LUBE-TECH

NO.42

Part 3 of a series of 3 LUBE Tech articles

UNDERSTANDING HOW THE TRANSMISSION FLUID RESPONDS TO DAILY OPERATIONS.

By Allison Transmission, General Motors Corporation

DESIGNING A FLUID ANALYSIS PROGRAM (CONT'D)

MONITORING WEAR

During normal operation, different components within the transmission will experience wear. As a result of this wear, microscopic particles will enter the fluid, which are small enough to pass through the external and sump filters. Fluid laboratories are equipped (emission and atomic absorption spectroscopy) to determine the elemental composition of the microscopic particles and will report their test results in parts per million (ppm). Transmission fluid wear metal analysis is concerned with monitoring the identity and the levels of these wear materials in the fluid. Recording the concentration levels of these particles over a period of time provides information on the wear rate of certain internal components. Table 5 is a list of elements typically identified by a spectrographic analysis of transmission fluid and includes possible sources. This information can only be meaningful, however, through a prescribed procedure.

Absolute maximum values cannot be applied to wear metals of an automatic transmission due to the many variables present that affect concentration limits. Extended studies have indicated that significant variation exists between units, models, applications, laboratories, interpretations, etc., rendering universal limits nearly impossible, even within a given model series. Wear metal analysis results must be evaluated using a "trend line" approach. Specifically, the concentration level of each wear metal from each transmission must be plotted over a period of time. A line of best fit drawn through the plotted prints is considered the "trend line." Four data points are generally sufficient to establish a trend. The first data point should be from a sample of new fluid establishing initial levels. The trend line is then projected beyond the plotted points and becomes the baseline by which future concentration levels will be judged. Subsequently, cause for concern should only be significant deviations from the projected line. A sample trend line plot is shown in ***Figure 9 (on page II)***.

While trend line analysis on wear metals can prove informative and useful, a transmission removal decision should not be based solely upon the analysis. The results should be used in conjunction with other inspection procedures such as a functional check, road test or a pan inspection. A removal based solely on wear metal analysis may result in an unnecessary strip down. Wear metal analysis should be considered an early warning signal indicating a need for further investigation, not immediate removal. The removal should occur only if the additional investigation warrants it.

