OPTIMAL SELECTION OF THE CYLINDRICAL GEAR UNIT THROUGH COMPARATIVE ANALYSIS

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Abstract

The paper presents a comparative analysis of gear unit's transmission after the principle constructive and functional parameters, which should be at the basis of the achievement of an optimal selection of those, corroborated which their destination. Theirs the following parameters: size, load value, weight, gear teeth surface, referred torques etc and analyzed.

Key words: *planetary gear, load value*

1. INTRODUCTION

Mechanical power transmission is to be adapted from the coupling and angular speed point of view to the characteristics of the driving engine. In the harmonizing of these characteristics the planetary reducers offer the best solutions under the conditions of a high dynamics quality achievement. The basic orientation in the construction of the gear units transmission is the optimal criterion associated with the reduction of the size and the weight, the most used solution in the branching of the pouter flow by using the field of gears, linked in parallel. Theist we come to transmissions that are not determined statically and dynamically.

The optimization of mechanical transmission the field of gears is the result of compromise taking into consideration the comparison of the two criteria, cinematic, energetic. We come this to the best solution used in design. Egg: the simple planetary transmissions, which show from a dynamic point of view, they show minimum advantages. In this analysis and synthesis we take info account the main particularity of the field of gears transmission we know that the field of gears transmission have, if we compare them with the after capacity transmission, the largest range of used in the technical of constructing machines owing to the special possibilities that they offer.

Planetary gear has a special importance within powerful modern transmission owing to the advantages they present concerning the kinematical and dynamical performances. These are constructions of gear with a complex structure and the kinematics structural synthesis methods of these transmission use planetary mechanisms of special construction. The analysis of planetary transmission of gearboxes type is often hard because of its compounding elements that can link in different ways concerning the activating of the exit power plugs, too.

2. COMPARISONS

Planetary gears trains take a very significant place among the gear transmissions which are used in many branches of industry, in the field of machine-tools and robots have an essential importance these of programmed position. The design of planetary gear trains requires conditions regarding the efficiency, volume factor of safety.

The applicative and experimental research has envisaged the practical checking and complementation of theoretical models adopted for efficiency, as well as the convergence with reality of the procedures of approaching the problems observed. The creation and development of performing mechanical systems of the informative product type, that represent the main method to increase the potential of energy conservation, has required the introduction of new optimization criteria and radical improvement solutions of dynamic quality.

The concept of performance–maximum efficiency establishes the exigencies of the user in relation with the level of energetic efficiency of products. Through this new method of approaching problems in the concept of machines, the technical progress and the unlimited innovative solutions are stimulated, but with a clear orientation to the operation requirements, in accordance with the development level of the present techniques.

In the industrial practice, different types of gear units are used. Preferably, standard helical gear units with fixed transmission ratio and size gradation are applied These single stages to four stage gear units according to the modular construction system cover a wide range of speeds and torques required by the driven machines. In the following single stage and to a ratio of $i = 16$ are examined. For common gear units the last or the last and last but one gear stage usually come to approximate 70 to 80 % of the total weight and also of the manufacturing expenditure

Adding further gear stages in order to achieve higher transmission ratios thus does not change anything about the following fundamental description. In figure 1, gear units without and with load sharing is shown, shaft 1 each being the H and shaft 2 being the L. The diameter ratios of the gears shown in figure 1 correspond to transmission ratio i = 7.

The gear units have the same output torques so that in figure 1 a size comparison to scale is illustrated G in figure 3. And also the comparison of the size of planetary reduction gears according to the transmission report is shown in figure 2

Ratio i, power P [kW] and diameter D [mm] the idler gear of one shaft have been joined to one gear so that they are also considered to be single–stage gear units.

According to Flender [9], in figure 1, referred torques for the gear units shown in figure 3 are represented, dependent on the transmission ratio i. The higher a curve, in figure 3, the better the respective gear unit in comparison with the others. in figure 3.

