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DYNOTECH

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PIPE SHOOTOUT #29

1993 YAMAHA EXCITER SX

We own almost as many Exciter pipes as Phazer pipes. Now that a few companies have come out with pipes specifically for the Exciter SX, our collection has grown.

The Exciter SX engine is a higher performance version of the Exciter II. Improved port timing, additional compression, a shorter Y-pipe, and revised tuned pipe give this engine about a ten CBHP advantage over the Exciter II.

The shorter Y-pipe is the main reason that special single pipes were made for the SX. We tested some standard Exciter II pipes as well, both with the stock short SX Y-pipe and the longer Exciter II Y-pipe. Where it is appropriate, we show long Y-pipe data.

For example, the Decker Exciter II single pipe works well on the SX engine, but only with a longer Exciter II Y-pipe. The Decker single pipe makes less than stock horsepower with the SX Y-pipe.

We also tested twin pipes from PSI and Decker Racing.

We should note that the stock Exciter SX pipe weighs 21 pounds. All of the aftermarket singles weighed around 10 pounds, and even the Decker and PSI twin pipes weighed a bit less than the stock single.

95.5 Octane unleaded pump gas was used for the test, with direct oil injection.

1993 YAMAHA EXCITER SX
BENDER RACING SX PIPE/STOCK Y
150 MJ/86 dB
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .749
Vapor Pressure: .50 Barometer: 29.95

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	55.8	63.7	43.3	119.7	12.7	.71	86
6250	60.2	71.6	47.5	127.6	12.3	.69	86
6550	62.2	77.0	51.7	131.0	11.6	.70	86
6750	65.0	83.5	52.5	134.6	11.8	.66	86
7000	66.3	88.4	54.0	137.5	11.7	.64	86
7250	66.5	91.8	55.7	141.7	11.7	.64	86
7500	67.7	96.7	57.2	147.2	11.8	.62	86
7750	68.2	100.6	62.4	152.3	11.2	.65	85
8000	65.8	100.2	62.3	158.0	11.6	.65	84
8250	54.8	86.1	61.7	155.1	11.5	.75	86

1993 YAMAHA EXCITER SX
REICHARD SX PIPE/STOCK Y
150 MJ/84 dB
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .749
Vapor Pressure: .50
Barometer: 29.95

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	59.5	68.0	45.8	128.2	12.9	.70	77
6250	63.2	75.2	49.8	134.2	12.4	.69	76
6550	66.1	81.8	53.9	139.3	11.9	.68	75
6750	70.4	90.5	58.2	142.6	11.3	.67	77
7000	72.0	96.0	56.6	146.9	11.9	.61	78
7250	71.6	98.8	56.3	148.8	12.1	.59	77
7500	71.3	101.8	56.4	152.5	12.4	.57	78
7750	56.1	82.8	64.8	153.0	10.8	.81	78
8000	44.5	67.8	59.4	148.1	11.4	.91	78
8250	40.9	64.2	56.3	147.6	12.0	.91	78
8500	33.1	53.6	56.5	145.9	11.9	1.10	77

1993 YAMAHA EXCITER SX
DELAUGHTER RACING PIPE/STOCK Y
150 MJ/86 dB
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .749
Vapor Pressure: .50
Barometer: 29.96

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	51.5	58.8	41.4	116.6	12.9	.73	75
6250	56.0	66.6	47.9	125.8	12.1	.74	75
6550	61.6	76.2	50.8	133.7	12.1	.69	76
6750	63.6	81.7	50.2	137.7	12.6	.64	75
7000	64.9	86.5	53.5	140.8	12.1	.64	75
7250	66.6	91.9	55.6	145.5	12.0	.63	75
7500	67.0	95.7	57.2	150.6	12.1	.62	75
7750	68.0	100.3	59.8	156.4	12.0	.62	76
8000	64.3	97.9	62.5	160.5	11.8	.66	76
8250	45.6	71.6	59.0	154.2	12.0	.86	76

PIPE SHOOTOUT #29

YAMAHA EXCITER SX

1993 YAMAHA EXCITER SX
PSI EXCITER II SINGLE PIPE/STOCK Y
150 MJ/90 dB

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .749
Vapor Pressure: .50
Barometer: 29.97

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	59.9	68.4	47.1	132.9	13.0	.71	69
6250	63.1	75.1	50.2	138.1	12.6	.69	69
6550	66.4	82.2	57.5	142.1	11.3	.72	70
6750	68.3	87.8	59.3	145.7	11.3	.70	70
7000	69.9	93.2	62.3	149.1	11.0	.69	70
7250	70.3	97.0	59.8	151.9	11.7	.63	70
7500	69.4	99.1	60.7	155.7	11.8	.63	70
7750	55.8	82.3	60.1	156.3	11.9	.75	69
8000	43.0	65.5	57.4	150.1	12.0	.90	69

1993 YAMAHA EXCITER SX
AAEN EXCITER II SINGLE PIPE/STOCK Y
150 MJ/88 dB

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .749
Vapor Pressure: .50
Barometer: 29.97

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	57.0	65.1	44.2	132.4	13.8	.70	67
6250	59.3	70.6	47.8	139.3	13.4	.69	68
6550	63.0	78.0	56.4	144.3	11.7	.74	69
6750	66.8	85.9	59.0	149.6	11.6	.71	70
7000	66.8	89.0	59.1	153.6	11.9	.68	69
7250	66.2	91.4	63.0	157.8	11.5	.71	69
7500	66.6	95.1	62.4	162.0	11.9	.67	69
7750	62.6	92.4	67.6	168.9	11.5	.75	69
8000	41.5	63.2	61.0	160.8	12.1	.99	69

1993 YAMAHA EXCITER SX
DG PIPE EXCITER II PIPE/STOCK Y
150 MJ/90 dB

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .749
Vapor Pressure: .50
Barometer: 29.96

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	52.6	60.1	38.3	112.0	13.4	.66	70
6250	53.1	63.2	38.4	113.7	13.6	.63	70
6550	63.6	78.7	49.5	130.4	12.1	.65	70
6750	65.7	84.4	52.8	134.8	11.7	.64	69
7000	65.8	87.7	53.7	137.8	11.8	.63	68
7250	65.7	97.4	53.6	140.4	12.0	.61	69
7500	65.8	94.0	57.1	144.8	11.6	.62	70
7750	59.7	88.1	60.3	148.2	11.3	.70	69

1993 YAMAHA EXCITER SX
DECKER TWIN PIPES
150 MJ/92 dB

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .749
Vapor Pressure: .50
Barometer: 29.96

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6500	57.6	71.3	50.3	142.7	13.0	.73	78
6750	61.7	79.3	51.8	147.1	13.0	.68	78
7000	63.5	84.6	54.1	148.8	12.6	.66	77
7250	63.0	87.0	53.4	150.4	12.9	.64	77
7500	64.3	91.8	55.1	157.8	13.2	.62	77
7750	64.5	95.2	63.8	163.9	11.8	.69	78
8000	65.1	99.2	63.6	173.2	12.5	.66	77
8250	64.5	101.3	60.5	177.7	13.5	.62	77
8500	59.2	95.8	60.4	179.3	13.6	.65	78
8750	52.9	88.1	61.6	175.7	13.1	.73	78

1993 YAMAHA EXCITER SX
PSI TWIN PIPES
150 MJ/94 dB

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .749
Vapor Pressure: .50
Barometer: 29.97

