Impact ofgraphite and sooton the tribological parameters of the friction lining for the motor vehicles clutchesphenolic

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Abstract – The clutch as a friction mechanism is placed between the engine and the gear box and it transfers the torque from the driving to the driven part. It is expected from the clutch to have stabile working and ecological characteristics. The main reasons for the working life shortage of the clutch are the occurrence of sliding in the process of engagement / disengagement, overloading of the clutch and the number of engagements. In order to increase the working life of the clutch a big effort has been done to improve the quality of friction linings. Most of the factors which impacts on the quality of the linings is the graphite and soot of the lining. That is why the aim of the research is to determine the impact of the graphite and soot on the lining tribological parameters over an extensive experimental testing.

Keywords – Friction clutches, linings, motor vehicles, friction parameters, yarn.

I INTRODUCTION

The main purpose of a clutch is to deliver a means to connect and disconnect the engine from the rest of the driveline, where it provides a mechanical coupling between the engine's flywheel and the transmission's input shaft. This transfers the power and torque from the engine to the transmission. Another function of the clutch is to absorb the powerful engine power pulsations so they are not transmitted through the driveline. This is all accomplished through careful design and usage of both static and kinetic friction. [3]

The Fig. 1 shows the section of the clutch with all the elements, where the clutch friction disc is the only part connected to the transmission and all rotational input and torque are delivered to the transmission through the disc. The importance of the friction comes when the spring pushes the pressure plate against the clutch friction disc, squeezing it between the pressure plate and the flywheel.

The principal function of a friction clutch is to convert kinetic energy to heat and then either to absorb or otherwise dissipate the heat while simultaneously, through friction, reducing the relative movement between the friction material and the part to which it is engaged. In order to achieve these objectives the necessary energyconversion must be accomplished outwear on the contacting

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parts.[2] [3] [4] [5] [7]

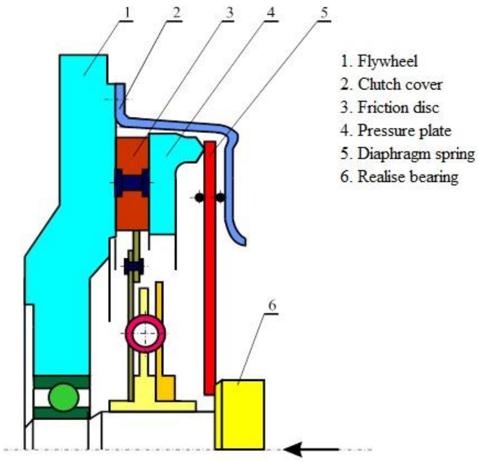

Fig. .1 Friction clutch with the elements

The reliability of a clutch system is generally very high and is the result of the low failure rate of its parts but still there is need to increase the working life of the clutch, especially through improvements in the quality of friction linings. One of the factors that impacts on the quality of the lining is the graphite and soot. This research determines the impact of the graphite and sooton the lining tribological parameters with extensive experiment.

The quality of the lining is expressed by:

- Tribologic parameters,
- The coefficient of friction, and
- The specific outwear of the lining.

The tribologic parameters depend upon the substances and their interrelation within the lining. The lining needs to provide for a stabile coefficient of friction and a small-scale specific outwear, depending on the temperature, specific pressure between the friction surfaces and the velocity of friction, in order to enable the transfer of the moment of motor to the transmission and to enable the vehicle to pass a longer path.

Factors that have an influence on the determination of the tribologic parameters of the linings:

- change in the ratio between the thread and the impregnation material;
- change in the diameter of the thread;

- change in the ratio of the modifiers;
- composition and way of weaving of the thread;
- way ofknitting of the lining;

The friction material is one of the important features of the clutch lining. The friction material is composed of impregnate and thread.