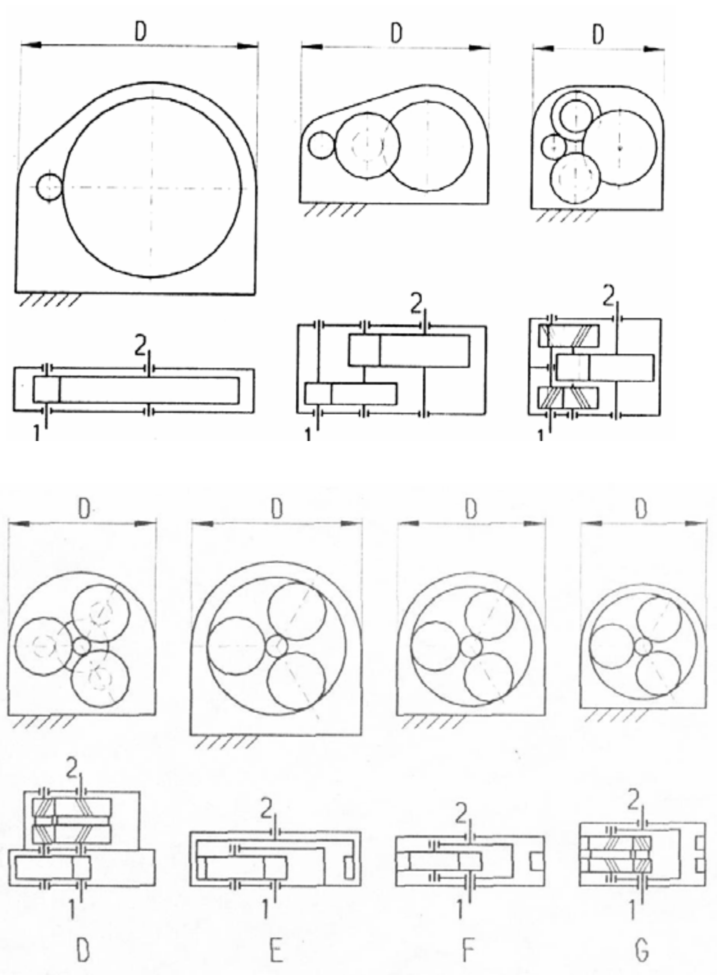


Fig. 1. Size comparison to scale of gear units with the output torque [8]

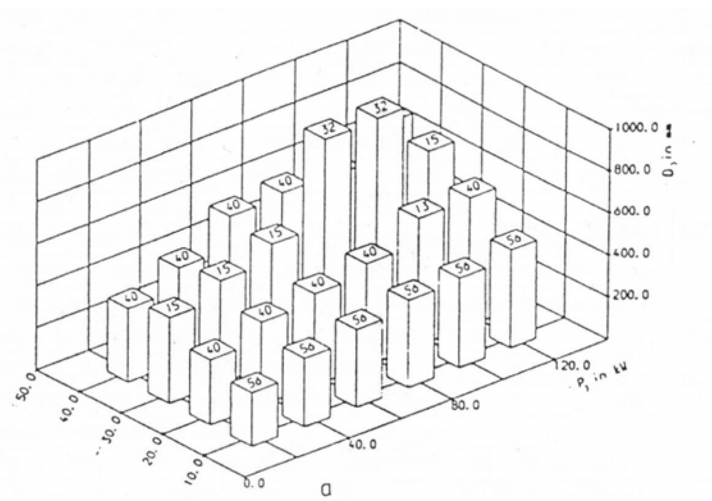
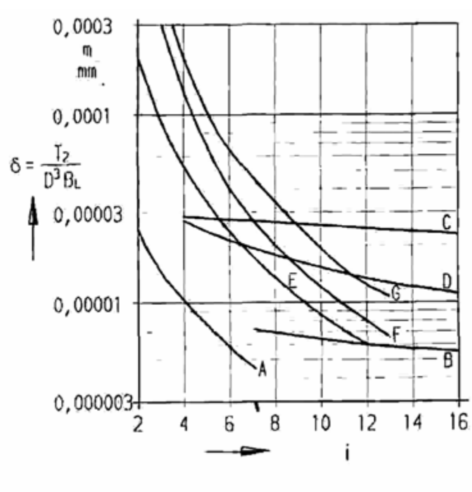
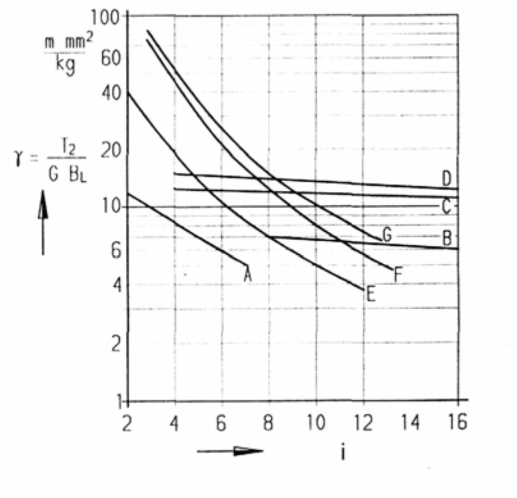


