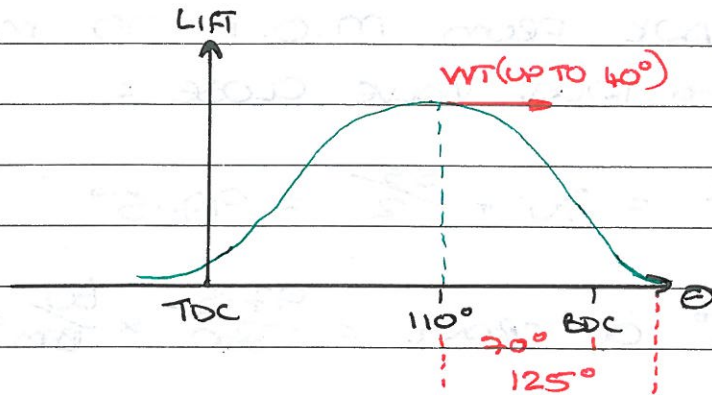


COMPETITION ENGINE PERFORMANCE

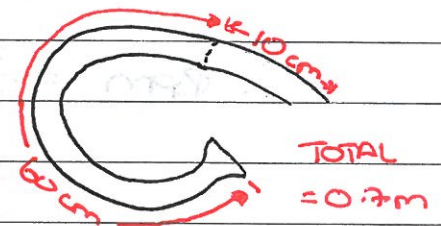
25/02/16

FORD 1600 SIGMA PLASTIC MANIFOLD

VALVE DURATION $\approx 250^\circ$ M.O.P. $\approx 110^\circ$ ATDC

VVT CAN ONLY RETARD
THE M.O.P TO AVOID
HITTING THE PISTON.

MANIFOLD DIMENSION -



IF DURATION IS 250° AND THE
CAM IS SYMMETRICAL THEN THERE
IS 125° BETWEEN M.O.P AND
VALVE CLOSING.

ASSUMING AIR V_{max} OCCURS AT M.O.P $\therefore$ FROM
BERNOULLI, LOWEST PRESSURE AT VALVE OCCURS
AT M.O.P. THIS IS THE START OF THE SUCTION
PULSE AND THIS PULSE TRAVELS UP THE INLET
TO THE ENTRY, SUCKS AIR IN AND RETURNS
AS A PRESSURE PULSE.

IF IT RETURNS AND THE VALVE IS OPEN IT
COLLAPSES INTO THE CYL. LEAVING A VACUUM
OR SUCTION PULSE IN THE INLET, WHICH
AGAIN TRAVELS BACK TO THE ENTRY AND PULLS
AIR IN AGAIN.... AND SO ON.

YOU NEED THE FINAL PULSE BACK SOMEWHERE
BETWEEN BDC $\rightarrow$ INLET CLOSING TO STOP THE
FLOW REVERSAL AS PISTON IS COMING UP.

THE TIME FOR THE PULSE TO TRAVEL FROM
VALVE $\rightarrow$ ENTRY AND BACK N TIMES $= N \times \frac{2L}{330}$ SECONDS

THIS TIME MUST EQUAL TIME THE CRAWK
TURNS FROM FULL LIFT TO MIDWAY BETWEEN
BDC $\rightarrow$ INLET VALVE CLOSE

DEGREES OF CRAWK FROM M.O.P TO MIDWAY
BETWEEN BDC $\rightarrow$ INLET VALVE CLOSE =

$$70 + \frac{(125-70)}{2} = 70 + \frac{55}{2} = 97.5^\circ$$

$$\text{TIME FOR } 97.5^\circ \text{ OF CRAWK} = \frac{97.5}{360} \times \frac{60}{\text{RPM}} = N \times \frac{24}{360}$$

$$\therefore \text{RPM} = \frac{330}{N \cdot 2.2} \times \frac{97.5}{360} \times 60$$

