	11.4	.72	52
7250	44.3	61.2	43.8	108.8	11.4	.71	51
7500	43.6	62.3	42.7	109.9	11.8	.68	51
7750	41.9	61.8	43.2	110.8	11.8	.69	51
8000	39.3	59.9	41.5	112.1	12.4	.69	51
8250	36.0	56.5	42.9	111.7	12.0	.75	52

PHASE 2:

A set of heads that had .020" removed from the sealing surfaces were installed. D&D's customers have found these heads produce a pump-gas safe performance improvement. Increased torque and horsepower, and improved mileage result from this modification.

1990 ARCTIC CAT PROWLER 440--STOCK PIPE
***HEAD CUT .020"*--35.5MM CARBS--250 MJ--P5NJ**
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .728
Vapor Pressure: .26 Barometer: 30.13

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5500	38.8	40.6	32.2	94.3	13.4	.78	48
5750	42.5	46.5	31.2	99.0	14.6	.66	49
6000	43.9	50.2	34.8	101.5	13.4	.69	50
6250	44.7	53.2	38.6	103.2	12.3	.72	50
6500	46.3	57.3	41.7	106.9	11.8	.72	49
6750	46.7	60.0	42.8	108.8	11.7	.71	49
7000	46.3	61.7	44.5	109.0	11.2	.71	49
7250	45.1	62.3	44.0	109.9	11.5	.70	49
7500	44.1	63.0	42.6	110.8	11.9	.67	50
7750	42.2	62.3	43.0	111.7	11.9	.68	50
8000	38.7	58.9	42.4	111.8	12.1	.71	50
8250	35.9	56.4	39.8	111.9	12.9	.70	50

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PROWLER 440

1990 ARCTIC CAT PROWLER 440 STOCK PIPE
SECOND DYNO SESSION (COLDER CAT)
BASELINE FOR PIPE SHOOTOUT #23
HEADS CUT .020"--35.5MM CARBS--270MJ--P5NJ
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .728
Vapor Pressure: .10 Barometer: 30.42

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5500	41.1	43.0	35.8	96.7	12.4	.79	29
5750	43.0	47.1	40.1	99.4	11.4	.81	29
6000	43.4	49.6	38.9	103.0	12.2	.75	29
6250	44.4	52.8	41.5	104.6	11.6	.75	29
6500	45.8	56.7	42.1	106.2	11.6	.71	29
6750	46.2	59.4	43.0	107.7	11.5	.69	29
7000	46.1	61.4	43.2	108.7	11.6	.67	29
7250	45.2	62.4	44.4	109.3	11.3	.68	29
7500	44.1	63.0	44.4	110.1	11.4	.67	30
7750	42.3	62.4	46.4	111.0	11.0	.71	30
8000	38.9	59.3	43.5	112.5	11.9	.70	29
8250	35.2	55.3	43.8	112.3	11.8	.75	29
8500	29.1	47.1	44.2	109.3	11.4	.89	30
8750	25.4	42.3	43.0	103.7	11.1	.96	29

PIPE SHOOTOUT #23

STOCK PROWLER 440

We tried the Aaen, DG, and PSI replacement stock pipes as well as several modified stock 1990-91 Prowler pipes on the stock engine. The only one that improved performance was one that had been shortened ONE INCH next to the flange that seals the large pipe to the Y pipe.

1990 ARCTIC CAT PROWLER 440
1991 STOCK PIPE HEADER PIPE SHORTENED 1"
HEADS CUT .020"--35.5MM CARBS--270MJ--P5NJ
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .728
Vapor Pressure: .10 Barometer: 30.42

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	43.2	49.4	38.8	102.9	12.2	.75	32
6250	43.0	51.2	39.5	103.1	12.0	.74	32
6500	44.6	55.2	39.0	104.9	12.4	.67	32
6750	45.0	57.8	40.6	105.7	12.0	.67	33
7000	45.1	60.1	42.7	106.5	11.5	.68	32
7250	45.0	62.1	45.3	107.0	10.8	.70	32
7500	44.6	63.7	45.0	108.1	11.0	.67	32
7750	44.0	64.9	44.4	111.6	11.5	.65	31
8000	42.6	64.9	42.6	114.3	12.3	.63	32
8250	39.9	62.7	44.4	114.9	11.9	.67	32
8500	37.0	59.9	44.1	114.6	11.9	.70	32
8750	29.3	48.8	43.3	111.6	11.8	.84	31

1990 ARCTIC CAT PROWLER
1991 PROWLER SPECIAL PIPE
HEADS CUT .020"--35.5MMCARBS--270MJ--P5NJ
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .728
Vapor Pressure: .10 Barometer: 30.43

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5500	40.4	b2.3	29.9	93.0	14.3	.67	27
5750	42.5	46.5	34.8	97.6	12.9	.71	27
6000	43.0	49.1	37.9	101.7	12.3	.73	27
6250	44.0	52.4	39.0	103.8	12.2	.71	26
6500	45.4	56.2	41.3	105.0	11.7	.70	26
6750	45.7	58.7	43.5	106.3	11.2	.70	26
7000	45.6	60.8	42.8	106.9	11.5	.67	26
7250	44.9	62.0	42.6	107.9	11.6	.65	26
7500	44.5	63.5	43.8	108.8	11.4	.65	26
7750	43.5	64.2	44.5	110.3	11.4	.66	28
8000	41.1	62.6	45.0	112.2	11.4	.68	27
8250	38.2	60.0	43.9	112.3	11.7	.69	26

1990 ARCTIC CAT PROWLER 440
PSI PROWLER PIPE
HEADS CUT .020"--35.5MM CARBS--270MJ--P5NJ
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .728
Vapor Pressure: .10 Barometer: 30.42

