SMART BLEND SYNTHETICS

The History of ATF, 1939-2006

by James Dickey

The "Hydra-Matic model 180" was the first fully automatic transmission for passenger cars. It was introduced in 1939 for the 1940 Oldsmobile. Model 250 was applied in the 1941 Cadillac. These cars did not have a clutch. One of the prime reasons for the development of the automatic transmission was safety. The driver could pay more attention to the road and other traffic when he did not have to concern himself with coordinating clutch application and release with the manual shift lever.

The technology in this first automatic transmission was the result of many years of transmission development, starting in the United States with the "automatic layshaft transmission" on the 1904 Sturdevant. These development efforts included a variety of CVT designs, direct friction drives, hydrostatic drives, toroidal traction drives and the REO self-shifter.

Initially, engine oil plus a supplemental friction modifier based on sulfurized sperm oil, was recommended as the working fluid in the automatic transmission. Problems with the transmission, mainly caused by the failure to add the supplement, led to the development by General Motors Research of a fluid specifically designed for the Hydramatic transmission. This new type of fluid, with better low temperature characteristics,, was the first "ATF".

The torque converter replaced the simple fluid coupling in Buick's 1948 Dynaflow transmission. Because more heat is generated in this device, an improved fluid was required. GM introduced the "Type A" ATF specification in 1949, which was succeeded in 1957 by the "Type A, Suffix A" specification (TASA). Other auto manufacturers used these fluids in their automatic transmissions until Ford in 1960 and Chrysler in 1964 introduced their own specifications. In 1967, GM introduced the improved DEXRON® fluid specification.

Automatic Transmission Fluids (ATF) are a complex mixture of base oil and chemicals that perform many essential functions in an automotive transmission. They:

- Transfer power in the torque converter,
- Provide hydraulic pressure to operate clutches and shift gears,
- Lubricate bearings, gears and bushings,
- Remove heat from the transmission, and
- Provide the right friction profile for proper operation of plate, band and torque converter clutches.

Automatic transmissions normally operate at temperatures of 170°F to 200°F and start up at temperatures as low as -40°F. ATFs must flow easily at low temperatures, be highly resistant to thermal and oxidative degradation at high temperatures, be non-corrosive towards all transmission components, resist foaming and have specialized friction, anti-wear and anti-scuffing properties. They may contain as many as 15 different chemical additives and synthetic, conventional or specially refined base oils.

Additives in ATFs include several anti-oxidants, which inhibit oxidation at different stages, foam inhibitors, pour point depressants, dispersants to keep the transmission clean, viscosity improvers to assure sufficient viscosity at high operating temperature, and friction modifiers.

In the 1960s and 1970s, the friction characteristics of the specified Ford and GM fluids differed significantly. Ford preferred a "hard shift" with fast, positive lock-up on clutches and bands. This required a static coefficient of friction higher than the dynamic coefficient. Friction modifiers were not used in these fluids. Toyota and Borg Warner had similar preferences.

GM, Chrysler and other manufacturers preferred a smoother shift feel, with more prolonged engagement of the clutches and bands. This required fluids with a static coefficient of friction lower than the dynamic coefficient. Friction modifiers are required in this type of fluid.

By 1980, however, because of unsatisfactory low-speed gear changes, Ford needed and specified friction modified ATFs for both factory-fill and service-fill. Toyota followed suit in 1984 and by 1987, when Ford introduced the MERCON® specification, fluids for service-fill were developed that met all major ATF specifications, Ford's MERCON, GM's updated DEXRON II and III specifications, Chrysler's MS 7176 (ATF+3®), Toyota's T-IV, and several others. These were generally labeled "DEXRON/MERCON" fluids.

