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CALCULATION FOR CHECKING THE MECHANICAL STRENGTH OF ROTOR POLES

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SUMMARY/ABSTRACT:

This paper presents the calculation for checking the mechanical strength of generator rotor poles by taking into consideration the generator runaway speed.

The next step after the hydrogenerator preliminary dimensioning is the hydrogenerator minute dimensioning, which includes this calculation.

The rotor pole, part of generator rotor, during hydrogenerator operation is submitted to centrifugal forces, which induce in pole the shearing, tensile and bending strains.

Pole checking calculation involves the followings:

1. *Calculation of strain in pole body*
2. *Calculation of strain in clamping plate*
3. *Calculation of clamping bolts*

For diminishing the calculation time frame and increasing the efficiency in design, software based on Borland Pascal was carried out. This software performs the calculation for checking the pole mechanical strength, starting from the geometrical data of rotor poles.

This calculus has a significant importance. An improper dimensioning from mechanical point of view can lead to major damages and even to hydrogenerator outage.

KEY WORDS:

Rotor poles, calculus, strength

1. INTRODUCTION

Hydrogenerators designed are made in two steps:

- first step represent a preliminary dimensioning of hydrogenerator. The preliminary dimensioning established overall dimensions of hydrogenerator for a properly work at nominal parameters. In this stage it is important to obtained optimal efficiency in accordance with type of hydrogenerator necessary to be designed. The values obtained in this stage are not the final one.

- second step is hydrogenerator minute dimensioning. In this stage are realized the designing of all assembly and subassembly of machine. This calculus includes the strength calculus of rotor poles.

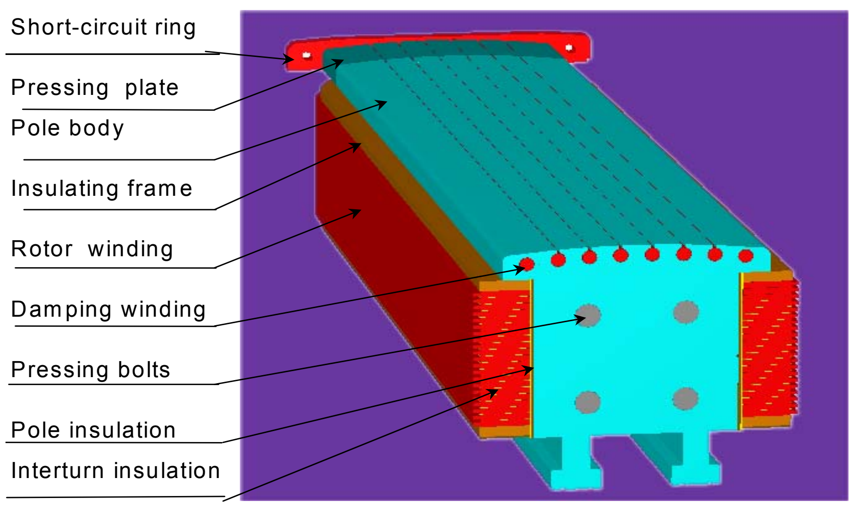
The rotor poles are component part of the rotor who is the rotative part of hydrogenerators.

Rotor dimensioning will be made so that at runaway speed, strength of most forced section to be maximum 70% out of ultimate tensile strength of materials.

2. CONTENTS OF PAPER

The rotor poles are assemblies made of punched steel sheets, pressed and clamped by means of pressing plates and clamping bolts. The polar shoe is equipped with damping winding, carried out of copper bars. The damper cage is closed, upon the poles width, by means of short-circuiting rings, and, between the poles, by means of elastic connections of copper lamellas.

The poles are fastened to the rim through one or two dovetails or hammer tails and inclined keys. The pole body is provided with continuous insulation [1]; [2]; [3].



The main characteristics of elements, which compose the rotor poles, are shown in table 1.

Table 1

Subassembly	Description
Pressing plate	High alloyed forged steel with reduced thickness and high mechanical characteristics.
Lamination sheet of pole	Rolled steel with high characteristics and 1.5 mm thickness.
Pole insulation	Continuous based upon glass fabric and epoxy resins.
Insulating frame	Glass-fibre reinforced plastic sheet.
Inter-turn insulation	NOMEX, 0.28÷0.3 mm thick
Turn	Profile according to the drawing

For diminishing the calculation time frame and increasing the efficiency in design, software based on Borland Pascal was carried out. This software performs the calculation for checking the pole mechanical strength, starting from the geometrical data of rotor poles.

