SYNCHRONOUS GENERATOR MECHANIC CONSTRUCTION REDESIGN

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ABSTRACT

The marine industry noted big upward trend during the last years. This expansion brings the big synchronous generators enquiry. There are some demands for batch produced machines and some job-order manufactured machines too. The enquiry investigation shows that there is big concern about the synchronous machines in frame sizes 560-910mm.

Since the diesel motors producer has arisen the power output of some diesel engines, there came the need to redesign some machines to get similar power output with the diesel engines and decrease the price of the generator. The first redesigned machine is the standard generator in frame size 560mm.

1 INTRODUTION

The original synchronous generator basic parameters:

frame size:	560mm
power output:	app. 1000-1800kVA
number of poles:	4
number of phases:	3
frequency:	60Hz
voltage:	690V
nominal revolution:	1800rpm

The generators with the frame size 560mm have uniform construction for many years because the current conception is well proven and reliable. Construction consists of housing, wound stator packet, wound complete rotor, exciter stator, front and back shields and cooler extender with the terminal box. Housing and the shields are welded and certificated. Rotor shaft is made of certificated steel according to customer requirements. The cooler extender is welded assembly without certification since it is not carrying part (cooler extender rigidity does not have to fulfill any special requirements).

2 REDESIGNED CONSTRUCTION

The mechanical construction redesign includes changes in most of generator parts. The first aim (to get cheaper machine with the higher power output) caused the general changes in the magnetic circuit (rotor and stator core) inside the machine. Previous investigations, tests, measurements and experiences showed that the magnetic circuit could be better designed to get suitable temperature distribution and electromagnetic load distribution in the stator and rotor cross-section area. In order to get balanced electromagnetic circuit the electric and magnetic calculation redesign was made. The yoke recalculation was so wide that it influenced all significant variables in electromagnetic circuit (rotor and stator core inner and outer diameters, number of slots, slots shape, number of turns, number of parallel wires, slot pitch, wire type, atc.). The recalculation results influenced the mechanical machine design significantly.

The redesigned synchronous generator basic parameters:

frame size:	560mm
power output:	2335kVA
number of poles:	4
number of phases:	3
frequency:	60Hz
voltage:	690V
nominal revolution:	1800rpm

The housing and bearing shields design is different in comparison with the original synchronous generator construction. Redesigned housing is welded assembly which includes the previous housing design and some bearing shields parts. This approach brings some simplifications to the manufacture. Final housing and bearing shields are quite simple, rigid enough and cheaper than the original housing and shields construction.

Different electromagnetic circuit of the rotor part influenced the brushless exciter design and the bearings kind selection. Since the generator power output is higher than the previous ones have, exciter stator and exciter rotor had to be designed for higher power output upon original exciter stator outer diameter preservation. Higher generator power output increased the rotor weight and the rotor dimensions so that the need of bearing kind selection change arisen.

Nodal points of the radial load on the bearings moved to the positions where the original bearings types could not ensure rotation speed margin wide enough. In order to get speed reserve big enough, the M-type of the sleeve-bearings was chosen. This type of bearing brings the advantage of radial load nodal points distance shortening. Radial and axial load rise is not significant.

