Changing Head gaskets and dual EGT gauge test program LDS-465-1A D-turbo in a M35A2

Reported by RL Whiting in conjunction with John A. Tennis, JATONKAM35s.com

First of all, I would like to acknowledge many people for their sharing of their experiences in doing the head gaskets and also specifically CRANETRUCK a.k.a. Bjorn for his pioneering efforts in understanding and properly maintaining a Multifuel engine. Bjorn was out there long before most of us were even thinking of buying a deuce and he has shared willingly his knowledge and experiences and in no way am I trying to replace his hard work and information he has relayed to all of us.

We had discovered that my deuce with the LDS engine was leaking oil out of the head gasket along the front and side of the heads. I never had a loss of coolant into the oil in my engine before we started the repair work. At the time we began repairs, the engine only had 160 hours on it.

JATONKA did the job for me in his shop. We drained the block and radiator and lost a very small amount of coolant. The oil filters were removed to improve access to the Head Studs and Nuts and the injector lines. As expected the nuts on the drivers side were a pain to remove. You definitely need the short special tool to do this IMHO. There was a smooth operating chain fall which made removing and installing the heads later a snap and I would not want to do this job without some sort of overhead lift.

Once the heads were off, we discovered that one of the fire rings had embedded itself in the head. I will go into more detail on the machine shop and the work done further on. The gaskets that were on the truck were the new style gaskets.

It is likely that the gasket problem along with the leaking of oil is due to over-fueling this truck. The excessive pressures in the combustion chambers simply were too much for the gasket to contain. I am very thankful that there was no coolant leakage into the motor. The combustion chambers and the pistons all looked like they were burning cleanly and properly and also evenly. I had never adjusted the IP and had bypassed the FDC.

Overall, it took about 2 full days to tear it apart and reassemble it including cleaning and prepping all gasket surfaces. We disassembled the turbo from the manifold (checked the free play and it was in great shape) and drilled the exhaust manifold for an EGT gauge probe. We used a magnet on inside the manifold to catch the drill shards. We also flushed out the manifold to ensure we would not have metal bits passing through the turbo. A bung for an additional EGT probe (Post turbo) was welded into the elbow that connects to the outlet of the turbo while it was off the truck..

The Machine shop reported that the heads would have to be milled to take care of the fire ring damage and to smooth them up. They milled the heads roughly 5 thousandths. The shop did a great job and also ground the valves an equal amount so the compression would be the same, the engine better balanced power wise and clearances would remain adequate. Both heads had issues of this nature and there was one broken stud for the water manifold which they fixed as well. Turnaround time was a little over a day; Fantastic!!!

After final assembly, we installed the pre-turbo EGT and I performed a test drive to see how the

truck ran. As we thought the truck is making too much power. It was too easy to run the temps up to the limit we had decided upon and actually I had to lift off the throttle to keep the EGTs down. This is on the pre-turbo EGT. For testing purposes we decided to not go over 1100F pre-turbo on the EGT. After the test drive we tightened a couple of clamps and added about a quart of coolant and I headed home, 100 miles away.

From the outset of planning this repair we planned a testing program with the use of two K-Type thermocouple EGT gauges to see how much of a temperature drop there is in the pre-post turbo locations and this thread will continue as the testing moves forward.

EGT Temps, pre and post turbo First test

LDS-465-1A with D turbo.

04-30-11

I finished the installation of the second PYROMETER in the deuce this afternoon. I also turned my fuel down 4 flats. I know it was four because I had to reposition the wrench as it would only turn the nut 1/12 a turn per set. I also had to grind the wrench thinner to fit the inner nut on the fuel pressure adjusting rod. Having adjusted the fuel once with a light and looking at everything, I could just about do it blindfolded now.

Test drive: 22 miles +/-

Initially I was easy on the truck simply to allow it to warm fully before actually pushing it hard. I observed a consistent 75-100 degree differential between the pre and post gauges. The one after the turbo being cooler. Idle was 350 pre and 300 post. This was "loafing" along the truck.

Once the engine was warmed up I pulled onto the state highway and accelerated to road speed. There was still ample power but the temperatures did not spike as easily as before on the first test drive immediately after the head gasket job was completed. Cruising 50-52 MPH I was running 850-1000 pre turbo and 750-900 post. Cruising was on a fairly level highway with good sight distance to allow for smooth driving practices and also plenty of time to monitor the gauges.