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	58.4	66.7	46.5	141.9	14.0	.72	73
6250	59.8	71.2	49.9	144.3	13.3	.72	72
6550	64.4	79.7	54.0	147.4	12.5	.70	72
6750	65.6	84.3	57.8	149.4	11.9	.71	72
7000	66.4	88.5	57.5	152.3	12.2	.67	73
7250	66.1	91.2	55.9	154.9	12.7	.63	73
7500	67.7	96.7	57.7	162.9	13.0	.62	72
7750	69.9	103.1	59.2	172.4	13.4	.59	72
8000	68.0	103.6	59.3	180.1	13.9	.59	72
8250	45.4	71.3	64.0	175.5	12.6	.93	71
8500	39.7	64.3	60.6	170.3	12.9	.98	72

1993 YAMAHA EXCITER SX
DECKER SINGLE PIPE/EXCITER II LONG Y
150 MJ/90 dB

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .749
Vapor Pressure: .50
Barometer: 29.97

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	54.6	62.4	40.6	117.5	13.3	.67	73
6250	58.0	69.0	46.3	127.9	12.7	.69	73
6550	63.8	79.0	49.5	133.6	12.4	.65	73
6750	67.0	86.1	52.5	137.5	12.0	.63	74
7000	67.8	90.4	51.7	141.6	12.6	.59	73
7250	67.7	93.5	54.9	146.2	12.2	.61	73
7500	68.4	97.7	57.2	151.9	12 2	.60	73
7750	67.3	99.3	62.3	157.7	11 6	.65	73
8000	56.7	86.4	61.5	158.8	11 9	.74	74
8250	48.3	75.9	60.7	157.3	11.9	.83	73

1993 YAMAHA EXCITER SX
BENDER RACING EXCITER II PIPE/LONG Y
150 MJ/86 dB

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .749
Vapor Pressure: .50 Barometer: 29.97

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	59.7	68.2	46.5	131.3	13.0	.70	70
6250	64.1	76.3	54.8	136.7	11.5	.74	72
6550	66.6	82.4	57.1	140.7	11.3	.71	71
6750	68.6	88.2	55.8	144.9	11.9	.65	71
7000	69.9	93.2	57.2	148.3	11.9	.63	72
7250	71.3	98.4	63.3	151.9	11.0	.66	71
7500	70.3	100.4	57.6	157.3	12.5	.59	72
7750	54.8	80.9	63.1	153.4	11.2	.80	73
8000	39.9	60.8	56.6	145.4	11.8	.96	71

1993 YAMAHA EXCITER SX
REICHARD EXCITER II SINGLE/EXCITER II LONG Y
150 MJ/88 dB

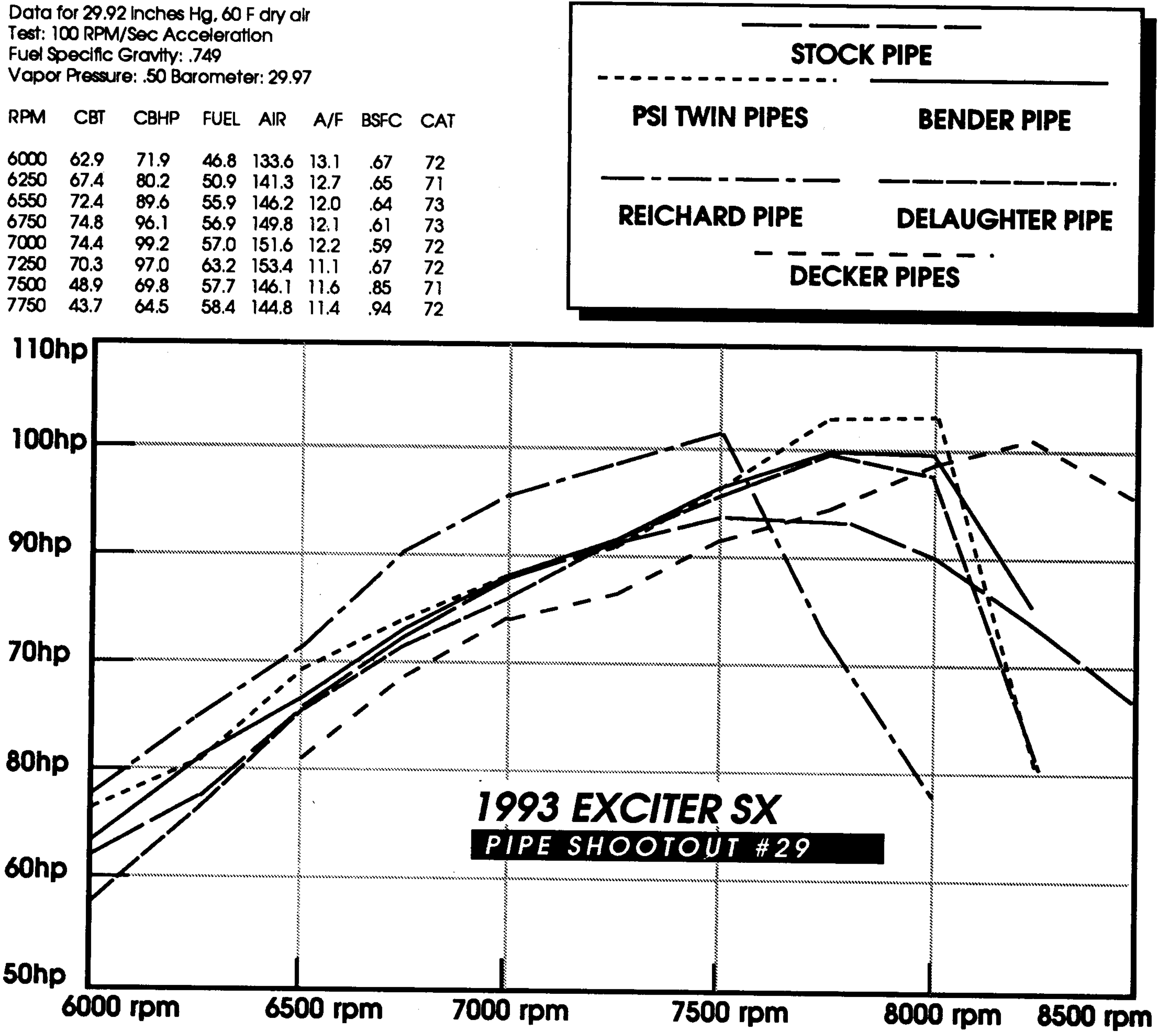
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .749
Vapor Pressure: .50 Barometer: 29.97

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	62.9	71.9	46.8	133.6	13.1	.67	72
6250	67.4	80.2	50.9	141.3	12.7	.65	71
6550	72.4	89.6	55.9	146.2	12.0	.64	73
6750	74.8	96.1	56.9	149.8	12.1	.61	73
7000	74.4	99.2	57.0	151.6	12.2	.59	72
7250	70.3	97.0	63.2	153.4	11.1	.67	72
7500	48.9	69.8	57.7	146.1	11.6	.85	71
7750	43.7	64.5	58.4	144.8	11.4	.94	72

1993 YAMAHA EXCITER SX
DELAUGHTER PIPE/EXCITER II LONG Y
150 MJ/86 dB

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .749
Vapor Pressure: .50
Barometer: 29.98

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	62.6	71.5	50.4	136.0	12.4	.72	70
6250	64.3	76.5	51.8	137.8	12.2	.70	71
6550	67.2	83.2	53.8	141.3	12.1	.67	71
6750	69.3	89.1	55.9	145.5	12.0	.65	71
7000	71.5	95.3	56.3	150.5	12.3	.61	70
7250	71.7	99.0	60.9	153.5	11.6	.63	70
7500	70.8	101.1	61.6	156.5	11.7	.63	71
7750	51.3	75.7	61.5	154.5	11.5	.84	70
8000	46.1	70.2	58.2	153.0	12.1	.85	71



INDY XLT: PIPE UPDATE

Present during test: John Cowie, Rich Daley, Dan Cross, Paul Cross

Our collection of triple pipes for the XLT has grown by five sets since we did our original test of the PSI and SLP pipes compared to the stock pipe in Vol. 4 #6. Here are the five sets of triple pipes, compared to the same set of SLP pipes we tested on the earlier engine.