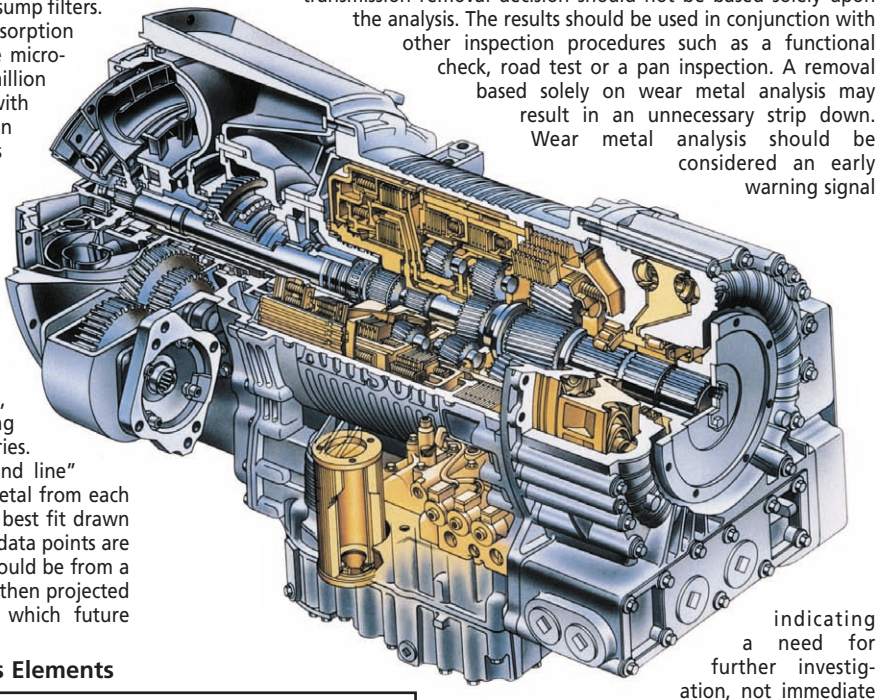

Table 5. Sources of Wear Metals and ATF Analysis Elements

ELEMENT	ELEMENT SOURCE
Aluminium	On-Highway: main case, converter, pistons. Off-Highway: converter, some valve bodies.
Barium	Detergent additives.
Boron	Detergent additive, supplementary coolant inhibitor additive.
Calcium	Detergent additive, sometimes present in road salt and "hard" water.
Copper	Bushings, thrust washers, bearings, cooler tube bundles. For off-highway only, sintered bronze clutch plates.
Iron	Wide range of parts throughout transmission. Common source: any rotating part.
Lead	Babbitt found in some bushings.
Magnesium	Detergent additive, traces in aluminium alloys, frequently presenting hard water.
Molybdenum	Friction modifier additive.
Phosphorous	Wear inhibitor additive.
Silicon	Silicone gasket material, silicone anti-foam additive, ingested airborne sand or dust, alloying element in aluminium.
Silver	Specialised applications: sealrings, bearings, hydrostatic components.
Sodium	Detergent additive, supplementary coolant inhibitor additive, road salt.
Tin	Babbitt found in some brushings, bronze bushings, thrust washers or some clutch plates
Zinc	Wear and oxidation inhibitor additive, brass components; speedometer gears, fluid couplings, etc.

A removal based solely on wear metal analysis may result in an unnecessary strip down

In summary, emphasis again is placed on monitoring fluid oxidation. However, the monitoring of contaminants and wear metals may well prove useful depending on the particular circumstances of the user. The user should evaluate individual needs and determine the economics of each test being considered. In any test selected, the user should remember the importance of proper sampling and the need for analysis of a sample of new fluid to establish a baseline for evaluation of subsequent analysis of used samples. Use of these techniques and a competent laboratory will insure maximum fluid analysis program efficiency.

FLUID SELECTION

Proper function and durability of an automatic transmission can be noticeably influenced by the fluid with which it is serviced.

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(Continued from Page I)

Figure 9. Sample Trend Line Plot: Wear Element - Copper (Sample graph illustrating deviation beyond projection)

