COMPARATIVE PERSPECTIVES REGARDING THE DEVELOPMENT OF THE TRANSMISSIONS WITH PLANETARY REDUCTION-GEARS

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Abstract: *The paper approaches a synthetic analysis of the reduction gear in general and especially of the planetary ones viewing it through some specific indicators which their performances of use. We had in view the reduction gears of the last generation which were taking into discussion and the critical approach on the basis of a certain type of reduction gear on a the of these, realizing that the planetary reduction gears have a larger working field or replacement. The study was done on only one step of gearing on a planetary train respectively in order to obtain more conclusive and more appropriate results being simpler the modeling of the transmission for any type of gear. 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. There are the following parameters: size, load value, weight, gear teeth surface, referred torques etc. In this paper the design considerations based on numerical optimal control studies and the mechanical realization of the achievable performance of decentralized, microcontroller based control architecture.*

Key words: mass factor, planetary, reduction gear, cylindrical gears, worm gear, bevel gear

1. INTRODUCTION

Many research groups and companies are developing reduction gears: cylindrical motor gears in one, two and three transmission steps, helical, bevel and worm gears, bevel-helical gear units, helical-worm motor gears and a comparative analysis of gear unit's transmission see [1-8].

The actual tendencies which are manifested in the construction of the transmission with dented wheels refer especially to the decrease of the mass and the weight, the increase of the efficiency, the decrease of the cost price, as well as the increase of the field of the best usage [5].

The basic orientation in the construction of the gear unity's 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. 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 [6]. In this analysis and synthesis we take into 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 In this context, the cylindrical gears of the planetary type are represented as a modern solution, which permits the achievement of these purposes. When choosing a transmission of dented wheels and working a gear there is a large variety of possibilities such as: reduction gears with cylindrical parallel gears, planetary reduction gears with one step, bevel gears, and worm gears. Each of these usually have certain limits of use resulted from the laws of gears technological possibilities, efficiency. Within this context, it is justified the initiation of a study regarding the comparative perspectives of use and the development of reduction gears in general and especially of the planetary ones [fig.1]. The way of analysis has as a basis the comparison of the main technical characteristics after a few criteria of performances using specific indicators such as the mass factor, the power and the moment of specific acting. Within the transmission of dented wheels, the reductions of planetary gears allow a series of technical and special economic advantages such as: a high report of transmission at low weight; a big couple of transmission at low turations; possibilities of usage within the automatic transmission.

For the organization of this paper: section 2 describes the comparative analysis of performances and the practical realization of the performances is discussed in section 3.

2. THE COMPARATIVE ANALYSIS OF PERFORMANCES

We know the limits of mechanic acting linked to the fact that they have got non linear characteristic very different from the ideal acting. Its approach is limited because of technical

reasons, economic and ergonomic. The more the complexity of the energy flow increases, the more complex and more expensive they become. They can't store structure energy only by expensive and non-economic means. On the basis of these facts, we can appreciate that in the future their use is limited at low and medium powers, which have a simple energetic flow and it is necessary the best award of the characteristic of the acting

Fig.1. Planetary train gear

engine with that of the trained the working body. All these make us reconsider the concept of these transmissions regarding the quality of the materials (especially for the gears and elastic elements) which should allow a mixture of the physical-mechanic characteristics of the composing elements in fields strictly checked.
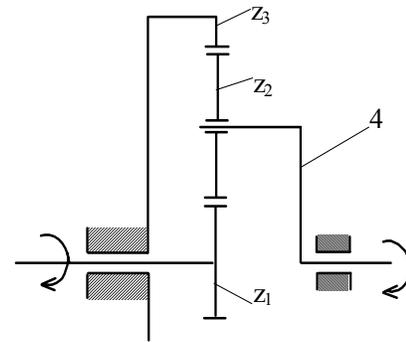
Following comparatively the parameters of first performance for the new domains of use of the technical progress we can draw useful conclusions for their acceptance. We can also make easier a performance design by dimensioning at the upper limited of loading and therefore the decrease of the factor of mass with the assurance of a competitive fiability.

Owing to a large diversity of typo-dimensions of transmission of dented wheels for achievement of a comparative analysis we discussed the one step transmission and according to reports of common transmission. Taking into consideration the characteristics of each type transmission we followed the parameters: the power and the moment of transmission, the net weight and the appropriate weight for each transmission reports established on the basis of the study of restrictions was 4; 5; 6,14; 8,2; 10; 13, from where we deducted for possible transmission for the types of one-stage reduction gears [fig.1], cylindrical, bevel, planetary and worm gears. Performances of the motors so far are in line with theoretical considerations on the choice of a motor-gear-combination. The index of comparison was the weight factor defined as a report between the weights of the reduction gear on the transmitted power.

