Seeding R&D ideas for innovative manufacturers
(Switchgear, Expulsion Fuses, Power Transformers)
(IEC 62271, IEC61439, IEC60282-2, IEC 60076 61439)

http://www.cognitor.com.br/seedingR&Dideas.pdf CV : http://www.cognitor.com.br/curriculum.html
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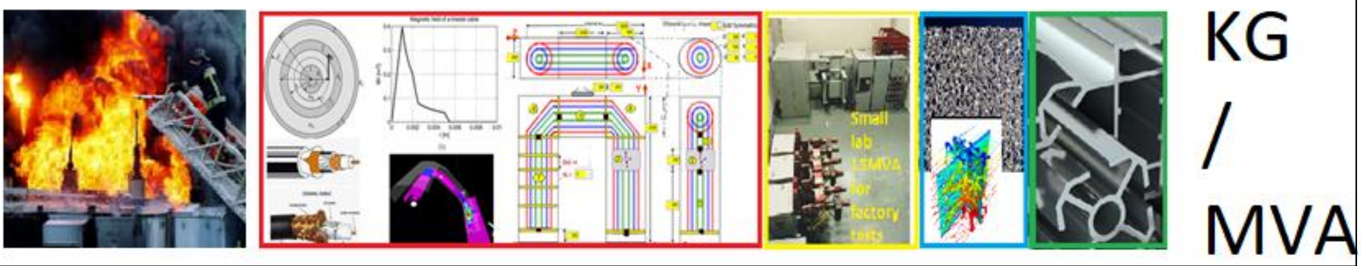


1. INTRODUCTION

If you do a neutral analysis about innovations and patents which appeared in the commercial market along the last 20 years, all over the World, you will find very few innovative products. The most common thing we see in the market are marketing investments with new names and colors for old products, falling into disuse in developed countries. There are advancements in informatics and automation, but these ones are normal evolution of previous original ideas. Companies are each time investing less in R&D and training of employees. The level has dropped a lot compared to the 70's and 90's.

The objective of this article is to disclose some ideas that I have been touching in my work of designing switchgear, fuses and substation equipment. During the trainings that I apply for manufacturers, I am used to demonstrate technically how these ideas work and are promising. I developed specific models for them, but I do not have conditions to pay for the laboratory tests to prove that my calculations are correct. I always say to the manufacturers for which I apply consultancies that having a small laboratory in the factory is very useful. It is easier if the simulation of tests is used to develop the design. Some people distrust me because know that I am a designer of testing labs and of simulation software. Others understand the message and implant them. Most of these ideas are related to the principles of the ENVIRONMENTAL EFFICIENCY CERTIFICATE of electrical products (kg/MVA) described in this article http://www.cognitor.com.br/EnvironmentalEfficiencyCertificate.pdf

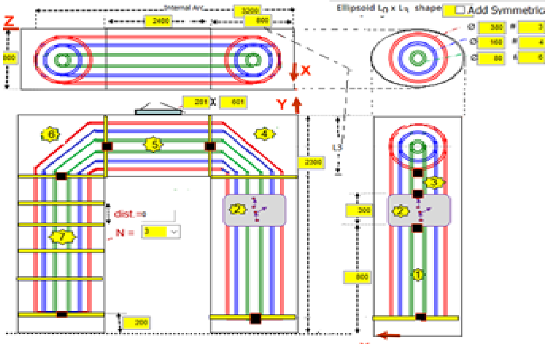
2. THE IDEAS

IDEA 1

- The triaxial busduct described in the article "TRIAXIAL high current AIS - GIS: disclosing an idea worldwide use"

http://www.cognitor.com.br/Post_01_2019_SergioFeitoza_Triaxial.pdf

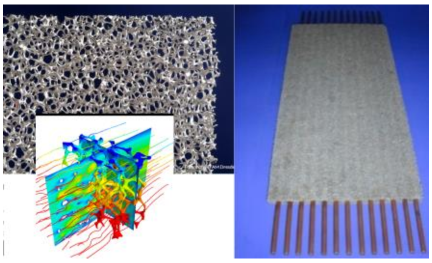
Figure 1



IDEA 2

- Metallic foam for use in busbar electric conductors for high currents (high heat dissipation and much less mass of copper and aluminum)

