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CEurSIS 2014

MINISTERUL EDUCAŢIEI ŞI CERCETĂRII
UNIVERSITATEA TEHNICĂ
DIN CLUJ-NAPOCA

CENTRUL UNIVERSITAR NORD
DIN BAIA MARE
FACULTATEA DE INGINERIE

CEurSIS 2014

THE INTERNATIONAL CONFERENCE OF THE CARPATHIAN EURO-REGION'S SPECIALISTS IN INDUSTRIAL SYSTEMS

-10th EDITION –

Programme & Abstracts

BAIA MARE
September, 11st – 13rd , 2014

SIMTech
INDUSTRIAL SYSTEMS & TECHNOLOGY MANAGEMENT
departament

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OBJECTIVE

Our objective is to ensure the conditions for high quality research and professional interactions in the benefit of science, technology, and collaboration.

CONFERENCE SECTIONS

1. Manufacturing Technologies;
2. Machine Elements, Tribology, Maintenance;
3. Product Design;
4. Management of Technology;
5. Electrical and Computer Engineering

GENERAL INFORMATION

The first edition of The International Meeting of the Carpathian Region Specialists, focused on Gears, was organized in 1996 under the coordination of Eugen PAY. The following editions had a continuously grown multidisciplinary approach of the research and technological development activities, so the 2014 meeting comprises a wide spectrum of engineering.
Until now more than 300 specialists from Romania, Poland, Hungary, Germany, Czech Republic, Austria, Serbia, Ukraine and Slovakia, with more than 500 papers, attended the CEurSIS.
The scientific activities it possible to be complete with proposed social activities (visit to History and Art Museum, Vilage Museum and Mineralogy Museum etc.).
THE OFFICIAL LANGUAGE: English for all printed material, presentations and discussion.

EVENT SCHEDULE

THURSDAY, September 11st, 2014

Str. Victoriei 76
19,30 Welcome dinner - Universitary Restaurant

FRIDAY September 12th, 2014

Str. Dr. Victor Babes 62A

09,00 – 10,00 - Registration of participants -

10,00 10,15 - OPENING OF CONFERENCE

10,15 – 11,30 - PLENARY SESSION PRESENTATION

11,30 – 11,45 - Coffee break

11,45 – 13,30 - THEMATIC SESSIONS

14,00 – 15,00 – Lunch at Universitary Restaurant

15,30 – 16,45 - THEMATIC SESSIONS

16.45 17,00 Coffee break

17,00-18,30 - THEMATIC SESSIONS

19,30 - Festive dinner

SATURDAY, September 13rd, 2014

10.00 - CONCLUSIONS. CLOSING OF CONFERENCE
12,00 – Social and cultural activities.

Departure of guests

PAPERS IN PLENARY SESSION

Chair: Prof. Nicolae Ungureanu
Room: Senat Hall

Dan SĂVESCU - **Aspects Regarding the Competitive Strategy in Companies with Technologic Vigilance (Part I and II)**

Abstract: *Paper presents some aspects regarding the strategy made by companies, the effort of the top management to be profitable. Beginning with some definitions, in the other hand it is presented from a synergetic point of view, a study case for company performance, in the way to be competitive, durable, with good clients, stakeholders. There are also presented ways to be adopted to open the excellence road.*

Ionuţ Gabriel GHIONEA Adrian GHIONEA - **Analysis of Measuring Data for Some Precision Indices of a Spur Gear Hydraulic Pump**

Abstract: *This paper presents the importance of knowing the constructive solutions and operational parameters regarding the performance of hydraulic pumps integrated in hydrostatic drive systems. For a considered pump product there are briefly presented the main stages of design and analysis. In the design steps, some parameters defining the hydraulic flow and spur gear teeth profiles are the main data in the pump's construction. The analysis is performed on the basis of data obtained by measuring gears deviations and tolerances according to the methodologies specified in standards. Among them there are retained and analyzed the most relevant that meet the requirements of accuracy criteria for the precision grade imposed to the spur gear. Also, the analysis presented in this paper leads to some interpretations of the causes of found deviations. The obtained results are important in assessing the required performances for these types of hydrostatic generators with reference to geometric and functional parameters.*

Grzegorz KOCOR - Stanislaw LEGUTKO - **The Application of the Magnetic Method in Investigation of Ropes Used in Mine Pit Shaft Hoists**