$$= \frac{330}{N \cdot 2.07} \times \frac{97.5}{360} \times 60$$

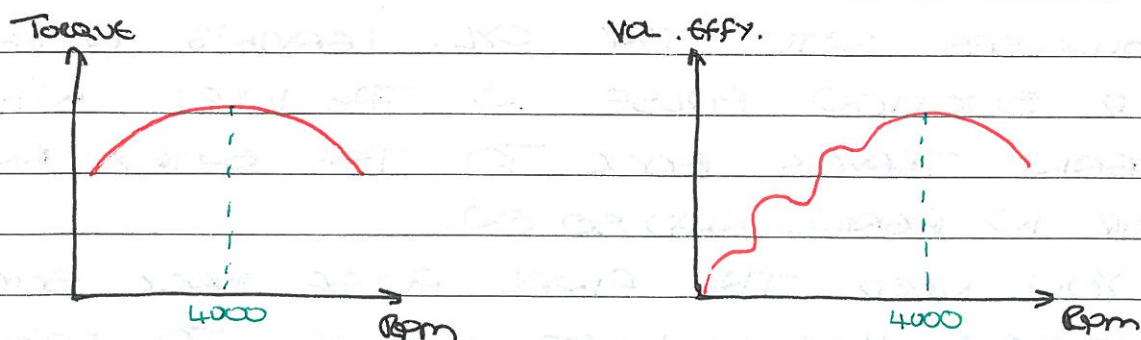
$$N_1 = 3830 \text{ RPM}$$

$$N_2 = 1915 \text{ RPM}$$

$$N_3 = 1277 \text{ RPM}$$

$$N_4 = 958 \text{ RPM}$$

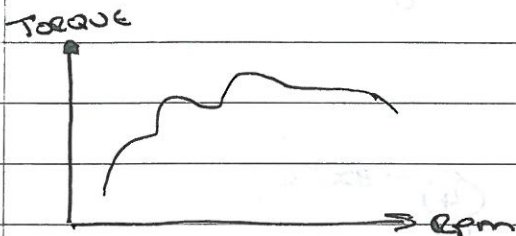
Sigma MAX TORQUE IS APPROX 4000 RPM, $\therefore$
FOLD ARE TUNING FOR TORQUE



INLET MANIFOLD LENGTH IS ALSO GOOD FOR THE
RAM EFFECT AT LOW RPM. A SHORTER MANIFOLD
WOULD HAVE LESS AIR MOMENTUM THEREFORE IT

WOULD SUFFER MORE FROM FLOW REVERSAL AFTER BDC.

FOLD SIGMA TUNING IS EFFECTIVE AT 3800 RPM AND 1900 RPM, W BETWEEN THE TUNED RPM'S THE VOL. EFFY. COULD BE WORSE.



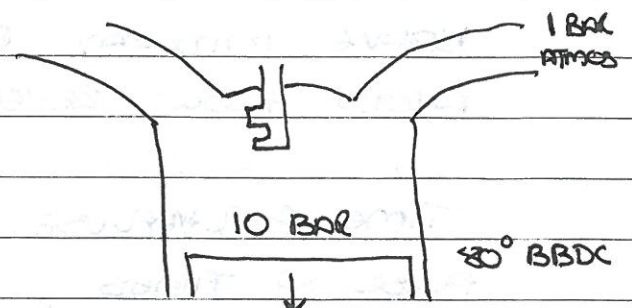
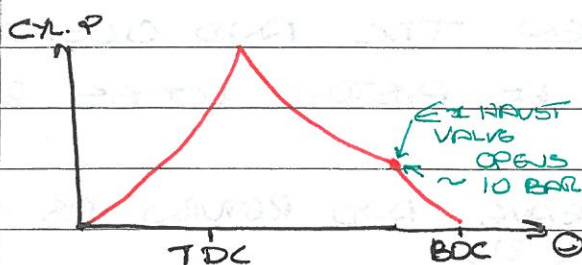
THE POOR VOL. EFFY COULD HAVE NEGATIVE EFFECT ON TORQUE.

EXHAUST PULSE TUNING

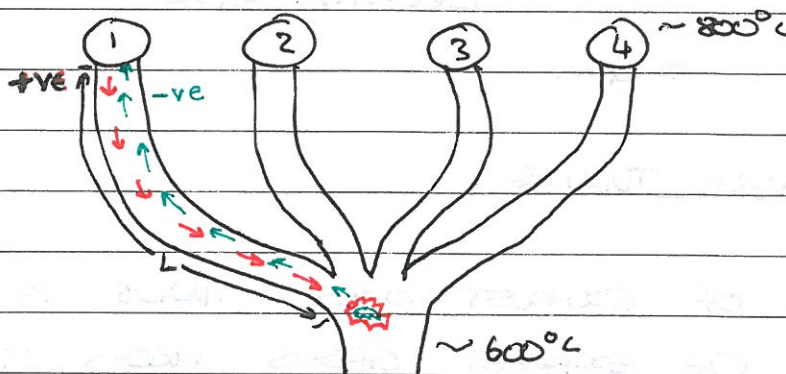
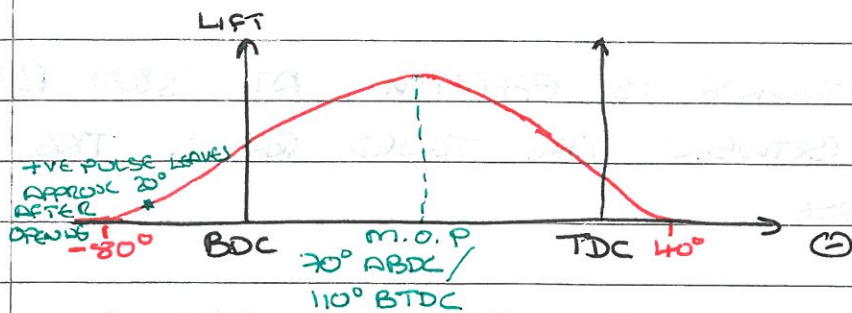
THE AIM OF EXHAUST PULSE TUNING IS TO PROMOTE SCAVENGING OF EXHAUST GASES FROM THE CYLINDER, DELIVERING A -VE PRESSURE PULSE JUST BEFORE THE EXHAUST VALVE CLOSURE.