The specific indicators mass factor is determined by the relation 1,

$$F_M = \frac{M}{P} ,$$ (1)

where: M is mass mechanism, the weights of the reduction gear, kg;

P- nominal power transmitted, kW

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In the tables 1, 2 and figure 2, there are presented numerical values comparatively determined

F_M [kg/kW]   *Table 1*

Type gear	Gear size												
	31	40	50	63	80	100	125	160	200	250	320	400	500
Cylindric	-	-	-	9,5	9	8	8	6,5	5,6	5,3	5	2,6	4,4
Bevel	-	-	-	21	20.5	20	18,5	16	12,5	8,9	7,1	7,3	20
Worm	13	10	15	14	10,5	14,5	11,5	10,5	9,3	12,5	13	17,5	20

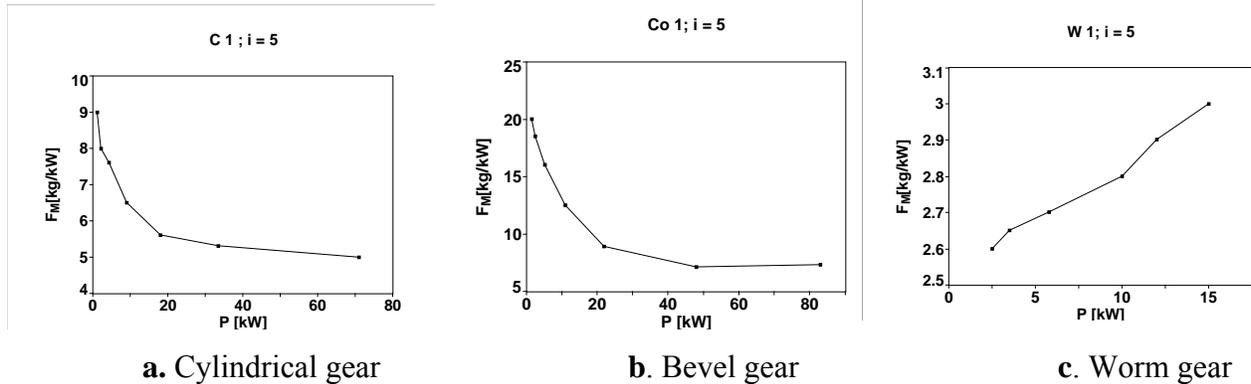**a.** Cylindrical gear   **b**. Bevel gear   **c**. Worm gear

Fig. 2. Specific indicators mass factor F_M for reduction gears

F_M [kg/kW] -Planetary gears   *Table.2*

Gear size	m	Line teeth	Gear reduction ratio - **i**					
			4	5	6,14	8	10	13
1	1	Oblige	0,34	0,34	0,30	0,43	0,54	0,80
		Straight	0,90	0,82	0,76	0,70	0,69	0,90
2	1,25	Oblique	0,26	0,25	0,24	0,42	0,55	0,80
		Straight	0,63	0,57	0,52	0,48	0,48	0,634
3	1,5	Oblique	0,41	0,39	0,46	0,47	0,60	0,88
		Straight	0,60	0,53	0,50	0,47	0,46	0,60
4	1,75	Oblique	0,30	0,29	0,27	0,34	0,43	0,63
		Straight	0,51	0,46	0,43	0,40	0,40	0,51
5	2,5	Oblique	0,25	0,24	0,23	0,30	0,40	0,57
		Straight	0,47	0,43	0,40	0,37	0,36	0,47
6	3	Oblique	0,25	0,32	0,30	0,31	0,40	0,59
		Straight	0,47	0,42	0,48	0,37	0,36	0,47
7	3,5	Oblique	0,30	0,28	0,27	0,26	0,26	0,38
		Straight	0,30	0,28	0,26	0,24	0,24	0,30
8	4,5	Oblique	0,23	0,22	0,21	0,21	0,25	0,36
		Straight	-	-	-	0,23	2,24	0,36
9	6	Oblique	-	0,23	0,29	0,27	0,31	0,40
		Straight	-	-	-	-	0,21	0,25

Analyzed on the word plan, this index is situated according to the material and the treatment of the wheel from the gearing, respectively this measure: -for the reduction gear with superficial treatment teeth; -for the reduction gear of better steel;-for the reduction gear of non-ironed material. The tendency is to deduct 10-20%

