The Great V160 Fluid Challenge

Disclaimer:

The results posted in analysis are for information only. No liability can be placed on or against any of the parties' involved in making of this analysis. Users who choose to use other fluid(s) besides the OEM specified fluid for the 6-speed Manual Transmission found in the 4th Generation USDM 1993.5-1998 Toyota Supra Twin Turbo are at their OWN RISK and accept any damages incurred by using fluids not approved by Toyota.

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2. **Craig Bush (Craig Bush)**
3. **Ken Henderson (KenHenderson)**
4. **John Firth (Axoman)**

Background

In the early years, some MKIV enthusiasts attempted to defer from OEM fluid and experiment with a MTF fluid from Redline. The outcome of this experiment resulted in swelling of the shift shaft seal which ultimately created leaks and shifting issues. The effect of this issue deferred most future attempts to use non-compatible fluids at the sake of damaging a once $2,500 transmission that is now over $5k in replacement cost. As time has passed since the last produced MKIV TT 6MT in 2001, the OEM fluid has continued to rise in cost and is eventually feared to become extinct in the coming years due to the limited number of 6MT vehicles produced.

Objective

After reading many debates in various threads if other fluids were compatible, equivalent and even potentially rebadged products for resale by Toyota, I decided to take the on the challenge by putting three competitors up against the benchmark.

My selection of competitive fluids was based on what is readily available in the North America market versus a global outlook. Some compatible fluids are still available for the European and Australian markets from the makers of Esso and Castrol. Due to complexity of obtaining these fluids from these other markets is the main reason for selecting the competitors (figure 1) seen below:

1. *Toyota V160 Fluid*
2. *Castrol Transmax ATF Import Formula*
3. *Royal Purple Synchromax MTF*
4. *Castle ATF Premium Synthetic Transmission fluid*
5. *Toyota T-IV ATF fluid*
6. *Jack's Transmission V160 Fluid*
7. *Mobil 1 Premium Synthetic ATF*

Figure 1 – Competitors (Not pictured is Jack Transmission fluid, Mobil1 ATF or Toyota T-IV)

When it comes to sourcing these competitors Castrol, Mobil1 and Royal Purple products can be found at most local automotive suppliers while the Castle needs to be purchased from a specific distributor. The Toyota fluids can be obtained from your local dealer or the preferred MKIV parts supplier (hint Curt). Pricing wise, these fluids quickly present a decent price variation amongst each contestant. The competitors ranged from $5.5 - $19 per quart/liter while the benchmark came in at ~ $44/liter the preferred Toyota supplier.

Process

Each virgin sample was extracted from the manufacturers packaging and sent to Blackstone Labs for a chemical analysis. Blackstone Labs is well known for performing analysis on automotive and industrial fluids for personal or commercial use.

Prior to reviewing the results, the following assumptions can be made with this assessment:

- *Each fluid was recently purchased from various retailers or distributor*
- *Each sample was of a virgin state prior to evaluation*

- *Each sample was assessed over the standard process plus Total Acid Number (TAN) analysis by Blackstone Labs.*
- *Total Base Number (TBN) analysis was not performed as its in-accurate for assessing ATF fluids as compared to engine oils*

Results

The key objectives to look at when reviewing the following data is to understand:

1. Type and Amount of Compounds that make up each fluid based on Parts-per-Million (PPM)
2. Viscosity
3. Flash Point
4. TAN value

The primary types of chemical compounds found in these types of fluids can be identified by four key categories consisting of friction modifiers (friction reducers), detergents (cleaners), anti-wear additives (minimize wear) and extreme pressure additives (high loaded).

Starting off with the standard, the Toyota V160 fluid is primarily comprised of boron (friction modifier) and phosphorus (extreme pressure additive) as the key compounds. Other small, insignificant amounts of silicon (potentially airborne contaminants), sodium, calcium (detergent), magnesium (detergent) and zinc (anti-wear/extreme pressure additive) were present. The viscosity of this fluid came in at 49.8 SUS and 7.22 cSt respectively. TAN was measured at 1.5.

