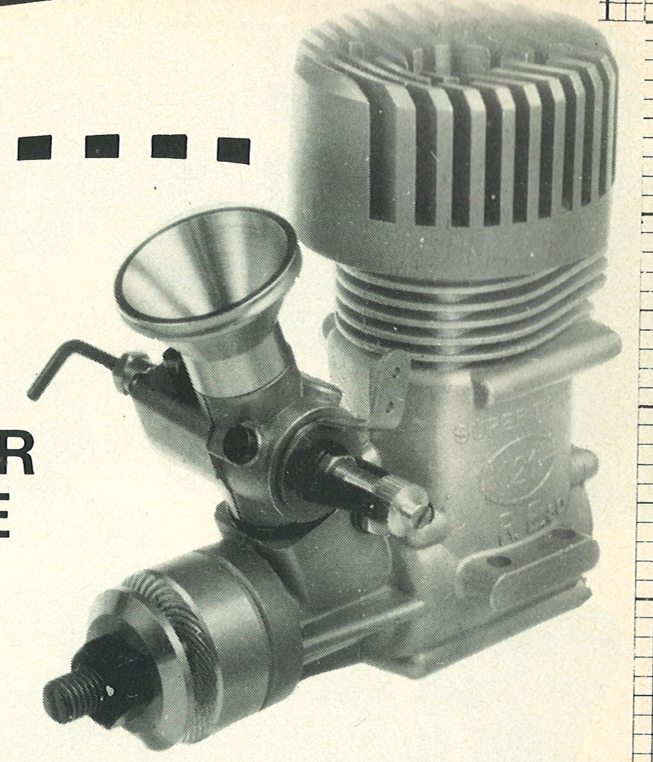
ENGINE TEST

No. 3

by Mike Billinton

SUPER TIGRE X-21 RE80

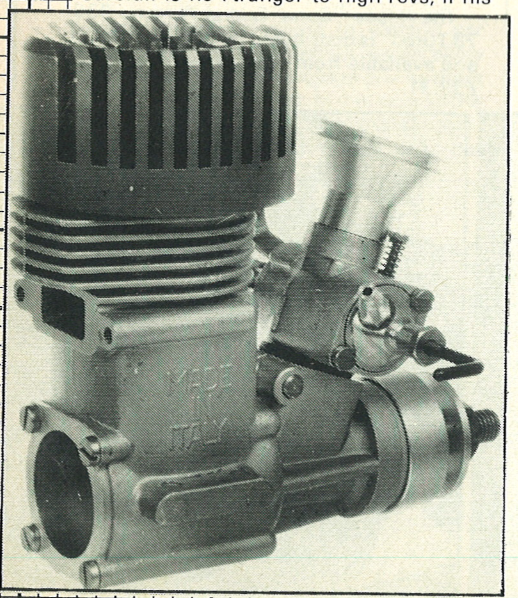


THERE MUST BE quite a battle at present in the 'home' of the racing engine, Italy; with OPS, Picco and Super Tigre reaching for ever-higher standards of power and reliability in the open model car field . . . but with Rossi though, keeping a discreet distance from the conflict.

Although the RE80 tested here is the current Super Tigre rear-exhaust answer, a yet more advanced machine is already in the pipeline, which points to the galvanising effect of competition on certain international classes using I/C engines. In view of the somewhat furious pace of development then, a look at the RE80 was advisable in continuance of this test series of currently available machinery.

Opportunity was also taken to assess effect of operating a motor on two alternative lengths of minipipe silencer — an appropriate engine on which to do so, because the RE80's rear-exhaust format often necessitates a right-angled (and thus longer) exhaust manifold to enable the silencer to occupy an occasional rear-of-car position.

An additional point of interest was to see whether S. Tigres are as high-revving as reported. Certainly manufacturer/designer Garofali is no stranger to high revs, if his rumoured practice of running-in some racing engines by shaft-running is true.



Mechanical layout and parts

The expected front induction with ABC piston/liner remains acceptable to S. Tigre, but they still retain faith in their own unusual version of cylinder porting . . . Perry/Schnuerle/Tigre. The test engine liner thus had three pairs of transfer ports, each having different areas and timings. Some RE80's have used a more normally Schnuerle ported liner, and photos show the two compared.

Crankcase internal layout is the same for either liner style, and as noted, rear-exhaust orientation is used, with asymetric cylinder finning extending backwards over manifold position. Because of the bluff square cylinder cross-section, the one-piece case is particularly rigid, with adequate material vertically present in each corner.