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5500	41.0	42.9	32.6	95.0	13.4	.72	26
5750	42.6	46.6	37.8	98.3	11.9	.77	27
6000	42.9	49.0	40.6	100.9	11.4	.79	28
6250	45.4	54.0	41.0	103.4	11.6	.72	27
6500	46.5	57.5	43.3	105.0	11.1	.71	27
6750	46.7	60.0	42.3	106.8	11.6	.67	26
7000	45.7	60.9	43.4	107.7	11.4	.68	26
7250	44.9	62.0	45.8	108.4	10.9	.70	27
7500	44.8	64.0	46.8	109.0	10.7	.69	27
7750	43.6	64.3	44.7	111.2	11.4	.66	26
8000	41.3	62.9	43.8	114.0	12.0	.66	25
8250	38.2	60.0	45.7	115.5	11.6	.72	27

1990 ARCTIC CAT PROWLER 440
AAEN PROWLER PIPE 86dB
HEADS CUT .020"--35.5MM CARBS--270MJ--P5NJ
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .728
Vapor Pressure: .10
Barometer: 30.42

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5500	42.9	44.9	31.9	97.7	14.1	.68	28
5750	44.8	49.0	38.7	102.7	12.2	.75	27
6000	44.8	51.2	38.6	105.6	12.6	.72	27
6250	47.2	56.2	41.3	108.0	12.0	.70	27
6500	48.1	59.5	40.3	108.9	12.4	.64	27
6750	48.6	62.5	43.2	109.9	11.7	.66	29
7000	46.9	62.5	44.2	109.6	11.4	.67	27
7250	43.6	60.2	44.5	107.8	11.1	.70	26
7500	39.5	56.4	41.3	105.8	11.8	.69	27
7750	34.6	51.1	40.1	104.6	12.0	.74	28
8000	30.6	46.6	40.1	105.0	12.0	.82	28
8250	26.0	40.8	41.3	104.6	11.6	.95	27

PROWLER 440

1990 ARCTIC CAT PROWLER 440
DG PROWLER PIPE
HEADS CUT .020"--35.5 MM CARBS--270MJ--P5NJ
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .728
Vapor Pressure: .10
Barometer: 30.40

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5500	42.3	44.3	31.3	95.2	14.0	.67	30
5750	43.3	47.4	37.0	100.4	12.5	.74	30
6000	44.3	50.6	40.4	104.9	11.9	.76	30
6250	45.1	53.7	40.0	106.4	12.2	.71	29
6500	45.6	56.4	40.1	105.8	12.1	.68	30
6750	45.0	57.8	43.7	106.1	11.1	.72	29
7000	44.3	59.0	42.6	105.7	11.4	.69	29
7250	44.2	61.0	43.0	106.6	11.4	.67	30
7500	34.2	63.1	46.1	109.1	10.9	.70	30
7750	43.7	64.5	45.5	112.2	11.3	.67	30
8000	42.0	64.0	44.8	115.6	11.8	.67	30
8250	38.5	60.5	45.5	117.3	11.8	.72	30

PHASE 3

With everything else left as in Phase 2, including the best (shortened stock 1991) pipe, we installed D&D's "trail ported" cylinders. These provided a remarkable 13% increase in airflow and 13% increase in horsepower.

1990 ARCTIC CAT PROWLER--SHORTENED '91 STOCK PIPE
TRAIL PORTED CYLINDERS
CUT HEADS 35.5 MM CARBS--270MJ--P5NJ
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .728
Vapor Pressure: .10
Barometer: 30.44

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	39.5	45.1	38.8	103.3	12.2	.82	31
6250	41.7	49.6	39.7	105.8	12.2	.76	30
6500	43.4	53.7	41.9	108.5	11.9	.74	30
6750	46.0	59.1	42.5	112.5	12.2	.68	31
7000	46.9	62.5	44.1	114.0	11.9	.67	30
7250	48.5	67.0	45.6	115.4	11.6	.65	31
7500	49.5	70.3	49.8	118.0	10.9	.67	31
7750	49.2	73.0	48.7	122.6	11.6	.63	30
8000	49.0	74.6	47.1	125.3	12.2	.60	29
8250	47.6	74.8	49.2	125.2	11.7	.63	30
8500	44.8	72.5	48.0	124.8	11.9	.63	31
8750	40.2	67.0	47.9	124.1	11.9	.68	31

PHASE 4

Larger 38mm carbs were installed; 310 main jets and P5 needle jets gave us similar A/F ratios to the 35.5mm carbs. These resulted in another slight gain in airflow and horsepower on top end, but we traded that for a similar loss in airflow and horsepower in the midrange and bottom end. This would also serve as a baseline for our "Pipe Shootout #24 Trail Ported Prowler 440" which follows.

1990 ARCTIC CAT PROWLER
SHORTENED '91 STOCK PIPE 84dB
TRAIL PORTED CYLINDERS
CUT HEADS *38 MM CARBS*--270MJ--P5 NJ
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .728
Vapor Pressure: .10 Barometer: 30.50

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	37.8	43.2	33.5	101.9	14.0	.74	32
6250	40.2	47.8	35.5	104.6	13.5	.71	32
6500	42.0	52.0	36.4	107.4	13.5	.67	32
6750	44.4	57.1	37.8	111.3	13.5	.63	33
7000	45.9	61.2	39.9	113.5	13.1	.62	33
7250	47.7	65.8	41.7	117.2	12.9	.60	33
7500	49.0	70.0	45.2	119.5	12.1	.62	33
7750	49.8	73.5	48.8	123.2	11.6	.63	33
8000	49.4	75.2	49.9	126.5	11.6	.63	32
8250	48.6	76.3	48.6	126.9	12.0	.61	31
8500	46.7	75.6	48.7	127.8	12.1	.61	32
8750	42.7	71.1	46.7	125.7	12.4	.62	33

PIPE SHOOTOUT #24

MODIFIED PROWLER 440

We had single pipes from Aaen, DG, and PSI to compare to our stock and shortened 1991 pipes. We also tested a 1992 Prowler single pipe, which is identical to the Prowler Special.