This XLT was totally stock, with 2000 trail miles on it. Both the foam and shelf were removed from the airbox. Sunoco 94 octane gas was used, with BSFC in the low .60's with each set of pipes.

We show only "hot" pipe data. Two-stroke engines with tuned pipes typically make more horsepower on the first ten to fifteen second dyno pull, then settle down a bit as pipes and engines become "hotter". We usually see our second and third acceleration tests, done in rapid succession, repeat themselves within a half a percent, while making one or two percent less horsepower than the first "cool" acceleration test.

Like the PSI pipes on our V-Max 4 in the last issue, the Decker XLT pipes made more horsepower as the pipes heated up. On our first "cool" pull, the Decker pipes made "only" 106.3 CBHP. But, instead of dropping slightly on the second and third tests, the Decker pipes picked up power, making 107.5 on the second run, 108.6 on the third, then 108.6 on the fourth.

The Dynoport, SLP, and Pro 5 pipes lost one to one and a half horsepower as the pipes heated up. The Aaen and DG pipes made identical power with cool and hot pipes.

The Decker and Aaen pipes require additional holes cut in the plastic bellypan for installation, the others use the stock bellypan outlet.

All of the pipe sets are stamped, with the exception of the Aaen pipes, which are hand-welded cone pipes.

This past winter, we've dyno tested several different full mod XLT engines. No one has yet come within 20 HP of the full mod 600 Indys. The 600's, even with their heavier weight, are still doing the job in "A Improved" dragracing in this part of the country. So much so, that old 600's are now bringing premium prices on the used sled market.

The rumor mill is grinding out stories of a limited build of 500 Polaris XLT's with triple tuned pipes! If so, these should still qualify for "A Stock" dragracing, which was pretty much dominated by the 100+ CBHP SkiDoo Plus X last season.

1993 POLARIS XLT *DYNOPORT PIPES*
34mm CARBS/220 MJ/92 dB
Data for 29.92 inches Hg, 60 F dry air
Test: 200 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .15
Barometer: 29.96

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
7000	56.7	75.6	55.8	169.5	13.9	.73	45
7250	59.2	81.7	58.2	176.1	13.9	.70	45
7500	58.7	83.8	58.4	178.3	14.0	.69	45
7750	60.6	89.4	58.3	173.5	13.7	.64	45
8000	61.8	94.1	58.8	171.6	13.4	.62	45
8250	62.6	98.3	59.4	169.7	13.1	.60	46
8500	63.3	102.4	60.7	170.7	12.9	.60	46
8750	63.2	105.3	63.0	171.8	12.5	.60	46
9000	62.6	107.3	65.4	172.7	12.1	.60	46
9250	60.3	106.2	69.3	177.4	11.8	.65	46
9500	48.1	87.0	69.9	173.1	11.4	.79	45

1993 POLARIS XLT *DECKER PIPES*
34mm CARBS/220 MJ/90 dB
Data for 29.92 inches Hg, 60 F dry air
Test: 200 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .15 Barometer: 29.99

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6750	60.5	77.8	57.1	174.2	14.0	.71	33
7000	59.7	79.6	59.2	176.0	13.7	.72	33
7250	60.5	83.5	60.3	179.5	13.7	.70	33
7500	63.1	90.1	62.0	182.7	13.5	.67	33
7750	63.7	94.0	62.1	175.2	13.0	.64	34
8000	63.5	96.7	62.8	175.2	12.8	.63	33
8250	65.1	100.5	62.3	175.2	12.9	.60	34
8500	65.2	105.4	62.7	175.1	12.8	.60	34
8750	62.8	108.6	65.6	177.6	12.4	.60	33
9000	47.5	107.6	67.0	181.0	12.4	.61	34
9250	47.1	83.7	69.5	178.6	11.8	.81	33

1993 POLARIS XLT *SLP PIPES*
34mm CARBS/210 MJ/94 dB

Data for 29.92 inches Hg, 60 F dry air
Test: 200 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .15 Barometer: 29.97

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6750	55.8	71.7	52.6	166.4	14.5	.73	47
7000	56.1	74.8	56.4	173.0	14.1	.75	47
7250	59.3	81.9	56.5	178.8	14.5	.68	47
7500	59.7	85.3	58.8	187.3	14.6	.68	47
7750	61.4	90.6	59.5	181.6	14.0	.65	47
8000	62.1	94.6	59.4	180.2	13.9	.62	47
8250	61.7	96.9	60.9	181.1	13.7	.62	45
8500	62.5	101.2	63.7	179.9	13.0	.62	45
8750	62.5	104.1	66.8	179.5	12.3	.63	47
9000	60.6	103.8	68.6	182.2	12.2	.65	46
9250	47.1	83.0	70.5	181.2	11.8	.84	47

1993 POLARIS XLT *AAEN PIPES*
34mm CARBS/220 MJ/90 dB

Data for 29.92 inches Hg, 60 F dry air
Test: 200 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .15 Barometer: 29.98

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6750	60.1	77.2	55.8	169.3	13.9	.71	43
7000	60.3	80.4	61.0	173.2	13.0	.75	43
7250	61.1	84.3	60.6	177.1	13.4	.71	43
7500	61.5	87.8	60.9	182.0	13.7	.68	43
7750	62.9	92.8	60.9	177.0	13.3	.65	43
8000	63.4	96.6	62.8	174.1	12.7	.64	43
8250	63.6	99.9	62.9	174.5	12.7	.62	43
8500	62.0	100.3	62.8	173.4	12.7	.62	44
8750	60.2	100.3	64.9	174.7	12.4	.64	44
9000	57.6	98.7	66.6	174.3	12.0	.66	44
9250	47.5	83.7	69.2	173.1	11.5	.81	44

