

MAGNET APPLIED AT TRUCK AND BUSES REAR AXLE HOUSING TO AVOID FIRST REPLACEMENT OIL AND INCREASE THE OIL CHANGE INTERVAL POSSIBILITY

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ABSTRACT

The truck and busses rear axle production process characteristics does not remove all impurities in parts per million (PPM) of metallic and non metallic materials, than as necessary a premature oil change knower “first replacement oil”. This kind of service occurs at five thousand kilometers in average to assure the internal components life (gear assy, retainers and bearings). Evaluating the material properties and rear axle functionalities characteristics were defined to fixing some magnets inside the rear axle housing separated according to minimum distance specification each other. The main idea is attract the metallic particles in oil at rear axle to the magnets (ferromagnetic properties) and also non metallic particles by mechanical friction created by oil movement around gear assy. Considering the impurities volume found out at samples universe at durability tests done are in PPM, the magnets dimension were defined to all rear axle life prediction. Oil samples were evaluated during durability test according to truck and busses maker, rear axle supplier and oil laboratory specialist definition. Up to now, the results show the materials reduction at suspension particles at oil and physical chemical characterizes oil stability after one hundred twenty five thousand kilometers (125.000 km). Were considered, based on the results, the magnets assembled at rear axle housing avoid the first replacement oil. Evaluating all analysis results were defined to increase one hundred kilometers (100.000) and keep the oil analysis. Tear down will be done, according to test schedule, after two hundred twenty five thousand kilometers (225.000 km) to evaluate the gear assy regarding a wear and carbon case reduction, retainers condition, bearings and lubricant oil condition to confirm all rear axle components and lubricant oil life prediction and also analyze the new rear axle oil change interval possibility.

1. INTRODUCTION

Nowadays the Truck and Busses makers normally are the responsible to pay the first replacement oil regarding to hand work according to owner's manual. Basically the current rear axle makers cleaning process does not remove all PPM particles and then the first replacement oil must be done to assure the rear axle life. The magnets applied provide some benefits for customers, Truck and Busses makers and environmental. The possibility to avoid the discharge oil not properly, reduces the oil lubricant cost paid by customer and also reduces the makers maintenance cost is the best situation for all. The definition about new oil change interval is under evaluation, however the results show no data variation after one hundred twenty five thousand kilometers (125.000 km).

2. REAR AXLE AND LUBRICATION – GENERAL INFORMATION

The rear axle is a mechanical gear assy with extreme importance for safety vehicle stability, torque transfer from engine to wheel, reduce the drag and tire premature wear. The lubrication as an essential item to keep the differential at good work condition, reducing wear friction and also temperature parts replacement. The modern's automotive lubricants are made with basic oils made by mineral, semi synthetic and synthetic bases. The lubricant bases are selected according to the film protection at mobile parts to resists mechanical shocks, temperature variation that can be change the oil properties and prevent the oxidation. The oil change interval as defined according to application and oil analysis did during durability tests. The Truck and Busses makers are the responsible to define the interval and describe the interval at owner's manual.

Maintenance Plan
Preventive Maintenance Plan follow:
1. Delivery Review
Made by dealer before vehicle delivery
2. Daily Operation
The operations must be checked daily by vehicle's owner before start running.
3. Weekly Operation
Must be checked by vehicle's owner.
4. First Replacemanet Oil
Executed by dealer – between 1000 ~ 5000km.

Table 1. Truck and Busses Maintenance Plan

3. PROJECT DESCRIPTION

Evaluating the durability test vehicles oil analysis already tested we could confirm metallic and non-metallic particles in PPM over than maximum limits defined by maker and viscosity according to SAEJ306. The high volume found out as a consequence of manufacturing process (stamping, casting, machine and etc.). This kind of materials could cause wear at gears through friction. To avoid the differential premature wear was defined to do the first replacement oil. This process removes the materials in excess and then keeps the differential life predicted for the vehicle application. Considering the maintenance plan showed at table 1, the first replacement oil are made by 80.65 % of all Truck and Busses maker according to benchmarking done. The others 19.35 % decide to use filter inside of axle housing, introduce magnets with synthetic oil bases or reduce the oil change interval. The strategies used by makers are defined according to his engineering application knowledge and marketing requirements. The first replacement oil normally are done at dealers, however some of then use the gas station for oil

replacement. Unfortunately this kind of practice sometimes causes an environmental problem because only 15% return to oil re-refin industries, according to Petroquímica Sul Survey on 2008. The table 2 shows the production volume previewed for 2012 and the oil volume replaced in average during first replacement oil.