1990 ARCTIC CAT PROWLER
TRAIL PORTED CYLINDERS
CUT HEADS 38 MM CARBS--270MJ--P5 NJ
STANDARD (UNCUT) 1991 PROWLER PIPE--84 dB
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .728
Vapor Pressure: .10 Barometer: 30.51

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	40.0	45.7	32.1	104.2	14.9	.67	30
6250	42.4	50.5	34.5	108.0	14.4	.65	29
6500	45.1	55.8	36.6	114.2	14.3	.62	29
6750	47.4	60.9	40.4	120.5	13.7	.63	29
7000	48.5	64.6	43.1	123.3	13.1	.63	29
7250	49.3	68.1	47.8	125.1	12.0	.66	28
7500	49.9	71.3	48.1	126.6	12.1	.64	29
7750	49.6	73.2	50.9	128.1	11.6	.66	30
8000	48.8	74.3	50.5	130.5	11.9	.64	29
8250	46.9	73.7	48.6	130.8	12.4	.62	29
8500	42.1	68.1	49.0	129.0	12.1	.68	29
8750	32.3	53.8	47.3	125.9	12.2	.83	29

1990 ARCTIC CAT PROWLER TRAIL PORTED CYLINDERS
CUT HEADS 38 MM CARBS--270MJ--P5 NJ
STANDARD (UNCUT) 1992 PROWLER PIPE--84 dB
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .728
Vapor Pressure: .10 Barometer: 30.51

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	38.2	43.6	35.1	103.9	13.6	.76	29
6250	40.3	48.0	35.0	104.8	13.7	.69	29
6500	41.5	51.4	36.0	106.6	13.6	.67	30
6750	43.8	56.3	38.4	110.5	13.2	.65	30
7000	45.2	60.2	40.2	112.0	12.8	.63	28
7250	45.8	63.2	41.5	112.5	12.4	.62	29
7500	47.3	67.5	43.1	115.5	12.3	.60	28
7750	48.2	71.1	47.6	120.0	11.6	.63	28
8000	48.0	73.1	48.1	125.4	12.0	.62	29
8250	48.1	75.6	50.0	126.7	11.6	.63	29
8500	45.5	73.6	48.8	127.1	12.0	.63	29
8750	37.6	62.6	46.2	125.9	12.5	.70	30

1990 ARCTIC CAT PROWLER TRAIL PORTED CYLINDERS
CUT HEADS 38 MM CARBS--270MJ--P5 NJ
PSI PROWLER PIPE--86 dB
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .728
Vapor Pressure: .10 Barometer: 30.49

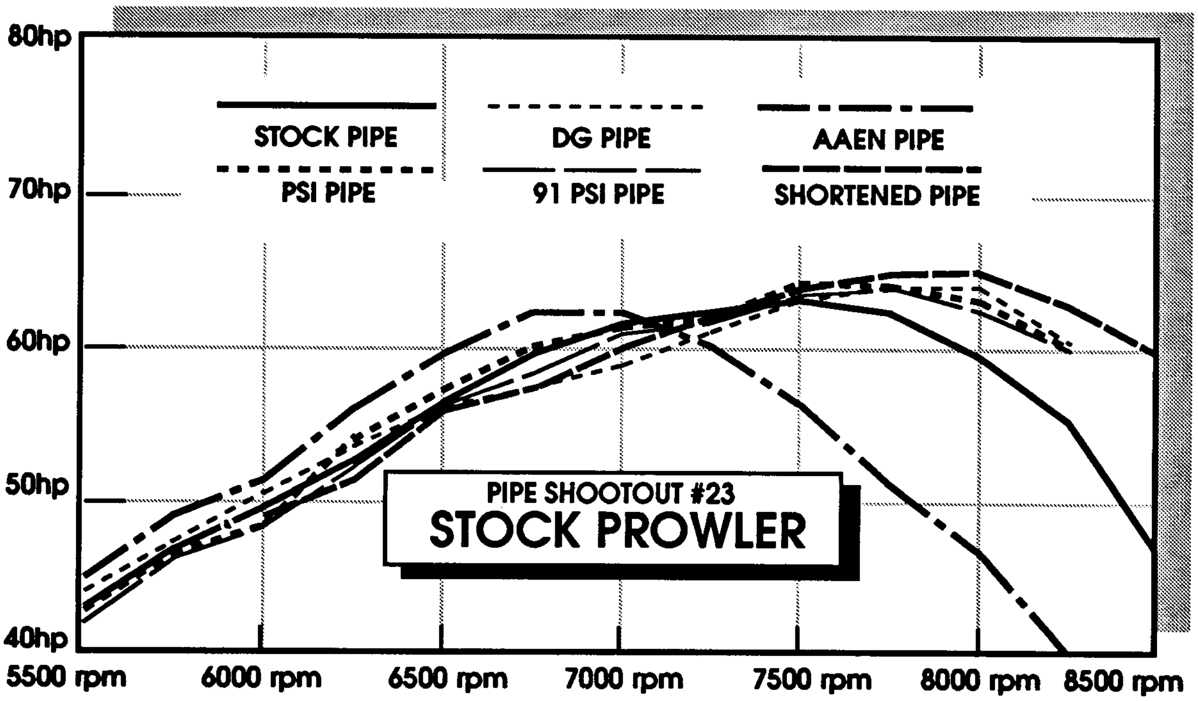
RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	38.0	43.4	33.5	105.7	14.5	.73	28
6250	39.2	46.6	34.4	106.2	14.2	.70	29
6500	43.8	54.2	38.3	111.6	13.4	.67	28
6750	47.8	61.4	40.6	117.8	13.3	.63	27
7000	49.0	65.3	43.7	120.3	12.6	.63	27
7250	48.8	67.4	44.9	122.1	12.5	.63	27
7500	49.7	71.0	47.3	123.3	12.0	.63	27
7750	50.1	73.9	48.6	125.9	11.9	.62	28
8000	49.4	75.2	48.6	128.8	12.2	.61	28
8250	48.0	75.4	49.2	129.6	12.1	.62	29
8500	41.8	67.7	47.4	129.9	12.6	.66	29
8750	29.9	49.8	48.0	126.2	12.1	.91	29