Crankshaft. Standing apart from most of the competition, the RE80 has a long stroke giving an under square stroke/bore ratio of 1.06/1.

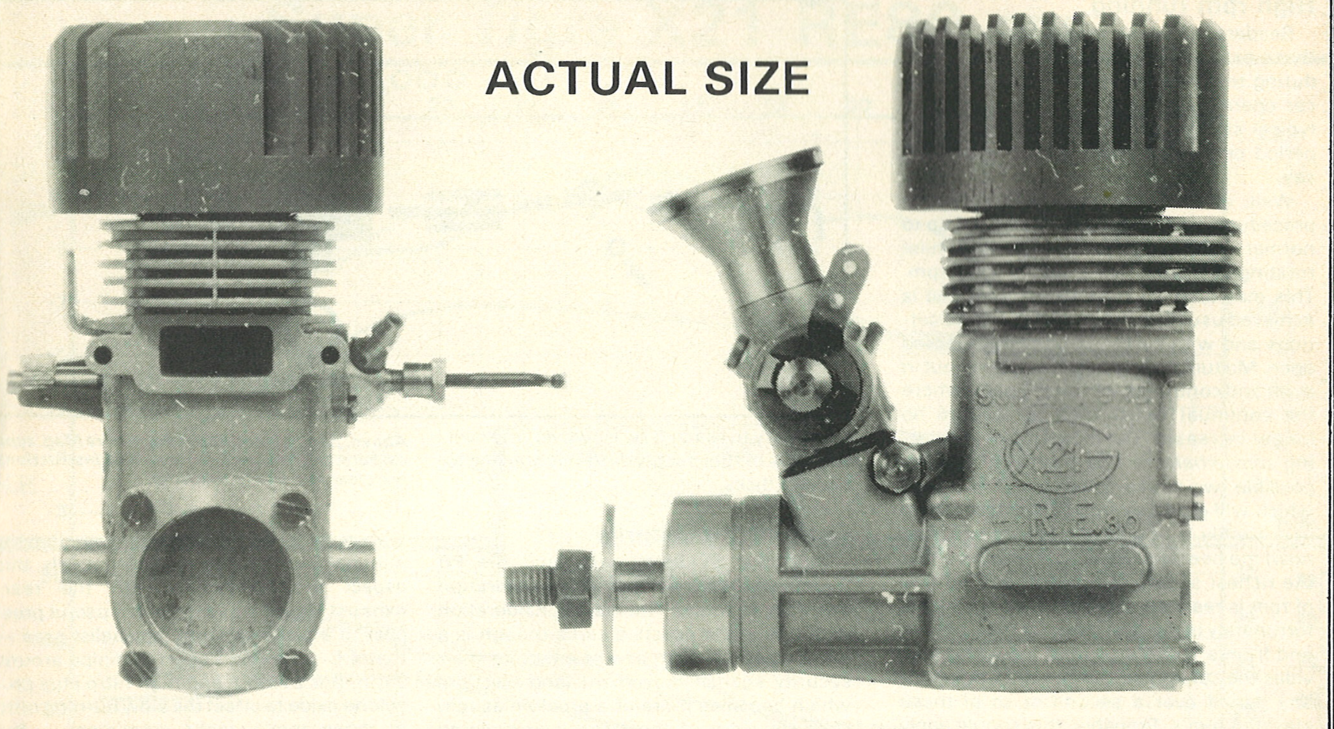
Though earlier shafts in the RE80 had 8.5mm. Induction bore and a bored crankpin, the current sizing (on this test engine) is 8.9mm, with a solid crankpin . . . a further pursuit of extra fuel/air flow and an indicator of the conflict between opposing demands of power and reliability. Going to a larger outside diameter than the 12mm of both these shafts (for greater strength) would mean a redesign of crankcase; which may yet be the next major step in this class.

Carburettor. The standard rotating barrel type (with two adjustable needles operating in a common spray-bar) is a large 9mm dia. and almost does full justice to the very large carb. boss in the crankcase. This could though take a much larger carb. even up to 12mm ID in which case the shaft bore becomes the limiting factor at present.

It is fitted with a simple but effective method of filter provision, i.e. the very large dia. screwed-on trumpet extension (25mm) can be covered by fine mesh nylon etc kept in place by elastic band seating in an external groove. S. Tigre have produced a 10mm slide carb for this car engine, but this was not available for the test; for direct comparison with previous test engines the PB slide carb of 9½mm ID was fitted for the max. power runs, though a sleeve bushing was required to marry PB and large 14mm boss together.

