Head Gasket Change - Lotus Elan M100

The Car

i. 1990 UK model, no catalytic converter, no air con.
ii. Stainless steel exhaust.
iii. 87,000 miles
iv. Tyres:- Bridgestone Potenza RE720 205/50 R15 86V on standard Lotus 6½ J, 15 inch Oz alloy wheels.
v. Some service history came with the car. Lotus Dealers had serviced it fairly regularly up until about 72,000 miles. There is no record for the 78,000 mile service as the previous owner had serviced it himself and, at some point, had fitted new stainless steel braided flexible brake hoses. I had it serviced by a Lotus Dealer at 84,000 miles.
vi. The car had Recaro seats, which had been fitted by the previous owner. I refitted the original Lotus seats, but the jury is still out to decide on preference.
vii. The oil cooler was leaking when the car was purchased so I had it (and the feed and return pipes) replaced by a Lotus Dealer.

The current problems

i. Continual loss of cooling water. Required coolant top-up two/three times per week.
ii. Oil in cooling water
iii. Oil leaks on front and side of engine.

Part numbers for new components (all from SJ Sports Cars, Crediton, UK)

i. Cam belt – ISUZU P/N 8944294860
ii. Alternator drive belt – Gates Auto Master Micro-V – P/N 48339
iii. PAS drive belt – Bando Rib-Ace 6PK945 - P/N 894364-5800
iv. Complete gasket set – Lotus P/N A100E6184S
v. Oil seals for CAS and cam shaft plug – Lotus P/N A100E6562S
vi. Water Pump – Lotus P/N A100E6172S

Tools

i. Lotus jack - to get the initial lift off the ground to allow removal of the front RH wheel.
ii. Trolley jack - under the rear bolts of the front RH raft (plus block of wood to spread the load) to get the car higher.
iii. Axle stand - under the front RH wishbone to give the car stability while off the ground.
iv. Another jack (plus block of wood to spread the load) under the sump, to support the engine when the RH engine mount is removed.
v. Good metric socket set and hex drive set. I have several sets of sockets, purchased over a number of years, so I was generally able to find the right size and depth of socket to suit the job.
vi. 17mm impact socket for stubborn crank bolt.
vii. A good torque wrench.
viii. Engine hoist.
ix. Prehensile fingers to get to the difficult nuts and bolts!!

The process

Disclaimer

All work that you do to your car is entirely at your own risk.
I take no responsibility whatsoever for any work that you may carry out on your car,
or for the outcome of any work that you may carry out on your car.
You will require some knowledge of mechanical engineering to carry out this work
and you should also ensure that all necessary safety precautions are taken at all times.
Most of all, use common sense.
Read the manual first, and then double check everything before
completing the job.

The process I adopted is very much as listed in the Lotus manual, section EC 8. The only exceptions and additions to this list that I had decided on, and the main problems, were as follows:-

