RESEARCH OF TECHNICAL PARAMETERS OF TRANSMISIONS FOR VEHICLES AND AGRICULTURAL MACHINES

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The technical parameters of transmissions for vehicles and agricultural machines are investigated. A summarized analysis and an evaluation considering different criteria are carried out. Options for the improvement of the technical parameters of transmissions for vehicles and agricultural machines through a multidimensional optimization and design are suggested as a result of the research.

Keywords: technical parameters, vehicles and agricultural machines, multidimensional optimization and design

1. Introduction

The development of complex transmissions for vehicles and agricultural machines impose the building up of a network of experienced engineering specialists, which enable the researchers to cover all development aspects concerning the design of a contemporary vehicle or machine.

Optimal transmission concepts can be determined during the concept phase, with CAE technologies and information systems. Optimum total system layout can also be achieved applying these technologies and means.

Simulation models of various powertrain configurations provide a detailed analysis of the interaction between powertrain components. The simulation work includes the applying of relevant software available (Matlab, SolidWorks), models available for relevant components**,** flexible boundary conditions (e.g. hybrid concept, driving profile, etc.)

The objective of the presented material is to suggest possibilities for the improvement of the technical parameters of transmissions for vehicles and agricultural machines.

The authors' experience enables the following transmission concept development:

1. Evaluation of existing transmissions configurations

2. Multidimensional optimization for areas such as meshing geometry, ratios and efficiencies

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2. Evaluation of existing transmissions configurations

The evaluation of existing transmissions configurations can be presented throgh the following examples of transmission concepts:

6-Speed Automatic Transmission 09G/09M, [3]

The transmission is adapted for use with different engines and vehicles by varying:

- the number of disc pairs for clutches and brakes;
- the adaptation of the automatic transmission fluid pressure on the clutches and brakes;
- the configuration of gear pairs, planetary gear sets (e. g. four instead of three planetary gears), shafts and bearings;
- the reinforcement of housing components;
- the ratio of the final drive and the intermediate drive.

The transmission sets new standards for dynamics and efficiency in the conventional automatic transmissions through:

- low weight;
- high overall transmission ratio spread;
- compact dimensions of the transmission;
- high speed of shifting;
- high level of shifting comfort.

The presented automatic transmission uses a special arrangement. The advantage of this arrangement is its simple, space-saving and lightweight design. It combines a simple planetary gear set with a subsequent special arrangement. This makes six speeds possible with only five shifting elements.

The engine torque first drives a simple planetary gear set. From the simple planetary gear set, it is transferred to a double planetary gear set. Multi-disc clutches K1 and K3 and multi-disc brake B1 are located on the simple planetary gear set. The number of planetary gears depends on the transmission's torque transfer. Multi-disc clutch K2 and multi-disc brake B2, as well as freewheel F, are located on the double planetary gear set. The clutches achieve a control behavior that is independent of engine speed through their dynamic pressure equalization. The clutches K1, K2 and K3 pass the engine torque into the planetary gear. The brakes B1 and B2 and the freewheel support the engine torque at the transmission housing. All clutches and brakes are indirectly controlled by the electrical pressure control valves. Freewheel F is a mechanical shifting element. It is arranged in parallel with brake B2.