Connecting-rod. A substantial 'machined from solid' aluminium alloy part, which sensibly increases in X-section towards big and little ends (as viewed from side of engine). Has phosphor-bronze bushing at big-end only — with two lubrication holes.

Piston/liner is the now universally accepted brass liner chromed internally in conjunction with a high silicon piston of quite generous wall thicknesses. (Crown 2.5mm thick — upper piston skirt 1½mm — lower skirt 1mm and it's similar in weight to a K&B40S Dykes ring piston!). It's worth remarking on the current acceptance of piston weights (for motors reaching 40K) which would have been frowned on during the previous decade of high expansion/



ACTUAL SIZE

high strength/ringed pistons, where extreme lightness was sought even though rpm's were not expected to go above 20/25,000! Certainly the higher silicons are not of such high tensile strength (and thus need increasing in X-section), but the altered thinking has really followed the bias towards greater rigidity and heat capacity to cope with high-nitro fuels. The consequent 'problem' of 'over-heavy' pistons has not affected rpm potential as feared. Though it must be said that lighter reciprocating weight of itself could raise the rpm point at which con-rod big-end problems are currently occurring . . . the essential compromises in IC engine design are clear even from consideration of this one area alone.

Cylinder head. A large one-piece heat-sink alloy part, attractively anodised powder blue. Interestingly fitted at a large squish clearance of .017in. and a low effective comp. ratio of 7.45/1. Three engines were measured thus — which shows the RE80 to have almost twice the clearance of the majority of competing engines. This may not be significant because what counts is the squish inside each of these engines when operating flat-out; and that's difficult to measure! i.e. depending on precise metallurgy in each make of engine, the change in vertical expansions with heat and/or inertia will vary. Therefore differing static (cold) squish clearances will likely be needed if various makes of engine hope to arrive at similar clearances when hot and rotating. Visual inspection of piston crown can tell one if the squish is too small a clearance, but that is its only value. A degree of experimentation is therefore required if max. performance is the aim. This was not done for the test because piston to head contact had not occurred; and generally for test purposes it is right to stick with the manufacturer's set-up, otherwise anomalies will abound . . . of which there are sufficient in any case!

All of this suggests that max. power outputs recorded in this test could have been different with squish changes — a finding sometimes noted on the tracks.

Power tests

Providing continuity with previous tests, this open class car engine was operated in two main comparative areas:

1. Open exhaust — five per cent nitro — standard carb.

2. Amps minipipe silencer — PB slide carb — 50 per cent nitro whilst for informative reasons a further curve 3 was arrived at by lengthening the minipipe's overall length by 1in. to 6in. (piston face to end of pipe). This was done partly because a longer manifold may in any case be used with the rear-exhaust layout, and partly to assess whether it is a worthwhile exercise to shift the peak power point to a lower rpm level in this way.

Curve 1. The main feature of this open exhaust test was the reluctance of the RE80 to stop revving onwards and upwards! In order to 'save' the engine for the demanding (and more relevant) running equipment tests, these open ex. runs were stopped at 35,360rpm. Although from 20,000 torque had been slowly declining, rpm's however were leaping up significantly with each reduction of load, with a consequence that resultant bhp (torque × rpm) was being maintained at quite a high level even after the peak at 21,500. This was an unusual finding in the writer's experience, and maybe should have led to equally unusual results in 'full power format.'

Curve 3. The '1in. longer than normal' minipipe silencer runs now followed. Overall, the pulses produced by the pipe all occurred at lower than usual rpm points. It seems wrong to assume though, (from this test at least) that a longer pipe will give 'more power lower down.' Agreed — it will at some rpm points, but not at others — due to the 'cycling' effect.

Curve 2. Reducing the pipe now to its shorter normal length of 5in. whilst still using the 'full house' gear, led to a curve similar to others in this test series, and revealing a definite power advantage over the longer pipe from 24k-34,000.

No further runs were attempted after a final rpm point of 37,500 was reached, because the picture seemed clear, and from previous experience the certainty was that disintegration would follow somewhere in the 40000 area. As photographs were still required of this test unit, here then was a good place to terminate.

During all runs 14 per cent ML70 synthetic oil was used, as were S. Tigre L/R 1½V glow-plus-in idle bar form. Also used was silencer-pressure fuel feed.