Because this program is inner used, the software is in Romanian language. For explain this program the used data are presented in English language.

This software is making in two steps, through by windows, presented in figure 1:

1. entry data for pole
2. going out data

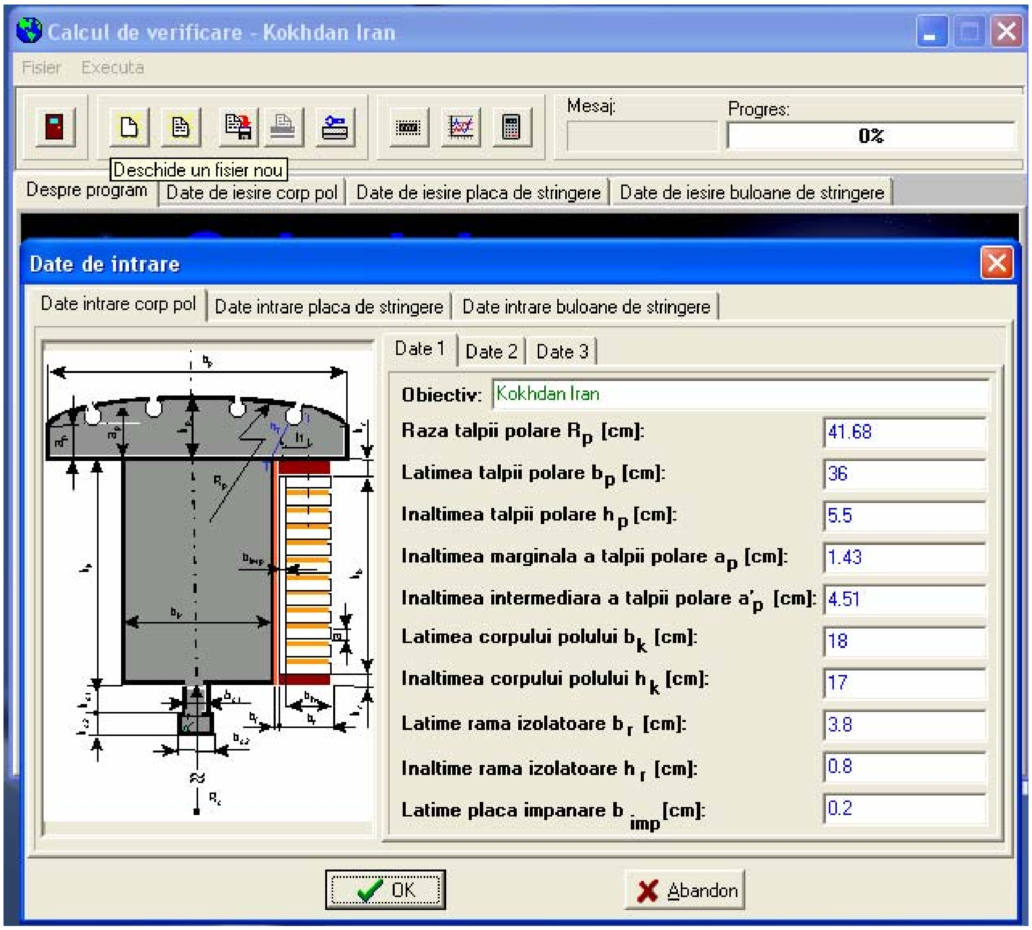


Figure 1

The entry data for pole are the followings:

- for body pole
- for clamping plate
- for clamping bolts

In calculus is taking about a machine for Kokhdan HEPP in Iran. In figure 1 are presented entry data for body pole. These data are the followings: polar shoe ray [cm]: 41.68; polar shoe width [cm]: 36; polar shoe height [cm]: 5.5; polar shoe marginal height [cm]: 1.43; polar shoe intermediate height [cm]: 4.51; body pole width [cm]: 18; body pole height [cm]: 17; insulated frame weight [cm]: 3.8; insulated frame height [cm]: 0.8; wedging frame width [cm]: 0.2.