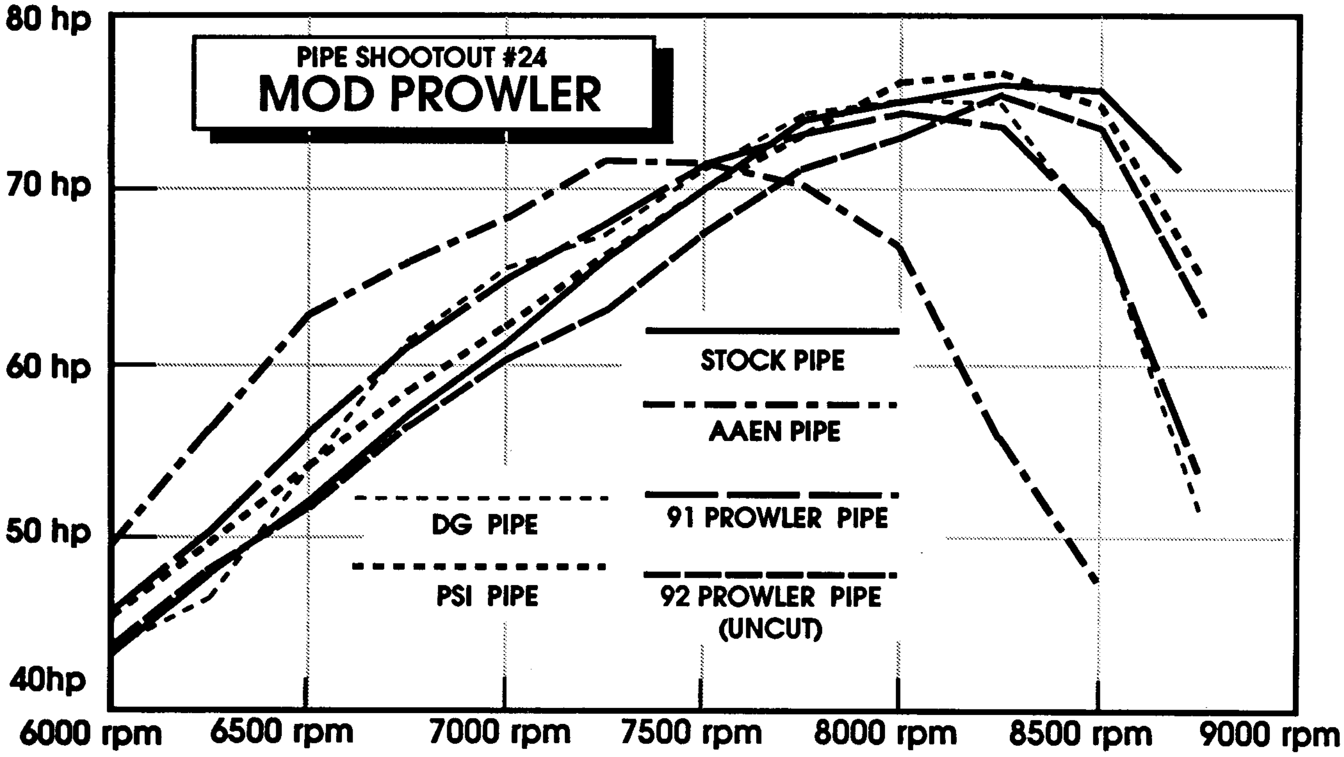
1990 ARCTIC CAT PROWLER TRAIL PORTED CYLINDERS
CUT HEADS 38 MM CARBS--270MJ--P5 NJ
AAEN PROWLER PIPE, 88 dB
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .728
Vapor Pressure: .10 Barometer: 30.47

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	43.2	49.4	34.7	111.2	14.7	.66	26
6250	47.5	56.5	37.5	115.0	14.1	.63	27
6500	50.6	62.6	39.9	119.4	13.7	.60	26
6750	51.3	65.9	43.7	122.0	12.8	.63	27
7000	51.5	68.6	44.6	121.8	12.5	.62	27
7250	51.8	71.5	47.1	121.4	11.8	.62	26
7500	49.9	71.3	46.8	120.9	11.9	.62	27
7750	47.7	70.4	48.1	121.6	11.6	.65	27
8000	43.7	66.6	47.0	122.3	11.9	.67	27
8250	35.4	55.6	45.1	120.2	12.2	.77	27
8500	25.7	41.6	44.6	116.0	11.9	1.01	27

1990 ARCTIC CAT PROWLER TRAIL PORTED CYLINDERS
CUT HEADS 38 MM CARBS--270MJ--P5 NJ
DG PROWLER PIPE--86 dB
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .728
Vapor Pressure: .10 Barometer: 30.48

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	39.7	45.4	30.4	104.1	15.7	.63	24
6250	41.5	49.4	33.2	107.0	14.8	.64	26
6500	43.8	54.2	35.2	109.9	14.3	.62	27
6750	45.6	58.6	37.3	112.1	13.8	.60	27
7000	46.7	62.2	38.5	113.2	13.5	.59	27
7250	47.9	66.1	41.7	115.4	12.7	.60	27
7500	49.0	70.0	43.6	118.1	12.4	.59	27
7750	49.6	73.2	46.3	122.2	12.1	.60	28
8000	49.8	75.9	49.4	126.8	11.8	.62	28
8250	48.9	76.8	49.2	128.8	12.0	.61	28
8500	46.2	74.8	47.6	128.9	12.4	.60	27
8750	39.0	65.0	47.4	128.3	12.4	.69	26





FEEDBACK BACKFEED

Jim Czekala

AIRFLOW NUMBERS

When examining our dyno test results, particularly pipe comparisons, airflow should be compared as well as torque and horsepower. Over the years, we have found that pipes which generate higher horsepower by increasing backpressure beyond stock are likely to be fussier on jetting. Combustion chamber heat buildup resulting from the combination of higher horsepower and less cooling airflow sometimes promotes deto when jetting is allowed to go too lean.