Abstract: *Hoisting ropes, depending on their destination, can be divided, among others, into lifting ones, balance ones, guiding-and-lifting ones, guiding ones, fender ones. Methods of assessment of the technical condition of steel ropes have been described in the paper. The results of investigations of the processes of wear of exploited ropes with using magnetic method have been presented. Complete or partial cracks of individual strands in the internal layer of the ropes were identifying.*

PAPERS IN THEMATIC SESSIONS

Section 1: Manufacturing Technologies

Section Chair: Prof. Mircea Lobonţiu / Prof. Ivan Kuric
Room: L18

Mihai BANICĂ, Nicolae MEDAN - **Statistical Analysis of the Experimental Data Obtained in Studying the Impact Forces of Water Jet Cleaning**

Abstract: *This paper presents statistical analysis of experimental data obtained in the study of impact forces of water jets cleaning used for maintenance of sewers. The values of the impact forces were measured used own conception device. We established the process parameters, the number of levels and their values. Depending on these parameters was set a full factorial experimental design, completely randomized with seven blocks. Statistical analysis of experimental data consisted of: verifying the aleatory character of data, verifying the normality of the experimental data distribution, identifying data affected by aberrant errors.*

Alina Bianca BONŢIU POP - **Investigating the Effect of Machining Parameters on Surface Roughness of 7136 Aluminum Alloy in End Milling**

Abstract: *Surface quality is affected by different processing parameters and inherent uncertainties of the metal cutting process. Thus, the anticipation of surface roughness becomes a real challenge for engineers and researchers. The purpose of this paper is to study the 7136 aluminum alloy used in the aircraft industry, to obtain data for the effect of the cutting feed on surface quality and manufacturing time reduction, in end milling operations using standard tools for aluminum machining. The final results are a database for future research.*

Alina Bianca BONŢIU POP, Mircea LOBONŢIU - **The Finite Element Analysis Approach in Metal Cutting**

Abstract: *Due to the complexity of metal cutting, numerical techniques were often developed and adopted to replace the experimental approaches - which are expensive and time consuming. In the last two decades, the most widely used numerical technique was the finite element method. The objective of this paper is to carry out a monographic study to identify the finite element analysis approach in the metal cutting process and to make assumptions and create scientific papers to provide a data basis to validate the approximations made by the finite element method.*

Radovan HOLUBEK, Roman RUŽAROVSKÝ - **On the Analysis of Direct Production Alternatives within the Flexible Production System ICIM 3000**

Abstract: *Currently is characterized production engineering together with the integration of industrial automation and robotics such very quick view to manufacture of the products. The production range is continuously changing; expanding and producers have to be flexible in this regard. It means that need to offer production possibilities, which can respond to the quick change. Engineering product development is focused on supporting CAD software; such systems are mainly used for product design. Those manufacturers are competitive; it should be kept procured machines made available capable of responding to output flexibility. In response to that problem is the development of flexible manufacturing systems, consisting of various automated systems. The integration of flexible manufacturing systems and subunits together with product design and of engineering is a possible solution for this issue. Integration is possible*

CONTENT

INVITED PAPERS

Section 1: Manufacturing Technologies

Section 2: Machine Elements, Tribology, Maintenance

Section 3: Product Design

Section 4: Management of Technology

Section 5: Electrical and Computer Engineering

Analysis of Measuring Data for Some Precision Indices of a Spur Gear Hydraulic Pump

Ionuţ Gabriel GHIONEA [1,*] Adrian GHIONEA [2]

Abstract: *This paper presents the importance of knowing the constructive solutions and operational parameters regarding the performance of hydraulic pumps integrated in hydrostatic drive systems. For a considered pump product there are briefly presented the main stages of design and analysis. In the design steps, some parameters defining the hydraulic flow and spur gear teeth profiles are the main data in the pump's construction. The analysis is performed on the basis of data obtained by measuring gears deviations and tolerances according to the methodologies specified in standards. Among them there are retained and analyzed the most relevant that meet the requirements of accuracy criteria for the precision grade imposed to the spur gear. Also, the analysis presented in this paper leads to some interpretations of the causes of found deviations. The obtained results are important in assessing the required performances for these types of hydrostatic generators with reference to geometric and functional parameters.*

Keywords: *spur gear pump, precision grades, tooth profile deviation, cumulative pitch deviation, indices*

1 INTRODUCTION

Generally, hydrostatic driving systems are used, corresponding to their technical data and performance, in important industry fields such as: machine building, automotive, equipment, various devices etc. Their basic component is the hydrostatic generator (pump) made in many constructive and functional variants for a specific destination [4, 13, 14].