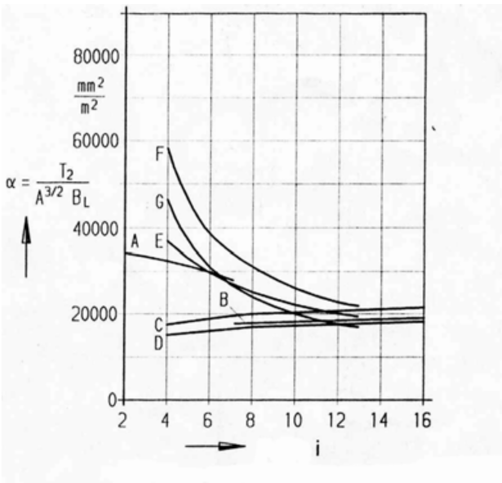
Fig. 2. Comparative analysis the cylindrical gear units [9]



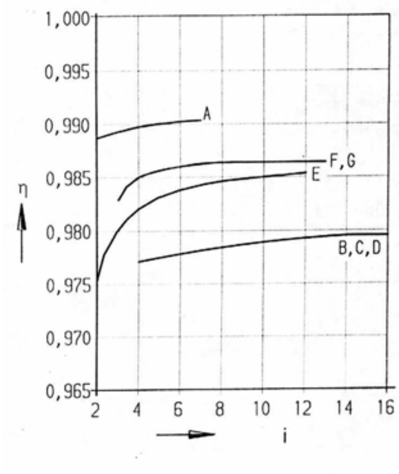
a) Torque referred to size



b) Torque referred to gear unit



c) Torque referred to gear teeth surface



d) Full-load efficiency

Fig. 3. Parameters dependent on the transmission ratio i [9]

3.COMPARISON CRITERIA

-Size

$$\delta = \frac{T_2}{D^{3\cdot} \cdot B_L} \quad [\text{N/mm}] \tag{1}$$

with B_L in N/mm^2, T_2 is referred torques in N.m; D in mm

-Weight:

$$\gamma = \frac{T_2}{G \cdot B_L} \quad [\frac{m..mm^2}{kg}] \tag{2}$$

-Gear teeth surface

$$\alpha = \frac{T_2}{A^{3/2} \cdot B_L} [\frac{mm^2}{m^2}] \tag{3}$$

with G in kg, A in m^2

Load value. By means of load value B_L , it possible to compare cylindrical gear units with different ultimate stress values of the gear materials with each other in the following examinations. The load value is the tooth peripheral force F_u referred to the pinion pitch diameter d_w and the carrying face width b:

$$B_L = \frac{F_u}{b \cdot d_w}, \tag{4}$$

The permissible load value of the meshing of the cylindrical gear units can be computed from the pitting resistance by approximation, as shown using the following formula:

$$B_L = 7 \cdot 10^{-6} \frac{i}{i+1} \cdot \frac{\sigma_{H\lim}}{k_A \cdot S_H^2} \tag{5}$$

with B_L in N/mm^2 and allowable stress number for contact stress $\sigma_{H\lim}$ in N/mm^2 as wells gear ratio i application factor $k_{A,}$ and factor of safety from stress S_H.

The comparisons show that there is not optimal gear unit available which combines all advantages over the entire transmission ratio range. Thus, the output torque referent to size and weight is the most favorable for the planetary gear unit, and this althea more, the smaller the transmission ratio in the planetary gear stage. With increasing ratio, however, the referent torque decreases considerably. For ratios above i=8, load sharing gear unit having external gears only are more favorable because with increasing ratio the referent torque decreases only slightly. With regard to the gear teeth surface, planetary gear units do not have such big advantages if compared to load sharing gear units having external gears only. The efficiency as a quantity of energy losses for cylindrical gear results from the following relation with the input power at shaft 1 and the torque T_1 and T_2

$$\eta = \left| \frac{1}{i} \cdot \frac{T_2}{T_1} \right|, \tag{6}$$

According to [FLENDER. AG], the single stage gear unit A has the best efficiency. The

efficiency of the two stage gear units B to G are lower because the power flow passes two meshing. Full-load efficiency of planetary gear dependent on the transmission ratio i shous in figure 4

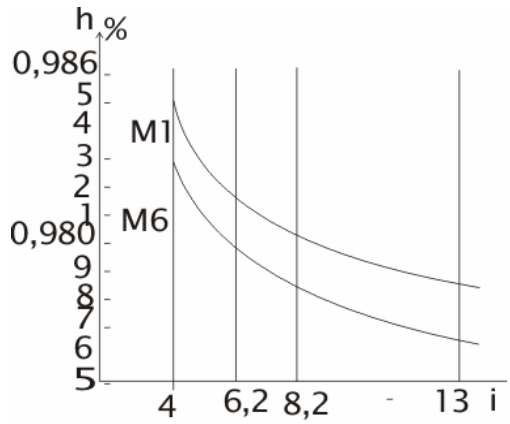


Fig. 4. Full-load efficiency of planetary gear

The internal gear pairs in gear units E, F and G show better efficiencies owing to lower sliding velocities in the meshing compared to gear units B, C and D, which only have external gear pairs. The loss free coupling performance of planetary gear units F and G results in a further improvement of the efficiency. It is therefore higher than that of other comparable load sharing gear units. For higher transmission ratios, however, more planetary gear stages are to be arranged in series so that the advantage of a better efficiency compared to gear units B, C and D is lost. The spaceal comparisons in [%] are show in table1

Table1

Definition parameters	Symbol	SI unit	A	B	C	D	E	F	G
Diameter	D	[mm]	1	0,78	0,56	O,60	0,70	0,60	O,50
Width	L	[mm]	1	1,90	2,00	2,00	1,10	1,00	1,33
Height	H	[mm]	1	0,57	O,60	0,68	0,80	0,68	0,57
Volume	V	[mm^3]	1	0,85	0,67	0,81	0,61	0,41	0,38

CONCLUSION

We notice that the more the size of the reduction gear increases, the theoretical efficiency and the experiment decrease while the transmission report increases, more in the experimental case, adimensional parameters degree of covering and the specific sliding increase. In conclusion the comparative analysis shows that the optimum solution is obtained as a compromise but with a tendency he wards the small values of reduction gears related to the weight and with the distribution of power on several branches as in case of planetary mechanisms.

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