Lower backpressure usually results in less horsepower. Lower backpressure sometimes allows the use of leaner jetting without detonating on low octane gas. Consult each pipe manufacturer for jetting recommendations.

AIR PRESSURE

The comments that I made in the last issue about the V-Max 4 carburetion difficulties got a lot of people thinking about their own sleds' pressure differentials.

Arctic Cat dragracer Greg Hennel has had to run much smaller than maximum dyno horsepower jetting on the track, and pressure differential may be the cause (the big Wildcats have underhood carb venting, and behind-the-cowl air intake.

Massachusetts Exciter dragracer Craig Sessions runs a Bender cold air intake kit, which seals out underhood air (and air pressure) from the airbox. Last winter, he ran 230 (!) main jets in his Exciter. This year, his sled runs better with 200 (!!) mains.

Gary Potyok reported a several miles per hour top end increase on Mach 1's that had some of their hood air intakes duct-taped shut. The intent had been to build additional pipe heat, but could that have reduced the pressure differential as well?

Dan Cross' Indy 500 improved stocker suffered from carburetion lean-out when he ran it without the foam sealing the airbox to the air intake in the hood. Now he realizes that he should have moved the carb vent lines to the underhood area. →

FEEDBACK BACKFEED CONTINUED

YAMAHA'S OIL INJECTION SYSTEM
For some years I've criticized (some say too harshly) Yamaha's method of injecting oil into the gas lines ***before*** the carburetors of the V-Max 2 & 4, and the Exciters. Now, I've found another, even more vocal critic of this method of providing lubrication for two-strokes: Yamaha Marine Division.

In a recent boating magazine, ***Yamaha*** has a full page ad touting the fact that ***their V-6 outboard engines are superior because they inject lubricating oil directly into the intake ports.*** Mercury and OMC both inject their oil into the fuel entering the carburetors. According to Yamaha, this method is less desireable, leading to the formation of gum in the carburetors, and delays response time for oil ratio changes.

THE NEW BIG IRON FOR 1993
Rumors are becoming reality. This will be a fun year for DYNOTECH subscribers.

ARCTIC CAT:
The Arctic Cat "Thunder Cat" case reed three cylinder will displace 900cc's, have triple pipes, 38mm round slide carbs, and will reportedly generate much more horsepower than the other new mountain motors. I've heard the number 165 CB-HP (!) batted about. The new Horsepower King will reside under the hood of a basically unchanged Wildcat AFS chassis. Arctco is probably lobbying the ISR rules committee to raise the 800cc competition ceiling on snowmobile engines. What's wrong with creating a AAA stock class?

SKI DOO:
I thought Bombardier might be up to something last summer when their race shop purchased a new 400 horsepower capacity SuperFlow computerized dyno testing system. I wondered if their old Schenck dyno wasn't handling whatever was in the works for 1993.

The new Mach 1Z engine is an all new, case reed 775cc triple with triple pipes, rack mounted (like the V-Max 4's) 38mm Mikuni flatslide carbs, reportedly detuned to 140 CBHP. While the exact power peak is not known, the tach only reads up to 9000 RPM, leading us to believe that horsepower will peak in the low 8000's. The chassis is all new, with extensive use of aluminum. A Polaris-style front suspension is used. An average of one per dealer may be available.

POLARIS:
The Indy Storm, as it's called, has a new 747cc case reed engine with triple pipes and 40mm roundslide carbs. The engine is reportedly detuned to 130 CBHP in stock trim, at around 8000 RPM. The chassis is supposed to have the same new rear suspension as the XLT 583. The quantities manufactured will apparently be determined by how many orders with deposits they have in their annual spring promotions.

YAMAHA:
The V-Max 4 engine will be tuned a bit tighter for 1993, with windowed intake skirts on the pistons, and increased port timing, somewhat like Bender Racing's "Tuneup". Expect horsepower to be in the 140 range. Clutch difficulties which plagued its first season will hopefully be resolved. Slide rail angle will be changed to reduce excessive friction in the front.

ASK KEVIN
Keep those questions coming! Remember, anyone whose question is used by Kevin will receive a cool DynoTech T-shirt.

MORE TURBO TESTING:
Turbo maven Greg Bennet of First Choice Auto in Avon, N.Y. has been bugging me all season to let him install a custom turbocharger on my V-Max 4.

Recently, I dyno tested a bone stock V-Max 4 that Michigan subscriber Phil Walker had turbocharged. It made 200 CBHP at only 7 lbs. of boost, with an astonishing 133 ft/lb of torque at 7500 RPM! I had a chance to drive the sled before they left, and was impressed with its apparent docility and drivability off boost, and rapid transition from vacuum to boost. These are both traits that are somewhat lacking in the turbocharged Indy 500.

The sled's owner, Bob Clement, has trail ridden the sled 400+ miles with 7 lbs. of boost, on pump gas.

So, I let Greg design and install his own turbo kit, with CNC milled aluminum airbox adaptor and a rare high flow Generation IV AeroDyne turbo. These are being replaced soon by a smaller, though perfect for 5-10 lbs. of boost, new generation AeroDyne unit that should be virtually lag-free on the big V-Max 4 engine.