ELEMENTS IN PARTS PER MILLION		
	MI/HR on Oil	
	MI/HR on Unit	
	Sample Date	11/12/13
	Make Up Oil Added	
	ALUMINUM	1
	CHROMIUM	0
	IRON	1
	COPPER	0
	LEAD	0
	TIN	1
	MOLYBDENUM	0
	NICKEL	0
	MANGANESE	0
	SILVER	0
	TITANIUM	0
	POTASSIUM	2
	BORON	152
	SILICON	1
	SODIUM	3
	CALCIUM	4
	MAGNESIUM	6
	PHOSPHORUS	245
	ZINC	7
	BARIUM	0

PROPERTIES		
	SUS Viscosity @ 210°F	49.8
	cSt Viscosity @ 100°C	7.22
	Flashpoint in °F	400
	Fuel %	-
	Antifreeze %	-
	Water %	0.0
	Insolubles %	0.0
	TBN	
	TAN	1.5
	ISO Code	

Figure 2 - Toyota V160 Fluid Breakdown

Moving onto the Castrol Transmax Import Formula, you will see it was also composed of the same key additives as the standard above. Some of the PPM per additive were slightly less than the standard, but nothing too concerning for not being compatible.

ELEMENTS IN PARTS PER MILLION	
MI/HR on Oil	
MI/HR on Unit	
Sample Date	11/12/13
Make Up Oil Added	
ALUMINUM	0
CHROMIUM	0
IRON	0
COPPER	0
LEAD	0
TIN	0
MOLYBDENUM	0
NICKEL	0
MANGANESE	0
SILVER	0
TITANIUM	0
POTASSIUM	0
BORON	90
SILICON	1
SODIUM	0
CALCIUM	29
MAGNESIUM	0
PHOSPHORUS	200
ZINC	1
BARIUM	0

PROPERTIES	
SUS Viscosity @ 210°F	50.5
cSt Viscosity @ 100°C	7.41
Flashpoint in °F	350
Fuel %	-
Antifreeze %	-
Water %	0.0
Insolubles %	0.0
TBN	
TAN	1.5
ISO Code	

Figure 3 - Castrol Transmax Import Breakdown

The next up is the Castle Premium Automatic Transmission Fluid. I speculated prior to this analysis that this fluid was going to be very similar, but clearly I was incorrect. Looking at the breakdown, this fluid shows almost no similarities to the standard with PPM per makeup. This fluid appears to be a more “Universal” ATF based on the specifications from various manufacturers s.

ELEMENTS IN PARTS PER MILLION	MI/HR on Oil	0
	MI/HR on Unit	
	Sample Date	11/12/13
	Make Up Oil Added	
	ALUMINUM	0
	CHROMIUM	0
	IRON	0
	COPPER	0
	LEAD	0
	TIN	0
	MOLYBDENUM	0
	NICKEL	0
	MANGANESE	0
	SILVER	0
	TITANIUM	0
	POTASSIUM	0
	BORON	1
	SILICON	0
	SODIUM	0
	CALCIUM	21
	MAGNESIUM	0
	PHOSPHORUS	88
	ZINC	1
	BARIUM	0

PROPERTIES	SUS Viscosity @ 210°F	49.4
	cSt Viscosity @ 100°C	7.09
	Flashpoint in °F	425
	Fuel %	-
	Antifreeze %	-
	Water %	0.0
	Insolubles %	0.0
	TBN	
	TAN	1.0
	ISO Code	

Figure 4 - Castle ATF Breakdown

The last and final contestant was the Royal Purple Synchromax. This fluid ironically purple in color showed significant amount of PPM of the expected materials, but also showed other materials that may or may not affect the sintered bronze and carbon friction layers that make up each synchro assembly.

ELEMENTS IN PARTS PER MILLION	MI/HR on Oil	0
	MI/HR on Unit	
	Sample Date	11/12/13
	Make Up Oil Added	
	ALUMINUM	0
	CHROMIUM	0
	IRON	2
	COPPER	0
	LEAD	0
	TIN	0
	MOLYBDENUM	0
	NICKEL	0
	MANGANESE	0
	SILVER	0
	TITANIUM	0
	POTASSIUM	0
	BORON	246
	SILICON	1
	SODIUM	0
	CALCIUM	238
	MAGNESIUM	2
	PHOSPHORUS	579
	ZINC	4
	BARIUM	0

PROPERTIES	SUS Viscosity @ 210°F	49.9
	cSt Viscosity @ 100°C	7.25
	Flashpoint in °F	430
	Fuel %	-
	Antifreeze %	-
	Water %	0.0
	Insolubles %	0.0
	TBN	
	TAN	2.8
	ISO Code	

Figure 5 - Royal Purple Synchromax Breakdown

The next fluid up is the Toyota T-IV ATF fluid. This ATF is considerably available and has been used in an extensive amount of Toyota transmissions over the last number of years. Looking over the composition of this fluid and you will see a lot same makeup similar to the V160 and Castrol Transmax Import ATF fluid.