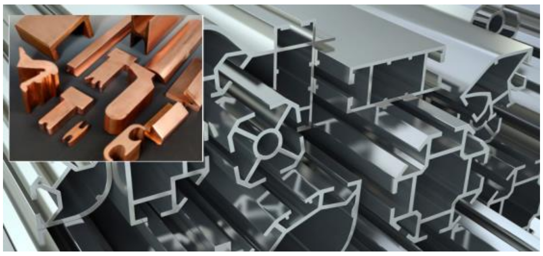
Read this article https://www.cognitor.com.br/switchgearmetalfoam.pdf



IDEA 3

- Aluminum or copper extruded profiles for use in busbar electric conductors for high currents (high heat dissipation and much less mass of copper and aluminum)

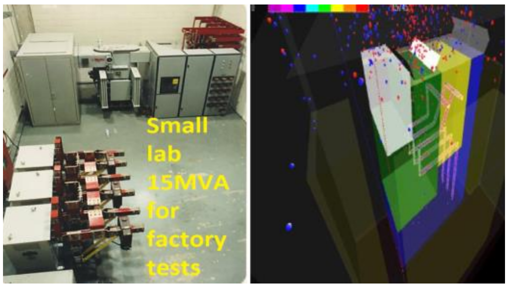
Read this article https://www.cognitor.com.br/DesignOptimizationCuxAl_2019.pdf



IDEA 4

- Implementing the concept in the article “SMALL HIGH-POWER TESTING LAB + SIMULATIONS - an idea to boost the electrical industry in developing countries”

http://www.cognitor.com.br/SmallLabPlusSimulations.pdf



IDEA 5

- Prevention system and test to avoid explosions and fires in power transformers and resorts

Read the article https://www.cognitor.com.br/transformersfiresexplosions.pdf

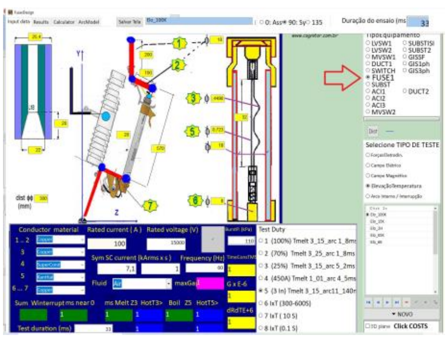
IDEA 6

implantation and new standard for the “ENVIRONMENTAL EFFICIENCY CERTIFICATE of electrical products (kg/MVA)”
Read the article
http://www.cognitor.com.br/EnvironmentalEfficiencyCertificate.pdf

IDEA 7

An alternative dropout expulsion fuse class A – 10 kArms

Read the article
https://www.cognitor.com.br/IEC602822sugestionstosc32afrombrazil.pdf



2.1) TRIAXIAL HIGH CURRENT AIS - GIS

The details are described in the article (link above). It is an idea ready to be used by manufacturers of low to high-voltage switchgear all over the World. The concept is presented in Figure1. The main difference to conventional AIS / GIS is that the conductors of the 3 phases are concentric while in conventional AIS they are arranged side by side.

The 3 concentric conductors may be of elliptical or circular cross section. Each of them carries the electric current of one of the phases A, B and C. Conductors can be made of aluminum or copper or even steel. Depending on the values you may use solid conductors or metal foam conductors. Externally to the 3conductors there is a grounded metallic enclosure made of steel or aluminum. The function of this enclosure is to avoid contact of people with the energized phase conductors. The enclosure could even be made of an insulated material like polyester reinforced with fiber glass. Usually these constructions are for indoor use, but it is possible to adapt the material of the external enclosure for outdoor use.

