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Part 1 of a series of 3 LUBE Tech articles **UNDERSTANDING HOW THE TRANSMISSION FLUID RESPONDS TO DAILY OPERATIONS.**

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INTRODUCTION

Oil Analysis is the key to understanding how the transmission fluid in your automatic transmission responds to daily operations. Oil analysis coupled with regularly scheduled transmission fluid and filter maintenance decreases the likelihood of experiencing downtime caused by serious transmission problems or failure.

Transmission fluid analysis makes it possible to set fluid change intervals more accurately. Operating loads, speeds, ambient temperature, number of shifts and retarder usage all have an effect on transmission fluid. Understanding these changes is critical to establishing proper fluid change intervals.

This article is intended to expand the user's knowledge of fluids and their analysis and offer guidelines on their use. Specifically, it addresses the basic characteristics and reactions of fluids, provides understanding of some standard laboratory test procedures accepted throughout the industry, and provides guidance in interpreting and using the results.

THE FUNCTIONS OF AN AUTOMATIC TRANSMISSION FLUID OPERATING ENVIRONMENT

Understanding the environment an Automatic Transmission Fluid (ATF) is subjected to is essential in discussing its function and requirements.

The environment in which an ATF is expected to operate is anything but mild. The transmission is typically placed in the same vehicle cavity as the engine and radiator and subject to whatever temperature is present. Further, the transmission cooling function is dependent on the temperature of the engine coolant for heat dissipation and any engine overheat results in transmission overheating. Airflow in this compartment is usually marginal. Dust and road contaminants are a part of this environment as well and some of it is ingested through the transmission breather. While in this environment, the transmission must transmit power from the engine to the drive axle. Consequently, the fluid in the transmission must perform a variety of functions to meet all of its requirements.

FUNCTIONS AND REQUIREMENTS

The fluid in an automatic transmission must perform many important functions beyond that of basic lubrication.

While lubrication is important, the fluid must first provide drive through the torque converter, supply logic pressure to the range control system and then supply hydraulic pressure that causes a clutch pack to engage. An engine will run, at least briefly, without its lubricating oil, but an automatic transmission will not function at all without its transmission fluid. Fluids used in automatic transmissions must perform several distinct functions. These are:

- Hydrodynamic energy transmission medium for use in the torque converter.
- Hydrostatic energy transmission medium for use in the hydraulic control logic circuits and for servo-mechanisms.
- Lubricating medium for shaft bearings, thrust bearings and involute or spur gear load surfaces.
- Sliding friction energy transmission medium for use with lubricated clutches.
- Heat transfer medium with liquid or air-cooled systems for maintenance of a suitable automatic transmission temperature range.
- Further maintain acceptable heat levels by overcoming friction between moving parts. When a layer of fluid separates two moving components, fluid friction replaces the much stronger dry friction.
- Absorb shock loads produced by variations in load and drive, engine torsional activity or vibration, shifting, and wheel slip. Even the impact caused by the meshing of gears - particularly on start-up - is softened to a large extent by the fluid trapped between the teeth of the gears.
- Improve the ability of seals to maintain hydraulic pressure by acting as a sealant.

In addition to these basic functions, other important requirements achieved through the use of additives include:

- Operate satisfactorily over a wide temperature range; i.e., provide

startability and essential lubricating flow at low temperature while maintaining its lubrication qualities and fluid film thickness at high temperatures.

- Be compatible with a variety of seal materials.
- Contain or keep in suspension contaminants introduced into or generated in the transmission, and thereby maintain transmission cleanliness.
- Resist oxidation and the fluid thickening it causes. Reduce friction beyond normal lubrication through the use of friction modifiers for reduced internal wear and improved operating efficiency.
- Minimize fluid foaming which reduces fluid film thickness and clutch-apply pressure.
- Be non-corrosive towards all transmission components and furthermore, inhibit corrosion of components from other sources by forming a protective layer.

These functions and requirements constitute quite a list of demands and one might doubt the ability of any fluid to meet them all. Today's fluids are the result of years of experience and research. Lubrication scientists have developed both the refinement processes and subsequent additives to such an extent that the resultant fluids effectively address the demands placed on them.

HOW AN AUTOMATIC TRANSMISSION FLUID MEETS ITS DEMANDS

A fluid's ability to meet demands placed on it depends entirely on its physical and chemical properties, which can either be inherent or induced through the use of additives. The properties or characteristics selected for discussion are viscosity, incompressibility, and oxidation inhibition.

VISCOSITY

Viscosity is one of the most important and most evident properties of a fluid, and is defined as its resistance to flow, recognisable by its thickness.

Viscosity can be further defined, as the resistance (fluid friction) of one layer of fluid to movement, while another layer in contact with it remains fixed. This resistance increases as viscosity increases. Thus, increasing viscosity leads to decreasing energy transmission efficiency. Yet, decreasing viscosity can lead to a fluid whose resistance to flow is so low that the film boundary between mating components is actually squeezed out allowing the components to contact. Obviously, a delicate balance must be achieved and then maintained throughout operation.

Another operating difficulty with the property of viscosity is its reaction to temperature. Most fluids are more viscous at reduced temperatures and less viscous at elevated temperatures. Because of the problems associated with extreme viscosities, high or low, a distinct need exists for a fluid of a more temperature-stable viscosity resulting in the development of multi-viscous fluids. Thus, two types of fluids are produced: straight-grade fluid and multi-viscous fluid.

Most fluids become thinner at elevated temperatures but a multi-viscous fluid will thin at a reduced rate compared to straight-grade fluid. An SAE 30 weight fluid behaves as a 30 weight fluid at all temperatures while a multi-viscous fluid, i.e., SAE 15W40, behaves as an SAE 15 weight fluid at low temperatures and as an SAE 40 weight fluid at elevated temperatures.

Figure 1 illustrates the relationship of viscosity to temperature and the behavior of a straight-grade versus a multi-viscous fluid. The chart is valid between the temperatures at which the viscosities were measured (100-210°F); 38-99°C. It is customary to project the plotted data as shown.

However, some deviation from the linear (negative slope) should be expected around the cloud point of the lubricant. Cloud point refers to the temperature at which wax crystals materialize in the fluid, (0-30°F) -18 to -1°C for most transmission fluids.

The "variable" viscosity characteristic is obtained by additives called Viscosity Index (VI) Improvers. VI Improvers are best described as oil-soluble organic polymer chains that are temperature sensitive. They are tightly coiled at low

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