2012 Sales Volume X First Replacement Oil			
Makers	Truck Market \geq 5 Ton (Unit)	Bus Market (Unit)	Oil volume (L) estimated
MAN / VW	175.838	40513	1.744.870
MBB			
FORD			
SCANIA			
VOLVO			
IVECO			
AGRALE			
INTERNATIONAL			
SINOTRUCK			
OTHERS			

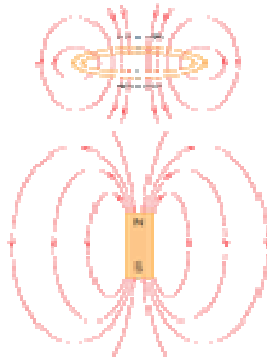
Table 2. Autodata Magazine Dec. 2012 Annual sales volume preview.

Truck and Busses makers normally pay the hand work, but the customer as a responsible to pay the oil. To avoid the first replacement oil and also reduce the high cost paid by makers was discussed with rear axle maker to assemble some magnets at rear axle housing in order to attract the metallic particles by magnetics characteristics and no-metallic particles by mechanical friction.



Picture 1. Magnets assembled at Rear Axle Housing (source: Meritor do Brasil)

The magnets showed at picture 1 have ferromagnetic properties to attract and repel magnetic substances.



Picture 2. Magnetic field lines of forces around a current loop and a bar magnetic i.e.[1].

Several of modern equipment and jigs using a magnetic materials such as generators, electric transformers, electric engines, radios, TV's, phones and computers. When work at high temperature, the magnet lost his properties caused by disorder at his particles, called Curie temperature. Iron lost his properties at around 770°C.

4. VALIDATION TEST

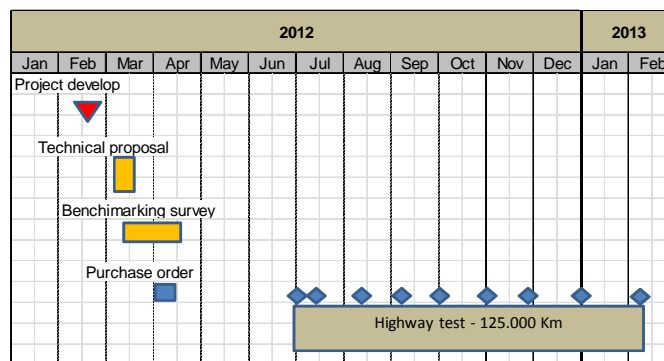
The vehicle defined to test the proposal was heavy duty truck 6X4 (tractor) at highway durability test with 125.000km at maximum load (63 tons). The main objective was evaluating the oil and vehicle without first replacement oil. Were defined oil analysis volume and mileage intervals to collect and send to laboratory for analysis according to SAE J306 Standard. (see table 3). Oil specification: API GL5 85W140, mineral base.

Oil Samples for Analysis Schedule		
Samples	Sample Mileage	Sample Volume (ml)
01 - Complete	0	70
02 - Partial	5000	30
03 - Partial	30000	30
04 - Partial	45000	30
05 - Complete	60000	70
06 - Partial	75000	30
07 - Partial	90000	30
08 - Partial	105000	30
09 - Complete	125000	70
	Total Volume	390

Table 3. Oil sample for analysis volume schedule

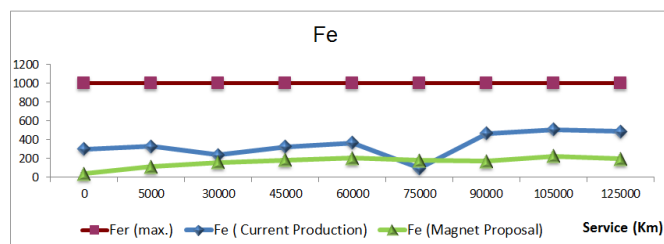
Complete Analysis	Partial Analysis
Viscosity at 100°C	Viscosidade a 100°C
Viscosity a 40°C	-
VI (Viscosity Index)	-
TAN	-
Metal Wear (Al, Cr, Cu, Fe, Mo, Ni, Pb, Si ...)	Metal Wear (Al, Cr, Cu, Fe, Mo, Ni, Pb, Si ...)
Water (Karl Fisher)	Water (Karl Fisher)
FTIR Oxidation, Nitration and Sulphatation	-
Aspect	Aspect
Color	Color
Smell	Smell