There are two main categories of pumps: with constant flow and with adjustable flow. Other characteristics of pumps are related to: constructive typology (spur gear, with blades, with piston etc.), maximum flow rate, working pressure, driving speed and torque, efficiency [10].

The spur gear pump assembly is characterized by a relative constructive simplicity, compactness, low noise level, reliability.

The conveyor cups of hydraulic fluid consist of gaps between the rotor teeth (pinion z_1 and wheel z_2) having the same number of teeth. One of the rotors (z_1) drives the wheel at a certain speed (n_0) in one direction (sketch of figure 1).

The hydraulic fluid is aspirated (Inlet aperture) at the atmospheric pressure and discharged (Outlet aperture) at a flow rate Q_p (l/min) and pressure p_p (bar).

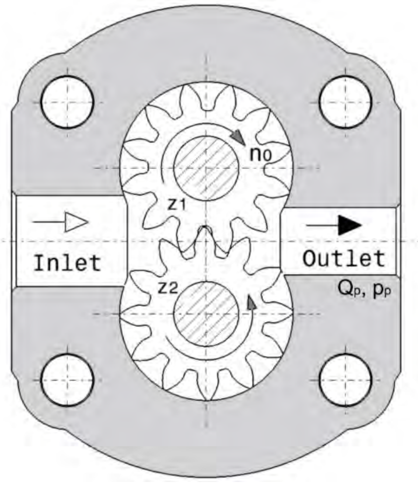

Fig. 1. Position of rotors inside the pump's body

Flow rates, inlet and outlet pressures, components dimensions, driving speeds, assembly constraints etc. are seized in wide limits established by pump's application. These parameters made it possible to conceive standardized series of pumps supplied by producers on order catalogue based.

The gear pump assembly must fulfil a number of requirements regarding the spur gearing operation under varying loads, low vibration and noise, durability and optimum efficiency [1, 5, 11]. All these impose conditions of design, manufacture and control for the two rotors (pinion and gear), shafts and holes, but also for the functional and assembly surfaces of the pump's components [7, 13].

2 CONCEPTION STAGES OF PUMPS

In the industrial practice, the development and improvement of new products or remodeling of the existing ones are important activities that need to be taken into account in any company having activities in industrial manufacturing. In the research, design, simulation, testing and manufacturing phases, many risks and unforeseen events often occur. They can reduce the manufacturing results and technical characteristics (defects, conception, processing and/or measurement errors).

Therefore, it appears the need of the design simulation at all stages: computer assisted parts design and technology, simulations on virtual CAD models, identification of several variants for the same product (parametric design) to diversify the production, establishment of the processing technologies and of the components' assembly, economic estimations to determine the manufacturing costs and delivery terms.

Figure 2 presents the main stages of design, manufacturing, product evaluation and certification of a Gear Pump. The main data are: geometrical and operational parameters of the product (parameters like: Q_p – flow rate, V_g - geometric volume/displacement, pressure p_p, s peed n_0, efficiency λ, other conditions and constraints). There are considered some variants (with one, two or more rotors, number of teeth, module, gear width, pressure angle etc.), electric motor driving.

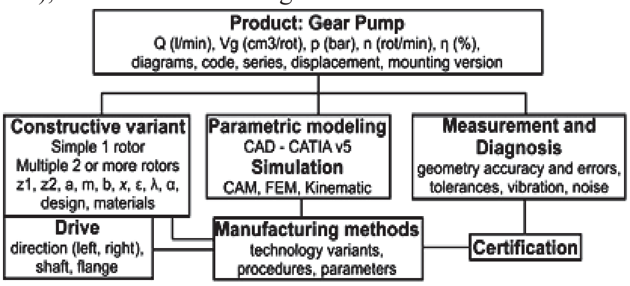

Fig. 2. Design stages for the gear pump product

An important step in designing the parametric tooth flank profile [6], created in CATIA v5, is shown in figure 3 and in figure 4 the 3D model of the gear pump.

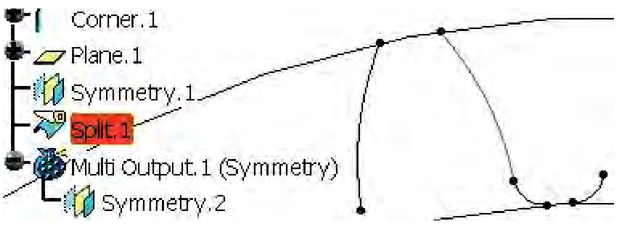

Fig. 3. Parametric drawing of the tooth flank profile

To draw the profile were applied parametric equations of the involute to generate points, joined by a spline curve. Some papers [2] indicate gearings with an asymmetric profile.