1993 POLARIS XLT *DG PIPES*
34mm CARBS/220 MJ/90 dB

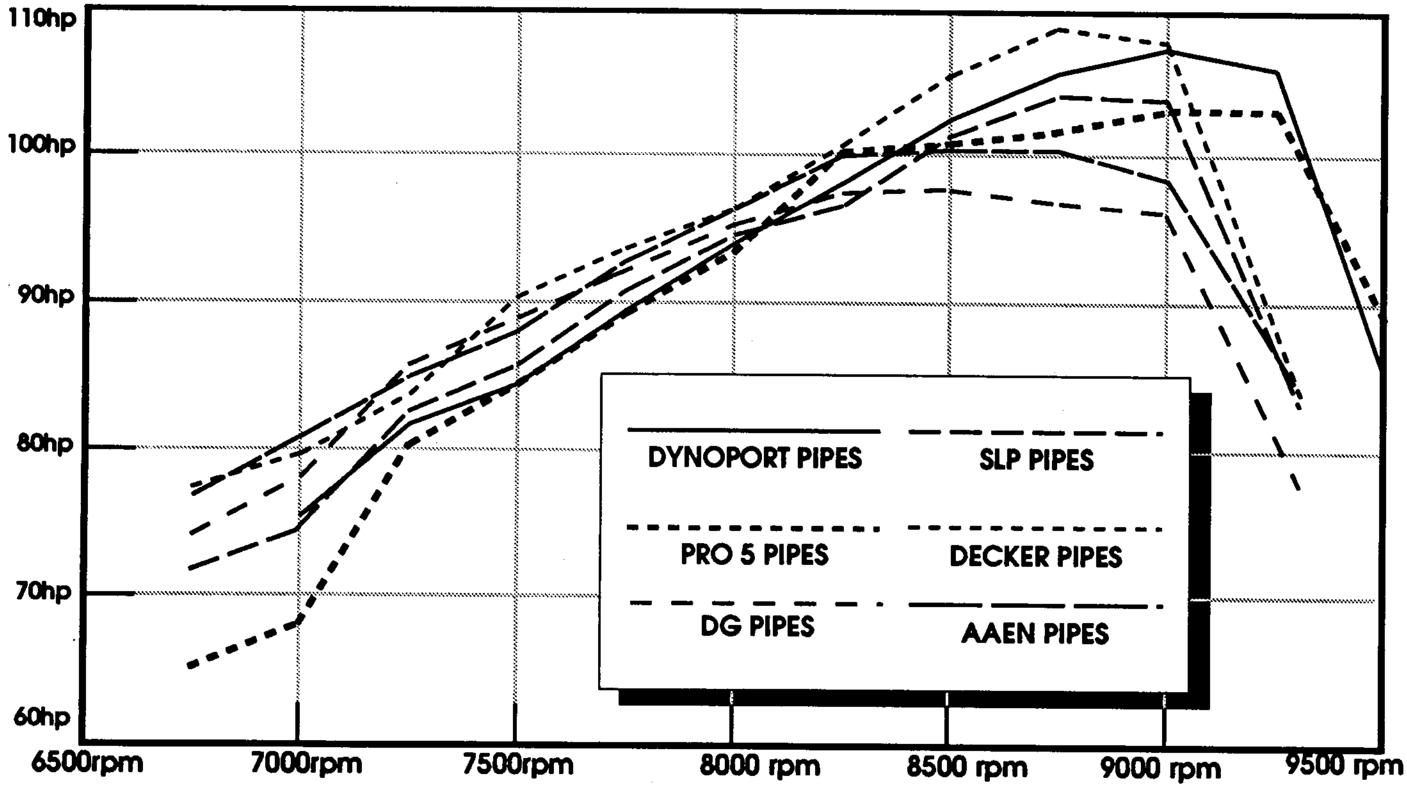
Data for 29.92 inches Hg, 60 F dry air
Test: 200 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .15 Barometer: 30.00

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6750	57.7	74.2	57.4	163.4	13.1	.76	43
7000	58.4	77.8	58.7	157.4	13.1	.74	43
7250	61.7	85.2	60.3	171.2	13.3	.70	43
7500	62.1	88.7	60.2	175.2	13.7	.67	44
7750	62.3	91.9	59.6	170.9	13.7	.64	44
8000	62.7	95.5	59.9	169.6	13.3	.62	43
8250	62.2	97.7	60.6	169.2	13.2	.61	43
8500	60.4	97.8	62.4	169.2	12.8	.63	43
8750	58.3	97.1	64.3	169.1	12.3	.65	43
9000	56.2	96.3	66.6	170.7	12.1	.68	43
9250	49.2	86.7	68.6	174.6	11.7	.78	43
9500	43.4	78.5	69.3	177.4	11.5	.87	43

1993 POLARIS XLT *PRO 5 PIPES*
34mm CARBS/220 MJ/90 dB

Data for 29.92 inches Hg, 60 F dry air
Test: 200 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .15 Barometer: 29.99

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6750	50.7	65.2	54.9	155.8	13.0	.82	37
7000	51.3	68.4	55.4	157.4	13.0	.79	37
7250	58.2	80.3	55.8	171.2	14.1	.68	37
7500	58.7	83.8	56.8	175.2	14.2	.66	37
7750	60.5	89.3	57.4	170.9	13.7	.63	37
8000	61.3	93.4	57.6	169.6	13.5	.60	38
8250	63.7	100.1	58.7	169.2	13.2	.60	38
8500	62.3	100.8	59.7	169.2	13.0	.60	37
8750	60.9	101.5	61.5	169.1	12.6	.61	35
9000	60.4	103.5	64.5	170.7	12.2	.61	36
9250	58.3	102.7	67.7	174.6	11.8	.64	37
9500	49.4	89.4	68.9	177.4	11.8	.75	38



FEEDBACK BACKFEED

Jim Czekala

V-Max 4 Pipe Shootout
During the execution of our latest V-Max 4 Pipe Shootout, the low RPM stock and aftermarket twin pipes needed 142.5 main jets. The high RPM quad pipes needed to be enrichened to 145 mains to be pump gas safe.

Bruce Kahlhammer, owner of PSI, pointed out the fact that his quad pipes caused the carburetion to enrichen more than the other quad pipes do. The low RPM PSI quad pipes were tested with the same main jets as the other, higher RPM quads, and were inadvertantly penalized by us with 108 lb/hr of fuel at the peak. They should have been tested with the 142.5 main jets, which would have dropped the fuel flow to @103-104 lb/hr, leaned out the A/F ratio, raised the horsepower to a higher level, and lowered the BSFC to the still-safe low .60's.

In reviewing all of our data, I must agree with his assessment. In the four runs that we made on the PSI quads, the fuel flow was consistantly higher than it was for the other three sets of quads.

During our Pipe Shootout, we also tested a then-experimental set of PSI Quads with internal stingers, which are now incorporated into their production quads. The benefits are greatly reduced noise levels (92 dB--a greater than 50% reduction)) and lowered fuel flow. These made 160.9, 161.0, 161.0, and 162.3 CBHP all at a slightly higher 8500 RPM on the four repeat runs we made with them. The fuel flow was in the 104 lb/hr range, and the BSFC was .60-.62 lb/hphr. Because they were experimental at the time, we didn't include them in the shootout. But, they will be available as standard next season.

Bruce also would have liked us to emphasize the fact that he spent a great deal of time developing the high horsepower quads for ultra-low RPM operation, so the stock CDI could be used. The additional benefit of the low RPM power peak is avoiding the high RPM resonant frequencies of the V-Max 4 crankshafts. Operation of even stock V-Max 4 engines in the 9000 RPM range requires either welding the center connecting gears or re-aligning the crank halves to fire at 180 degrees instead of 90.

TURBOCHARGING AND A CONFLICT OF INTEREST???
Bruce Kahlhammer and a few others have mentioned to me the possibility of a "conflict of interest" resulting from my heavy involvement with Greg Bennett in First Choice Turbo Center.

Turbocharging will never make more traditional snowmobile engine modifications and tuned pipes obsolete. There are many thousands of people out there whose budgets limit them to purchasing pipe(s) and lower cost engine mods. Investing the $3000+ required for a complete Turbo System, unfortunately, is beyond the reach of most snowmobile performance enthusiasts.

Also, turbochargers are in an entirely different class--illegal for most sanctioned oval and dragracing--and don't compete directly with "conventional" snowmobile engine modifications. Turbos don't compete directly against conventional mods in DynoTech for the same reason. Turbochargers are a totally separate, but interesting to most, technology that I'm quite proud to have helped perfect (almost).

