

Tuning and Understanding your Toyota Viscous Fan Clutch

Landcruiser or Hilux overheating? Your factory fan clutch is probably under-filled and incorrectly set from factory. Fix this first and you may save a lot of time chasing issues.

(4 Runner or Tacoma in the USA)



The stock Toyota cooling system can sometimes be somewhat marginal. The suspicion for this falls on every component and modification in the system.

- Radiator (Size / Efficiency)
- Thermostat (Brand / Effectiveness)
- Water Pump (Flow, Cavitation)
- Radiator Cap (Quality, Pressure, Leaks, Recovery)
- Coolant (Freezing / Boiling points, Specific heat, Anti-corrosion)
- Hoses (Restriction)
- Engine Type (Diesel / Turbo / Petrol)
- Engine Load / Modifications (Driving style, load on vehicle, Mods)
- Gearbox (Auto Cooling, Slipping)
- Airflow (Obstructions / Restrictions In / Out, Forced / Natural)
- Ambient Operating Environment (Temp, Altitude, Terrain)
- Shrouds (Closeness to Fan, Leaks, gaps between radiators)
- Fan (Size / Pitch / Airflow)
- Fan Clutch (Lockup Temp / Stages / % Slip)
- Temperature Gauge (Damping / Accuracy)
- Bullbars / Winches / Lights / Antenna's / Plates / Screens

Ask anyone and they'll start listing random items from the list above that they have seen before or are suspicious of. It would appear that the issue is simply that the system is marginal in certain areas, and several small changes may be enough to tip it over the limit.

The end goal of a cooling system is to transfer heat to the surrounding air. All the other components are only there to allow this transfer to occur in some improved fashion. There are plenty of air cooled motors in existence that do not have these complexities, and they too may be subject to overheating.

It would appear that Mr Toyota VERY closely [engineers](#) his vehicles, with many parts sharing multiple purposes, and many many tradeoffs being made. This is good engineering, but it means that small changes may have many unintended impacts. Despite this, it appears the Landcruiser and Hilux are intended to be frequently modified. There are many attachment points, and the OEM design has many dealer supported aftermarket options that are not from the Toyota factory.

If all the basic checks have been performed on the cooling system – no leaks, nothing obviously blocked, quick warm up, infrequent overheating except under specific circumstances, then it is a fair bet that the overall system is simply marginal. In this case, a dramatic increase in specific areas may yield a significant benefit.

In my case the overheating was limited to situations with a pre-turbo EGT in excess of 550C. This equated to High Load or High Speed driving. Despite expectations, off-road steep terrain (sand excluded) does not yield high EGT's. Mountain Ranges, Large Trailers, Roof Racks, High Speed or Deep Sand all would yield high EGT's and therefore problems.

I have measured many temperature points around the engine bay, and spent some time listening to the engagement and disengagement of the fan. All this yielded much confusion rather than understanding.

I replaced most components, some twice. It was during this that I had time to closely examine and understand the Toyota Viscous Fan Clutch. Possibly more than any other component, this is the key item in the cooling system. It is this that creates the airflow, not vehicle forward speed. Without airflow, the radiator is not effective. My experience was very similar in a Toyota Surf I had owned previously. It is common knowledge that additional Silicon Fluid will often improve these units. What is not common knowledge is:

- Brand new OEM clutches appear to be under-filled
- They can be adjusted where they engage
- There are 4 separate engagement stages
- Testing cannot be done on the bench. The device requires centrifugal force to operate.

Credit goes to [Frank for his guide on how to split and refill the fan clutch](#). I am just explaining the operation in further detail.

It must be remembered that these types of fluid couplings always have some slip. They may slip by 98% (free spin) or 5% (coupled), but there is always slip. It is difficult to test the slip in any simple manner, and impossible to bench test. Therefore a fan that appears to be engaging and disengaging successfully, may in fact be slipping at 50%, significantly reducing maximum airflow. Worse, the slip will only happen at high RPM and maximum load.

The key points are that there are **4 operating stages**, and that there is **not enough fluid** to couple the system adequately.

This is why so many people report success with simply adding more fluid. Adding fluid means that when the system is operating with the valve fully open, the rings are full of silicon fluid, and not partly full. The only drive is through the fluid, so insufficient fluid will reduce maximum coupling ability. There was clearly not enough fluid in the unit to fill all the rings to the depth of the final valve.

The factory engagement points are also quite high. This reduces noise and fuel consumption, but also means maximum engagement doesn't occur until the air temp is around 95C. Engine coolant temperature will always be higher than air temperature.

This was all tested with a Digital Thermometer and a water bath on the stove. The water was heated and cooled and the valve set points noted as it moved.



Temperature Set Points (all at 1/2 open)

Stage	Original Temp	Adjusted Temp
Closed	50	40
Stage 1	55	45
Stage 2	85	75
Stage 3	95	85

Pictures of operation:

Fan Clutch



The 2 halves opened



The “drive disc” spins freely in the housing except for the silicon fluid.



The “drive disc” and the “front half” share these closely spaced rings. It is these rings, and the silicon fluid in the gaps between them that couple the system together. The inner ring is taller than the others.



The oil is slowly thrown to the outside of the system by centrifugal force.



The fluid is rated at 10000 Cst – [Centistokes](#) – a measure of viscosity



The valve that controls where the fluid flows. It operates over 4 stages:0) Closed

- A) Some oil to some rings
- B) Some oil to all rings
- C) Maximum oil to all of rings

This is why it seems to be more than engaged / disengaged.



The temperature sensing Bi-Metal spring on the front face that controls the valve.



The reservoir behind the valve disc in the front half where the fluid is stored. When operating it is held here by centrifugal force, and pumped here by the slipping “drive disc”



The “vaness” on the edge of the drive disc in the rear half that pump the fluid forward to the outer channel for return to the reservoir. Some slip is required to allow the pumping to occur. The slots in the back of the disc pump the fluid from behind the disc to the edges, and then to the channel at the front.



The rear of the disc is not used for coupling.



The wedge shaped guides and small holes in the front half that collect the fluid from the outer channel and push it back into the reservoir.



Adding Fluid



Adjust the valve set point by loosening the 2 screws and rotating the disc.
The outer valve should be 1/2 open at about 45C for Australia. (US quotes 35C).
Air temp will always be less than engine water temp.



Getting the fluid level right is a little difficult and involves some guesswork. The minimum amount required is enough to fill the entire outer rim past the depth of the fins in both halves, this fully couples the unit.

The maximum amount is when the reservoir in the front is full and overflows through the central hole. Not so simple though, as full is controlled by centrifugal force, so when operating it fills the “outside” of the reservoir, not the bottom.

Luckily there is a fair tolerance between the two. Overfull will couple the fan all the time.

Mine took 1.5 tubes of fluid in addition to the factory fill to stay a few mm below the level of the valve disc.