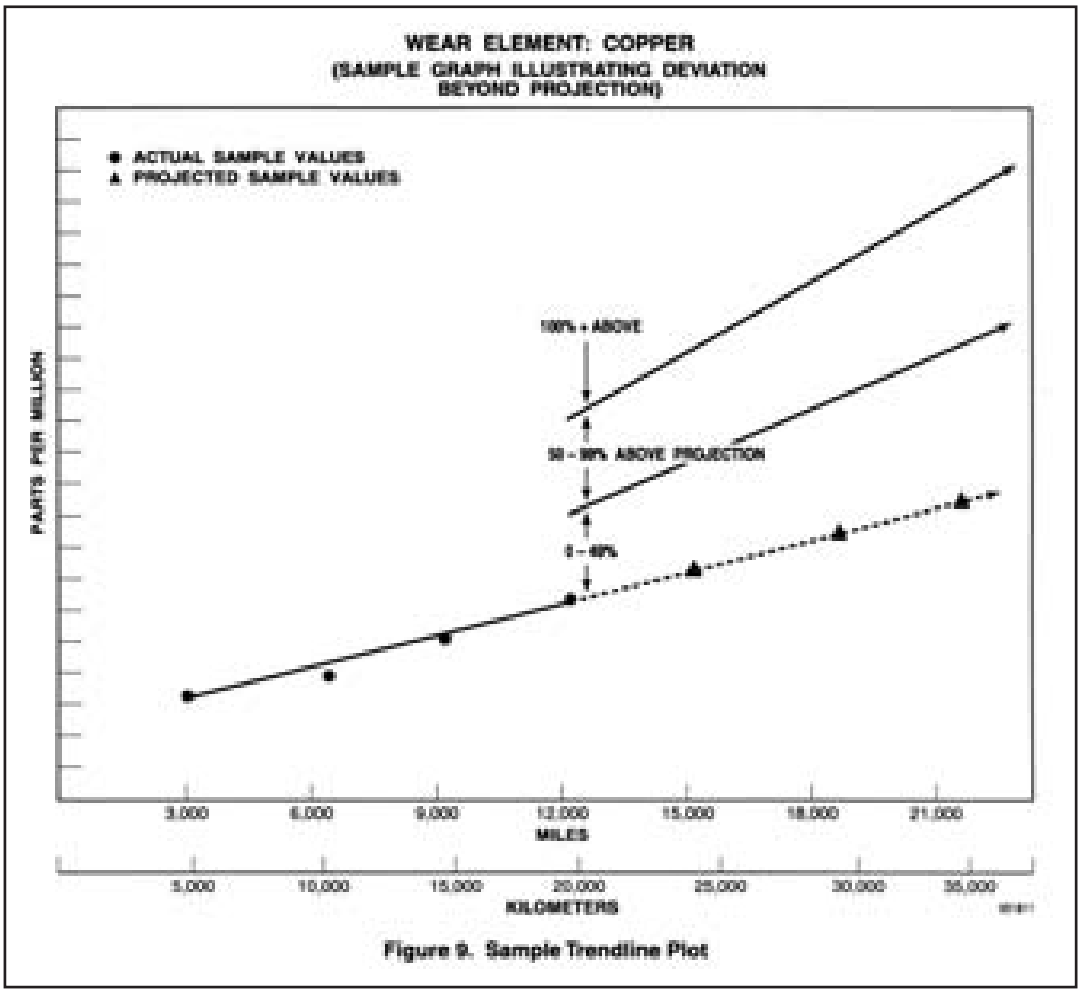

Figure 9. Sample Trendline Plot

RECOMMENDED FLUIDS

TranSynd™ - TranSynd™ is a full synthetic automatic transmission fluids from Allison Transmission Division and Castrol Ltd. TranSynd™ meets new Allison specifications for Severe Duty and Extended Drain Intervals (TES-295). TranSynd™ is available through Allison distributors and dealerships. TranSynd™ is also fully qualified to the Allison C-4 specification and the GM DEXRON-III specification.

DEXRON-III Automatic Transmission Fluids – DEXRON is a registered trademark of the General Motors Corporation. Proper use of this trademark requires that the GM license number be included on the product container. The GM license number is a five digit number preceded by the letter designation "G" (example: GXXXXX). DEXRONIII transmission fluids are dyed red in color for identification purposes. Some DEXRONIII automatic transmission fluids qualify to the Allison C-4 specification.

C-4 Fluids - Some approved C-4 products are heavy duty diesel engine oils. A variety of SAE viscosity grades (i.e., SAE 30, 15W-40, etc.) have been approved to the C-4 specification. Also, some DEXRON-III automatic transmission fluids qualify as a C-4 fluid. These oils are tested and evaluated in accordance with the Allison C-4 Transmission Fluid Specification (TES-228). An approved oil list

(GN3465EN) is available from your local Allison dealer/distributor or via the Allison website at www.allisontransmission.com.

OTHER FLUIDS AND ADDITIVES

A wide assortment of fluid manufacturers offer an almost unlimited variety of fluids and additives to consumers today. Some of these manufacturers publish sales material that makes very impressive claims about their products. It is often supported by selected field data. While these claims may well be valid, ATD cannot take the responsibility of evaluating data or validating the claims of any manufacturer. GM and ATD have designed specific tests that thoroughly evaluate the ability of the fluid to perform well and protect their products. Consequently, ATD can only approve a fluid that has passed the appropriate tests and been granted a DEXRON-III license or C-4 approval number. No other fluid or additive can be approved, regardless of the claims of the manufacturer or the validity of the supportive data; the marketer must initiate participation in the appropriate tests. This requirement is designed to protect the user as well as the transmission manufacturer because optimal transmission life will be realised only when it is serviced with a quality fluid. An approved fluid has all the additives it needs and addition of others, besides being unnecessary and expensive, may upset the chemical balance and effectiveness of the original additives.

Selection of an approved fluid and its singular use will ensure customer satisfaction

FLUID STORAGE AND HANDLING PRECAUTIONS

Because lubricating fluids are generally based on petroleum or related hydrocarbons, they have certain inherent characteristics of which the user should be aware. There are, of course, no unusual hazards associated with most lubricating fluids provided reasonable care is taken with their storage, handling and usage.

Cleanliness and orderliness cannot be overemphasized.