Turbochargers are here to stay. Arctic Cat factory guys Kirk Hibbert and Al Schimpa cleaned house with their First Choice Turbocharged EXT-ZR in West Yellowstone and Jacksons Hole. Tim Berg's Black Magic is building 15 First Choice 700 Turbo ZRs. Gerard and David Karpik field tested the unbelievable Turbo Mach in Alaska this past April. Don't be surprised if you see our Turbo Systems in FAST's catalog next season. As this goes to press, SLP's Jim Noble and Jim Fairchild will be field testing one of our XLT Turbo Systems at high altitude. They want to provide their customers with this exciting technology. And, ask Tim Bender and Jim Reichard how the Turbo Yamahas run. With all of these qualified people involved in this project, it can only get better.

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FEEDBACK CONTINUED BACKFEED

Turbocharging will still only be for a fortunate few. We, meaning myself, Debbie, Kevin, the others who help with DynoTech, and the general performance snowmobiling public, will always need conventional modifications to softly-tune stock snowmobiles. That's the way it always will be. Imagine how boring it would be for us if every snowmobile were turbocharged! I doubt that Kevin would really enjoy doing tech articles on "Glycerin filled bourdon-tube boost gauges" or "The metallurgy of super-duty cylinder studs".

And, as far as conflict of interest goes, don't worry about vendors of our Turbo Systems getting any special consideration when we do future engine and component comparisons. As always, they must earn their horsepower. Besides, there are hundreds of other dyno testing facilities and DynoMites out there to check OUR work!

SPEAKING OF DYNOMITES

I have purchased a DynoMite from Land & Sea in Hampstead, N.H.

The DynoMite is one of those "I should have thought of that" creations that really fits a particular niche in the snowmobile industry. For about three grand, anyone can know what their torque and horsepower is, where the peak is, compare pipes, etc.

Four of my very best dyno customers, Bender Racing, HTG Racing, D&D Cycle, and Arnprior Sportland now have DynoMites. My reduced dyno bookings reflect the success they are having doing their own basic dyno analyses at their own shops. Now they only have to use the C&H SuperFlow Dyno for determining the effects of extremely subtle component changes and to obtain fuel flow and air flow data.

In the near future, we will do a side-by-side comparison of the torque and horsepower readings we get from our DynoMite and our SuperFlow dyno.

THE BATTLE OF THE MIDDLEWEIGHTS

The Middleweight class, or 580 class, is a hot topic among performance enthusiasts. This "class" makes up the bulk of the sales of performance snowmobiles in the industry today. All four factories would like to do well in organized competition--winning on the racetrack results in greater market share. Performance sells snowmobiles.

Here is how we believe each factory is attempting to secure or improve their competitive positions:

SKI DOO

For next season, the new 580 Formula Z will be many pounds lighter than the Plus X. And, with the reportedly increased horsepower from the addition of 40mm roundslides, this should be the "one to beat" in A Stock.

POLARIS

There is a good possibility that Polaris will build 500 triple-piped 580 XLT's. Assuming that the Polaris triple XLT pipes, if they indeed become a reality, are as good as the good aftermarket triples, the XLT might wind up with 105+ CBHP. This should put the Polaris right in the hunt.

YAMAHA

The new VMax 600 won't be available for us to test until late summer. Assuming that it will be stronger than the stock Exciter SX due to its 5% displacement increase and cylinder reed induction, we should expect close to 100 horsepower from the new Yamaha twin. From the looks of the new VMax chassis, the weight should be close to the old Exciter, which should put it in the thick of the A stock battles.

ARCTIC CAT

The 1994 Arctic Cat 580 ZR might wind up with a bunch more horsepower when production time rolls around. If twin pipes, triple exhaust port cylinders, and 40mm carbs that have been talked about wind up on the 580cc engine, we just might see 105+ CBHP. Combine this with new lighter weight chassis, and this would be an extremely competetive A stocker.

Once again, we are seeing four examples of relative perfection being delivered by the factories. This new breed of middleweight performance snowmobile is not the "softly tuned stocker" that I alluded to earlier in this FEEDBACK. The aftermarket people will have their work cut out to improve the performance of the new sleds much, without raising the engine operating speed.

REVISED RPC PIPES FOR THE V-MAX 4

As we mentioned in our last issue, Reichard's Performance Center was revising their quad pipes. The new quad pipes have shorter header pipes and internal stingers.

Jeff Simon of RPC sent us two more sets of V-Max 4 quad pipes to test. One set was a brand new production set, the other an early production set that had been shortened, with internal stingers added to "update" them to the new spec. We installed our original RPC pipes, as tested in Vol. 5 #2, on a new stock 1993 V-Max 4, with 137.5 main jets (safe for the day's 70+ degree F Carb Air Temp), and the following data resulted.

1993 V-MAX 4 ORIGINAL RPC PRODUCTION QUAD PIPES
33mm CARBS/145 MJ/98 dB
Data for 29.92 inches Hg, 60 F dry air
Test: 200 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .50 Barometer: 29.70

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
7000	86.7	115.6	77.8	209.6	12.4	.70	72
7250	87.4	120.6	80.6	220.8	12.6	.70	73
7500	88.2	126.0	81.7	227.2	12.8	.68	72
7750	93.5	138.0	85.7	235.6	12.6	.65	73
8000	96.3	146.7	96.9	245.6	11.6	.69	73
8250	96.9	152.2	111.5	257.0	10.6	.76	72
8500	94.4	152.8	107.1	264.2	11.4	.73	71
8750	79.8	132.9	95.8	271.6	13.0	.75	72
9000	62.0	106.2	92.1	268.2	13.4	.90	72
9250	49.3	86.8	99.5	257.4	11.8	1.20	70

We tested both the new production and the revised early RPC pipes. Both sets were identical, making 160 CBHP. The horsepower peak shifted from 8750 to 9000 RPM, depending on how hot the pipes were. Anyone who returns their quad pipes to RPC for shortening and internal stingers can expect the extra seven or eight extra horsepower that we saw here. As a side benefit, the internal stingers contribute to a greatly reduced sound level. Our dB meter registered 94 with the revised pipes a greater than 50% reduction in sound level.

1993 V-MAX 4 REVISED RPC PRODUCTION QUAD PIPES
33mm CARBS/145 MJ/94 dB
Data for 29.92 inches Hg, 60 F dry air
Test: 200 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .50 Barometer: 29.69

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
7000	80.4	107.2	77.9	217.0	12.8	.76	73
7250	81.4	112.4	79.3	220.4	12.8	.74	74
7500	83.8	119.7	82.0	224.6	12.6	.71	73
7750	85.9	126.8	83.4	227.2	12.6	.69	74
8000	86.7	132.1	82.9	229.0	12.6	.65	74
8250	89.2	140.1	85.5	232.4	12.4	.64	73
8500	95.1	153.9	103.8	245.8	10.8	.70	74
8750	94.8	157.9	107.6	258.2	11.0	.71	74
9000	93.5	160.2	103.9	271.0	12.0	.68	75
9250	80.2	141.3	102.3	279.8	12.6	.76	75

TURBO WILDCAT 700

Here is the turbocharged stock Wildcat 700 engine, with the same size Aerodyne turbocharger that we use on the V-Max 4 and the Mach 1 670. Stock twin pipes feed into a two-into-one manifold that bolts to the turbo exhaust inlet. A single glasspack muffler exits out the stock bellypan opening. 38 TMX carbs are used for this application, and provide crisp response and fuel delivery for all altitudes.

