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ANALYTIC-GRAPHIC ANALYSIS OF NOMINAL CONVEYING CAPACITY FOR THE TOOTHED BELT WITH STD PROFILE

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ABSTRACT

In this paper is carried out a detailed analysis of the representation of mathematical model for nominal conveying ability of toothed belts with STD profile. Determination of nominal conveying ability for the respective belt profile has a special practical importance for the designers and constructors of transmitters with toothed belts. Based on this power and under specific working conditions of transmitter, constructor is able to determine conveying ability, respectively the power that transmitter might be able to carry. From the mathematical expressions for each of the STD belts profiles, through MathCAD program, are gained the diagrams showing the variations of nominal conveying ability, depending by the number of rotations of the driving pulley (small pulley) (n_1) and its kinematic diameter (d_{w1}). Expressions for nominal conveying ability given in this paper belongs to the transmission ratio $i = 1$.

Keywords: Toothed belts, nominal conveying ability.

1. INTRODUCTION

The goal of each belt manufacturers is to produce belts with greater conveying ability, trying to reduce belts size and increasing its life time.

Factors which affect on the nominal conveying ability are divided in two groups:

- *Technological, and*
- *Construction - exploiting.*

Technological factors include:

- *The quality of materials components of constructive parts of belt,*
- *Ingredients of the technological process, and*
- *Technological parameters at various stages of the production process.*

These factors are directly affected by the chemical, physical and mechanical properties of materials participation in the construction of the belt. Technological production processes are subject to continuous studies for the research & development experts at the companies dealing with the belt production. Technological devices, skills of labour force and technological disciplines have a major impact on the quality of the belts.

All the technological impacts on the conveying ability are expressed by the coefficients of conveying ability, which are part of the mathematical model at given expressions from 1 to 4.

Construction - exploiting factors includes:

- *Number of rotations of the driving pulley (small pulley) (n1),*
- *Kinematic diameter of the driving pulley (small pulley) (dw1),*
- *Effective number of teeth in the mesh between belt and driving pulley,*
- *Width of conveyer belt,*
- *Geometric accuracy of the transmitter pulley,*
- *Technical conditions of the other parts of transmitter, and*
- *Other working conditions.*

In this paper is carried out the analysis of constructive impact of rotation number and kinematic diameter of the driving pulley for nominal conveying ability. Exploiting factors mainly affect the life time of the belt.

Based on the mathematical expressions for nominal conveying ability are constructed graphs of these impacts for each profile. Graphs of the impacts for the conveying ability have special practical importance, for easy set optimal areas of conveying ability and data given in the following tables provide support for many experts and students for calculation of the different types of toothed belts, or transmitters. Different graphs for impacts on nominal conveying ability are carried out by MathCad program.

Figure 1. Toothed belt-profile STD.

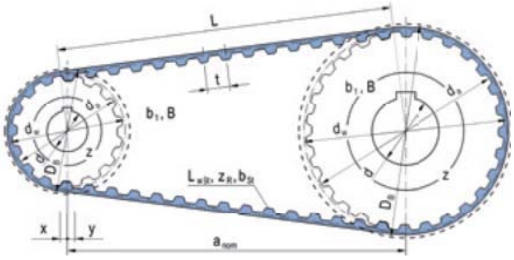

Figure 2. Transmitter with toothed belt.

2. MATHEMATICAL MODEL OF NOMINAL CONVEYING ABILITY FOR TOOTHED BELT WITH EVOLVENT PROFILES OF THE TEETH SIDE (STD)

Mathematical expressions to calculate the nominal conveying ability are different for each profile. In these expressions, the kinematic diameter of the driving pulley (d_{w1}) and the number of rotations (n_1) are presented in a linear form, in exponents to the third power, and in a form of logarithmic function.

P r o f i l e **STD 3mm;** *pitch p=3mm, width b=6mm:*

$$P_{n1}(n_1) = A_1 \cdot \left[A2 \cdot (d_{w1} \cdot n_1) - A_3 \cdot (d_{w1} \cdot n_1)^3 - A_4 \cdot n_1 - A_5 \cdot (d_{w1} \cdot n_1) \cdot \log(d_{w1} \cdot n_1) \right] \quad \ldots (1)$$

P r o f i l e **STD 5mm;** *pitch p=5mm, width b=10mm:*

$$P_{n1}(n_1) = B_1 \cdot \left[B_2 \cdot (d_{w1} \cdot n_1) - B_3 \cdot (d_{w1} \cdot n_1)^3 - B_4 \cdot n_1 - B_5 \cdot (d_{w1} \cdot n_1) \cdot \log(d_{w1} \cdot n_1) \right] \quad \ldots (2)$$