STORING AND HANDLING

Where possible, a specific room or at least a designated area should be reserved for fluid storage rather than randomly placed containers. A specific storage area will lend itself more readily to order and cleanliness. Order must be maintained to ensure that inadvertent mixing of non-similar fluids - engine, transmission, power steering, and brake - does not occur. The storage facility should be heated and the temperature stabilized to avoid moisture condensation and separation of additives. Drums should be stored on their sides to prevent water contamination; improper storage of drums is the primary cause of water contamination. When drums are stored on end, temperature fluctuations can draw water along the cap threads and into the drum. Cleanliness is also an essential part of proper storage. It is important in preventing contamination of the fluid as well as contamination by the fluid. Not only must the fluid be kept clean, but the floor must be kept free of fluid for obvious safety reasons. The cleanliness standard must also be extended to the transfer containers, pumps, measuring cans, etc. These containers should be cleaned with mineral spirits since it evaporates entirely

and will keep the equipment clean without the danger of product contamination.

HEALTH & SAFETY ISSUES

There are no unusual hazards in using most lubricating fluids provided ordinary and reasonable care is taken to keep them off the skin, away from the eyes and to avoid breathing their vapors or mists. Inhalation of fluid mist is always to be avoided. If inhaled in high enough concentrations, fluid mist can cause irritation of the lungs which may lead to pneumonia. Medical problems arising from contact with petroleum-based fluids are relatively infrequent and occur chiefly in circumstances where there is excessive bodily contact; i.e., where fluid soaked clothing is not regularly changed.

The principle problem associated with the handling of lubricant fluids is dermatitis resulting from prolonged or repeated contact with the skin. This is characterized by acne-type lesions mainly on the back of the hands and on the forearms and thighs where the hair follicles and sweat pores can become infected with the formation of small boils or pimples. In general, dermatitis is not a problem if unnecessary contact with the fluid is avoided and good personal hygiene and cleanliness are always observed. The remote risk is further minimized by the use of a barrier and reconditioning skin cream.

Consult your transmission fluid supplier with any questions about storage, handling, and/or health issues. The supplier can furnish a copy of the appropriate Safety Data Sheet (SDS) for the product in use.

SUMMARY

As emphasized throughout this article, effective fluid analysis is only possible though the use of a trained analyst who is familiar with fluids, fluid analysis, and the subject hydraulic components. The competency of the analysis laboratory understandably plays an important part as well.

The competent lab will provide quality and timely analysis, sell only those tests that are needed, and stick to reporting the facts of fluid condition and contaminant levels, leaving judgments on component condition to the component manufacturer.

The prime intent of fluid analysis should be to monitor the functional capability of fluid - can it do its intended function?

Primary hindrances to fluid capability are oxidation and contamination, and fluid analysis program funds are best spent in those areas. Wear metal analysis can also prove useful but should be analyzed by the "trend line" method. Wear metal analysis seldom stands alone; it must be used in conjunction with other inspection techniques.

The assigned analyst should study the analysis techniques and recommendations in this booklet along with other available information, establish a meaningful program, and then supervise it with commitment. The entire organization must be committed to the fluid analysis to realize any benefits.

If there is ever any doubt on the significance of any fluid analysis reports, or a need to react to a condition, the user must remember that the vehicle component manufacturer is the final authority on the product and assistance should be sought through a servicing outlet or a regional office.

Table 6. Summary

THE SERIOUS FLUID ANLAYSIS USER WILL:

- Utilise a Trained Expert
- Utilise a Competent Lab
- Utilise Only Justifiable Tests
- Utilise Proper Sampling Techniques
- Recognise the Manufacturer as the Expert
- Utilise Manufacturer Recommendation
- Assure commitment to the Program
- Utilise Common Sense

COMMON MISCONCEPTION

Table 7.

MISCONCEPTION	REALITY
Fluid never wears out	Even in an isolated, clean system, fluid will oxidise with time; it has a finite life.
Fluid brands should not be mixed.	Fluid brands may be mixed as long as they are approved fluids.
DEXRON® -III and C-4 should not be mixed	DEXRON® -III and C-4 may be mixed, thought this should not be standard practice.
Overfill is better than underfill	Overfill, through heat and aeration, is just as harmful as underfill. Care should be exercised to maintain proper fluid level.
Colour or odour can indicate fluid change need.	Colour and odour are not indicative of fluid change need. Fluid change interval should be established as described in the Fluid Analysis Utilisation section.
Use extra additives . at fluid change	An approved fluid has all the additives it needs. Addition of more is expensive and could be harmful.

