

# **Some Approaches for Resource Efficient Manufacturing of Traditional Ceramics**

**Ferhat KARA**

**Anadolu University, Department of Materials Science and Engineering, Eskisehir / TURKEY**

Turkey has a long history of traditional ceramics production. Currently, it is one of the main countries in the production of tiles and sanitarywares in the world with an export value of over 35% of its production. About 35% of the European sanitaryware market is hold by Turkey.

Ceramic tile manufacturing process is energy intensive process and energy cost is about 30% of the total manufacturing cost in Turkey. Thus, there is a great need to reduce the energy consumption and associated CO<sub>2</sub> emission in ceramic industry. Temperatures over 1200 °C are required for firing of vitreous products. Although ceramic tiles can be fired in a fast firing regime, firing of sanitaryware articles requires much longer times due to their complex shapes. One obvious route to reduce the energy consumption is to reduce the firing temperatures by developing new compositions that can form a liquid phase at lower temperatures. Thus, extensive studies were made to develop such compositions for both porcelain tile and sanitaryware products.

On the ceramic tile front, results will be given about the effect of systematical variation of porcelain tile body composition on its firing behaviour and phase development where it was found that it is possible to reduce firing time and temperature of porcelain tile substantially by proper adjustment of alkali/alkaline earth ratio. It will also be demonstrated that by forming crystalline phases in the microstructure that are able to incorporate iron into their crystal structure, less quality clays can be used without degrading the body colour substantially.

Furthermore, more radical improvement with respect to energy saving and associated CO<sub>2</sub> reduction is possible by geopolymerization method where ceramic wall tile can be produced almost at room temperature without the need of firing and such tiles can even be made functional such that they can regulate indoor humidity to provide comfort to reduce the use of air conditioners in hot and humid environments.

On the sanitaryware front, similar approach to tiles made it possible to reduce firing temperatures of sanitaryware products substantially such that sintering temperatures as low as about 1100 °C, which is 100 °C lower than a typical standard sanitaryware firing temperature, were achieved. The same approach can be extended where less glassy phase can be used to keep the firing temperature as it is but achieve over 40% lower firing deformations to facilitate the producibility of thinner cross section sanitaryware articles.

Finally, mention will be made about the future challenges where innovative cross cutting approaches are needed to increase wider appearance of ceramic tiles in the market against competitive materials with environmental pay back. These will particularly include the issues about how to make them as warm as wood and about their self cleaning ability.