i. Remove bonnet.
ii. Remove coolant header tank. This gives much better access to the area behind the engine, especially when the air intake pipes are removed from the plenum input and from the air filter to turbo. Removing the tank also provides access to the HT generator wiring.
iii. Undo the crankshaft bolt while the car is still on the ground with the handbrake on and in 5th gear. This provides maximum resistance to crank rotation while applying lots of torque to undo the crank bolt. You should release the bolt at this time, as it will be almost impossible to undo it later, when the car is off the ground. I used a 17mm impact socket (to help prevent rounding the corners of the hex head of the bolt), a ½" drive universal joint (to allow the ½" drive bar to pass in front of the RH wheel. The steering had been turned fully to the right), a long ½" drive bar and a very long wrench. The crank nut was extremely tight. It felt as if it had been tightened by an air driven ratchet (similar to that used in a tyre bay, to remove and fit wheel studs). It took two people to undo it - one to lean on the wrench and one to steady the whole set up. When this bolt is released, proceed to the next steps.
iv. Remove the alternator and PAS belts and remove the crank pulley. This provides much greater access to the bolts holding the engine mounting beam, and to the cam belt covers.
v. I didn't completely disconnect the high-pressure pipe from the PAS pump because fluid dribbles out everywhere! I loosened the nut on the high-pressure feed pipe on the top of the PAS pump, and manoeuvred the pipe out of the way while removing engine mount and cam belt covers. I always locked it in the new position, before moving onto something else. I only lost a few drops of fluid.
vi. I fitted small polythene bags (sandwich bags from local supermarket) over all of the exposed apertures, especially turbo input, boost gauge sensor, high-pressure fuel line, etc… A simple way to keep dirt out of sensitive areas.
vii. All nuts, bolts, pipes, brackets, etc.. that were removed from the car, were cleaned and immediately put into plastic bags and labelled.
viii. All pipes and cables that were disconnected were labelled.
ix. I did not disconnect the knock sensor wire, or disconnect the two fuel pipes, or undo the bolt securing the 'P' clip holding the battery leads, until the head had been lifted a few inches. This allowed much better access to all of them. I had to continually check that none of the wiring was stressed in any way, but there is lots of slack in the flexible fuel hoses.
x. Disconnect and completely remove the bracket holding the starter catalyst housing to the bottom of the block before attempting to remove the turbo oil feed pipe. Removing this bracket allows good access to the lower connection of the oil feed pipe.
xi. While the crank pulley and the cam covers were lying on the garage floor, I cleaned them and marked the TDC timing mark on the crank pulley and the 16 deg BTDC and TDC marks on the cam belt cover to ease setting the timing when

the job was finished (I used 'Tippex' – a white paste in solvent, normally used for painting over spelling mistakes on documents). Thanks for the excellent write-ups on your web site on setting the timing. They worked a treat for me.

xii. The only serious technical aspects of the process are:-

a) Before the new cam belt is put onto the engine, ensure that the cam belt tensioning pulley is rotated clockwise around its locking bolt, and locked in place. When the new belt is in place, and the lock released, the spring on the tensioning pulley will then automatically provide belt tension as the spring tries to unwind anti-clockwise and pushes the pulley against the belt. If necessary, final tension can then be applied manually anti-clockwise, using an Allen key in the hex hole in the tensioning pulley, while the splined bolt locks it all in place. Take care not to over tighten the belt, as this will potentially cause undue load on the water pump drive. I replaced my water pump as a precautionary exercise.
b) Ensure that the relative positions of the crank pulley and two cam pulleys are set correctly when installing the new cam belt.
c) Ensure that all nuts and bolts are torqued correctly when components are reassembled.
d) Apart from these issues, some of the other jobs were 'fiddly' and time consuming, but not really too difficult, so the rest of the process is relatively straightforward.

The investigation and some observations

i. A fair amount of oil had dribbled down the face of the block, in the area behind the cam belt covers. The old belt did not have any contaminant on it. This oil had clearly been leaking from the head gasket area.
ii. There was a lot of oil on the underside of the engine and all over the gearbox casing. Again, it looked as if this had dribbled down the front of the block from the head gasket area behind the turbo, and had almost completely covered the block, gearbox and sump. It looked as if some oil had also come from the Cam Angle Sensor oil seal, so this was replaced at the same time.
iii. The cam cover bolts were so loose that I could almost remove them by turning the hex drive using only my fingers. However, the cam cover itself was very difficult to remove and care is required as the cover is very weak when twisted. The gasket was soft and had been stuck to the head with black 'glue' (liquid gasket of some description?). I spent a lot of time with a very sharp knife splitting the seal, and then scraping the black mess off the head. When the cam cover was off, the gasket pulled out of its groove quite easily.