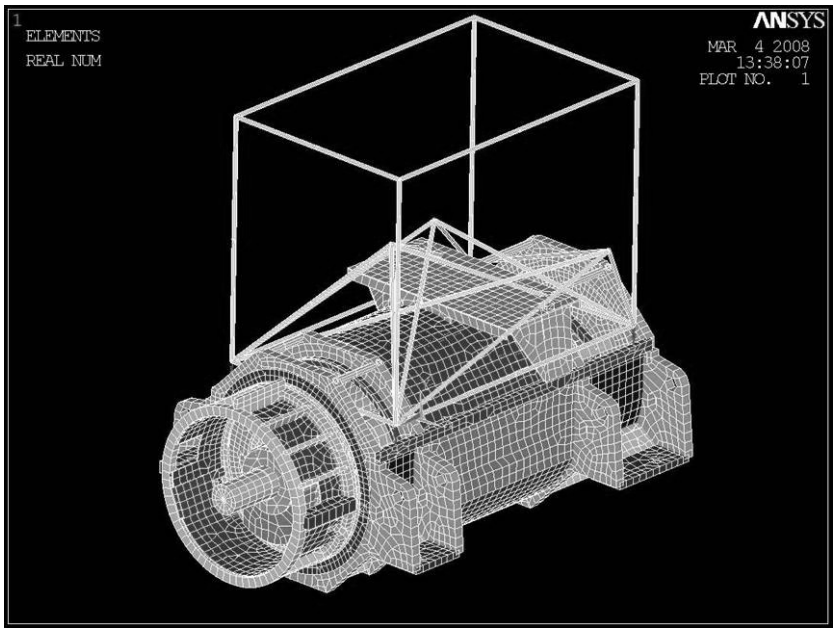

Figure 1: Housing-shields-bell model in Ansys for mechanical analysis

Housing-shields-bell assembly model was created in Ansys software and analyzed (figures 1 and 2). The self-frequency and vibrations test results showed that the construction is rigid enough for the running with the diesel engine. Self-frequencies values are far enough from diesel exciting frequencies.

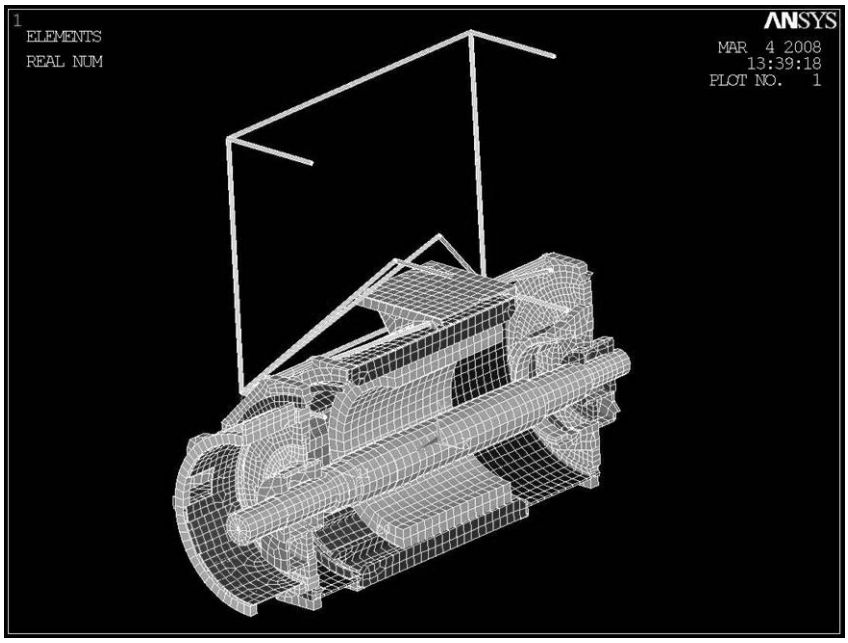

Figure 2: Housing-shields-bell cross-section in Ansys

2.1 REDESIGNED MACHINE MECHANICAL DESIGN

Mechanical construction was designed and optimized in VariCAD software. In order to get fast generator construction change according to customer requirements, the 3D parametric model of the machine was created in Unigraphics NX software.
Mechanic calculations were established in Ansys software. Bearings, ventilation and water cooler calculations were optimized using special software and calculation orders.