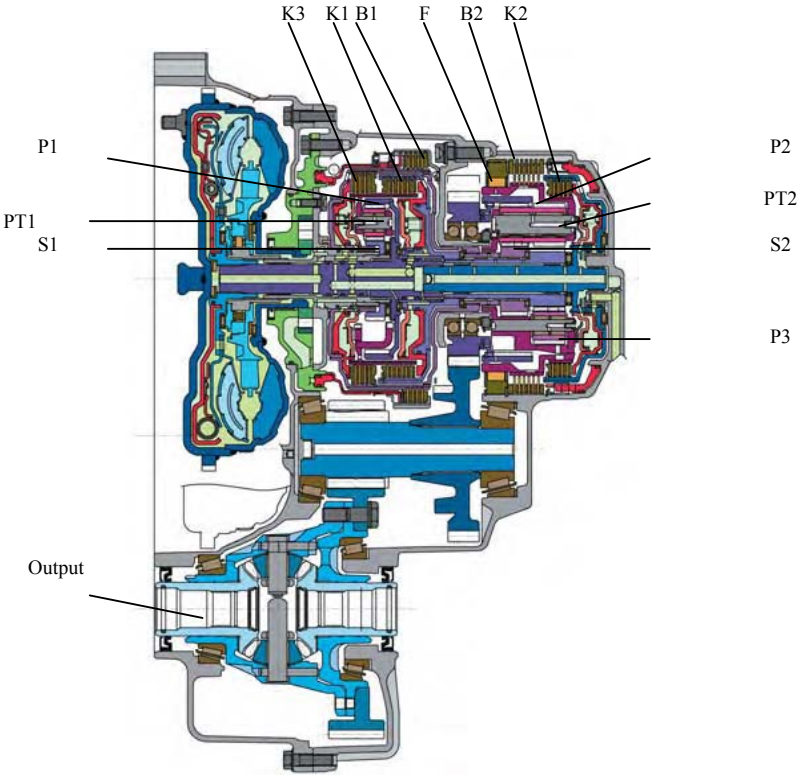

Fig.1. The transmission design and configuration of the components in the transmission:
K = Multi-disc Clutch; B = Multi-disc Brake; S = Sun; P = Planetary Gears;
PT = Planet Carrier; F = Freewheel, [3]

Hybrid transmission (HT) including a belt, [9]

The most important characteristics of this kind of transmission are:

- carry over base transmission;
- additional gearset, E-Motor and clutches;
- simplify base transmissions;
- full hybrid functionality through: excellent performance; excellent shift quality.

Fig.2. HT, [9]

Considering the implemented theoretical research of existing transmissions on a high contemporary level, the carried out analysis is a groud for the following conclusion: it is necessary to perfect already elaborated information systems through their extension and through creating links between their separate elements for the achievement of improved transmission parameters on a high contemporary level.

3. Multidimensional optimization and design

Improvement of the transmission design is carried out through:
- Layout of appropriate transmission ratios, [6]
- Software development, [5,7]
- Gear parameter determination, [1, 4, 6].

The testing of power transmissions trough appropriate software has been supported, [2, 5, 8]. An improved and upgraded experimental test machine for power transmisions has been developed. It examines the friction process between the driving pulley and the belt truck systems. Through the improved test machine tribological experimental research of traction capability of belt truck systems is carried out.

The software system “VisiCate” (Visual Caterpillar) is designed for the analysis of the contact of the driving pulley and the belt upon the traction capability of power transmissions in agricultural machines [5], Fig. 3.

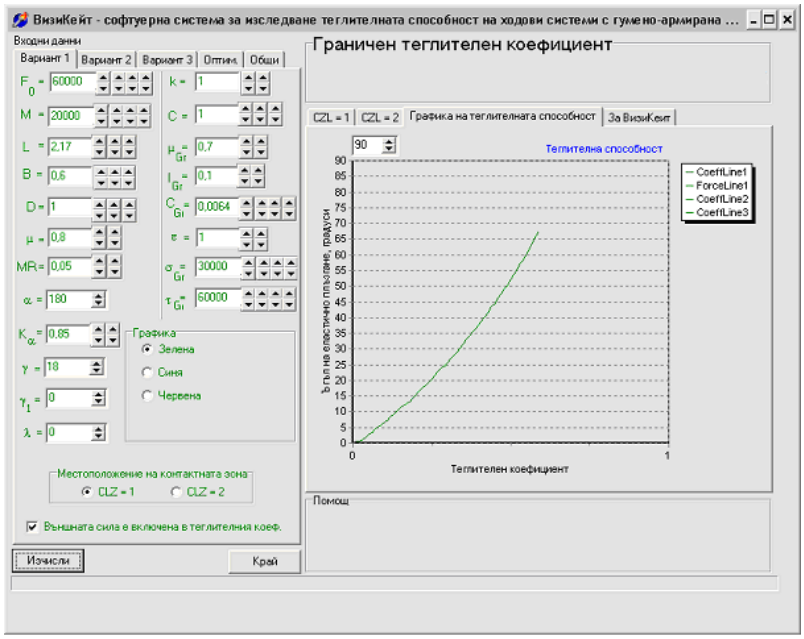

Fig. 3. Window of the software system "VisiCate", [5]