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

iv. When the head was being lifted off, the head gasket came away very easily from both the block and the head. Fig 1 (gasket bottom side) and fig 2 (gasket top side) show the two faces of the gasket. They show that there was no visible damage to the seals around any of the bores, but there was damage to several oil and waterway holes. The gasket had deteriorated very badly with substantial fretting to the surfaces on both sides. A thin amount of gasket had been left on most of the surface of both the block and head, which had to be carefully scraped off to ensure that the two mating faces were not contaminated in any way when reassembled. There was evidence of leaks tracking across the gasket, including between oil and waterways, and outwards to the edge of the gasket. The raised parts of the gasket, around each of the holes used to seal the holes, had all been flattened (to be expected) but some of them had actually fractured around holes, and were not sealing properly. Fig 3 shows complete loss of gasket material between two adjacent holes. Fig 4 shows blackening of the gasket around the oil hole situated in the corner of the block underneath the CAS sensor. The gasket had completely delaminated in this area. It had become porous to oil and had consequently discoloured very badly. Fig 5 shows complete failure of a seal around a gasket hole. I couldn't find any of the missing pieces of gasket, so presume they had disappeared into the water and oil systems somewhere !!

v. There was absolutely no sign of any metal damage or cracking between cylinders, either in the block or in the head. The surface of the head and block (when cleaned of gasket material) were very smooth and neither had experienced any corrosion, damage, warping or indentations. Both were in excellent condition.

vi. I inspected the bores, which appeared to be 'perfect'. There were still signs of the original grinding marks in all bores, and the piston crowns were only slightly contaminated with carbon build up. The faces of the valves were also contaminated slightly with carbon build up. The carbon was very carefully removed.

vii. All cams were 'perfect'. There was absolutely no sign of wear or damage to any of the lobes or shafts.

viii. None of the cam belt pulleys were worn or corroded in any way. Beware of the camshaft belt pulleys, these have very sharp edges which easily lead to cut fingers and knuckles.

ix. The water pump had some play in the bearing so was removed.

Putting it back together.

i. First, clean around the water pump area, and fit new water pump and gasket.

ii. Gently remove any contamination or corrosion from around the mouth of all the metal water pipes with emery cloth. I replaced the sprung hose clamps with screw tightening "Jubilee" hose clips to ensure good watertight seals.

iii. Put the new head gasket on the alignment pins in the block, and lower the head to within two/three inches of the block. This allows adequate clearance to get hands in to reconnect fuel pipes, to fit the 'P' clip to support the battery leads, and to reconnect the knock sensor wiring.

iv. Carefully lower the head onto the block. While doing this, ensure that water pipes slip into their respective connections – I used a small amount of grease on each connection to make it easier.
v. Put the head studs in and tighten them according to the recommended procedure in the manual.
vi. Refit the cam cover. Tighten studs to the recommended procedure.
vii. Reconnect all wires, pipes, connectors, etc.., that are located in the general area above the gearbox, as they are all easily accessible.
viii. Reconnect the earth wires at the rear of the engine, near the oil cooler pipe connections, just below the inlet plenum.
ix. Refit the turbo oil feed pipe, then refit the big bracket holding the starter catalyst housing to the engine block.
x. Reconnect the exhaust down pipe to the starter catalyst housing. I used three new studs as the old ones were severely rusted and could not be salvaged.
xi. Fit new cam belt. The following is the process I adopted, but there may be other, and better, ways to do this.