Table 4. Oil analysis according to ASTM D445, D95 and D91 Standards

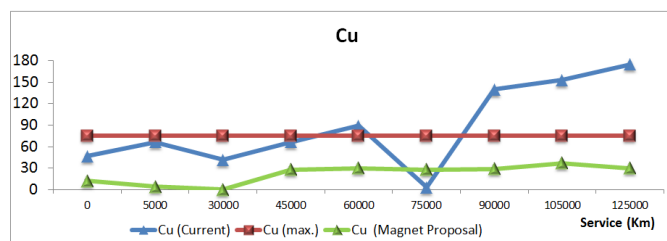


Picture 3. Project and test schedule

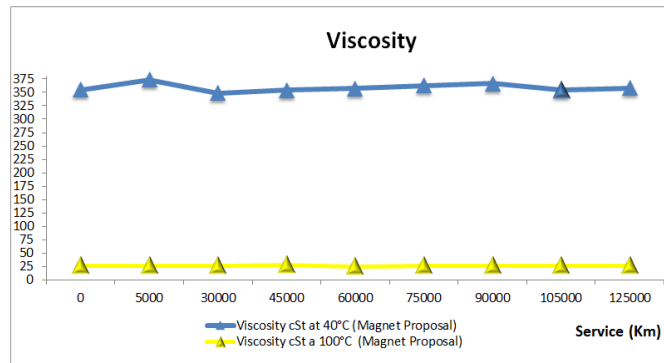
The oil analysis results show a stability trend for all metallic and non-metallic materials and also viscosity. The excess of Copper (Cu) in 75.000 Km makes the oil replacement but after that the volume of Cu in PPM continuous high.



Graphic 1. Oil analysis show Fe stability trend

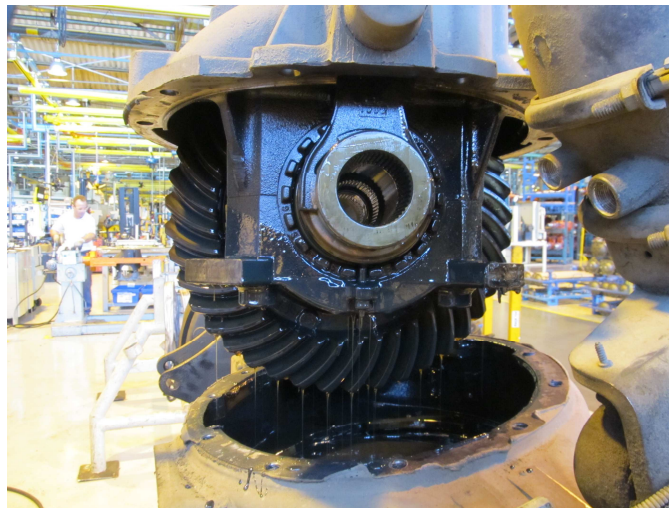


Graphic 2. Oil analysis show Cu stability trend



Graphic 3. Oil analysis show Viscosity stability trend

After durability test done was decided to replace the third axle and send to supplier to do a tear down. In parallel new third axle was assembled and keep running more 100.000 km at same durability test condition to evaluate the oil stability and also the possibility to change the oil change interval according to the data.



Picture 4. Differential disassembly



Picture 5. Magnets at rear axle housing



Picture 6. Ring Gear without pitting or damages

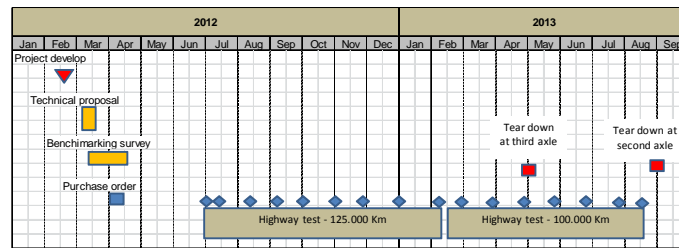


Picture 7. Pinion Gear without pitting or damages

The gear assy evaluation regarding wear and carbon case reduction, retainers condition, bearings life prediction is on going at rear axle maker and the results are previewed to calendar week 26.