Keeping in mind the fact that the very best high compression full race mod 700 Cats just touch 150 CBHP (see Vol. 3 no. 6), we quit at 175+ CBHP, at only seven pounds of boost. This engine has run deto-free at this boost level for a whole season of trail riding (see "ASK KEVIN" in this issue). The only change we made was to add a Thundercat tunnel heat exchanger to keep up with the Thundercat+ horsepower that our turbo Wildcat was makes.

We have run the Turbo 700 at 10 lbs. of boost for short runs, at what must be close to 200 CBHP, and it has been up to that task.

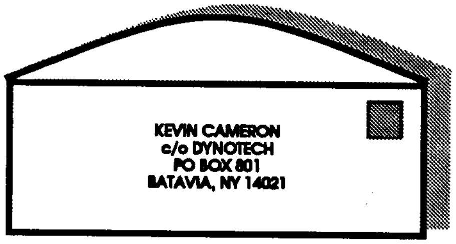
When we have a chance to dyno one of these again, we will run the boost up to ten or twelve pounds to see exactly what horsepower we are being rewarded with at that level.

Black Magic Motorsports is going to build fifteen 700 ZR's with this turbo system on them, for sale to the public.

1993 WILDCAT 700 TURBO
7 LBS BOOST
Data for 29.92 inches Hg, 60 F dry air
Test: 200 RPM/Sec Acceleration
Fuel Specific Gravity: .745
Vapor Pressure: .17
Barometer: 30.30

RPM	CBT	CBHP	FUEL	AIR	A/F	Man. Press. In.Hg.	BSFC	CAT
7000	106.3	141.7	103.2	259.8	11.6	13.5	.71	48
7250	106.8	147.4	96.7	262.8	12.5	13.4	.64	49
7500	111.4	159.1	101.1	270.3	12.3	13.8	.62	48
7750	113.0	166.7	113.4	280.2	11.3	13.9	.67	48
8000	112.8	171.8	115.6	287.0	11.4	14.0	.66	47
8250	111.6	175.3	117.9	290.2	11.3	14.4	.66	48
8500	102.5	165.9	121.5	288.5	10.9	14.5	.72	48

ASK KEVIN



KEVIN CAMERON
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This issue's column features questions Jim has fielded from subscribers calling for technical help, as well as questions he has raised himself for Kevin.

Can I use last season's, stale, almost odorless race gas as an octane booster to "sweeten up" some fresh unleaded premium gas?

Yes, but the knock resistance of the resulting brew will be unknown. Most current race gas contains about 4 grams of tetraethyl lead (TEL) per gallon; the unleaded premium contains none. You get a big octane boost from the first gram of TEL, less from the second, and so on until gains get very small in the range of 4-6 gm/gal. This being so, the unleaded premium responds strongly to the lead shared from the race gas, so its octane rating rises. If the unleaded contains a lot of alkylate, which has high-lead susceptibility, the octane of the resulting brew will be quite high. If the unleaded is mostly aromatic - say 40-50% toluene, which has poor lead susceptibility, the octane rise will be less, but still some. Use brews like this for non-critical applications.

Does mixing one gallon of stale or fresh 100 octane "100 LL Av Gas" with one gallon of 90 octane pump gas result in a true 95 octane mix?

No. Different antiknock scales are used for aviation and for motor gasolines. Aviation fuels are rated by performance number (PN), which compares the power it is possible to make in a test engine by turning up the supercharger boost, while remaining at the threshold of knock. For example, an engine running on aviation fuel rated at PN 120 could be supercharged to develop roughly 20% more power without knock than it could on 100 PN fuel.

The antiknock rating of motor gasolines is determined in an entirely different way, based upon two reference fuels; one is arbitrarily given the rating of 100 (the fuel is iso-octane), the other of zero (this is n-heptane). A mixture of the two reference fuels is found which knocks in a standard variable-compression test engine at the same compression ratio as does the fuel under test. The antiknock rating of the fuel under test is then stated as being the percentage of the 100-rated reference fuel in the mixture of reference fuels. For example, if an 87/13 mixture of iso-octane and n-heptane is found to knock at the same compression ratio as the fuel under test, the test fuel's antiknock rating is given as "87 octane".

This is complicated by the fact that there are several standards for knock-rating motor gasoline; research octane number (RON), motor octane number (MON), plus their average (RON +MON)/2, are only the beginning. Is the "90-octane pump gas" 90 RON, 90 MON, or 90 (RON + MON)/2? Unless the test method is given along with the octane number, the octane number is meaningless.

THE QUESTION OF ENGINE "SEVERITY"

Engines vary in their need for antiknock protection. A built-to-the-limit, large-bore, air-cooled will heat its intake charge a lot more than will a stock, small-bore, water-cooled engine - so it will be far more likely to provoke knock in any given fuel. This is one reason why there are different octane test methods; the RON is a less-severe test, using a lower intake temperature than the MON, and is intended to simulate cruising highway conditions. The MON test uses a higher intake temperature to simulate more severe engine conditions, and is intended to simulate acceleration or hard pulling. Because of these differences in test method, the RON is almost always a larger number than the MON, for a given fuel.

LYING BY TELLING THE PARTIAL TRUTH

Because the RON is usually larger, and because racers are suckers for bigger numbers, some fuel blenders have now taken to stating their products octane number as RON - even though the RON test does not even remotely simulate the conditions in a racing snowmobile engine. It makes far more sense to give the MON for a racing fuel - but even blenders who know better are forced to give the RON, simply because if they don't, their uninformed customers will all go and buy their competitor's gas because it has a bigger number on it. So everyone has to give inappropriate information.

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After years of seizing snowmobile engines, I am quite sure that high coolant temperature promotes detonation. I assume that high coolant temperature results in higher combustion chamber surface temp. The hot aluminum combustion chambers must transfer heat, like a radiator, into the incoming charge, increasing the likelihood of deto in lean, hot mixtures.

Smokey Yunick wrote that when you boil water over a combustion chamber, deto happens immediately. I saw that happen to Tim Bender a few years back with an improperly widened cylinder head (on the stroked, backwards Exciter). Coolant flow was short-circuiting between the cylinders, and allowed to "stagnate" over the combustion chambers. The engine would detonate even on huge, blubbery main jets! Once the coolant was forced to move over the combustion chambers, the engine could be leaned down, and no more deto occurred. Would you comment on this?

"Steam formation can lead directly to detonation if it causes a rise in cylinder head or piston temperature."

The present trend in design of cooling jackets is to make water passages as small as possible to speed up circulation velocity - especially over critical areas. Older engines often have such big jackets that modified engines can generate steam over their hottest parts - and the sluggish water circulation is incapable of sweeping the steam away. Once steam begins to form, cooling in that area drops to practically nothing because there is only a hot, dry gas - steam - to carry the heat away, and this steam is preventing cooling water from reaching the overheating area. Steam formation can lead directly to detonation if it causes a rise in cylinder head or piston temperature.

Another scheme being used in recent designs is so-called "strategic cooling", in which water circulation is planned so as to produce maximum cooling in the areas that need it most. On a racing two-stroke, this would include the region around the exhaust gate (if any) and between the tops of the main transfers and the bottoms of the booster exhausts, plus the general exhaust port region as a whole. On four-strokes, special measures are taken to cool the area between pairs of exhaust valves, and the exhaust valve guides.

