MAKERERE UNIVERSITY

P.O. Box 7062, Kampala, Uganda
Website: http://www.cedat.mak.ac.ug

Tel: +256-702-697500
Fax: +256-414-532780
Email: pr@cedat.mak.ac.ug

COLLEGE OF ENGINEERING, DESIGN, ART AND TECHNOLOGY
(CEDAT)

June 04, 2012

PRESS RELEASE

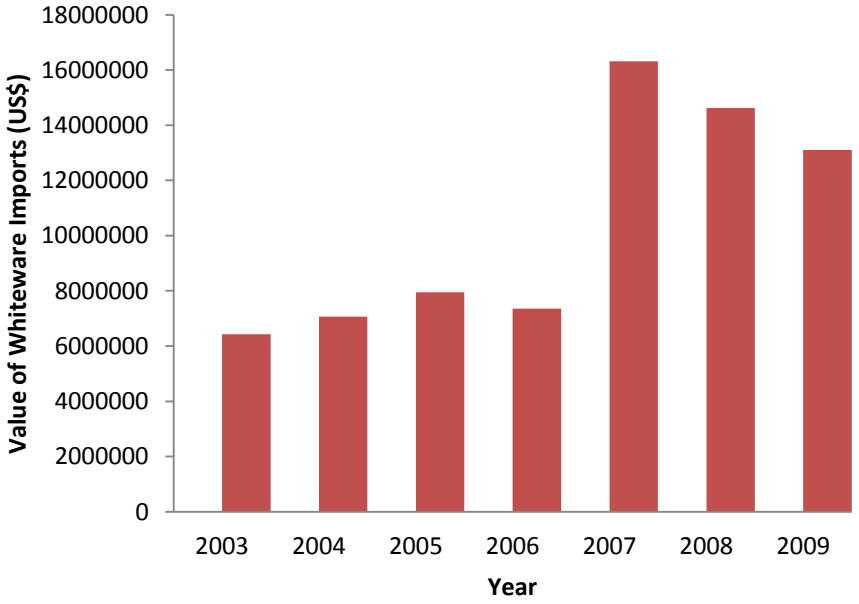
Development of an Appropriate Technology for Production of Electric Porcelain Insulators from Ceramic Minerals in Uganda

Uganda's electricity connectivity is very low, with grid access of 9% for the whole country and 3% in rural areas(MEMD, 2007). The country has one of the lowest electricity consumption per capita in the world, estimated at 69.5kWh in 2009. This is significantly lower than Africa's average of 578kWh per capita and the world's average of 2,752kWh. Although the consumption per capita is low, Uganda has an estimated hydropower potential of over 4500MW, biomass cogeneration of 1650MW, geothermal potential of 450MW, peat power potential of 800MW, high solar, fossil fuel thermal and nuclear energy potentials. The installed power generation capacity was 595.84MW in 2009. This was planned to rise to about 802MW with the commissioning of the Bujagali hydropower plant, then under construction and the various mini hydro plants (NDP, 2010).

Beyond generation, improving access and use also requires increasing both geographical coverage of the grid and number of households connected to it. In terms of network infrastructure development, there are a total of 1,115 km of 132kV high voltage transmission lines and 54 km of 66 kV in the country. The distribution facilities include 3,258 km of 33 kV lines, 3,443 km of 11 kV lines and 6,496 km of low voltage lines (MEMD, 2002). Insulators are extensively used in grid extensions. All insulators used on these lines are currently imported into the country. Insulators play the roles of supporting conductors, supporting electrical equipment, isolating conductors from other objects and from each other. Porcelains are among the major materials used for insulation on power lines. They are polycrystalline ceramic bodies primarily composed of clay, feldspar and a filler material, usually quartz or alumina. The clay gives plasticity to the ceramic mixture; quartz maintains the shape of the formed article during firing and feldsparserves as flux. The three constituents are widely available in Uganda. The fired product contains mullite and undissolved quartz crystals embedded in a continuous glassy phase, originating from feldspar and other low melting impurities in the raw materials. By varying the proportions of the three main ingredients, it is possible to emphasize thermal, dielectric or mechanical properties.For electrical insulation applications, porcelains are expected to meet minimum specifications of the latter two.