Atmospheric correction factor of 1.04 has been applied to bhp open ex. runs, whilst for both minipipe runs (on a separate date) a factor of 1.06 was necessary.

High rpm running

Readers may wish to know for how long these extremely high rpm points are held during test, bearing in mind that in actual car operations, the peaks of rpm along a typical straight are maintained for a brief period only — no more than one second, say.

Well, under the writer's torque testing procedures, the motor is first coaxed up to normal operating temperatures whilst rotating at around two-thirds of likely rpm. This may take 20 seconds or more and is achieved usually by slightly rich needle settings and with carb. slide or barrel locked open. Mixture strength is then leaned out in swift and controlled way to the point where the continual visual read-out of rpm no longer increases. The motor is now operating *somewhere* on that narrow plateau of possible two-stroke settings — any one of which will give max. rpm. Therefore (again very swiftly — it's all happening very fast now) the needle valve is opened out so that the richest setting consistent with no loss of rpm is reached. On high-nitro fuels, this fortunately is the best point for max. power; and from a tester's point of view also provides the safest point to run the engine for any period over a second or so at these elevated rpm's. Probably, this should apply out on the tracks also.

The above procedure then, results in a period of max. rpm running of around ten seconds or so, during which time torque readings will have stabilised. Fuel supply is then quickly richened out to cool the motor and then totally cut off. The alternative of gradual closure of needle valve is highly dangerous, because traversing the overlean settings to cut-off fuel supply may not succeed without damage.

To conduct actual running operations at the other (lean) end of possible max. rpm settings is hazardous all round; although admittedly fuel economy would improve:

1. Pro-rata, there's less lubricant getting through to reciprocating parts.

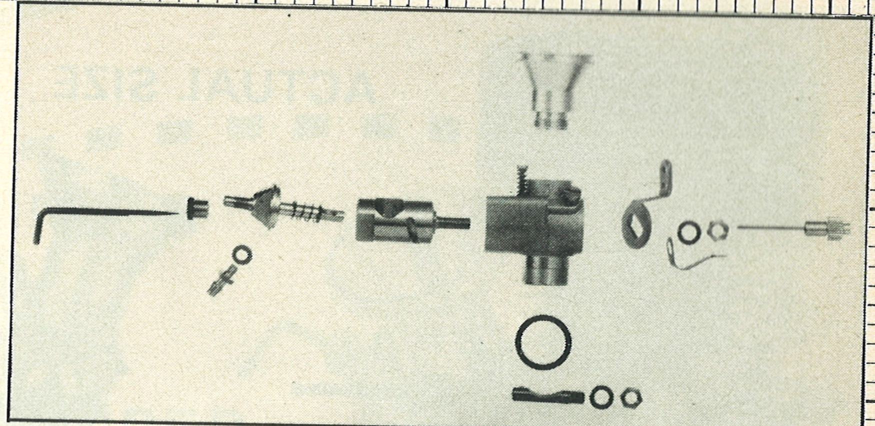
2. Motor runs much hotter, partly through delayed combustion processes with leaner settings (which leads to carry-over and build-up of heat from one cycle to the next) and partly as there is now less fuel to take its share of combustion heat away through exhaust port.

3. Operation is now only a 'whisker' away from the real lean (slower rpm) settings, and which usually herald a disastrous run-away overlean situation. There is here no margin for error, as there is at the other end of the range.

4. Glow-plugs will rarely survive lean runs on high-nitro fuels, but could hold together if slightly rich.

Starting

Although mechanical starting was used for the major part of the test, hand-starting was used throughout the final run (curve two) and proved to be very simple, with l-flick starts even on the very small loads necessary to reach 37k. However any over-richness of fuel supply *did* delay starting for several flicks.



Above; parts spread of the 9mm bore Mag. type carburettor. Unit works well and instructions are clear and easily followed.