3. THE MASS FACTOR FOR THE PLANETARY REDUCTION GEAR

In a first step, the performance of the planetary reduction gears with straight and oblique teeth is investigated referring to the mass factor F_M is represented in figure 3. One important aspect is the maximally achievable sampling rate for the control loop.
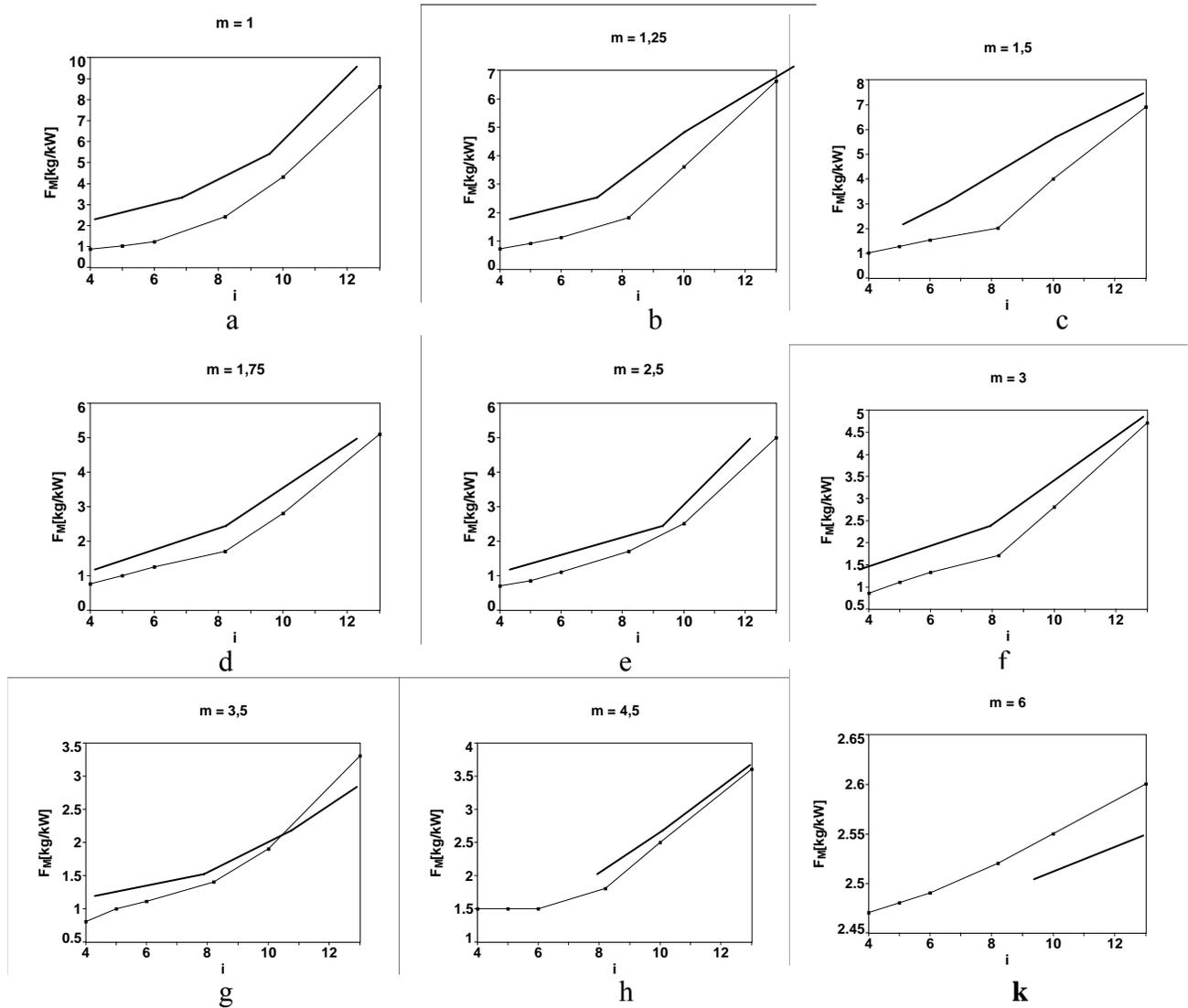

Fig. 3. Specific indicators mass factor F_M for planetary reduction gears

The planetary reduction gears with straight has the same weight the weigh factor is three times lower at the low transmission reports 4 and the high ones 13. The variation of the transmissions moment and of the power presented in the table 1 and figure 2 for the mechanic transmissions that are being analyzed showing the superiority of the planetary ones. The repartition of the weight factor for these transmissions category is represented in table 2. We also

represent a comparison of the weight factor between the planetary reduction gear with tilled wheels is rendered, or for those with straight dents in figure 3.

4. CONCLUSIONS AND OUTLOOK

The maximum factor is minimum at the planetary reduction gears and it has maximum values at the cone-shaped ones; this makes the planetary transmission be high as performances. We realize that weight factor is bigger at low values because of superdimenssion of mechanic components. The right tooth is more advantageous according to the criterion of the minimum weight factor owing to the necessity of constructive components super dimensioned to the supplementary requests, which appear at the angled tooth

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, dimensional 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 towards the small values of reduction gears related to the weight and with the distribution of power on several branches as in the case of planetary mechanisms.

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