P r o f i l e **STD 8mm;** *pitch p=8mm, width b=60mm:*

$$P_{n1}(n_1) = C_1 \cdot \left[C_2 \cdot (d_{w1} \cdot n_1) - C_3 \cdot (d_{w1} \cdot n_1)^3 \right] \quad \ldots (3)$$

P r o f i l e **STD 14mm;** *pitch p=14mm, width b=120mm:*

$$P_{n1}(n_1) = D_1 \cdot \left[D_2 \cdot (d_{w1} \cdot n_1) - D_3 \cdot (d_{w1} \cdot n_1)^3 \right] \quad \ldots (4)$$

Where are:

A_1, A_2, A_3, A_4, A_5; B_1, B_2, B_3, B_4, B_5; C_1, C_2, C_3, ; D_1, D_2, D_3, - *nominal conveying ability coefficients.*

2.1. The impact of the rotation number of the driving pulley on the nominal conveying ability of toothed belts with teeth profile STD

Belts with STD of side profile teeth are more advanced in comparison with trapezoidal profile, since the distribution of the load on teeth mesh is much more uniform.

Based on these analytical expressions, the diagrams of changing nominal conveying ability are shown in the following.

P r o f i l e **STD 3mm:**
From expression (1), for $n_1 = 1000...10000\ min^{-1}$ and values of the kinematic diameter d_{w1}= 9.55 mm; 20.05 mm; 38.20 mm; 68.75 mm, in the fig. 3., is shown nominal conveying ability.

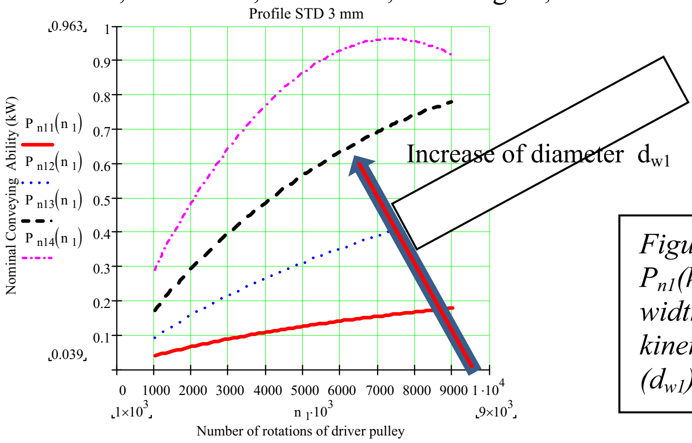

Figure 3. Nominal conveying ability $P_{n1}(kW)$ for profile STD 3mm and width b = 6mm on dependency of kinematic diameter of driving pulley (d_{w1}) and number of rotations (n_1).

From the diagram shown in Fig. 3., can be seen that with increases in kinematic diameter of the driving pulley for the same number of rotations increases nominal conveying ability.

P r o f i l e **STD 5mm:**
From expression (2), for the mathematical model of nominal conveying ability, is constructed a diagram shown in Fig. 4., for the following values: n_1 = 1000 ... 10000 min^{-1}, and d_{w1} = 19.10 mm; 38.20 mm; 70.03 mm; 114.59 mm.

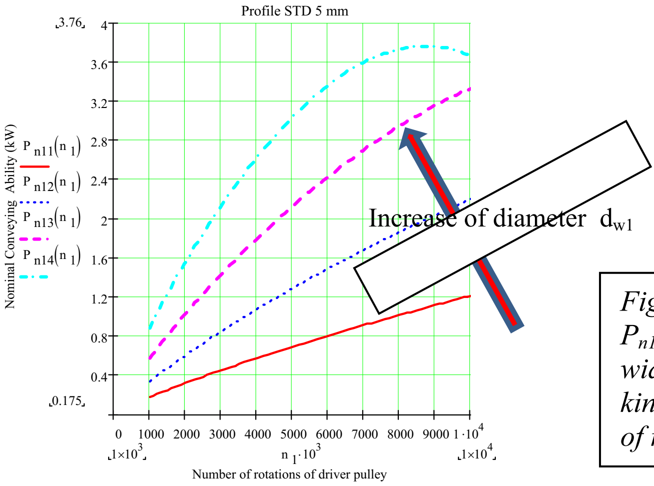

Figure 4. Nominal conveying ability $P_{n1}(kW)$ for profile STD 5mm and width b =10 mm on dependency of kinematic diameter (d_{w1}) and number of rotations of driving pulley (n_1).