DEFINITION OF TERMS AND ABBREVIATIONS

Acid Number - Property of petroleum fluid usually measured by the amount of potassium hydroxide (KOH) needed to neutralize all or part of the fluid's acidity.

Additive - Anything added to a petroleum or synthetic base fluid to alter its natural properties or performance characteristics.

Anti-Foam Agent - A petroleum additive that reduces surface tension thereby assisting a fluid in the release of air bubbles.

Anti-Oxidant - A petroleum additive that works on a molecular scale, sacrificing itself to the oxidation process thus limiting oxidation of the lubricant.

Anti-Wear Agent - A petroleum additive that protects metal surfaces by chemically reacting with or plating onto a surface and wearing in place of the surface.

API - American Petroleum Institute.

Aromatic - One of the three types of petroleum fluid. Derived from aromatic crude oil, thus containing a high proportion of closed-ring Benzene groups.

ASTM - American Society for Testing and Materials (Philadelphia, PA).

ATF - Automatic Transmission Fluid

Base Fluid - Refers to a synthetic or petroleum fluid prior to the inclusion of additives. The three basic types are naphthenic, paraffinic, and aromatic.

Base Number - Property of petroleum fluid usually measured by the amount of acid (expressed in potassium hydroxide (KOH) equivalents) that the fluid can neutralize.

C-4 - A fluid quality specification designed and maintained by ATD primarily intended for off-highway transmission use. Also approved for on-highway use.

Carbonyl Absorbance - An indication of oxidation found by measuring the amount of infrared light absorbed at a 5.8 microns IR wavelength.

Centipoise (cP) - One-hundredth of a poise which is the dynamic measurement unit of the resistance of a fluid to flow defined by the shear stress required to move one layer of fluid along another over a total layer thickness of one centimeter at a shear rate of one centimeter per second. Independent of fluid density and directly related to resistance to flow.

Centistoke (cSt) - One-hundredth of a stoke which is the kinematic measurement unit of the resistance to flow of a fluid defined by the ratio of the viscosity of a fluid to its density.

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Cloud Point - The temperature at which a cloudy haze initially appears when the fluid is cooled under prescribed controlled conditions. It is indicative of the temperature at which a gel, partially consisting of wax crystals, begins to form.

ATD - Allison Transmission Division of General Motors.

Demulsibilty - A measure of the ability of a fluid to separate from water.

Detergent - A petroleum additive that cleans or maintains cleanliness of the working parts of the equipment wetted by the host fluid. Sometimes used interchangeably with dispersant though they are technically different.

DEXRONIII - A registered trademark of General Motors used to designate fluids designed exclusively for on-highway products. Often mistakenly pronounced DEXTRON.

Dispersant - A petroleum additive that disperses or maintains in solution normally insoluble products of combustion and contaminants.

Elemental Analysis - The activity of detecting and identifying elements in solution or microscopic suspension in a fluid sample. Typically used to measure wear metals.

Emulsify - The ability of a fluid to suspend and disperse an immiscible (incapable of mixing) liquid such as water.

EP Agent - Extreme Pressure agent - a petroleum additive that chemically reacts on highly-stressed and loaded metal surfaces forming a protective chemical barrier (dry lubricant) capable of withstanding greater loads.

Esterification - The process of creating an ester; the resultant of a chemical reaction of organic acids and alcohol; one method of creating a synthetic fluid.

Flashpoint - The minimum temperature at which a fluid will just support instantaneous combustion (a flash) but before it will burn continuously (fire point).

Fluid - Typically used to refer to petroleum or synthetic lubricants for application other than engines (oils).

Friction Modifier - The petroleum additive that reduces the coefficient of friction of a fluid making the fluid more lubricious.

Hydrocarbon - A compound consisting mainly of hydrogen and carbon; commonly petroleum.

Hydrofinishing - A process for treating raw extracted base stocks with hydrogen to saturate them for improved stability.

Hydrolysis - The decomposition of a chemical compound, such as a fluid additive, when exposed to water.