The friction materials may generally be divided into two groups:

- asbestos (which is banned for use in multiple countries)
- non-asbestos materials:
  - synthetic organic fiber, constant temperature materials: fiber-kevler, nomex, kermal fiber etc;
  - inorganic chemical fiber: glass, ceramic, steel fiber);
  - carbon fiber;

There are two technologies for the manufacture of friction linings:

- adhesive means on the basis of caoutchouc and resins, are predominant;
- adhesive means on the basis of water dispersion (synthetic latex), are less frequently used;

Components of the lining can be divided into two parts: thread and impregnate (adhesive means on the basis of water dispersion).

- Impregnate composition is:
  - latex (main raw material);
  - net working;
  - fillers;
  - stabilizers;
  - modifiers etc.
- The thread is drawn:
  - glass,
  - organic materials (cotton, rayon, etc.),
  - metal (copper, brass)

Relationship of thread and impregnate is:

- thread (60÷40)%,
- impregnate (40÷60)%.

Both ways of obtaining linings have basically same structure, determined by four main components:

- thrad (mesh)
- charger
- adhesion meansand
- friction modifiers.

Thread is obtained by spinning of its components. The number of the torsion of one meter long this (100÷250)**tex** for thin thread (1000÷2500) **tex**, for the thick thread (2700÷4500) **tex**the number oftorsions (20÷80).If in thread has more torsion than it receive less impregnate and vice-versa.

Texis the weight of the thread length of one meter in grams (1200tex = 1200gr / m)

Latex is a key element of impregnate, it should be resistant to high temperature. It adds sulphur to increase thestrength of the latex, but on the other hand prevents slipping molecules latex which is not good, so his percentage is low.Soot give higher viscosity of impregnate.Graphite is good sticky, it supports thecoagulation impregnate.Phenolic resins provide strength and enable the impregnate pressure on the lining to be equal. [5] [6]

Impregnate contains: latex (40-60)%, graphite(8÷-12)%, soot (4÷6)%, phenolic resin (10÷20)%,sulphur(3÷5)%, other (3÷6)%.

II. RESEARCH METHODOLOGY

Research methodology includes the study of the available knowledge and experience of clutch and lining manufacturers as well as the literature data.Own experimental research of the influence of the change of the graphite and soot on the friction coefficient and specific lining outwear.Analysis of the results and conclusions.

III. RESEARCH

In order to get the information about the impact of the graphite and soot on the tribological parameters linings of the motor vehicle clutches, the following testing, based on the following approach, were done:[1] [5] [6] [8] [9]

- The tested linings are made of material produced by the adhesive means on the basis of water dispersion (synthetic latex),
- Linings with dimensions ∅350/∅195/3.5
- The composition friction linings:
  - Thread (glass 52%, viskose 10%, copper 17%) 52%,impregnate (latex 58%, ….,**graphite12%**) 48%,
  - Thread (glass 52%, viskose 10%, copper 17%) 52%, impregnate (latex 60%, ….,**graphite 10%) 48%**
  - Thread (glass 52%, viscose 10%, copper 17%) 52%, impregnate (latex 62%, ….,**graphite 8%**) 48%
  - Thread (glass 52%, viskose 10%, copper 17%) 52%, impregnate (latex 60%, ….,**soot 6%**) 48%,
  - Thread (glass 52%, viskose 10%, copper 17%) 52%, impregnate (latex 58%, ….,**soot 8%) 48%**
  - Thread (glass 52%, viskose 10%, copper 17%) 52%, impregnate (latex 64%, ….,**soot 10%**) 48%

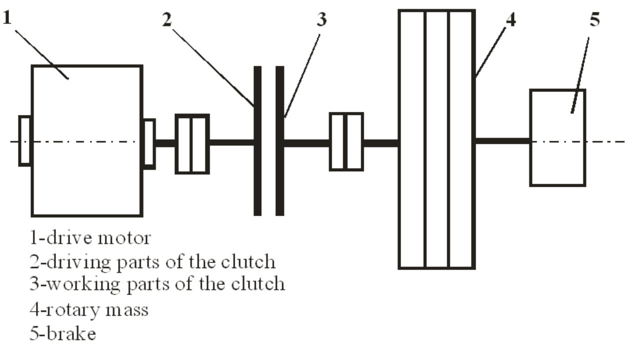

Fig. 2. Test benches

Test bench, there are 2 models of the test benches. Some work in conditions of braking, and the other test bench works with moving of certain rotary mass. The testing were done on the test bench that works with moving of certain rotary mass (Fig2.)