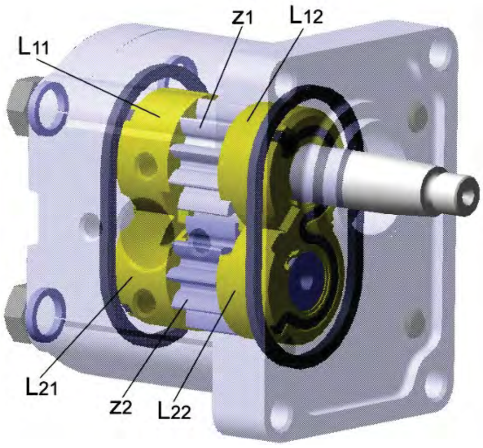

Fig. 4. Parametric 3D model of the gear pump

The gaps between the gearing's teeth form conveyor cups for the hydraulic fluid. The cups volume is determined by the geometrical elements of the involute tooth gear [10] supported by bearings L11 ... L22. The 3D model of the pump in figure 4 was obtained based on the parameters: number of teeth z_1 = z_2 = 12, center distance A = 31.4 mm, module m = 2.54 mm (normal specific displacements x_n = 0.2 mm pinion, x_n = 0.199 mm gear and frontal specific displacement x_f = 0.2 mm), face width b = 18.3 mm, pitch circle diameter d_d = 30.48 mm, outside circle diameter d_a = 37.413 mm, rolling circle diameter d_r = 31.4 mm, base circle diameter d_b = 28.642 mm, pressure angle α = 20^0, teeth height h = 6.205 mm, normal gear pitch p_n, normal arc of dividing the tooth/gap s_n/e_n, frontal contact ratio ε = 1.494, constant chord s_c = 3.85 mm. The parameter values are based on calculation methods [10, 11] and standards in the field [15]. Analysis of these data shows that the involute tooth gear is corrected.

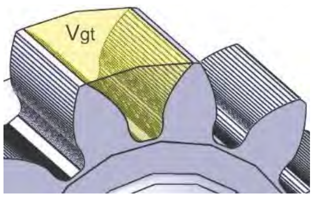

Fig. 5. The gap volume of two succesive teeth

Figure 5 contains a 3D detail of the gear which is marked a gap (cup) of two successive teeth, its volume was noted V_{gt} ≈ 0.52 cm^3. The geometric volume V_g of the pump is calculated by the formula (1):

$$V_g = 2 \cdot z \cdot V_{gt} \cdot 10^{-3},\ [\text{cm}^3/\text{rot}] \qquad (1)$$

The pump flow Q_p results from formula (2):

$$Q_p = \frac{V_g \cdot n}{10^3} \cdot \eta_v,\ [\text{l/min}] \qquad (2)$$

where: n_0 - driving speed (rot/min), and η_v - volumetric efficiency (%).

High speeds, over 1500-2000 rot/min, lead to appearance of the cavity process, which reduces the pump flow, efficiency and gas occurrence in the hydraulic fluid.

The market demands and pump producers' concerns prove interest for the parametric design of pumps' series. There are imposed computer aided design techniques which offer many possibilities to edit the parameters in order to obtain other custom versions of the actual pumps. The validation of the pumps series is possible and is done by modern and complex simulations, such as: kinematics, FEM, CAM etc.

3 MEASURED DATA AND RESULTS

The practical approach in this paper graphically presents the influence of pump's processing errors over the constructive and functional performances, subject researched also in the thesis [6].

From the constructive point of view, the gear pump which was measured (gear, body, bearings) consist of an involute cylindrical external gear (fig. 6) contained in the housing C, provided with two apertures: for aspiration/inlet I and for discharge/outlet O. The pinion z_1 and gear z_2 have involute profiles. The geometrical elements, presented above in §2 were used to represent the pump's assembly (fig. 4).

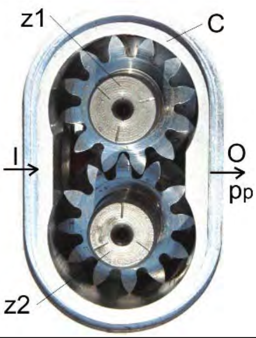

Fig. 6. Pinion z_1, gear z_2 and the two apertures I, O

The errors and deflections of the gearing and bearing elements appear throughout the various stages of processing: the body, the housing, the gears, the tooth flanks, bearing bores, operating conditions etc.