People have often solved cooling problems by pumping water through parts made transparent by using RTV to bond on plexiglas windows, then adding dye streams to the water to see where it goes. It's amazing what a little porting can sometimes do to improve cooling. One area that often responds well is the entry to the waterpump; any sharp bends or edges here can cause the pump to cavitate (generate steam on the low-pressure side of the impeller vanes) at higher RPM. I have often seen 5 degree reductions from five minutes of die-grinder work on pump inlets. Another fruitful area is flow dividers in water lines serving the heads or cylinders; a poor design will favor one side and starve the other. Blow water though it with a garden hose and see if either side flows more. Common sense, as so often is the case, is our guide.

A second related question concerns Polaris' non-pressurized cooling systems on two of the current models. What is the boiling point of 50/50 mix at sea level and high altitude, and how much higher is it with the ten PSI head pressure that exists in normal cooling systems? If the boiling point at the combustion chambers is reached, and vapor pockets are formed, is it likely, as Smokey says, that deto will promptly occur? This would explain some strange meltdowns that have been described to me.

Water at sea-level atmospheric pressure boils at 212 degrees F, and each added pound per square inch of pressure raises its boiling point by 3.25 degrees F. Adding the standard 50% of ethylene glycol raises the atmospheric pressure boiling point to 227 degrees. The boiling point of 100% glycol is high - 385 deg. F. Before WW II, aircraft engineers eager to reduce drag used 97/3 glycol-water mixtures, running at a coolant temperature of 325 deg. F, as a means of allowing use of smaller radiators; the hotter the coolant, the faster the heat transfer from rad to air. However, heavy glycol mixes leaked at all the joints. Coming back to 50/50 or 30/70 banished the leaks, and acceptably high coolant temps were achieved through pressure rather than chemistry.

Racing engines - two-stroke or four-stroke - are currently being run at coolant temps very much

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ASK KEVIN CONTINUED

lower than the familiar 220-235 deg. F that automotive engines use. Why? The hotter an engine runs, the more it expands the air it breathes, and the less it gets of it. A racing two-stroke is considered warmed-up today when its coolant reaches 122 deg. F - provided that the fuel is volatile enough to form a mixture at that engine temperature. Four-stroke racing engines such as the Honda RC30 or the Muzzy Kawasaki ZX7-R run at about 150 deg. F.

Yes, perhaps some power is lost to overcooling of the combustion chambers, but is more than made up for by limiting the heating and expansion of the intake charge. An ideal engine would have two cooling loops; a hot loop for the cylinder head and exhaust region, and a cold loop for the crankcase and transfer port regions. Present designs try to approximate this by circulating the coolest water to the cylinder first, then letting it flow through the heads last.

Along the same lines, would you address the value of the currently available Thermal Barrier Coatings applied to the combustion chambers. We have hypothesized that the TBC surface temp must be, at least temporarily during the power stroke, higher than the bare aluminum would be. The telltale deposits of fuel lead on TBC coated pistons and combustion chambers that we seldom see on stock pistons or chambers are a temperature indicator of sorts. If our assumption that the surface temperature is higher is correct, is it possible that this would cause even greater intake charge preheating?

First, does the use of thermal barrier coatings raise the combustion chamber-side temperature of coated pistons or heads? You bet. When you lie down to sleep in bed, you cover yourself with a thermal barrier coating called a blanket. It makes you comfortable because the side of the blanket facing the heat (your hot body) itself becomes hot. It does so because the heat, unable to flow easily through the insulating material, accumulates as a rise in temperature of the material next to the heat.

In an engine, the TBC works to reduce heat flow to coolant by resisting heat flow through itself and into the metal of the combustion chamber. Since heat cannot flow rapidly through the TBC, the side of the coating facing the heat naturally rises in temperature - just as did the blanket.

It may be that the specific heat of the TBC material - the amount of heat it takes to raise a pound or a gram of it a degree F or C - is so low that on the next intake cycle, the first little puff of fresh air cools that hot layer instantly. I suspect not, though.

Taken to extremes, this business of insulating engine combustion chambers leads to what the Army is doing in its low heat rejection engine program - the so-called adiabatic engine. The idea here is to reduce heat loss from the combustion gas by making the piston crown, combustion chamber, and cylinder walls operate as near to flame temperature as possible. As noted in the 2nd law of thermodynamics, heat flows from hotter to cooler, so if there is no temperature difference between two bodies, there will be zero heat flow. Therefore a hotter engine loses less heat, and should give higher efficiency. (see the note below)

A simple way to see this is to compare the operation of a normal engine with an overcooled one - say an outboard motor with no thermostat. The overcooled engine develops less power because heat is lost faster from its hot combustion gas to its overcooled parts. Similarly, in drag racing, an iron-headed engine often gives more power than an aluminum-headed one (other things being equal) because of greater heat loss to aluminum.

However, detonation sets the upper limit; get the chamber, piston, or walls too hot and the fresh charge will be overheated before the flame front can burn all the way through it, and the last bits of the charge will go off by themselves - they'll detonate - likely damaging your engine.

Seeking a happy medium is all you can do; try the coatings to see if you make more power, but don't assume that more of something (whether it be cooling or heating) will always be better. The more effective the coating is at slowing the outflow of heat from your combustion chamber, the hotter its inside surface will run. This, in turn, will cause expansion of fresh air charged into the

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engine on the next cycle, leading to some loss of power.

Regarding the adiabatic engine; although some progress has been made in improving Diesel engine efficiency through extreme insulation of the combustion space, there are losses arising from the intake process; to have high intake density (which is the basis of power, for it determines how much oxygen there is in the cylinder with which to burn fuel), the intake charge must remain cool. This is impossible when the inside of the cylinder is at or anywhere near flame temperature. As soon as the fresh charge enters, it is heated and it expands, causing a great density loss. To overcome this, adiabatic engines are heavily turbocharged to force the air in. This consumes power and is complicated, suggesting there may be no free lunch.

> **"...at a tolerable boost level, (turbo) operation can be knock-free and power output still very high."**

Another question I've had relates to the amazing survival of the turbocharged snowmobile engines, on pump gas, at high horsepower and BMEP levels that would quickly cause deto in a normally aspirated engine.

One case in point would be the Rotax 670 rotary valve twin. Stock, it generates @115 CBHP at 7500 RPM. In its most highly modified state of tune, it will make 160 CBHP at 9200 RPM. It takes 18-1 compression to do this, which would not handle 92 octane gas for more than a few seconds without detonating.

The same stock engine, turbocharged with stock 11-1 compression, with 7.5 pounds of boost will make more than 170 CBHP, at a lower 7800 RPM. At it will run great distances, happily, on 92 octane gas.

Another case would be the 750cc Yamaha V-Max 4. In it most modified state of tune, it will make 185 CBHP at 9800 RPM. Ultra-high compression, race gas only, and even then for short periods of time.

Leave the engine stock, add a turbo at only 7.5 PSI of boost and it will make 185+ CBHP, and do it for long periods of time on pump gas.

My question is how does the turbo, even with its much higher intake charge temperature, resist detonation so well? Does this high temperature help homogenize the A/F mixture? Does the low RPM allow more piston cooling time between explosions? Is a turbocharged engine's power-stroke more "gentle", or less violent than a high RPM, high compression engine? Would the low RPM turbo engine have lower peak combustion chamber temperature? The Brake Specific Air Consumption is higher with the turbocharged engine; does that help cool the cylinder? Can you make some sense of all this?

Why do turbocharged engines run happily on available fuels while making big horsepower, but to get similar power from a non-turbo engine, you must play footsie with detonation and overheating, while paying for the very finest in racing fuels?

Power output is determined by the amount of fuel/air mixture burned per second. This simplified power output is modified by a thermal efficiency term - the compression ratio. The higher the ratio we can run, the larger the percentage of the fuel's energy we can take out on the piston crowns - subject to the detonation limit - and the less goes out the exhaust pipe as waste heat.