The Pre turbo gauge rose quicker and dropped quicker with the post turbo gauge coming up slower and taking longer to cool off. This is likely due to the actual amount of heat that the turbo retains until it cools from a spike in exhaust temperature. This is a reminder about why these engines need to idle for at least 3 minutes after a hard run and preferably 5. The turbo can hold a significant amount of heat and not allow it to dissipate is not good for them if you shut down too quickly.

I stopped in town (7 miles out) and did a leak check and then resumed my test drive. I still have a small oil leak in the center of the two valve covers. That will be dealt with probably tomorrow. On my return trip I took a different route and I also ran a few additional miles to ensure the engine was fully warmed up.

This alternate route includes a 3/4 mile hill with portions at 14% and the rest at about 10%. I am

still over fueling the engine as it was indicated by the ease in which I could approach the limit set for the experiment which is 1100 F Pre turbo. Even so another interesting factor is that when the engine is really working I saw that the pre and post turbo temps were almost identical. This is while steadily pulling the hill in 3rd and running 1600-1900-2100 RPM at 1050 - 1100F on both gauges. This equal reading situation only occurred when the truck was really working hard. I was not on the floor either with the throttle. I could have run up faster with the commensurate increase in EGTs.

Cruising at speed where you can accelerate at will it was less of a problem temperature wise, but when the truck was laboring and the turbo warmed up the temps were virtually the same. I will be lowering my fuel another 4 flats tomorrow. I suspect this will make it so the truck has the ability to run over 1100 but only when I am working it VERY hard. My goal is to have it so the temperatures in the exhaust stream are always under a damage causing level to preserve my engine.

Lastly, I will be adjusting the gauges so the max temperature I want either to achieve is when the indicator will be pointed straight up. I figure that a vertical reference is the easiest to check visually as compared to trying to see if it is one or two little marks above 1000. If I know that the highest it can go it when the needle is pointed at the ceiling, I can quickly check this and keep focused on the road.

More to follow; Many thanks to JATONKA for the support and work on the head gaskets, his informed input and guidance in this project. John is the one who thought of putting two Pyrometer Gauges in my truck to run this set of tests to begin with....

More to follow

In response to the head gasket change:

What did we find when the heads were removed?

The heads looked clean except for the denting from the fire ring. The engine looked very good otherwise and the problem and the sole cause for the leaking of the oil, and potentially a coolant leak had we let it go was caused by the IP being set too high and producing too much power. This is according to JATONKA's way of thinking.

I will be making a second test run on Wednesday after turning the fuel down some and see how things are. Our intent is to add to the overall deuce information database and this is just our approach to fine tuning for both power and motor longevity.

We chose 1100 as a peak temperature because we are not interested in destructive testing and by staying below the absolute maximum we stay in what I would call the Safe Zone of operation. However before the pyrometer was installed I was really running that engine much harder than it is really designed for. I say this based on how much I have had to stay our of the throttle to keep the temperatures down.

More to follow

UPDATE: ***Still waiting to do the second test.***

I saw that I could have EASILY taken the EGT to beyond any comfortable level without even trying on my trip home. It took a decided effort to keep the EGTs below 1100.

The next run should be very interesting when I lower the fuel a bit more.

As much as we love more power, sometimes you have to be careful if you want things to last.

Some factiods about turbocharging.

I gleaned this from a few sources on the web. I do not in any way make any statement that the data in this is applicable to the deuce/multifuel. I am simply putting this out here for you to get a better understanding of the concept of EGTs and Turbochargers
RL

So the big question is, what constitutes excessive EGT? If everything is working properly, 1250º to 1300º F. is a safe turbine inlet temperature, even for sustained running, mile after mile. Above 1300º F. things can start to get edgy. Remember, excessive EGT damage is cumulative. Over 1400º F., you're usually gambling against a stacked deck and it's only a matter of time until you lose. The higher the EGT, the shorter that time will be.

As we pointed out earlier, high EGTs are the result of too much fuel for the available air. If you see EGTs climbing over 1300º F., the fastest way to reduce the amount of fuel going to the engine is to back off the accelerator pedal. Another possible solution is to downshift if your speed permits it. For example, while the engine might be capable of producing enough power to pull the load in fifth gear at high EGTs, running in fourth gear at lower EGTs is definitely easier on the engine as long as the engine's RPM red line is not exceeded.

Excessively high EGTs mean over-fueling, so "driving by the pyrometer" to keep EGTs in the safe zone can actually improve fuel economy. Some drivers swear by this procedure. This is true even when the EGT are below the danger point. Of course, driving by the pyrometer can be a nuisance, and it takes away from the driver's full attention to the road.