ELEMENTS IN PARTS PER MILLION	MI/HR on Oil	0
	MI/HR on Unit	
	Sample Date	12/31/13
	Make Up Oil Added	
	ALUMINUM	0
	CHROMIUM	0
	IRON	0
	COPPER	0
	LEAD	0
	TIN	0
	MOLYBDENUM	0
	NICKEL	0
	MANGANESE	0
	SILVER	0
	TITANIUM	0
	POTASSIUM	0
	BORON	77
	SILICON	13
	SODIUM	0
	CALCIUM	119
	MAGNESIUM	1
	PHOSPHORUS	320
	ZINC	1
	BARIUM	0

PROPERTIES	SUS Viscosity @ 210°F	49.1
	cSt Viscosity @ 100°C	7.01
	Flashpoint in °F	420
	Fuel %	-
	Antifreeze %	0.0
	Water %	0.0
	Insolubles %	0.0
	TBN	
	TAN	1.8
	ISO Code	

Figure 6 - Toyota T-IV Transmission Fluid

Next up is the fluid from Jack's Transmission in Boulder, Co.. This fluid was light brown in color which leads me to believe it was a product similar to Pennzoil's Synchormesh. Upon receiving the analysis, this was not the case as the additive makeup was significantly different. Looking over the values, you can clearly see that Jack's fluid has very stout additive package made up high amounts of anti-wear and extreme pressure additives. The viscosity of the fluid also comes about 33+% higher than the standard.

ELEMENTS IN PARTS PER MILLION	MI/HR on Oil	0
	MI/HR on Unit	
	Sample Date	12/03/13
	Make Up Oil Added	
	ALUMINUM	1
	CHROMIUM	0
	IRON	0
	COPPER	0
	LEAD	0
	TIN	0
	MOLYBDENUM	8
	NICKEL	0
	MANGANESE	0
	SILVER	0
	TITANIUM	0
	POTASSIUM	0
	BORON	5
	SILICON	5
	SODIUM	1
	CALCIUM	1648
	MAGNESIUM	1346
	PHOSPHORUS	1241
	ZINC	1133
	BARIUM	0

PROPERTIES	SUS Viscosity @ 210°F	64.7
	cSt Viscosity @ 100°C	11.54
	Flashpoint in °F	420
	Fuel %	-
	Antifreeze %	-
	Water %	0.0
	Insolubles %	0.0
	TBN	
	TAN	3.7
	ISO Code	

Figure 7 - Jack's Transmission V160 Fluid

The last and final competitor was the offering from Mobil1. The fluid selected was their Premium Syntethic ATF.

	MI/HR on Oil	0
	MI/HR on Unit	
	Sample Date	12/31/13
	Make Up Oil Added	
ELEMENTS IN PARTS PER MILLION	ALUMINUM	0
	CHROMIUM	0
	IRON	1
	COPPER	0
	LEAD	0
	TIN	0
	MOLYBDENUM	0
	NICKEL	0
	MANGANESE	0
	SILVER	0
	TITANIUM	0
	POTASSIUM	1
	BORON	324
	SILICON	3
	SODIUM	7
	CALCIUM	263
	MAGNESIUM	1
	PHOSPHORUS	686
	ZINC	8
	BARIUM	0

PROPERTIES	SUS Viscosity @ 210°F	48.1
	cSt Viscosity @ 100°C	6.69
	Flashpoint in °F	415
	Fuel %	-
	Antifreeze %	-
	Water %	0.0
	Insolubles %	0.0
	TBN	
	TAN	2.6
	ISO Code	

Figure 8 - Mobil1 Synthetic ATF

So with all of this information, here is what all of information looks like with everyone on the same chart:

Compound Use		Fluid	Toyota V160	Castrol Transmax Import ATF	Toyota T-IV ATF	Mobil1 ATF	Royal Purple Synchromax	Jacks Transmission V160 Fluid	Castle ATF
		Miles on Fluid	**0**	0	0	0	0	0	0
		Sample Date	**11/12/2013**	11/12/2013	12/31/2013	12/31/2013	11/12/2013	12/3/2013	
	Parts Per Million	**Aluminum**	**1**	0	0	0	0	1	0
		Chromium	**0**	0	0	0	0	0	0
		Iron	**1**	0	0	1	2	0	0
		Copper	**0**	0	0	0	0	0	0
		Lead	**0**	0	0	0	0	0	0
		Tin	**1**	0	0	0	0	0	0
		Molybdenum	**0**	0	0	0	0	8	0
		Nickel	**0**	0	0	0	0	0	0
		Manganese	**0**	0	0	0	0	0	0
		Silver	**0**	0	0	0	0	0	0
		Titanium	**0**	0	0	0	0	0	0
		Potassium	**2**	0	0	1	0	0	0
Friction Modifer		**Boron**	**152**	90	77	324	246	5	1
		Silicon	**1**	1	13	3	1	5	0
		Sodium	**3**	0	0	7	0	1	0
Detergent		**Calcium**	**4**	29	119	263	238	1648	21
Detergent		**Magnesium**	**6**	0	1	1	2	1346	0
EP		**Phosphorus**	**245**	200	320	686	579	1241	88
Antiwear/EP		**Zinc**	**7**	1	1	8	4	1133	1
		Barium	**0**	0	0	0	0	0	0
		SUS Viscosity@ 210F	**49.8**	50.5	49.1	48.1	49.9	64.7	49.4
		Cst Viscosity @ 100C	**7.22**	7.41	7.01	6.69	7.25	11.54	7.09
		Flashpoint F	**400**	350	420	415	430	420	425
		Fuel %							
		Antifreeze %							
		Water%	**0**	0	0	0	0	0	0
		Insolubles	**0**	0	0	0	0	0	0
		TBN							
		TAN	**1.5**	1.5	1.8	2.6	2.8	3.7	1.0
		ISO Code							

The conclusions I draw from this information are the following:

1. The closest fluids to the composition and TAN to the OEM Toyota V160 fluid are the Castrol Transmax Import ATF and Toyota T-IV.
2. All the fluids flashpoints exceeded the standard except the Castrol ATF Transmax Import which came in at 50°F low. I don't find this much of an issue as the gearbox with the proper fluid level should not see temperatures this high. Actual confirmation will need to occur to valid this assessment.
3. The fluid with the least composition would be the Castle ATF. This may be a good alternative for a high mileage gearbox as the detergents are low to minimize the cleaning of surfaces during use, but I would probably refer to the fluids in comment 1 above.
4. Royal Purple and Mobil1 had higher additives over the fluids above which may be better suited for more demanding applications such as road racing or high amounts of torque being transferred through the gearbox. Between these two fluids, I would lean towards the RP as the viscosity comes in roughly the same as the V160 with a slightly greater flash point. In regards to composition, both of these fluids are very similar.
5. Jacks Transmission's fluid had significantly increased levels of anti-wear and detergent additives over the standard and any other competitor. These high amounts can be good or bad depending on the reaction with carbon and sintered bronze surfaces for engagement or disengagement of the synchronizers between shifts (I believe both are in the V160). Higher acidic levels were also apparent that exceeded 2x the standard. To truly see if these higher levels are helping or hurting, a separate, controlled reliability and durability evaluation would need to be done to determine the effects of these higher PPM values.
6. The viscosity of the V160, Mobil1, T-IV and Transmax fluid are fairly equivalent. The higher viscosity seen in the Jack's fluid would work better with wider oil passages. This outlook follows the recommendations by Jacks Transmission that their fluid should only be used in modified V160 setups that they perform.

Based on all of this, I would continue to use the OEM fluid or substitute Castrol Transmax Import ATF or Toyota T-IV if necessary. For more demanding applications, I would consider RP only if your gearbox is still stock. With regards to Jack's Transmission fluid, I would follow this recommendation only use if your gearbox has been upgraded by them to handle this fluid.