Carburettor security

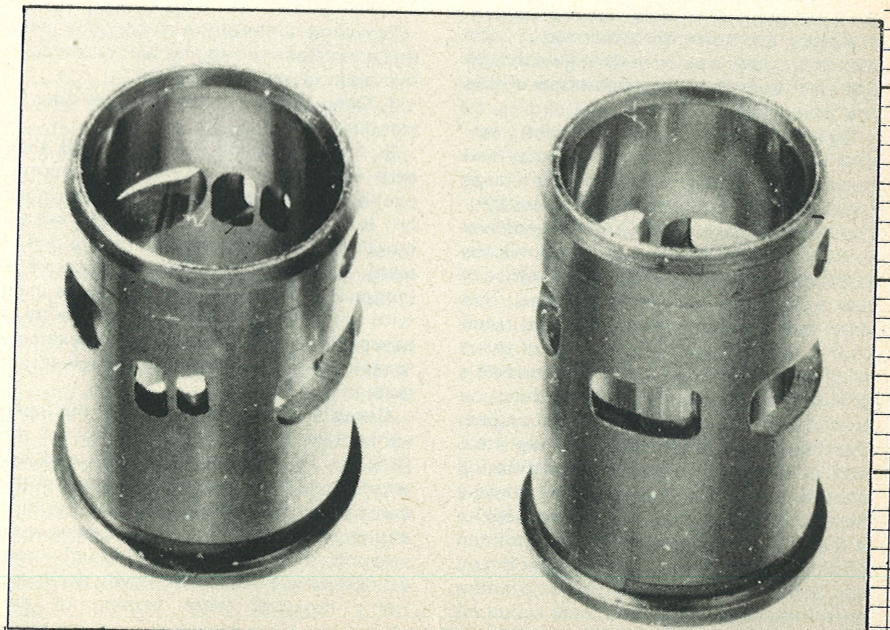
Both the ST 9mm carb. and the PB 9½mm slide carb were positive in operation and easy to adjust. The main consideration with any of the possible carbs though is a more down-to-earth one of ensuring their security against movement (and ejection) which becomes more of a problem as rpm rises. In view of the large over-hanging weight these large bore carbs represent (particularly as an air-filter is a required addition) it is advisable to additionally secure them to the intake boss with *Araldite* or silicon rubber cement — applied to clean dry surfaces.

Summary

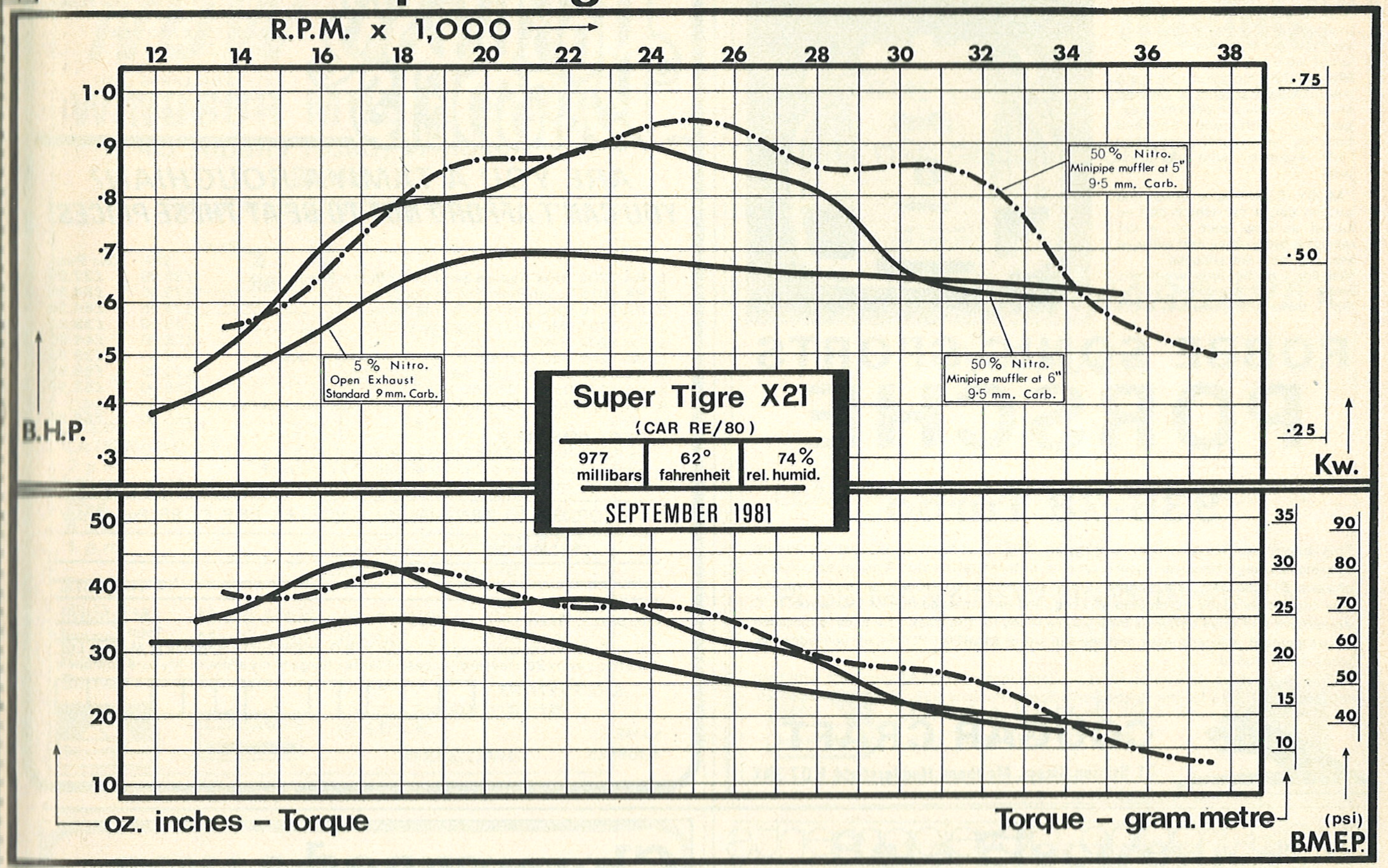
The RE80 was a pleasant motor to operate, and shared similar characteristics to those of other Open class car engines so far tested. Its unusual power curve in open exhaust format though, might match well with quite large standard silencers (having minimal back-pressure). Alternatively, this aspect in conjunction with the rear-exhaust layout could make it a useful prospect in a quite separate specialist area — thatof C/L speed. A short minipipe around 3¾in. (for 27,000) and high nitro plus propylene oxide to offset the slow burning nitro at those rpm's, looks promising ... but that's digressing.