Our dyno and trail testing should be complete by the next issue.

KEVIN CAMERON
c/o DYNOTECH
PO BOX 801
BATAVIA, NY 14021

ASK KEVIN

RUNNING ON ALCOHOL

Mr. Allan Leonard, of Hayward, Wi., writes to ask about alcohol (methanol) conversions to sled engines. Knowing little about this subject myself, I have turned to Mike Schmidt, who has extensive two-stroke alcohol experience.

His first point is that the carb's float valve must be enlarged. A standard pressure system valve is 1.5 mm; it should be enlarged by drilling to 2.3 mm. This will allow the float system to keep up with engine needs.

Schmidt's experience is that the main system will not supply enough fuel for top-end operation, and must be supplemented by use of a power jet as well. The rule of thumb for alcohol operation is that jet *area* (not diameter) must be increased by 2-2.5 times. This is done by needle jet drilling. Because alcohol has more latitude in jetting than does gasoline, you can be wrong in the midrange and the engine will still run. On top-end, however, too little fuel will cause burndowns. I hope soon to have specific information about needle tapers and needle-jet sizes.

Even in summer temperatures, alcohol burning engines start harder because alcohol isn't as volatile as the most volatile fractions in gasoline. Schmidt uses lacquer thinner, squirted into carb throats before starting. In cold weather, it may be necessary to preheat the engine before it will run on alcohol. Practices such as packing snow around crankcases will have to be re-evaluated; if the engine runs too cold, it will fail to form a good mixture, and carburetion will become very sensitive to every change in atmospheric conditions. It may be necessary to run the fuel through a heat-exchanger, or to heat the bowls, to ensure good running in cold weather on alcohol.

Alcohol absorbs a great deal of heat in evaporating. This refrigerates the intake charge, greatly increasing its density. It is this effect which increases power; alcohol by itself has less than half the energy content of gasoline, by weight. Because the intake charge is cooler going in, peak combustion temperature is similarly reduced. This a great benefit to engines which have, for example, a piston-cooling problem on gasoline. Because of this cooling effect, you will be able to use a higher than normal compression ratio. Experiment.

Mineral and most synthetic oils won't dissolve in alcohol, so castor-based oils are required. Experiment with alcohol and oil in a transparent container and see if separation occurs. Sometimes use of a co-solvent will help the process, such as 5% acetone. Remember the severe fire hazard with all fuels, and that alcohol flame is nearly invisible.

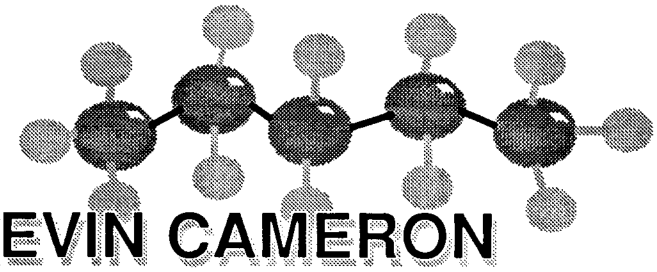
Alcohol must not be left in the fuel system or the engine itself for more than overnight. Alcohol eventually turns aluminum in to white powdery stuff, and the water inevitably found in it will rust piston rings, cylinder bores, and crank bearings. When the racing is over, empty the tank and restart on gasoline; run for a few minutes to flush the remaining alcohol. The engine will run horribly on gasoline, but sufficient to get the job of flushing done.

LEAN COMBUSTION MIXTURES

Mr. Alan Bahem of Homedale, Id., writes to ask about a combustion system he read about in SAE's paper #790501. This paper describes (in rather guarded terms) a lean combustion system that makes use of the fact that a completely homogenous mixture, even if lean, is easier to ignite than the irregular mixture that most engines get. The well-known Smokey Yunick has worked with such a combustion system, in which the intake charge is mixed and thoroughly evaporated by the agitation and heat of a turbocharger. While such combustion systems may have application in future auto engines, the low flame speed of lean combustion may disqualify its use in 9500 RPM sled two-strokes.

Note that the recently released Honda Civic lean-combustion engine (a four-stroke) is a dual mode powerplant. For acceleration and higher power levels, it reverts to chemically correct combustion. The more economical lean combustion is used only for low-power cruise operation. Becase lean combustion engines don't use all the oxygen in the air thay pump, and because power is roughly proportional to the amount of air reacted with fuel, such engines must be made larger to produce the same power as a chemically-correct combustion engine. The dual-mode concept neatly gets around this limitation.

WHAT IS GASOLINE?



THE CELLAR DWELLER KEVIN CAMERON

What is gasoline? This question is important in racing classes that specify gasoline as the only legal fuel. What is gasoline?

Asking that is a lot like asking "What are people?" People are so varied that there is no clear definition. Likewise gasoline, a mixture of literally hundreds of different hydrocarbon compounds derived from crude oil, varies with the origin of the crude oil, varies according to the method used to make the fuel, and varies according to the intended use of the fuel.

THE DEFINITION CHANGES WITH TECHNOLOGY

The original definition of gasoline was identical with the method of making it; all the fractions of crude oil more volatile than light kerosene were lumped together as gasoline. When straight distillation failed to yield enough gasoline, methods were developed by which heavier crude fractions could be cracked by heat or catalysis to yield more light fractions--gasoline. Since that time, our growing knowledge of the properties of individual hydrocarbons, and our ability to tailor fuels to specific purposes, have greatly broadened the definition of "gasoline".

When engine knock was identified as a limit on compression ratio, and therefore engine power and efficiency, it was discovered that gasolines made from certain crudes had better anti-knock behavior than others. With intensive research, the various constituent molecular species in gasoline were identified, and their anti-knock properties measured. It became known that branched-chain hydrocarbons were more knock-resistant than straight chain hydrocarbons. Eventually, aviation gasolines very resistant to knock were blended from synthetic alkylate--branched-chain paraffins--mixed with various other stocks, plus the potent anti-knock additive tetraethyl lead.