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Systems for automated design of spur, helical and worm drives have been elaborated, [1, 4, 6]. Applying the option "SolidWorks" (Fig. 4), a three dimensional parameter model of the gear train is created in the working environment of SolidWorks® - Fig. 4.

The tooth profile is obtained through a spline interpolation. After the creation of the model, the connection between Visual Gear 1.0 and SolidWorks® is preserved, the values of the parameters can be upgraded in real time. Those options give the users the opportunities to operate with the model – to modify it, to add new elements, to create simulations, to generate technical documents without interrupting the design process. Applying this method, the system Visual Gear 1.0 is integrated in SolidWorks®, [6].

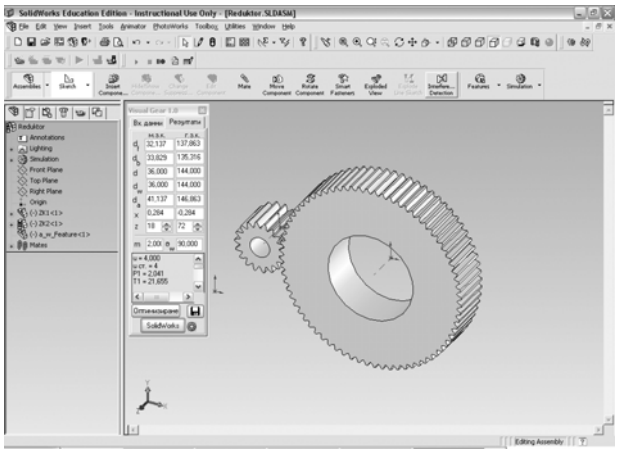

Fig. 4. Visual Gear 1.0 in the integrated environment of SolidWorks, [6]

The design of the system is compact and comprehensive at the same time. It is an appropriate one for working in the environment of SolidWorks®. The elaborated system affords a graphical interface for optimization options. A three dimensional parameter model of a gear train in the environment of SolidWorks® is automatically created.

The presented in [4] software system includes the calculation and optimization of worm gear trains. Different combinations of parameters could be used as input data. An optimization considering the following criteria is possible: an optimal centre distance and maximal efficiency coefficient.

The interaction with this system is carried out through several windows – for input data, for preliminary and for final results and for presenting the theory of worm gear transmissions. An automated design of worm drives is envasaged as well, Fig.4.

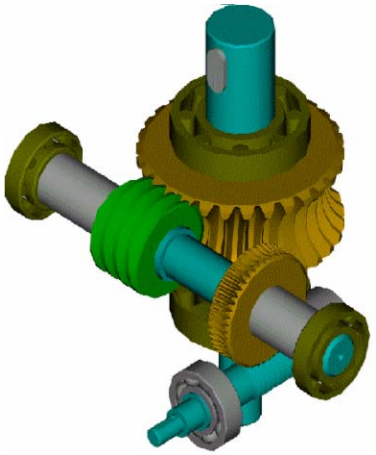

Fig. 4. Two-stages worm gear drive

A combined information system is to be elaborated, which envisaged the integration of the listed and described components. Links between the different software packages are to be created.

4. Conclusions

Based upon the carried out analysis and the presented authors' elaborations, the following conclusions can be made:

1. The design of the contemporary transmissions is possible only through multidisciplinary activities working in a team.

2. The applying of information systems and technologies improves significantly the level of the design elaborations.

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