a. If you had removed it earlier for inspection/cleaning, refit the cam belt drive pulley fully onto the crankshaft.
b. Set the camshaft pulleys at TDC, fitting 6 mm rods through the pulley alignment holes.
c. Put the new cam belt around the crank pulley.
d. Feed the belt carefully around the belt tensioning pulley (having already rotated it clockwise and locked it in a position to provide no tension to the belt – see section above).
e. Feed the belt up and around the water pump pulley and idling pulley, but not onto the cam pulleys at this point.
f. Fit the alternator/PAS drive pulley onto the crankshaft. Tighten the crank bolt enough to pull the pulley fully onto the crankshaft. No need to torque the bolt at this point.
g. Locate the cam belt lower cover in position on the engine. If necessary, put one screw in place to locate the cover firmly.
h. Turn the crank pulley to TDC, locate the belt on the crank pulley teeth and gently pull the slack out of the belt. Fit the belt initially halfway onto the exhaust (front) cam pulley and then ease it onto the inlet (rear) cam pulley. Because the crank is at TDC, all pistons are either at TDC or BDC and there is virtually no resistance to turning the crank a few degrees backwards or forwards. Therefore, pulling the belt can easily cause the crank to rotate a few degrees and cause timing misalignment, so be very vigilant.
i. When satisfied that everything is at TDC, release the lock on the tensioning pulley, which will now naturally rotate anti-clockwise under spring tension to provide tension to the belt. If necessary, gently rotate the pulley a further few degrees anti-clockwise around its locking bolt to provide more tension to ensure that the belt is not slack enough to jump teeth. Lock the tensioning pulley again.
j. Remove the two cam pulley locks and rotate the crank several times in the normal engine drive direction to seat the belt and stop when the cam pulleys are back at TDC. Check that the crank pulley is also at TDC.
k. If it is not, you will have to remove the belt from the cam pulleys, rotate and lock the tensioning pulley in the clockwise position and do it all again (steps (h) to (j), first ensuring locked cam pulleys).
l. When confident that all three pulleys are aligned correctly at TDC, remove the alternator/PAS drive pulley and the lower cam cover. Remove the cam pulley locks. Rotate the crank to 60 deg ATDC, tension the belt properly, according to the manual, and lock the belt tensioning pulley. (The 60 degrees ATDC position was presumably chosen by Lotus because exhaust valves are closed at this point. Therefore, there are minimum forces acting on the exhaust cam lobes, and the exhaust

cam pulley is more easily 'jiggled' left and right to settle the belt and obtain the correct belt tension – just my theory!!).

m. Refit the alternator/PAS drive pulley on the crankshaft. Tighten the crank bolt sufficiently to pull the pulley completely onto the crankshaft.
n. I rotated the crank a few more times and rechecked the TDC marks and the tension, just to be doubly sure.
o. Breathe a hefty sigh of relief, as the tricky part is complete.

xii. Once again remove the alternator/PAS drive pulley to make it easier to refit the lower cam belt cover and screws.
xiii. Manoeuvre the engine support beam and the RH engine bracket into place, ensuring that the rubber buffers are first fitted to each side of the RH engine mount (I believe US cars also have an energy absorbing 'crash cone' in there).
xiv. Manoeuvre the cam belt top cover into place and fit the screws.
xv. Loosely fit the socket head screws to attach the support beam to the engine.
xvi. Fit the bolt through the RH engine mount and engine bracket, and then tighten the four socket head screws. Remove the jack from under the sump.
xvii. Refit the alternator/PAS drive pulley.
xviii. Refit the alternator belt. Tension belt according to the manual.
xix. Refit the PAS pump and belt. Tension the belt according to the manual. Ensure the PAS high-pressure hose connections are tight and the hose is not stressed. Clip the hose to the top of RH engine bracket.
xx. Ensure that all of the final pipes, accelerator cable, turbo ducting, coolant header tank, battery, etc…etc… are refitted and connected.
xxi. Refit front RH wheel and lower car to ground. Torque the crank bolt to the correct torque.
xxii. Check and top up all fluids.
xxiii. I left the spark plugs out and the fuel pump disconnected (inertia trip switch activated) and turned the engine over several times on the ignition key to get some oil pressure showing on the gauge, and to make sure that there were no unexpected crashes and bangs.
xxiv. Reset the inertia switch and check that the fuel pump runs and that there are no fuel leaks.
xxv. Refit and connect spark plugs and run the engine. Check for any leaks, unwanted exhaust noises, etc…
xxvi. Check CAS set-up and correct the timing, if necessary.
xxvii. Now you can GO, GO, GO.

There was a marked improvement in general car performance after the work, so it was definitely worth the effort and aggravation.

It took me four days (two weekends) to complete the work. The first weekend to remove and clean the head, and the second weekend to reassemble. Total hours were approximately 25. With a bit more effort on the first weekend I could have done the work in three days. I was almost in a position to refit the head on the first Sunday, leaving general refitting of components and overall completion to the following Saturday.

If you have any questions, please contact me by e-mail, I would be pleased to help wherever possible.

Dave

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