Our familiar racing fuels make use of this same basic 1940's technology, modified to provide two properties that large aircraft engines don't need; cold starting ability and rapid throttle response. Large aircraft engines are heated before starting in cold weather, and they run at essentially constant speed. Their superchargers provide both heat (through compression) and mechanical mixing to ensure formation of a relatively uniform and combustible mixture. In racing engines--car, bike, snowmobile, etc., RPM is high so there is less time for fuel evaporation. Intake manifold temperatures are low, and suupercharging is often not permitted by rules. Changes of engine speeds and load are frequent and drastic. Formation of a good mixture under all these conditions therefore requires a far more volatile fuel.

This volatility is provided, as with pump gasolines for highway use, by dissolving gaseous constituents such as propane, butane and isopentane in the fuel; their high volatility assists cold starting and helps throttle response. If used in aviation fuels, these gases would simply evaporate from the tanks at high altitude. It is the presence of these gases in racing fuel that causes the PSSSSSSS sound when you open the bung on a fresh drum. Summer pump fuels contain less of these gases, winter fuels contain more.

RACING GASOLINES ARE SPECIALIZED

Today even racing gasolines are specialized. To sell at lower prices, some are blended from alkylate plus lead, together with less expensive catalytic reformate (desirable molecular forms created out of less desirable ones by breaking them down in the presence of heat and a cataylst, then allowing them to reform into other structures). Aromatics (ring compounds such as benzene, tolene and xylene) also have good anti-knock ratings and are a leading component of no-lead fuels--both pump and racing. Super high-octane fuels are necessary to prevent knock in highly supercharged racing engines; here as with aircraft some volatility can be sacrificed in favor of anti-knock quality. For types of racing where throttle movement is constant, some octane number has to be sacrificed in favor of greater volatility. Bear in mind that a high-octane fuel that doesn't evaporate completely in your engine may knock worse than a slightly lower octane fuel that does evaporate and form an easily-ignited, fast burning mixture. By failing to evaporate fully during acceleration, the lower volatility fuel causes momentary leanness--leading to knock. Despite their obvious differences from one another, all these fuels are classed as gasolines because their molecular species all come from standard crude oil refining practices.

HOW FAR CAN THE DEFINITION BE STRETCHED?

There are more extreme cases. When Honda wanted maximum fuel density to get around a fuel tank capacity limit in Formula One car racing, they used a fuel that was 80% toluene. To permit normal mixture formation, this low volatility fuel had to be heated on its way to the fuel injection nozzles. Can we call an 80% toluene blend gasoline? How can all these specialized fuels, compounded from pure substances rather than just boiled or cracked out of crude oil, be called gasoline?

More important, how can a tech inspector determine whether a given blend is, or is not, gasoline? →

STANDARD METHODS OF FUEL TESTING

For many years, race sanctioning bodies have tended to follow the lead of the NHRA, defining gasoline in a simple, easily field-measurable way as follows: gasoline is that class of liquids whose specific gravity falls between two limits (typically between .700 and .775) and whose dielectric constant is less than a specified value, such as 2.025. Specific gravity is simply weight per cubic centimeter, in grams. Dielectric constant measures the degree to which the fuel molecule is polar. A non-polar molecule has its positive and negative charges evenly distributed, but a polar molecule has some excess of positive at one end, negative at the other. As it turns out, all of the normal petroleum hydrocarbons are just slightly polar, while more "interesting" molecular species, such as nitromethane, nitropropane, etc., are very much more so. Specific gravity is easily measured by putting a graduated float into a column of the fluid; the float sinks more deeply into lighter fluids, and vice versa. Fuel polarity (dielectric constant) is measured with a $200 dielectric meter. Just a few drops of nitro in a 50cc gasoline sample will peg this meter.

This kind of rule was a great improvement on earlier rules which were moral in tone and unenforceable in fact. They tended to say things like "it's illegal to use any fuel with over 102 octane", or "the use of oxygen bearing fuel additives shall be illegal". Measuring octane number is time consuming and expensive, requiring that a large sample be taken for the purpose of running it in a Cooperative Fuel Research (CFR) variable compression ratio test engine. That sample must be taken in a metal or glass container--some normal fuel components will diffuse right through plastic. In those days, tech inspectors took gas samples with great dignity, then dissappeared in a locked room where they enjoyed a cup of coffee, dumped the samples into the car out back, and emerged later to declare the fuels legal.

The specific gravity/dielecric meter tests substitute real measurements for all that old-time moralizing.

NOW THE NO LEAD ERA

But times change. The coming of the no-lead era meant gasoline blenders had to find other ways of boosting pump fuel octane number. One was to increase the fraction of expensive alkylate in the fuel. Another was to boost use of knock-resistant aromatics. Yet another was to incorporate non-petroleum oxygen-bearing compounds of high anti-knock rating (such as alcohols and ethers) into fuels. This means that many pump fuels will now not pass the dielectric test. Now what do we do?

The NHRA has one answer; ban all use of high-polarity compounds that annoy the dielectric meter. This, in effect says "Thou shall not use modern pump gasolines!" That's OK because all right thinking racers are already using racing gasoline anyway.

OCTANE NUMBER VERSUS ENERGY CONTENT

Let's digress for a moment and distinguish between octane number and fuel energy content. Octane number is simply a measure of the fuel's resistance to detonation; we can make more power on higher octane brews because we can safely put the compression ratio up higher on them. Simply switching from lower to higher octane on the same engine, without simultaneously raising compression ratio, gains no power. Fuel energy content is the amount of heat released when a given weight of the fuel is burned to completion with the right amount af air. For all useful fuel hydrocarbons this number is almost constant at 19,000 BTU per pound, give or take 2-3%. This means that there are no "superfuels" among the hydrocarbons.