P r o f i l e **STD 8mm:**
From the expression (3) is constructed a diagram in Fig. 5., for the following values: n_1 = 200 ... 3000 min^{-1} and d_{w1}= 56.02 mm; 101.86 mm; 203.72 mm; 488.92 mm.

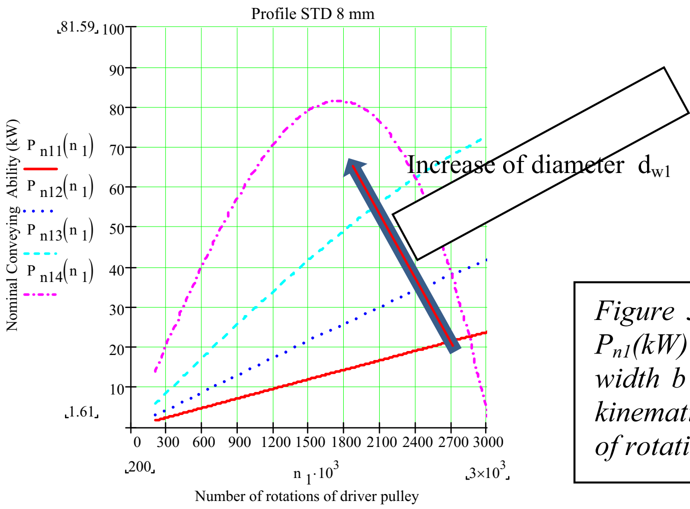

Figure 5. Nominal conveying ability $P_{n1}(kW)$ for profile STD 8mm and width b = 60 mm on dependency of kinematic diameter (d_{w1}) and number of rotations of driving pulley (n_1).

***P r o f i l e* STD 14mm:**

Applying the expression (4), is constructed a diagram in Fig. 6., for the following values: $n_1 = 100...4000\ min^{-1}$ and d_{w1} = 124.78 mm; 213.90 mm; 401.07 mm; 962.57 mm.

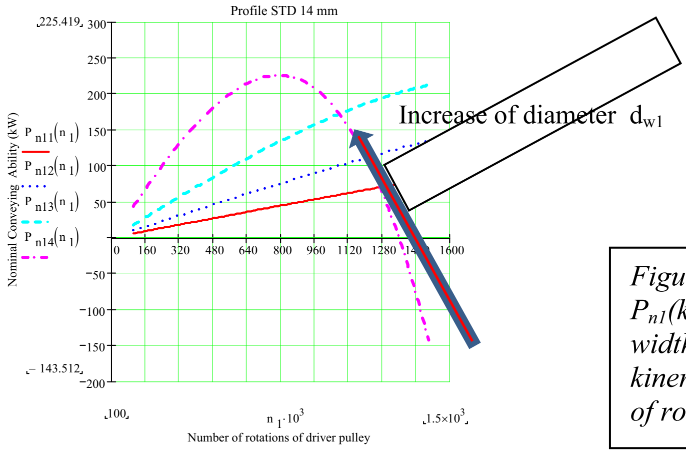

Figure 6. Nominal conveying ability P_{n1}(kW) for profile STD 14mm and width b = 120 mm on dependency of kinematic diameter (d_{w1}) and number of rotations of driving pulley (n_1).

3. CONCLUSIONS

Based on the analysis which is carried out in this paper, by a given mathematical expressions to calculate nominal conveying ability, tables obtained through application the MathCad program and graphics of the parameters which are calculated for toothed belts with evolvent teeth profile (STD), we can conclude that:

- *Nominal conveying ability curves are divided into two characteristic parts, as follows:*
  - *a. At monotone ascending part where P_{n1} nominal conveying ability increases by increasing the number of rotations of the driving pulley n_1,*
  - *b. At monotone descending part where P_{n1} nominal conveying ability decreases by increasing the number of rotations of the driving pulley n_1.*
- *When calculating the belt transmitters, nominal conveying ability of belt should be taken from the first part of the curve, from monotone ascending part,*
- *In the first part of the curve, nominal conveying ability increases by increasing the number of rotations of the driving pulley; while in the second part of the curve, the opposite occurs,*
- *The point that splits these two curves represents the maximum value of nominal conveying ability P_{n1max}.*
- *By the increase of the kinematic diameter of the driving pulley d_{w1}, nominal conveying ability increases,*
- *By the increase of the kinematic diameter of the driving pulley, nominal conveying ability curves reaches maximum value for a smaller number of rotations of the driving pulley.*

Therefore, considering the results and given arguments, it might be reaches to the conclusion that this paper represents a contribution in this field and provide some support to designers of belt transmitters with toothed belts with STD-profile teeth.

4. REFERENCES

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