To establish the causes and sources of errors there are applied specific steps, rules and tools presented in handbooks and scientific papers with topics in the field and in professional standards [15].

In many study cases are identified which sources have a greater influence: the machine tool and the cutting tool as basis components of the technological system. It is also necessary to analyze the process, its parameters and the processing.

The execution precision of gears in their diversity is defined by the grade of accuracy, flanks roughness and clearance between the flanks.

Precision indices, their names and symbols, specific deviations limits and tolerances are set by standards that indicate individual and cumulative errors.

Precision criteria. In their definition are considered the main areas of gearings' use.

Thus, there are established three criteria of precision corresponding to: kinematics, smooth running, contact between teeth. For each criterion are specified indices and group of precision indices.

Spur gear division		
Prog. no. GST0409d44 0 P150	Operator: Op1, NEPTUN	Data: 23.06.2014 15:41
Name: Pinion	No. of teeth: 12	Pressure angle: $20^0 00'00''$
Drawing no. Pinion z1=12	Module m=2.54 mm	Helix inclination angle: $0^0 0'0''$
Order no. 01	Condition: final	Place of measurement: UPB

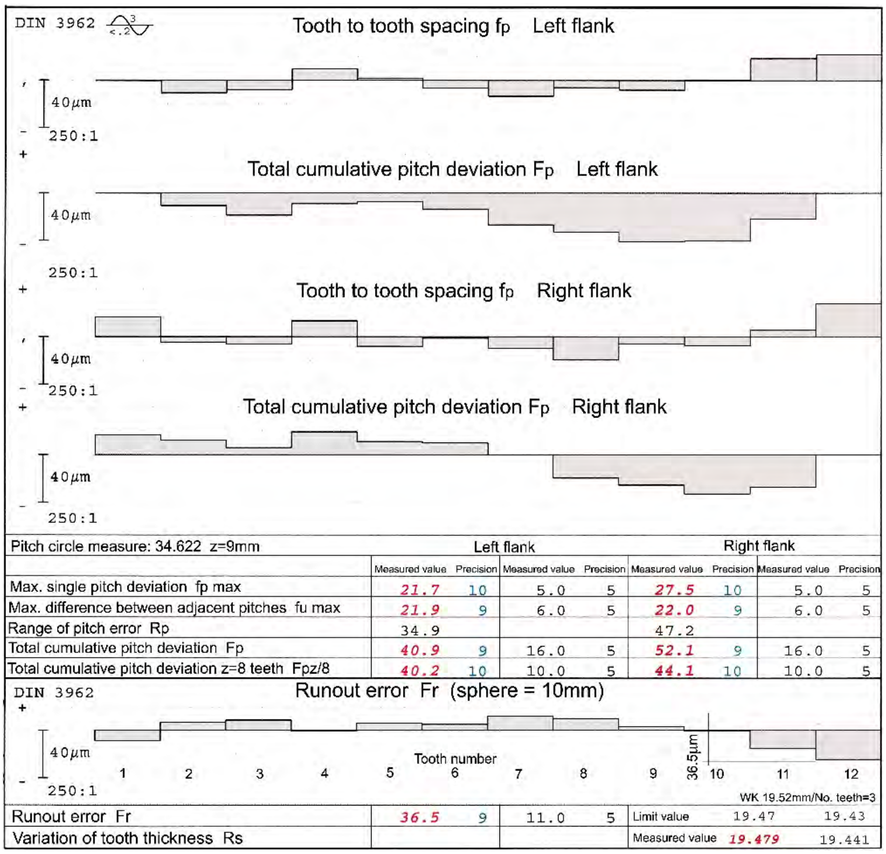

Fig. 7. Individual and cumulative pitch deviations and runout

In figure 7, the notations are: F_p - total cumulative pitch deviation (difference between the most positive and the most negative index value for all teeth), f_p –single pitch deviation (difference between two adjacent teeth index values +, -), f_{pmax} – maximum single pitch deviation (maximum difference between two adjacent teeth index values +, -), f_{umax} – maximum difference between adjacent pitches (maximum difference between actual dimensions of two successive right or left flank transverse pitches), R_p – range of pitch error, pitch variation (difference between the largest and the smallest actual size of the transverse pitches of a given flank), $F_pz/8$ – total cumulative pitch deviation for eight teeth (maximum difference in cumulative deviations of actual values and those nominal for eight teeth), F_r – runout error (radial position difference of a probe contacting all teeth at measuring diameter – pitch diameter, it combines tooth eccentricity in relation to the datum axis and the tooth spacing error), R_s – variation of tooth thickness (difference between the largest and the smallest tooth thickness of a gear).