LOW TEMPERATURE FLOW OF AUTOMATIC TRANSMISSION FLUIDS

Automatic Transmission Fluid	Year	Brookfield Viscosity, cP@-40°C, max
GM Type A, Suffix A	1957	64,000
Ford Type F	1967	55,000
DEXRON	1967	55,000
DEXRON II		50,000
Ford Type CJ	1977	50,000
Ford MERCON	1992	20,000
DEXRON III	1993	20,000
ATF+3		20,000 (typical)
Toyota T-IV & JWS 3309		19,000 (typical)
MERCON V	1997	13,000
ATF+4	1998	10,000
TES-295	1999	8,700
MERCON SP	2004	7,500
Toyota ATF WS	2005	9,000 (typical)

This situation prevailed well into the 1990s with improvements in the specifications to include lock-up torque converter, CVT, transaxle and "fill-for-life" applications. Low-temperature Brookfield viscosity requirements were lowered uniformly to a maximum of 20,000 cP @ -40°C. This was about as low a viscosity as could be obtained with conventionally refined base stocks. During this period, there was an effort by Japanese and American auto manufacturers, now abandoned, to develop a universal ATF specification.

ATF specifications started to diverge again with Ford's MERCON V in 1996, Daimler Chrysler's MS 9602 (ATF+4®) in 1998 and Allison's TES-295 in 1999. These new fluids had significantly better low-temperature flow properties and oxidation stability, and friction characteristics matched to individual transmission designs. Some of these specifications, particularly the Daimler Chrysler MS 9602, used proprietary test procedures to qualify fluids. No one fluid could meet all of these specifications. Nor was it any longer possible, with additive technology, to convert DEXRON/MERCON fluids to meet all of the requirements of these new specifications.

Improved low temperature flow is required by electronic control systems now used in automatic transmissions. Better oxidation stability and low temperature flow also dictate the use of better base stocks. Conventionally refined stocks, even with pour depressant additives, can not, by themselves, meet the low temperature requirements. Increasing amounts of premium hydrofinished (group II), HVHI (group III) and polyalphaolefin (group IV) base stocks, up to 100%, must be added. These premium oils do not need as much expensive antioxidant additive to meet oxidation stability requirements of the new ATFs. They contain significantly less wax, or none at all, so that meeting the low temperature flow requirements is much easier and less expensive. The following table illustrates the dramatic drop in low temperature flow properties of ATFs over the years.

The divergence of ATF specifications is clearly confirmed by European manufacturers. They will have one specialized oil for one transmission model. Changes in hardware will be followed by lubricant changes. And all of the fluids will be designed to be "filled-for-life".

In 2004, Ford introduced MERCON SP, designed for exclusive use in six-speed transmissions for rear wheel drive applications. This fluid is not compatible with other Ford transmissions. In 2005, GM upgraded its service-fill DEXRON III specification to it's "H" version.

Compared to the DEXRON III/MERCON fluids of the 1990s, Daimler-Chrysler's ATF+, GM's Heavy duty TES-295, Dexron III H and MERCON SP have much better oxidation stability. DEXRON III H and MERCON SP have better anti-shudder and friction durability. ATF+4, TES-295 and MERCON V have improved shear stability. These improvements are in addition to the low-temperature viscosity improvements listed in the table.

In 2003, Toyota and two Japanese oil companies reported the development of a "Fuel Economy" ATF. Fuel economy is achieved by lowering the start-up viscosity of the fluid. The durability of clutch materials and the fatigue life of metal transmission components are preserved by keeping the long-term, after-shear viscosity of the fluid at the same level as that of current fluids. Extensive testing was reported in all three papers that assured that the overall performance of the fuel economy ATF, identified as "WS" was at least equivalent to the Toyota T-IV ATF. The oxidation stability of the WS ATF is better than that of the T-IV ATF.

The fuel saving WS ATF is recommended by Toyota for their Aisin AW six-speed automatic transmission for rear wheel drive vehicles.

Adding an ATF Protectant/Supplement to a DEXRON III/MERCON ATF will not change its low temperature viscosity characteristics. It will, however, improve the oxidation stability to the level required in MERCON V, MERCON SP and ATF+3. This will extend the durability of the fluid's low temperature flow characteristics. It will also enhance the anti-shudder durability and anti-wear characteristics of the ATF.

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