BY TUNING THE HEADER LENGTH + DIA ^{AND COLLECTOR,} IT IS POSSIBLE TO ALTER THE TORQUE CHARACTERISTIC. IN A SIMILAR WAY TO INLET PULSE TUNING THE EXHAUST PULSES CAN BE TUNED TO AN RPM POINT TO ~~WORKING~~ ^{INCREASE} TORQUE. BY COMBINING THIS WITH TUNED INTAKE SYSTEMS (TO A DIFFERENT RPM POINT) IT IS POSSIBLE TO CREATE A BROAD TORQUE CURVE (OR NARROW IF DESIRED).

TAKE A 4:1 MANIFOLD $\rightarrow$ 4 $\times$ EQUAL LENGTH PRIMARY PIPES + COLLECTOR + 1 $\times$ SECONDARY PIPE.



50:40 RALLY CAM, DURATION = 300°



+VE PULSE LEAVES APPROX 20° AFTER OPENING AND TRAVELS AT SPEED OF SOUND TOWARDS COLLECTOR. WHEN IT REACHES THE COLLECTOR/EXPANSION THE +VE PULSE COLLAPSES RESULTING IN A -VE PULSE WHICH WILL TRAVEL BACK TOWARDS THE VALVE. A -VE PULSE BETWEEN TDC + EXHAUST VALVE CLOSE WILL HELP TO SCAVENGE THE CYL. CLEARANCE VOLUME.

IF THE SUCTION PULSE ARRIVES BACK AT VALVE AND IT IS OPEN IT WILL SUCK AIR/EXHAUST GASES OUT OF THE CYLINDER CREATING ANOTHER +VE PULSE TO TRAVEL TO THE COLLECTOR. THE AIM IS FOR THE FINAL SUCTION PULSE TO RETURN TO VALVE MIDWAY BETWEEN TDC AND CLOSING TO AVOID FLOW REVERSAL AS PISTON COMES DOWN.

TIME FOR PULSE TO LEAVE AND RETURN AS -VE PULSE N TIMES, $T = N \cdot \frac{2L}{\text{SPEED OF SOUND}}$

THE SPEED OF SOUND CHANGES WITH TEMPERATURE.

YOU WANT THE EXHAUST PULSE BACK MIDWAY BETWEEN TDC + EXHAUST VALVE CLOSING $\therefore$ PULSE MUST RETURN 260° AFTER IT LEFT.

$$\text{TIME FOR } 260^\circ = \frac{260}{360} \times \frac{60}{\text{RPM}} = N \cdot \frac{2L}{\text{SPEED OF SOUND}}$$

WE WILL HAVE TO USE THERMOCOUPLES TO FIND EXHAUST TEMP AT DIFFERENT RPM'S, THIS WILL AFFECT THE SPEED OF SOUND -

$$T_{\text{AV OF EXHAUST}} = \frac{800 + 600}{2} = 700^\circ$$

$$\text{SPEED OF SOUND} \propto \sqrt{T_{\text{ABS}}}$$

$$\frac{\text{SPEED OF SOUND @ } 700^\circ\text{C}}{\text{SPEED OF SOUND @ } 20^\circ\text{C}} = \sqrt{\frac{700 + 273}{20 + 273}} = 1.82 \quad (\text{RATIO OF ABSOLUTE TEMPS})$$

$$\text{SPEED OF SOUND @ } 700^\circ\text{C} = 1.82 \times 330 = 601 \text{ m/s}$$

$$\text{RPM} = \frac{\text{SPEED OF SOUND}}{N \cdot 2 \cdot L} \times \frac{260}{360} \times 60$$

$$= \frac{601}{N \cdot 2 \cdot 0.6} \times \frac{260}{360} \times 60$$

$$N_1 = 21,703$$

$$N_2 = 10,851$$

$$N_3 = 7,234$$

$$N_4 = 5,426$$

$$N_5 = 4,341$$

SO AIM FOR BEST TUNING OF EXHAUST IS TO GET -VE PRESSURE PULSE BACK TO THE VALVE WHEN THE PISTON IS STARTING TO ~~MOVE~~ DOWN AFTER TDC TO HELP PREVENT THE FLOW REVERSAL CAUSED BY THE PISTON TRYING TO SUCK EXHAUST GASSES BACK INTO THE CYLINDER.

REASONS EXHAUST VALVE IS OPEN AFTER TDC -

① - USE EXHAUST VELOCITY (+VE PULSE TOWARDS COLLECTOR) TO SUCK AIR IN.

② - CANT CLOSE VALVE INSTANTLY SO YOU HAVE TO CLOSE IT OVER TIME BUT YOU DONT WANT TO START CLOSING TOO EARLY AS IT WILL ACT AS A RESTRICTOR AS PISTON IS MOVING UP.