According to the figure 7, F_p and f_p analysis diagrams for the left and right flanks do not match. The reason is that the left flank has a addendum and dedendum relief/flanking. The graphs show the results of different measurements for the left and right flanks, and the prescribed tolerance precision according to the grade 5 of accuracy. In the size of radial runout, the largest ratio has the gear eccentricity.

Thus, the radial runout (F_{rr}) influence the general aspect of the diagram of the gear kinematic error. This kinematic error diagram is used to determine the number of many other individual errors and deviations.

Regarding the F_r deviation, the measured values deviations (Fig. 7), greater than those prescribed, generate noise during the pump's operation. In this approach, the measured value of F_r = 36.5 µm corresponds [15] to the 9th grade of precision.

The requirements for precision of the spur gear pumps' gearing is that it should correspond to the 5th grade accuracy, at the imposed value of F_r = 11 µm.

According to the laboratory measurements using the Klingelnberg measuring center for the gear z_2 found errors and similar values to those of the pinion.

We believe that this gearing, from the point of view of its functional role, shall meet the criterion of smooth operation. Limit deviation tolerance for F_r are determined [15] depending on the precision grade of the gearing.

Spur gear tooth direction		
Prog. no. GST0409d44 0 P150	Operator: Op1	Data: 23.06.2014 15:41
Name: Pinion	No. of teeth: 12	Pressure angle: $20^0 00' 00''$
Drawing no. Pinion z1=12 pinion	Module m=2.54 mm	Helix inclination angle: $0^0 0' 0''$
Order no. 01	Base circle diameter d_b=28.6418 mm	Face width b=18.3 mm

Condition: final	Temperature: 21.4^0 Probe rod ball diameter 2 mm	Profile evaluation range L_a=9.28 mm
Place of measurement: UPB		Helix evaluation range L_b=14.64 mm

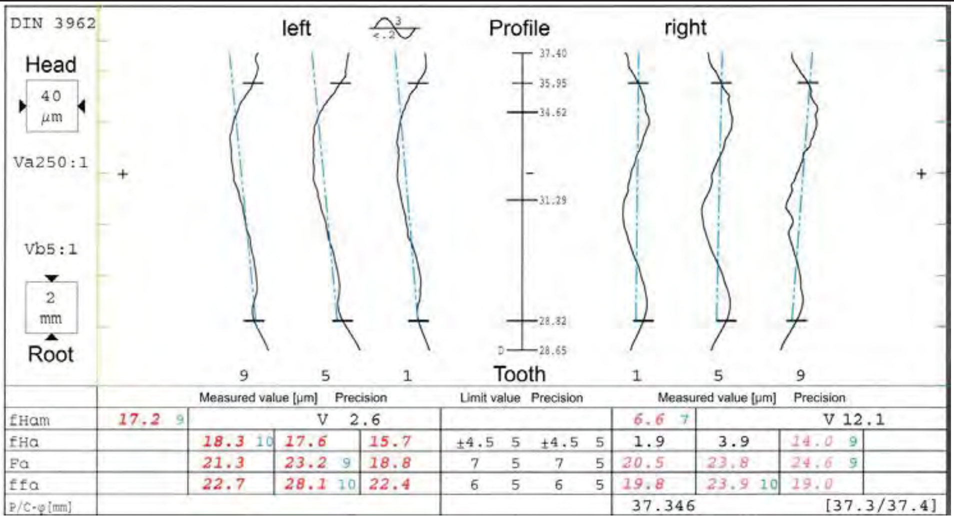

Fig. 8. Certificate of measurement tooth profile - pinion

In figures 8, 9, 10 and 11 are shown pairs of three measurements on teeth 1, 5 and 9. The measured values refer to: $f_{H\alpha m}$ – mean profile slope deviation (arithmetic mean of the profile slope deviation of three or more equally spaced tooth flanks around the gear's circumference), $f_{H\alpha}$ – profile slope deviation/profile angular error (distance between two nominal profiles that intersect the average profile at start and end points of the profile range), F_α – total profile deviation/profile total error (distance between two nominal profiles enclosed within the profile test range, $f_{f\alpha}$ – profile form deviation/profile form error (distance between two involutes of the actual base circle, that enclose the actual involute profile within the profile inspection range), $f_{H\beta m}$ – mean helix slope deviation (arithmetic mean of the helix slope deviations of three or more equally spaced tooth flanks around the gear's circumference), $f_{H\beta}$ – helix slope deviation/tooth alignment tolerance (distance in transverse plane between two nominal leads that intersect that intersect the average lead – helix at start and end points of the lead inspection range), F_β – total helix deviation/lead total error (distance between the two nominal leads enclosed within the lead inspection range), $F_{f\beta}$ – helix form deviation/lead form error (distance between two helical lines that enclose the actual lead within the lead inspection range).