STANDARD METHODS OF CHEATING

That doesn't, however, mean we can't finish better through chemistry. The easy stuff--cheating that is detected by the dielectric meter--works in a couple of ways. The alcohols contain less energy per pound than hydrocarbons, but because they absorb so much heat during evaporation, they refrigerate the intake charge, causing a denser charge to be delivered to the engine. This is what produces more power.

Another approach is to use chemicals that smuggle oxygen into the cylinders. Normally, power is limited by how much air an engine can pump, but if extra oxygen is chemically bound in the fuel, power can be raised beyond that. Nitromemthane, nitropropane, propylene oxide, and nitrous oxide all produce their power gains in this way. All are highly polar and are detectable by the dielectric meter.

Finally there are the genuine "super-fuels", which increase power by virtue of delivering more heat per pound than do normal hydrocarbons. Some of these chemicals are tricky substances--things like the hydrides of boron, which ignite spontaneously on contact with air, or break down vigorously in the presence of even small amounts of water. Back in the 1960's a good many racers-turned-chemists blew themselves up while experimenting with the notoriously dangerous nitromethane-hydrazine combination. While these substances make fascinating reading, being blown up in the process of investigating them seems unnecessary and stupid.

WHAT IS FUEL CHEATING?

Just as the old counterfeiter salved his conscience by saying "If it passes for money, it is money" so we now are ignoring chemical cleverness by saying, "If it passes specific gravity and dielectric, it is gasoline". Propylene oxide has the desirable quality of evaporating out of fuel fairly quickly, leaving nothing to be analyzed. Nitrous oxide is usually piped as a gas into the engine's intake in some concealed fashion, so it doesn't show up in fuel analysis. How do fuel innovators get past the rules? Is there a miraculous meter-beater fuel additive? →

THE CELLAR DWELLER CONTINUED

At present, there appear to be one or more ways to defeat the dielectric meter. One is to balance the upward swing of the meter needle caused by, say, nitropropane, by adding some substance with a near-zero dielectric constant. Some claim such a substance is 1-4 dioxane, a somewhat carcinogenic solvent used in liquid chromatography. In fact, its dielectric constant is 2.209 at 25 deg C, so if it works at all, it works in some other way. Another solution is to wrap the polar nitro molecule in a much larger, non-polar molecule. By such means it is claimed to be possible to raise engine power a useful amount--five or more percent. It should be understood that some of these substances are listed carcinogens. However, before panicking over this, remember that there are few substances known that are more toxic than the good old teraethyl lead that is the basis of most racing fuels' octane number. That's why granddad said "Don't wash parts in gasoline, sonny, and don't clean your hands with it either". Even no-lead gasolines contain aromatics--including the quite carcinogenic benzene (its use in gasolines is now limited to 3-5% in some countries). Its good antiknock properties made it the basis for the pre-war "benzole" racing fuels. There is no way to get clean away from carcinogenic compounds in the fuel business. Don't get the liquids on you, don't handle fuels in closed spaces, don't breathe vapors, and do observe sensible precautions against accidental ignition. Rubber gloves are no protection against many of these questionable compounds; they diffuse through most kinds of rubber.

BEYOND THE NORMAL

Now we hear that the French fuel company ELF is contracted to supply new gasoline to the Williams-Renault Formula One auto racing team--a fuel that is claimed to simultaneously reduce fuel consumption and substantially (8-12%) increase power. It's not likely that this can be done with hydrocarbons, as noted above. Further, fumes from this fuel are reputed to be carcinogenic, and the stuff is said to be very unstable. The fuel is said to cost $175 per liter--almost $700 per gallon--and much of the expense is in handling precautions in transporting it to the track. Could these boys be doing something rash?

Look in any book on rocket motor technology and you will see boron and metal hydrides mentioned as hard-to-handle but potentially powerful fuels. Boranes were proposed as range-increasing superfuels for the high flying YF-12A and SR-71 aircraft twenty-five years ago. In addition to having higher energy content than hydrocarbon based fuels, the boranes also have very high flame speed (100 times those of hydrocarbons). This would have been an advantage in preventing engine flameouts at very high altitudes and Mach numbers. Indeed, legend has it that a special, boron-based relight fuel was actually tested in the J58 turbo-ramjet engines of the SR-71. In any case, isn't it interesting that JP-7, the special fuel used in the J58 engine, was dewatered to the nth degree?

BLOW YOURSELF UP

hese developments are fascinating, but the dangers are very real. No doubt it is good theater in high-dollar Formula One car racing to have the fueling crew come out in pressurized flak suits, but despite all their precautions, there was a destructive fuel explosion during winter F1 testing. I can't believe the sport of snowmobile racing will benefit from injuries to competitors from blast, poisoning, or cancers. Gasoline is sufficiently hazardous as it is.

Many racers have the experience of seeing a formerly uncompetitive rival suddenly become a star without buying new equipment. The conclusion drawn is that he must be using some kind of undetectable illegal fuel. At present, there is no way to know. Fuel experimenters are at least as clever as the tech inspectors who are trying to detect them; that creates a permanent "arms race" in which those fair-minded competitors still burning gasoline are losers. This situation exists at present in many branches of motorsport. There is a remedy for it, but it's one that potentially hurts everyone in racing. That is mandatory use of spec fuel. This hurts competitors because it eliminates at one stroke all fuel companies but the spec fuel maker as potential racing sponsors.

At present, tech inspectors are adding to their armamentarium of fuel-testing equipment, hoping to build up enough knowledge to catch most fuel cheating. It's hard to love tech inspectors, but they are the only protection we have against "broadly-defined" gasolines. Unless you believe we can all "Just say no!" to such fuels.

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