For the other entry data (for clamping plate and for clamping bolts) the program has similarly interfaces with specific entry data.

In figure 2 the alghoritm for calculus is presented.

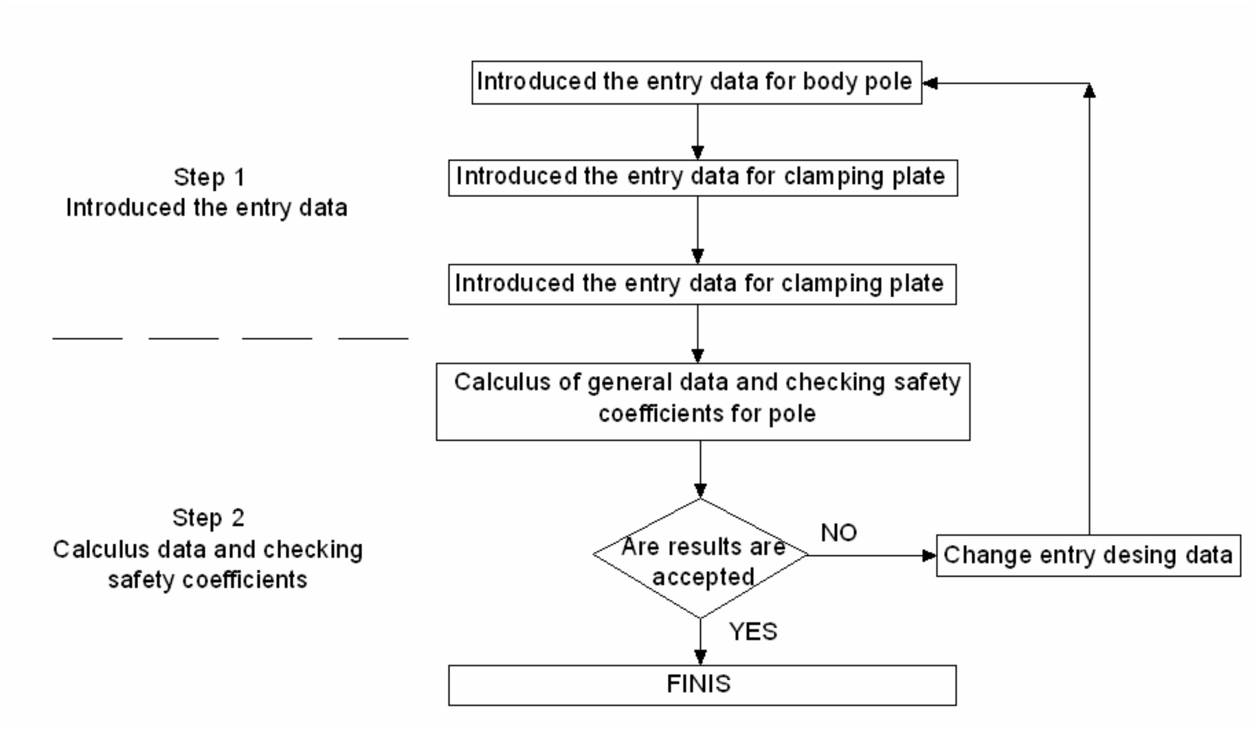


Figure 2

The data are two categories:

- entry data are from preliminary geometrical and electrical dimensioning–Step 1
- output data are obtained after the calculus – Step 2. If the safety coefficients are not in safety limits the entry data will be modified and the whole process will be started again from Step 1. The design engineer will decide what entry data will be change for obtained the optimally results.

In figure 3 is presented the results of strength calculus and safety coefficients for body pole:

- centrifugal force creates by tail's capillary shoe [kgf/cm]: 91.3454; centrifugal force creates by tail's capillary neck [kgf/cm]: 113.8177; total centrifugal force of pole [kgf/cm]: 4920.0627; .
- stretching strain [kg/cm^2]: 1230.0157; shearing strain [kg/cm^2]: 768.7598; compound strain:
  - stretching + flexure [kg/cm^2]: 2290.3528
  - stretching + shearing [kg/cm^2]: 1309.2275
  - flexure strain [kg/cm^2]: 1140.2096

- safety coefficients:
  - stretching + flexure: 1.5281 – is recommended not be less than 1.1
  - stretching + shearing: 2.6733 – is recommended not be less than 1.5
  - flexure: 3.0696 – is recommended not be less than 1.5

In this way the design engineer is able to compare the results data with safety coefficients and decide if any data must be modified or not.