5. INCREASE THE OIL CHANGE INTERVAL POSSIBILITY

Following the results found out at durability test were defined new test schedule with same truck at same highway test condition increase 100.000 km at first test. The current oil change interval for this application is 120.000 km considering first replacement oil. The proposal keep the same oil refuel only the necessary volume specified by rear axle maker.

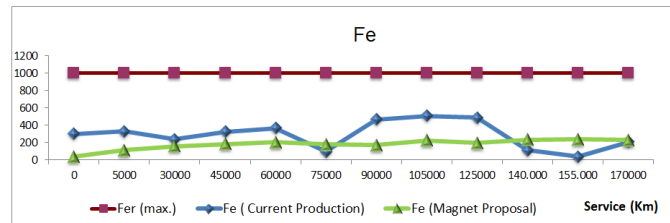


Picture 8. Test schedule with 100000 km increased

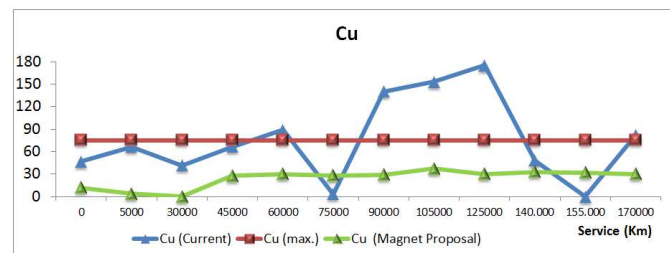
Oil Samples for Analysis Schedule		
Samples	Sample Mileage	Sample Volume (ml)
01 - Complete	140000	70
02 - Partial	155000	30
03 - Partial	170000	30
04 - Complete	185000	70
05 - Partial	200000	30
06 - Partial	215000	30
07 - Complete	225000	70
Total Volume		330

Table 5. Oil sample for analysis volume schedule

The oil analysis keep same trend up to now according to the graphic 4.

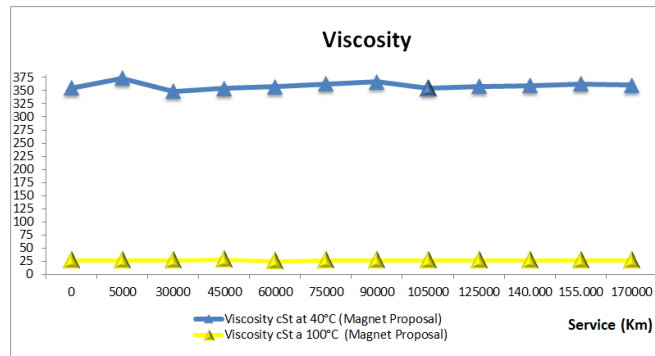


Graphic 4. Oil analysis show Fe stability trend until 170000km tested



Graphic 5. Oil analysis show Cu stability trend until 170000km tested

The graphic 5 shows new oil replacement at 155,000 km. The Cu particles reduction at 140,000 km as a result of oil refueled to the level specified by rear axle maker.



Graphic 6. Oil analysis show Viscosity stability trend until 170000 km tested

6. CONCLUSIONS

- Comparing the current rear axle and the proposal with magnet we could see clearly the stability trend at metallic and non-metallic particles.
- The teardown at rear axle and differential confirm by visual analysis that no pitting or damages were found out at ring gears, pinion gears, others components and the magnets were fixed properly according to the expectation.
- According to the analysis results, the first replacement oil can be avoided applying magnets at rear axle housing, reducing the hand work cost paid by Truck and Busses makers and also reduce the oil cost paid by customer.
- The oil change intervals are under analysis however it is possible to see the stability of materials and viscosity. All analysis shows no water presence avoiding oxidation possibility. Final analysis from rear axle maker will be available on calendar week 26, however we could see normal condition considering 50.000 km over then oil change specification.

7. REFERENCES

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