The measuring on the tooth profile is properly performed according to the tooth height, between the base circle and the head circle. The highest measured value has $f_{f\alpha}$ deviation = 28.1 µm for the 5th tooth on the left flank (Fig. 8), which corresponds to the precision grade 10, a value that can not be accepted because it generates an inappropriate operation. Alongside are presented the limit values of deviations and tolerance F_α for the 5th grade precision. Also, the measured values are indicated for the right flank.

The analysis of the tooth profile's shape for the three measurements show some resemblance to their corresponding left and right flank. We believe that this may be due to the general profile of the tool cutting edges.

On diagrams are identified some specific points of the profile controlled on the left and right flank for the three teeth taken into account.

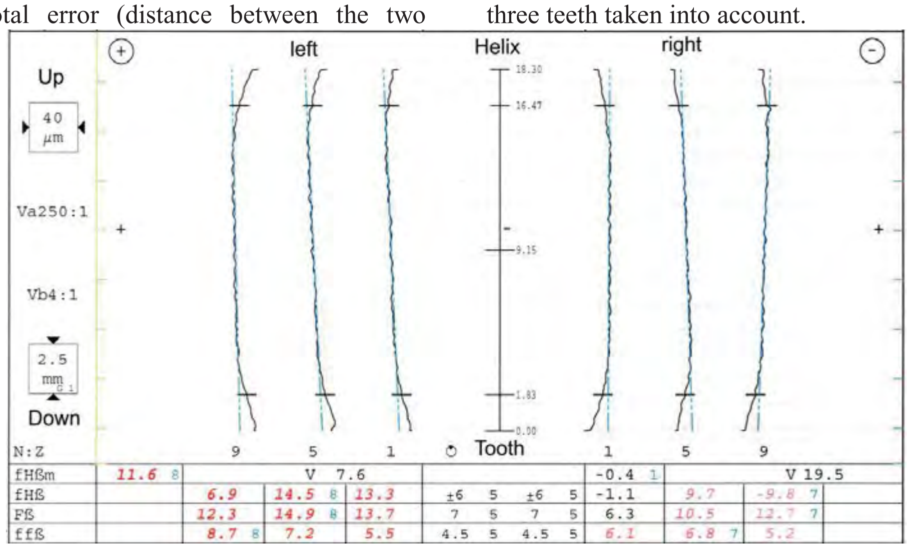

Fig. 9. Certificate of measurement tooth helix - pinion

Spur gear tooth direction		
Prog. no. GST0409d44 0 P150	Operator: Op1	Data: 23.06.2014 15:41
Name: Gear	No. of teeth: 12	Pressure angle: $20^0 00' 00''$
Drawing no. Gear z2=12 gear	Module m=2.54 mm	Helix inclination angle: 0^0
Order no. 01 Condition: final	Base circle diameter d_b=28.6418 mm Temperature: 21.3^0	Face width b=18.3 mm Profile evaluation range L_a=9.28 mm
Place of measurement: UPB	Probe rod ball diameter 2 mm	Helix evaluation range L_b=14.64 mm