Tests were performed on test benches for clutches that operates on the principles running rotating masses which generate torque equivalent to the moment of inertia of the vehicle whose clutch is tested

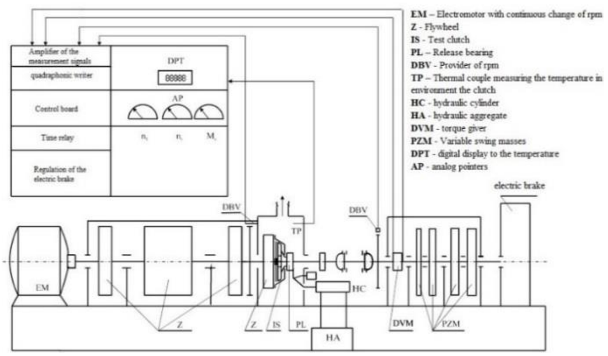

Fig. 3a. Schematic preview of test bench for friction clutches

Based on capability analysis of the test bench which is a product of the company Fichtel Sacks – type K-D-14 – Germany (Fig.3a and Fig.3b), and on the products of main lining manufactures it isadopted the test to be performed with dimensions
∅350/∅195/3.5, often used in vehicles.

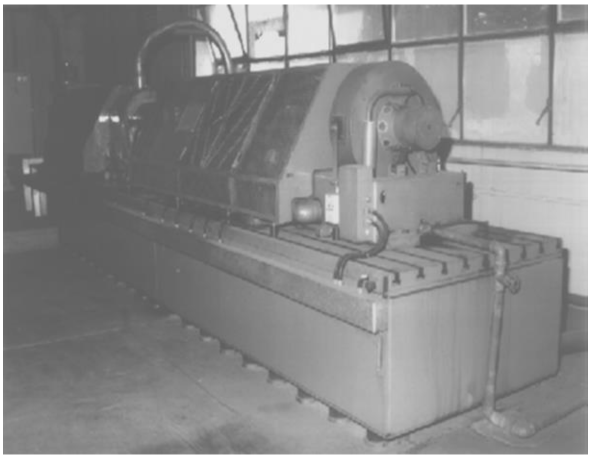

Fig. 3b.Photography of test bench for friction clutches

Testing were performed in the following mode:

- number of the revolutions: n=1600 rpm;
- inertial momentum of the rotating mass: J=10.22 kgm^2;
- specific workload: a=107 J/cm^2;
- engaging frequency : f=1.5 1/min;
- number of cycles: N=1000;

Test method:

- Friction linings are riveted on the disk and together with the clutch are mounted on the test bench.
- Friction linings are submitted to 500 cycles with 75 % contact surface of the total surface of linings.
- Dismantling of the friction disc and the clutch and the test bench.
- Dismantling of linings and disc.
- Measuring the thickness of each lining of 16 places (8 places evenly to the outer diameter, 8 places evenly to the inner diameter)
- Determination of the average thickness of the lining.
- Re-assembling of the linings with hard drive installation disk, clutch and the test bench.
- Fulfillment of the test with 1000, dismantling and measurement of linings (after linings outwear).

The 3 pairs of linings are examined.

The coefficient of friction is determined by the expression:

$$\mu = \frac{M}{z \cdot r_{sr} \cdot P} \qquad (1)$$

M[Nm]-average torque clutch read fromthe diagram of the machine;
z-Number of friction surfaces (z=2);
r_{sr}[m]- mean radius of the friction lining;
P[N]- pressing force of the clutch;

Where:

$$r_{sr} = \frac{1}{2} \cdot d_{sr} \,[\mathrm{m}] \qquad (2)$$

$$d_{sr} = \frac{2}{3} \cdot \left(\frac{D^3 - d^3}{D^2 - d^2} \right) [\mathrm{m}] \qquad (3)$$

D[m]-outer diameter Lining;
d[m]-internal diameter Lining;