With small adaptations you may use as underground avoiding the horrible, antiesthetic and dangerous (by proximity inside urban areas) aerial systems in distribution networks like 13,8kV

This idea not yet present in the commercial market. Technology innovations need a maturation time to arrive to the market. It is necessary to do initial tests that, in this article, are replaced by testing simulations using SwitchgearDesign.

The electrodynamical forces and stresses are much lower in this technology because conductors are concentric. The magnetic effects are very small even near the corners. This enables the use of bigger distances between supports of the conductors. In a deeper sense, the reasons why triaxial measuring cables are used to reduce electromagnetic noises are the same for having lower "forces". When you have 2or 3 conductors' side by side the magnetic fields are much higher. Higher magnetic fields mean higher mechanical forces during short circuits.

Temperature rise requirements specified in technical standards are usually the main design factor, from the point of view of costs. The design parameters are presented in IEC 62271-307 or in my training. The key factors for optimizing the design are ventilation, wider dissipation surfaces of hot conductors and the use of lower resistance connections. The concentric arrangement enables to create closed paths of forced ventilation and ventilation holes spaced of a certain distance extracting the heat from the central conductor

For Internal Arc, the use of the concentric conductors facilitates the control of internal arc pressures because volumes and paths are well defined and enable the use of pressure relief devices. Using rounded conductor profiles reduce the use of edges and so, enable lower electric fields and smaller dielectric distances between conductors.

Magnetic field effects (exposure levels from legislation) due to the proximity are much smaller because the sum of the external field after the enclosure is almost zero

2.2) METALLIC FOAM FOR USE IN BUSBAR ELECTRIC CONDUCTORS

The objective is to reduce weight and temperature rise and power losses The main design factor is the surface of the conductor exposed to ventilation, as demonstrated in the equations in page 106 of this book http://www.cognitor.com.br/Book_SE_SW_2013_ENG.pdf

The use of metallic foams evolved in the last two decades and you can have them in several metals like copper and aluminum as well as several shapes.

To understand the idea, do this single experience. Take a rectangular copper bar 100 x 10 mmm with 2m of length and circulate in it a current around 1700A. Measure the temperature of the air at 1 meter from the bar, in the central position. Measure also the temperature in the bar at the central position. The difference between the two values is the temperature rise of the bar. You will find something around 50K.

Now do the same experience using a bar made of copper metallic foam with the same external profile and length. Increase the current up to the point that you have the same temperature rise, of the previous test, in the central point.

Now divide the value of the current which produced the same temperature rise by the weight of the copper bar, in the two cases. You will be surprised. To do a correct comparison you need also to consider how much you paid by each copper bar.

An additional good aspect is that If you inject some ventilation over the metallic foam bar you will extract much more heat from the inner parts that would occur with a solid bar. The potential uses of this kind of solution in connections and conductors is enormous for a creative designer. Start with the experience that I mentioned and if you want to do comparisons read also the approaches in this article and use parameters like USD/transmitted power.
http://www.cognitor.com.br/DesignOptimizationCuxAl_2019.pdf

2.3) EXTRUDED PROFILES OF ALUMINUM OR COPPER IN BUSBAR ELECTRIC CONDUCTORS

The concept here is the same as the previous in 2.2. The idea is to carry more current by weight of copper, considering the cost of the type of profile. We will not repeat the details but repeating the experience described for metallic foam and doing the economic comparisons is a good start.

2.4) SMALL HIGH-POWER TESTING LAB + SIMULATIONS (or at least small test labs in factories)

This is a new concept described in the article http://www.cognitor.com.br/SmallLabPlusSimulations.pdf .

It starts from the fact that the best catalyst for moving up the electric industry of a country is a "high power testing laboratory (HPL)". The idea is aimed at countries with lack of testing laboratories, but which are on the way to make a positive leap in the electrical industry. There are at least 10 countries in Asia, Africa and Latin America at this promising stage. The central idea, which is original because nobody implemented it in the World is:

a) To deploy a testing laboratory able to perform high-power tests up to 200 to 250 MVA (3 seconds) and temperature rise tests up to 10.000A. If you do this, several other tests will also be possible.

b) To have in this lab a well-trained staff of 10 people prepared to, in addition to do the commercial tests, to have abilities to simulate such tests and to know concepts of equipment design.

c) To create a regulation to qualify and certify electrical products which clearly states, ***"Do lab tests where possible to test in the country and use test simulations to replace tests that cannot be done in the country".***

d) Create some R&D projects to demonstrate to the electrical sector actors that simulation results represent very well the results of (many) expensive laboratory tests. Use the “small” testing lab to do the validation tests.