Porcelains belong to a major group of ceramics referred to as whitewares, all of which are made from the same basic raw materials, differences only arising from the material processing and production

procedures adopted.The products in this category include glazed ceramic flags and paving, hearth or wall tiles, ceramic sinks and other sanitary fixtures of porcelain, tableware and kitchenware of porcelain or china, household and toilet articles, statuettes and other ornamental articles of porcelain, ceramic electrical insulators, etc. Most whiteware products are imported into Uganda. As shown in the figure below, the amounts of money and import volumes in Uganda are significant. As such, this is a potential sector to employ many people in Uganda based on the local minerals. The choice in our study for insulators is partly because of its big impact on electricity supply, but also because insulators have tighter production requirements, success with them means that a lot many similar products can be made.



Import value of white wares in Uganda (Source: Uganda Bureau of Statistics)

Production requirements and challenges for industrial production.

The trend of electrical insulator demand is bound to increase as more electricity becomes available and as more households get connected to the national grid. Low voltage porcelain insulators do not have high quality requirements desired for the high voltage applications, besides, porcelains are still the most suitable as compared to other insulation materials like polymers and glasses for low voltage applications. Their production requirements make them suitable for small scale plant manufacturing facility. The major challenges to surmount in Uganda include the following:

Raw material preparation

Particle size and consistency of the properties of the starting powders is a very critical requirement. For industrial application a number of options are possible that can be adopted as:

1. Have a specialised material supplier with dedicated machinery for material processing. In this case the insulator producer is able to have the minerals supplied to their specification. Indeed this material supplier is bound to have various clients given the fact that various users of these minerals desire varied characteristics of the materials. For example kaolin particle size and quality in paper filling, in paint and in insulator applications are different.
2. The material preparation section to be incorporated in the manufacturing facility. Standardisation of the milling process and close matching to experimental investigation be introduced.
3. Laboratory for quality assurance in regard to chemical and physical properties of the minerals. Although slight variations may not significantly affect the body formulation, it can have significant effects on the properties of the glaze. This is a key component of the set up.

Forming process

Experimental investigations have been carried out using both slip casting techniques and plastic vacuum extrusion processes. Although the former process is cheap, it produced products with inferior strength properties. It is thus advisable to use a vacuum extruder for a pore free product.

Firing process

The kiln environment, firing rate, peak temperature and soak time are important for proper sintering and densification to occur. This step forms the desired microstructural features in terms of the size and distribution of mullite and quartz particles and the resultant quantity of the glass phase. This is very critical requires a consistent non interrupted firing cycle where firing, soaking and cooling rates can be maintained and regulated.

Glazing Process

This step sets the final surface texture and appearance of a porcelain product. For both aesthetic and technical purposes, capacity has to be established to make satisfactory glazes and to understudy what parameters are necessary for any improvements. Most of the natural materials for making glazes exist locally and various glazes can be easily developed. This has successfully been demonstrated in our specimens.

Quality assurance and testing

Uganda Electricty Transmission Company Ltdand other power utility companies have a pre-arranged set of qualification tests. Some of these tests can be done locally while others can be contracted out of the country.

Conclusion:

Our studies have demonstrated that porcelain insulators and other related whiteware products can be produced from local minerals available. The major challenges especially related to strength requirements, material choices, material preparation, forming, firing, finishing and testing were identified and solutions to address them suggested. The market potential for whitewares in Uganda is shown to be significant. The raw material availability and processing requirements have been ascertained for successful production of high quality whitewares from Uganda's minerals. There exists a big potential for development of small scale manufacturing enterprises in the sector with multiple benefits to the economy. Our studies have established the right production requirements for satisfactory insulator properties. These can be replicated to other related whiteware products.

For more information contact;

1. Dr.Peter W. Olupot, Department of Mechanical Engineering, CEDAT
   polupot@tech.mak.ac.ug

2. Prof. Joseph Byaruhanga, Department of Mechanical Engineering, CEDAT
   0772647364, jbyaruhanga@tech.mak.ac.ug

3. Betty Kyakuwa, Communication officer, CEDAT
   0772697500,pr@cedat.mak.ac.ug