Detonation is a time-and-temperature-dependent phenomenon; temperature has the effect of knocking loose hydrogens from fuel hydrocarbon molecules. A single loose hydrogen then combines with an O2 molecule from the air to form an OH radical and an O radical. The hotter the charge, and the longer it spends at temperature, the more of these extremely reactive OH radicals accumulate in the unburned charge. When there are enough of them in a given region of the end gas, that bit of unburned charge can autoignite - go off by itself - and it does so explosively. This is detonation.

To get max power from a non-turbo engine, you must spin it as fast as it will pump air, and you must squeeze the charge hard to get the most power out of every bang. The very high compression ratio heats the charge a lot even before ignition, and the ignition and initial burning of the charge then compresses the remaining charge and heats it a great deal more. This creates ideal conditions for detonation in that remaining charge out near the

ASK KEVIN CONTINUED

cylinder wall. Making this worse is the fact that some hot exhaust product will always mix with the fresh charge, heating it even more. Compression ratios like 18 to one are common in small-bore, non-turbo two-stroke race engines - and the engine can live with this super-high ratio only on racing gasolines of maximum antiknock rating.

Now contrast the turbo engine. Instead of spinning the engine and squeezing the daylights out of it, we can make power by actually flowing more mixture per engine revolution - by blowing more mixture into the engine rather than just letting the feeble atmosphere try to push it in. Because of this ability to cram mixture in, we no longer have to be so concerned about squeezing (compressing) that charge so much. What is the compression ratio of a turbo motor, anyway? Well, it's the pressure ratio of the turbo, multiplied times the engine's compression ratio. If the turbo is putting out 1.5 atmospheres, and the engine compression ratio is 7:1, then the total compression ratio is 10.5:1. Because that's a lot less than the 18:1 of the non-turbo engine, there is less compression heating and so, less of a knock problem.

But there is a temperature rise through the turbo, isn't there? The hotter the intake temperature, the more likely detonation becomes, right? Yes, but the non-turbo engine's temperature rise is even higher, because its total compression ratio is higher; its temperature rise takes place inside the cylinder as the piston rises.

Here is another point; the turbo probably scavenges the cylinder a lot better than the atmosphere does, and so it blows out more of the exhaust residue from the previous cycle. That, in turn, means that the fresh charge will be less heated by exhaust product, so gaining less temperature from that cause.

Now consider charge heating inside the engine; the turbo engine packs more charge into the cylinder, so the heat it picks up is spread out over a greater mass of charge; that charge therefore rises in temperature less than would a smaller charge in the same cylinder. This effect may contribute to a lower charge temperature at the moment of ignition in the turbo engine.

In sum, the turbo engine makes its pressure by make its pressure by burning its lesser amount of charge at a higher temperature - to extract the greatest energy from it. Temperature, not pressure, is what leads to detonation, so the non-turbo engine has all the problems.

Don't misunderstand me - you can make a turbo motor detonate quite easily by turning up the boost a bunch. It's just that at a tolerable boost level, operation can be knock-free and power output still very high.

My final question pertains to the low RPM "fuel puddling" in the crankcase of the new Polaris "Storm" Fuji 750 case reed (eight petal) triple engine. As we discussed in the last issue, a low RPM burble has been blamed on rich or lean jetting (depending on who you talk to), but on the dyno, the engine burbles at part throttle, at a "perfect" 12-1 A/F ratio. People claim to have cured the burble with stiffer reeds--at the expense of high RPM power.

Have you encountered this before? Is this a common occurence on the case reed motorcycle engines? Is this unavoidable with large reed areas and large crankcase volumes?

Sometimes an engine will run poorly at part-throttle even when the mixture is known to be correct. This may be caused by fuel puddling in the crankcase, then being picked up at irregular times by the flywheels and tossed up the transfers, making the engine suddenly rich and stumbling.

I believe other makers have encountered this same problem. Back in 1974 or so, Kawasaki motorcycle triples were equipped with a tiny diaphragm pump on the front of each crankcase, intended to suck up and return to the carburetors the puddled fuel that accumulated in the case during lower-RPM running. Another story has to do with a maker who provided a shroud that covered its crank flywheels completely, leaving only a narrow slot through which the con-rod worked. A year later, this maker changed the design, putting a transverse slot across the shroud that would allow the wheels to centrifuge out any fuel that puddled (this was a racing engine that didn't spend any significant time below 9000).

I don't know this, but I would suspect that any engine in which it is hard for air to flow around the flywheels - for example, engines with full-circle wheels, crank shrouds, or away-from-the-crank intake flow direction - would be a candidate for this fuel puddling/burbling phenomenon.

Bear in mind that less volatile fuels - by which I mean pump gas or "circle-track gas" intended for hot-running V8 car engines - will turn your engine into a distillation apparatus. The volatile part of the fuel will flash into vapor instantly, and somewhat less volatile stuff will be evaporated by contact with hot interior engine surfaces. The rest of the fuel may puddle obstinately around your crankshaft, and refuse to evaporate. This is the stuff that boils only at temperatures hotter than your coolant ever sees.

> **"This is just what was found on the C&H dyno with one of these much discussed drilled flywheel sets; nothing."**

Is this "puddling" unavoidable with large reed areas and crankcase volumes? One possible cure would be use of a more volatile fuel, one with an end point (EP) down close to 240 degrees F, rather than the more common 300 degrees F of pump, circle-track, and so-called turbo gasolines. End point is the temperature it takes to evaporate the last part of a fuel sample in an ASTM distillation apparatus, and it is a measure of how easy a fuel will be to completely evaporate in a puddling situation.

Will using stiffer reeds solve the problem? Here is how it might. The softer the reed, the sooner it opens under the pressure difference created by the moving piston. Soft reeds are therefore associated with a "soft" intake event, one which starts slowly and builds up speed gradually - just as the piston does.

The stiffer the reeds are made, the more delayed the intake event becomes, and the more violent is the start of air motion - because the piston has pulled a lot of vacuum on the case before the reed opens. POP, the reeds open, and there is a high-speed rush of air through the carb. It may be that this more violent intake process better atomizes the fuel, reducing the portion that splatters as wet droplets on the walls, later to dribble down to the crankcase and pool there to create part-throttle burble.

Everyone has heard about the "turbo cranks" that have been tested; these are promoted by their advocates as turning your crank into a centrifugal supercharger that will force high pressure up your transfer ports, leading to gains of a claimed 15-25%. This is accomplished by drilling holes, welding on vanes, or milling slots into the wheels. Baloney.

The tip speed of centrifugal compressor impellers has to be 1-1.5 times the speed of sound (1100-1600 feet per second) to produce any serious pressure - and the "tip speed" of a snowmobile flywheel is far less than this at about 150-200 feet per second. Because the compression effect is proportional to the square of the speed, the "pressure" produced by a flywheel's rotation would be negligibly small.

This is just what was found at the C & H dyno with one of these much-discussed drilled flywheel sets; nothing. No gain at any speed. Ditto the track test.

On the other hand, if you had a bad puddling problem, with fuel accumulating around the crank at part-throttle, flywheels with holes, vanes, or big cut-outs might just have some stirring-up effect that would help paddle that fuel back into the air stream. Ah, but at what cost; the drilled crank we tested cost its owner $900 extra, beyond the manufacturer's price.

If I had this problem, I'd go with the more volatile gasoline first. I could think of alternative uses for the $900.

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