So far, we've been talking about peak sustained EGTs at full power or under a heavy load, and certainly EGT needs to be kept within limits for engine and turbocharger reliability. At all other times, the EGT of a turbo-diesel will be lower, usually below 1000º F., and sometimes much lower. Such low EGTs pose no threat. In fact, the lower the EGT for a given speed and load, the more efficiently the engine is running.

Generally, 1/3 of the heat energy obtained from burning the fuel in the cylinder is transferred to the crankshaft in a diesel engine. Another 1/3 of heat energy is dumped into the cooling system, and the last 1/3 escapes through the engine exhaust. This means that an engine producing 100 hp at the flywheel also dumps the equivalent of 100 hp into the cooling system and another 100 hp into the exhaust system.

Now, a well designed turbocharger converts 1/3 of the heat and pressure in the exhaust stream into compressor power. This means that an engine producing 100 hp to the drive train is using 33hp from the exhaust to power the turbocharger. At 200hp (near full throttle), the turbocharger in a Cummins B can extract 66 hp from the exhaust to power the turbocharger.

My work is done for now

I finished my adjustment and study work on my Deuce Saturday, a few days later than I had hoped but somethings come before others....

"Well, today dawned nicely and I finally was caught up enough to continue tinkering with the deuce. I believe I am finished based on my results which I will work my way to in this discussion.

I was asked in a pm if there was any re-torque work required as a result of changing the head gaskets. The head gaskets I used are the new style and do not require a re-torque and the valves do not require any further adjustment either. I am planning an oil change sometime before the event at Fort Drum in mid June.

I turned the fuel down 3 additional flats today. This makes the reduction of fuel 7 flats total.

I checked all the bolts and nuts on the accessories on the engine some of which had loosened up a bit and I believe I have the very small oil drip solved. To have to re-tighten the valve covers and other connections is not unusual in a large motor plus we relieved the dish that occurs where the valve cover bolts tighten and they most likely settled a bit. To be quite honest, I expected to have to do some minor work like this.

My second test drive was similar to before and I noticed a reduction in power, but not really much. I also noticed it was running about 150 degrees cooler at a similar speed on the highway. Now I cruise at 900 or even less and another aspect I noticed was the roar was lessened somewhat by the drop in fuel. I can still smoke it up if I lay right into it on take off, but it is only when I am applying more throttle than is needed that I get a big amount of smoke.

I took the same route heading home up the big hill. The major difference was that I could stay right on the throttle in 4th until the rpms dropped to a place where I had to shift. Temps at the max were at 1100F on the pre-turbo EGT gauge and the post was essentially the same. That brings me to another interesting piece of data.

I have noticed that at steady cruise where you are working a bit the pre and post EGTs eventually become virtually the same. I would have to guess that the turbo heats up and once it is at the same temperature as the inlet is, there is virtually no drop across the turbine to the post gauge. This could be simply a minor variation in the gauge one to the other. Even if this is the case, it still indicates that the exhaust system will eventually equalize in temperature if you are cruising at a steady speed, at least 45 I would say.

So, after turning the fuel down 7 flats or slightly more than one turn of the nut on the screw I am satisfied with the results. I have adjusted my fuel so that normally the pre and post EGTs are predictably 75-100 degrees apart with the post turbo temperature lagging behind the inlet temperature. This occurs when I am not really working the truck. I also noticed that the harder you work the engine, the closer they come to being nearly the same and when you let off the post-turbo temperatures will actually be much higher than the pre temps at least for a while. I have my fuel set so I can drive the truck pretty much without looking at the gauges until I am really working it.

As it was explained in the article I posted a day or two ago, I am trying to keep the EGTs down in an effort to both save fuel and also to prolong the life of my engine. I am pleased with the results and feel I have a much better idea of how my engine is running and what to expect. While others will keep the fuel turned up more than I have mine set at, They will have to drive so they are not

operating at too high a temperature. I am more comfortable just getting things set so it does not do so to begin with. Besides, with the cost of fuel at nearly $4.45 a gallon here I am in no hurry to burn it up faster.

One item I want to emphasize is that cool down time is important. You do not want to have the turbo smoking hot when you shut your truck off. Besides a 5 minute Turbo cool down time will allow the engine and the coolant to equalize and that is also important. This aspect of the operation of these trucks is outlined in the manuals and in the PS articles that we have seen. The same goes for warming things up before really getting into the throttle too.

If anyone has any specific questions please feel free to hijack the thread and share or ask away"

Added note of interest:

I replaced my stack with muffler with a stock stack and noticed a 50 degree drop in EGTs.

There is no apparent change in power.

Thought I would pass this along.

RL