Inhibitor - Any additive used to inhibit or control an undesirable reaction or process which could reduce or destroy the usefulness of a fluid; i.e., oxidation inhibitor, rust inhibitor, etc.

Insolubles - Contaminants found in used fluids due to dust, dirt, wear and/or oxidation. Often measured as having a pentane- or benzene-insoluble character.

IP - Institute of Petroleum (London, England, UK), now named The Energy Institute.

IR Scan - Infrared scan; the process of exposing a fluid sample to infrared light at various wave-lengths and measuring the amount of light absorbed.

KOH - Potassium Hydroxide Karl Fischer Reagent - A colored solution of pyridine, sulfur dioxide, iodine, and anhydrous methanol that reacts quantitatively with water to form a colorless solution and is used to determine the amount of water in numerous substances.

Lubricant - A fluid whose prime intended function is the reduction of friction through lubrication.

Lubricious - Term used to indicate a smooth or slippery quality.

Lubricity - The property or state of being lubricious: the capacity for reducing friction.

Multi-Vis - Short for multi-viscous, also the term 'multi-grade' can be used. Refers to a fluid having multiple viscosity characteristics according to temperature; i.e., 10W30. The multi-viscous characteristic is obtained through the use of an additive, a Viscosity Index (VI) Improver.

Naphthenic - One of three types of petroleum fluid. Derived from naphthenic crude oil, thus containing a high proportion of close-ring methylene groups.

Neutral Oils - Lubricant base stocks that are light overhead cuts from vacuum distillation measured in SUS at 100°F (3S"C), mostly Group I base oils. These oils are the basis of most commonly used automotive and diesel lubricants.

Oxidation - The process of oxygen attacking petroleum fluids. Accelerates at high temperatures and with increased exposure to air. Usually leads to viscosity increase and deposit formation.

Paraffinic - One of three types of petroleum fluid. Derived from paraffinic crude oil, thus containing a high portion of straight-chain saturated hydrocarbons. Often susceptible to cold flow problems.

Polymer - A complex chemical compound of high molecular weight obtained from the combination of lower weight molecules. Best visualized as a long chain of molecules.

Polymerisation - The process of creating a polymer, one method of creating a synthetic fluid.

Pour Point - Usually the lowest temperature at which a substance will flow. Lack of fluidity of a naphthenic fluid stems from the increase in viscosity while that of a paraffinic fluid is due to the formation of wax crystals. The pour point can be lowered by additives.

SAE - Society of Automotive Engineers.

Saybolt Universal Seconds (SUS) - A unit used to measure the relative viscosity of fluids under controlled laboratory conditions of temperature and volumes; the static measurement of viscosity.

Shear Index - The measure of the percentage of viscosity loss in a fluid.

Shearing (Polymer) - Shearing of a polymer is literally a splitting, cutting, or dividing of the molecule into two parts having lesser molecular weight. The end result of shearing is a reduction in fluid viscosity.

Shear Stability Index - The measure of the contribution of the VI Improver to the percentage of viscosity loss of the fluid.

Sludge - An undesirable, insoluble substance that forms due to fluid oxidation and/or interaction with water. Sludge can drop out of the fluid, depositing onto internal components causing malfunction.

Straight Grade - Refers to a fluid exhibiting only one viscosity characteristic; i.e., 10 weight has no VI Improvers.

Tribology - The science of surfaces in relative motion to one another and these are influenced by material, lubrication, friction, and wear. Previously this science was called lubrication engineering.

User , also called 'end-user' -Refers to the final purchaser and user of a product.

Varnish - A non-wipeable deposit which can be found on the working parts (especially friction-faced clutch plates) of a transmission. Excessive varnish can interfere with proper function. Also referred to as lacquer.

Viscosity - A measure of the resistance of a fluid to flow due to internal molecular friction; the thickness of a fluid. Centipoise, centistoke, and Saybolt Universal Seconds are common measurement terms.

Viscosity Index (VI) Improver - Oil-soluble polymer chains with very high molecular weights. A fluid additive designed to reduce the thinning effect of increasing temperature. Polymer chains swell with temperature thus imparting a thickening effect as temperature increases.

Wear Metals - Refers to microscopic metal particles or metal in solution in the fluid. Wear metals can be indicative of component wear.

This is the final part of this series of three LUBE-Tech articles.