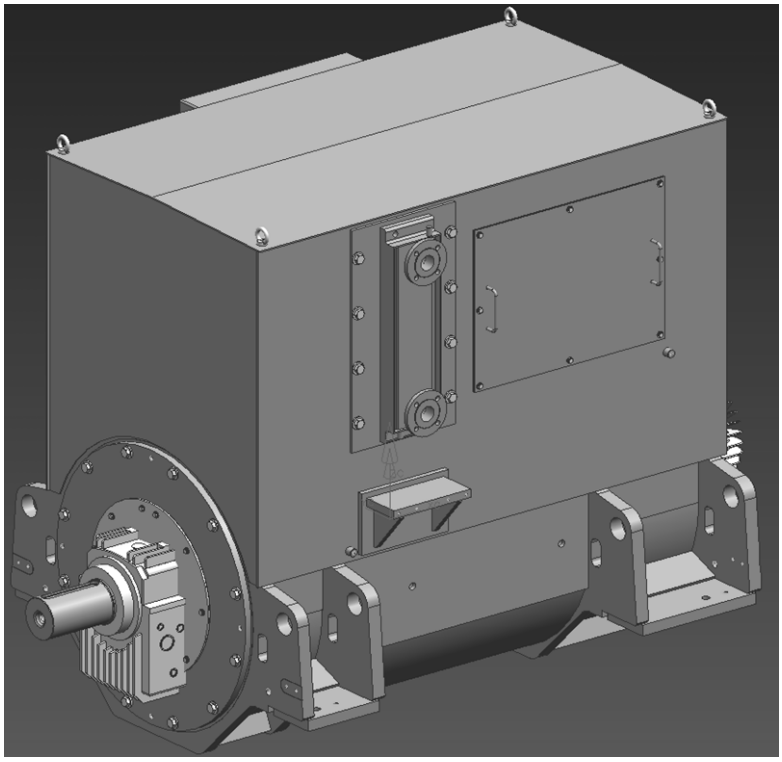

Figure 3: Redesigned machine 3D model in Unigraphics NX software

2.2 ACTUAL SYNCHRONOUS MACHINE CONSTRUCTION

Redesigned and analyzed machine was manufactured in the company Siemens Electric Machines, Drásov, Czech Republic (figure 4). Electrical test measurement was accomplished at Siemens Drásov. It is possible to claim that the generator prototype is suitable design considering the results of measurements.

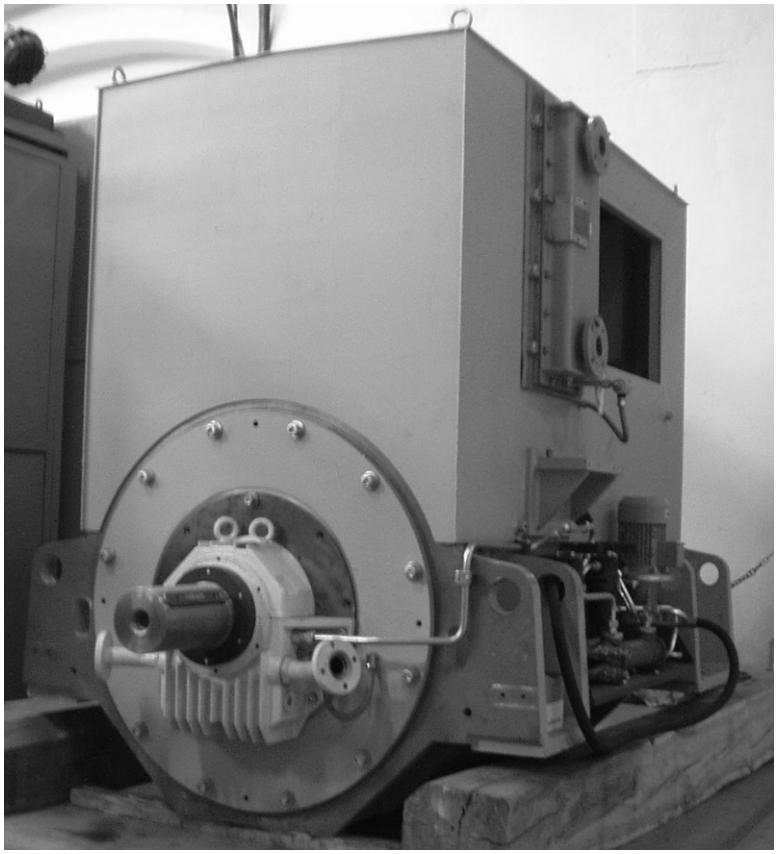

Figure 4: Generator photo

3 CONCLUSION

Synchronous machine design is the complex of calculations, optimizations and technological progresses. It is necessary to have experience and knowledge to accomplish correct machine design. Even if the know-how is available, there are needed any other important things to have a success in the industry and business world. It is aim to reduce the machine prices and increase its quality. There is also goal to shorten the machine delivery time in case of custom-made manufacture.

Redesigned generator with the frame-size 560mm has the power output close to usual power outputs of the synchronous machines with the frame-size 630mm. It results in better power output-cubage rate. The result of generator redesign brings the product with the small frame-size in comparison with the power output. Synchronous machine cubage reduction decreases the price of the generator per Watt unit. It makes the generator competitive and budget-priced.

REFERENCES

[1] Karel Fučík, Mechanical design of synchronous generator with respect to vibration excitation coming, siemens Electric Machines s.r.o., Drásov, Czech republic, 2003