Specific outwearing lining is determined by the expression:

$$\vartheta = \frac{\Delta b \cdot F}{A_{vk}} \,[\mathrm{cm^3/10MJ}) \qquad (4)$$

Δb[cm]- outwear lining, measuring the difference in the thickness ofboth linings before and after the test, lining which has a greater difference multiplied by 2;
F[cm^2]- surface lining;
A_{vk}[10MJ]- total work being accomplished in the process of slipping clutch for one test;

$$A_{vk} = \sum_{1}^{n} A_{sr} \quad [\mathrm{J}] \qquad (5)$$

A_{sr}[J]- average work of a cycle;
n[-]-number of cycles;

The work by slipping the clutch is determined by the expression:

$$A_{sr} = \frac{M_{sr} \cdot \omega \cdot t_{sr}}{2} \; [\mathrm{J}] \qquad (6)$$

M_{sr}[Nm]- medium torque, which is calculated as the average of the read values of mean friction moments recorded cycles of the machine diagram;

t_{sr}[s]- average time of inclusion, which is calculated as the average value of the times read by every recorded cycle diagram of the machine.

ω[1/s]-Angular speed the hunted (working) part;

IV. RESULTS

The coefficient of friction in a cycle has a great scattering-derogation (that is the ratio of the maximum and minimum value). This is removed by changing the ratio of soot andgraphite in impregnate. If only graphite will have a major scattering coefficient of friction. By replacing a portion of graphite with soot are getting positive results (Fig.4).

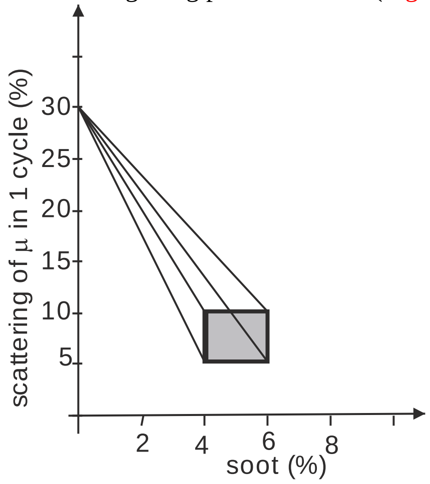

Fig.4.

The specific outwear of the liningdepending graphite (Fig.5).The diagram shows that percentage of graphite depends and on othercomponents that come into the composition of impregnate-soot.

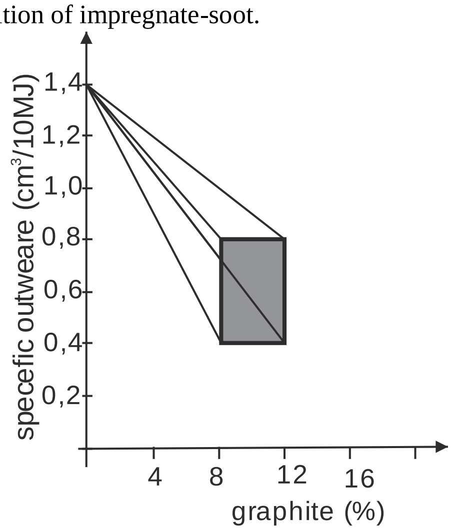

Fig. 5.

V. ANALYSIS AND CONCLUSION

Starting from the tests in dependence tribologicalparameters of the thread diameter can give the following conclusions:

- Tests were performed on test benches for clutches , that operates on the principles running rotating masses;
- Testing were performed in the following mode: specific workload: a=107 J/cm^2;Soot reduces the scattering of friction coefficient of lining within the range of (4-6)% (by replacing part of graphite).If no soot dispersion is 30%, which is not well.;
- Graphite is one of the factors that affect the outwear of the lining (other factors are the number of engagemen/ disengagement hardness of lining etc.). The percentage (8-12)% within the impregnate, outwear on the lining is (0.4 to 0, 8)[cm^3/10MJ];
- Performed testing of methodological approach, given an opportunity for further research in the area of the impact of the elements of the structure of the material for friction linings.

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