The motor did not reveal any power advantage over its competitors by virtue of its rear-exhaust layout; so it will be of interest to see what the future holds for this particular design point in the open car field. Boats and aircraft certainly find the R/Ex mode of value but for cars the advantages are less clear.

Below; cylinder liner below right has normal Schnuerle transfer and boost parts, both at 136°. Left hand liner has S. Tigres individual porting - see text for timings.



Super Tigre X21 RE80 car



Dimensions and weights:

Capacity	—	.209cu. in. (3.42cc)
Bore	—	.6302in. (16mm)
Stroke	—	.6705in. (17.03mm)
Stroke/bore ratio	—	1.06/1
Timing periods	—	Exhaust 156° Main boost transfers 126° Side transfer (large) 122° Side transfer (small) 106° Front induction opens 46° ABDC closes 63° ATDC
Combustion volume	—	.36cc
Compression ratios		
Geometric	—	10.5/1
Effective	—	7.45/1
Exhaust port height	—	.216in.
Cyl. head squish	—	.017in.
Squish band width	—	.118in.
Squish band angle	—	0°
Overall height	—	3.45in.
Width	—	1.65in.
Length	—	2.78in.
Frontal area	—	4.56sq. in.
Mounting centres	—	.52in. × 1.34in.
Mounting hole dia.	—	.136in. (3.45mm)
Carburettor bores	—	S. Tigre MAG 9mm PB slide 9½mm
Mainshaft dia.	—	12mm
Crankpin dia.	—	5mm
Induction bore	—	8.9mm
Gudgeon pin dia.	—	4mm
Weight	—	11oz (.31 kilo) (with ST Carb and ex-manifold)

Performance

Max bhp:

.94 at 25,000rpm (minipipe silencer/PB slide carb./50% nitro)
.69 at 21,000rpm (open exhaust/ST carb./5% nitro)

Max torque

45oz in. at 16,670rpm (pipe 1in. longer/PB slide/50% nitro)
35oz in. at 17,800rpm (open ex./ST carb/5% nitro)

RPM standard propellers

8 × 6 Zlinger — 14,430 (open ex./ST 9mm carb/5% nitro)
8 × 4 Zlinger — 16,450 (open ex./ST 9mm carb/5% nitro)
7 × 6 Zlinger — 16,580 (open ex./ST 9mm carb/5% nitro)
7 × 4 Zlinger — 22,050 (open ex./ST 9mm carb/5% nitro)

Performance equivalents

BHP/cu. in. — 4.49
BHP/cc. — .275
Oz in./cu. in. — 215
Oz in./cc — 13.15
Gm metre/cc — 9.35
BHP/lb — 1.36
BHP/kilo — 3.0
BHP/sq. in. frontal area — .206

Manufacturer

Super Tigre SRL, Bologna, Italy.

UK distributor

Tigre Engines and Micromold.