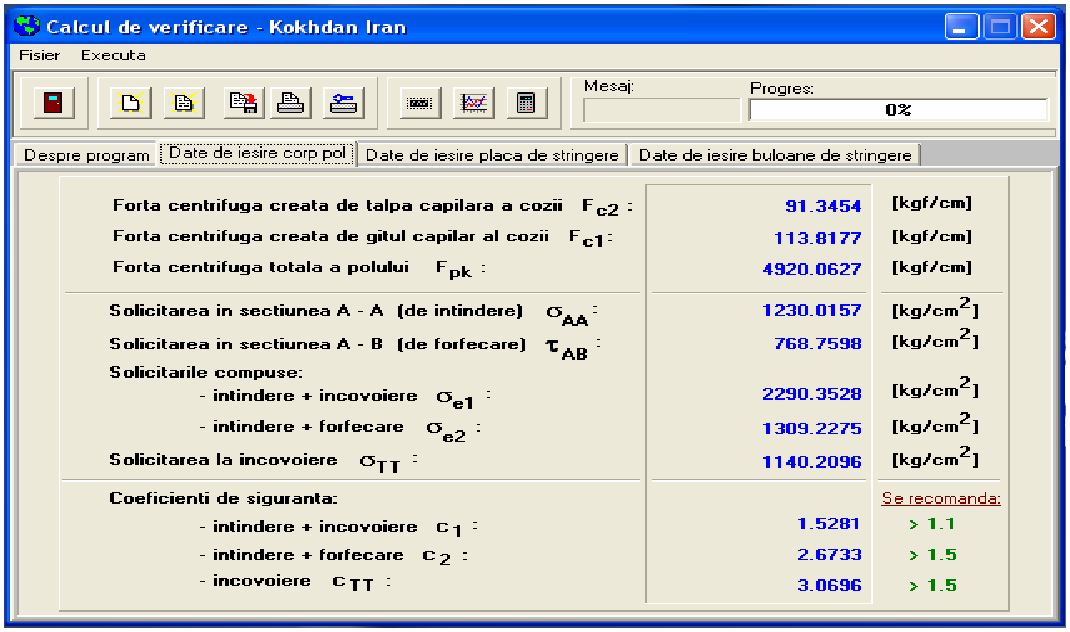


Figure 3

For the calculus of clamping plate and of clamping bolts the program have similarly interfaces with specific output data. In figure 4 is presented what is happened when after calculation the results are not in accordance with safety coefficients for body pole. In this case the program warning us about the problem and in the same time recommended what data can be modified for optimally results obtained. The data, which is out off, establish border limits are writing with red color. In the same time, the program suggests us what can be change. In this case is recommended choose another material type or another tail type.

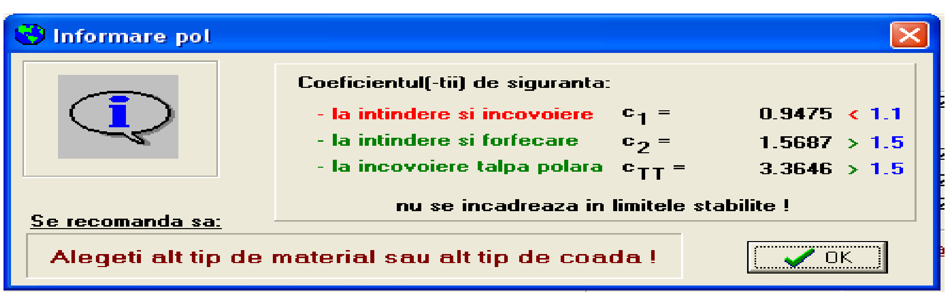


Figure 4

Similarly warning can appear and for clamping plate and clamping bolts.

3. CONCLUSIONS

Used this program, design time is reduced and precision of calculus is more increased.

Importance of this program consists in the same time in possibility to calculate body pole, clamping plate and clamping bolts all together.

4. BIBLIOGRAPHY

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