With a “small” lab properly designed (I designed and implemented successfully something like this before) you can do more than 90% of the needed high-power tests:

- Short time current tests up to 65 to 200 kA for low to UHV equipment, depending on the size of the equipment.
- Temperature rise tests up to 25.000A
- All LV internal arc tests and breaking tests and some internal arc MV tests (accepting the existing openings of IEC standards and creating some others).
- You cannot do breaking tests in high voltage circuit breakers and similar things. However, they are rare to do.
- You can do a lot of tests to demonstrate that simulations arrive to the same results. After doing this Users and certifiers gain confidence to accept simulations (low cost) by replacing laboratory tests (high cost)

If you think testing and simulations as single alternatives, you will get a certain level of good results. However, if you think in both as complementary things of a unique project the results will be much bigger.

Simulations to replace tests are a new thing all over the World. The world references in this area are the work of the international Cigrè (WG A3-24, WG A3-36 and mentions in a brochure by WG B3-43). The WG A3-24 (internal arc) and WG A3-36 (temperature rise) have made complete validations involving experts from many different countries and tests in major laboratories in the world like (see brochure Cigrè 602/2014). Brochure Cigrè 740/2018 has several references to the use of simulations in developing countries.

Simulations must be validated but there are no World-Wide written rules nor technical standards to do this. I do not know any written publication issued by testing labs validating or even supporting testing simulations. I mean a public text more or less in this format http://www.cognitor.com.br/TR_071_ENG_ValidationSwitchgear.pdf

An acceptable neutral text prepared with the objective of being a technical standard (regulation) is the one entitled "Guidelines for the Use of Simulations & Calculations to Replace Some Tests Specified in IEC Standards". The full text of the proposal can be read in Reference [1] . This text is referred in Section B4 of the Brochure Cigrè 602/2014. The article in Reference [2] bring more information . http://www.cognitor.com.br/GUIDE_Simulations_v0_October2010.pdf.

2.5 to 2.7) SMALL HIGH-POWER TESTING LAB + SIMULATIONS (or at least small test labs in factories)

Check the articles referred above and write me in case of doubts

3) CONCLUSIONS

So, here are the ideas. To develop some of them may be a good action for medium and small companies. If anyone want to develop any of these four ideas, I can help you with my experience in laboratory testing, in simulations and in writing IEC and national technical standards.

REFERENCES

[1] "Guidelines for the Use of Simulations & Calculations to Replace Some Tests Specified in IEC Standards". http://www.cognitor.com.br/GUIDE_Simulations_v0_October2010.pdf

[2] A "Guide" For the Use Of Calculations & Simulation Of Laboratory Tests For Increasing The Competitiveness Of The Electric Industry – http://www.cognitor.com.br/Article_Competitivity_Eng_04102011.pdf

[3] How can IEC standards help to reduce the gap between developed and developing countries? "IEC IEEE KATS 2018 Academic Challenge" for the topic "New roles of standards to keep the balance human and technology" http://www.cognitor.com.br/IECIEEEKATS__SergioFeitoza.pdf

[4] IEC 62271-307 - IEC TR 62271-307:2015 - High-voltage switchgear and controlgear - Part 307: Guidance for the extension of validity of type tests of AC metal and solid-insulation enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV

[5] Book "Switchgear, Busways, Isolators - Substations & Lines" (available also in Spanish and Portuguese) http://www.cognitor.com.br/Book_SE_SW_2013_ENG.pdf

[6] Other articles in http://www.cognitor.com.br/downloads1.html

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