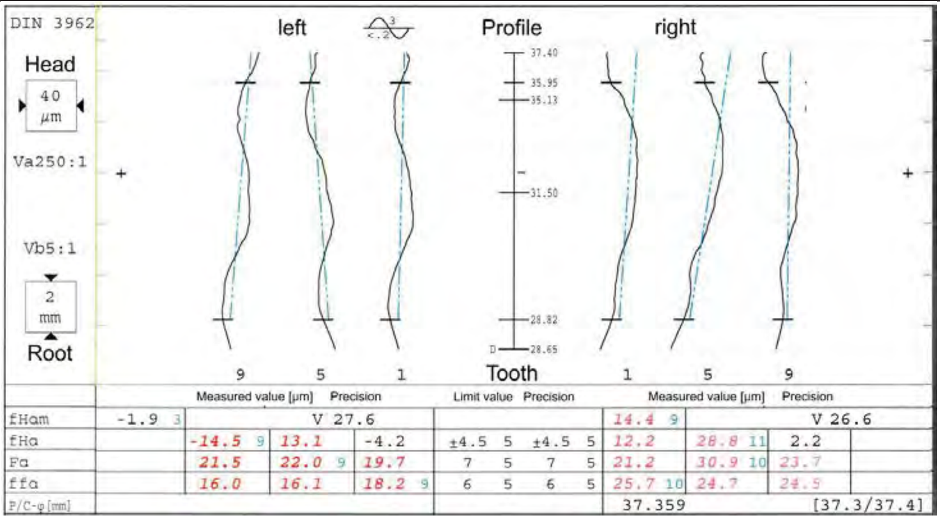

Fig. 10. Certificate of measurement tooth profile - gear

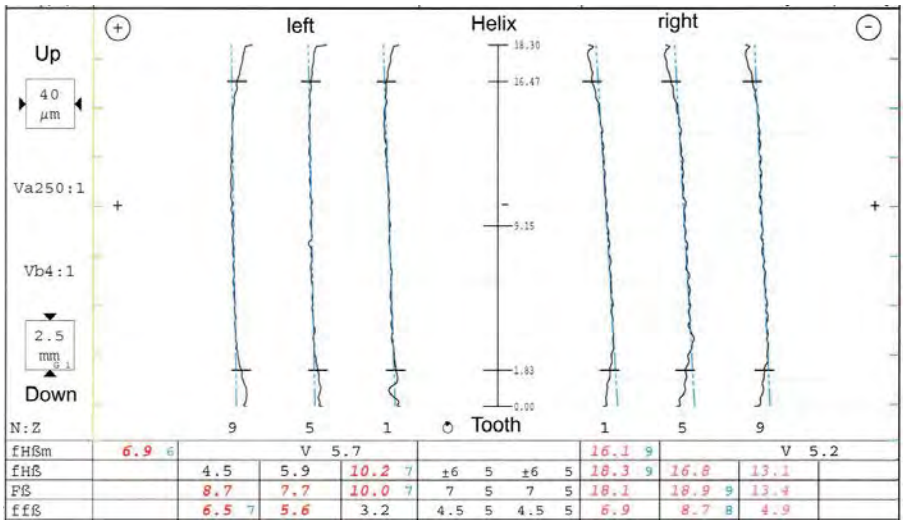

Fig. 11. Certificate of measurement tooth helix - gear

Therefore, on the representations shown in figures 8 and 10, it is possible to identify, without being noted, the following characteristic points [12]: the start of the measurement (diameter 28.65 mm), the start of the generated profile (diameter 28.82 mm), the start of flanking (diameter 34.6 mm - pinion and 35.13 mm - gea r), of singular gearing on the tooth head (diameter 35.95 mm) and of profile limit on the tooth head (diameter 37.4 mm). From the profiles diagrams results that it was applied a modification by flanking on the left flanks (pinion) and on the right flanks for the gear. On the other corresponding flanks, right on the pinion and left on the gear is also applied a modification called roundness on the tooth width.

According to [15] for evaluation of the flanks direction deviations (fig. 9 and fig. 11) there were measured every three flanks left - right on pinion and on gear. For these deviations there are indicated actual values and limit values. Two areas are identified on the gear's face width (18.3 mm): the first at the flanks ends (each on a 1.8 mm width) and the second on a length ($L_\beta \approx 15$ mm). The active area of the flanks presents small deviations corresponding to the precision grades 7 and 8, which we consider acceptable. The flank on its width may be considered to have a slight longitudinal swell modification, which leads to a functional improvement. Also, this modification may diminish the deviations influence on axes not being parallel.

4 CONCLUSIONS

Measurement of the geometric elements of the two gears and their deviations was performed with a precision specialized equipment, according to the methodology specified in standards [15]. Graphical and numerical results indicate that the two gears' teeth are corrected. Measured deviations have some valuesdifferent from those prescribed. The precision indices values of the tolerances and deviations have common causes: cutting tool wear, imprecision of the gear cutting machine, tool's position towards the gear part, speeds of the generation movements, inaccuracy or lack of rigidity in the fixture and driving devices. Choosing the precision grade and flank roughness correspond to the operating conditions.

The next phase in a future research could be the development of a methodology for selection and calculation of values and tolerances deviations for the parametric design of gearings and of precision criteria, taking into account the type of fabrication and establish the optimum technological parameters of processing.

Acknowledgement
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