

Substitution of Aluminum Silicate Wool Products in the Furnace Industry

In addition to solving technical challenges, it is the constant task of the industrial furnace manufacturers, applying all the know how to limit the health risk of their employees and users of their furnace technology to a minimum. The Technical Rules for Hazardous Substances (TRGS) reflect the state of the art of occupational medicine and occupational hygiene and other proven knowledge about activities involving hazardous substances including their classification and labeling. These rules specify requirements of the Hazardous Substances Act within its scope of application.

With the complete substitution of aluminum silicate wool in its product range, Nabertherm GmbH successfully was able to comply in total with the requirements of the TRGS 619 setting new standards in the furnace industry.

Scope of Application

The TRGS 619 explains the substitution possibilities of amorphous aluminum silicate wool products, which are primarily used for thermal insulation in furnace and incinerator construction, heating systems and exhaust systems for motor vehicles, especially for application temperatures above 900 °C.

The substitution is following the goal to eliminate or reduce to a minimum the hazard entailed in activities when dealing with hazardous substances.



Muffle furnace L 5/11

Definitions

Aluminium silicate wool, previously also known as ceramic fibers (Refractory Ceramic Fiber = RCF), consists of amorphous fibers produced by melting a combination of Al₂O₃ and SiO₂, usually in a 50:50 weight ratio (see also VDI 3469 Sheet 1 and Sheet 5 and TRGS 558). They can additionally include ZrO₂. Aluminium silicate wool products are mainly used at temperatures > 900 °C and primarily in equipment that operates intermittently or under intermittent application conditions.

AES wools (alkaline earth silicate wools = high-temperature glass wools) consist of amorphous fibers produced by melting a combination of CaO, MgO and SiO₂ and are intended for high-temperature applications. AES wool products are generally used at application temperatures of up to max. 1200 °C and in continuously operating equipment and domestic appliances.

Polycrystalline wools (PCWs) consist of fibers with an Al₂O₃ content > 63 wt. percentage and a SiO₂ content < 37 wt. percentage; they are produced from aqueous spinning solutions in the "sol-gel method". The water-soluble green fibers formed initially as a precursor are then crystallized by means of heat treatment. Polycrystalline wools are generally used at application temperatures > 1300 °C and in critical chemical and physical application conditions.

Determination of Substitution Possibilities

The employer is obliged to check always what hazards can arise during the use of refractory products. The substitution solution must achieve an overall reduction in the hazards posed by hazardous substances at the workplace. At the same time, it should not lead to an increase in other hazards at the workplace or to an increased impairment of other goods to be protected (e.g. fire and explosion hazards, furnace breakouts accompanied by the escape of molten materials).



HT 160/18 DB200 with pneumatically driven and parallel lift door

Hazardous Properties of Fibrous Dusts from High-Temperature Wools and Resulting Hazards for Workers

Elongated particles have a carcinogenic effect if they are sufficiently long, thin and biostable. Fibers that meet the TRGS 619 criteria under number 2 paragraph 2 are deemed to be sufficiently long and thin (critical fibers). Potentially carcinogenic fibrous dusts can be released during activities involving aluminium silicate wools and polycrystalline wools.

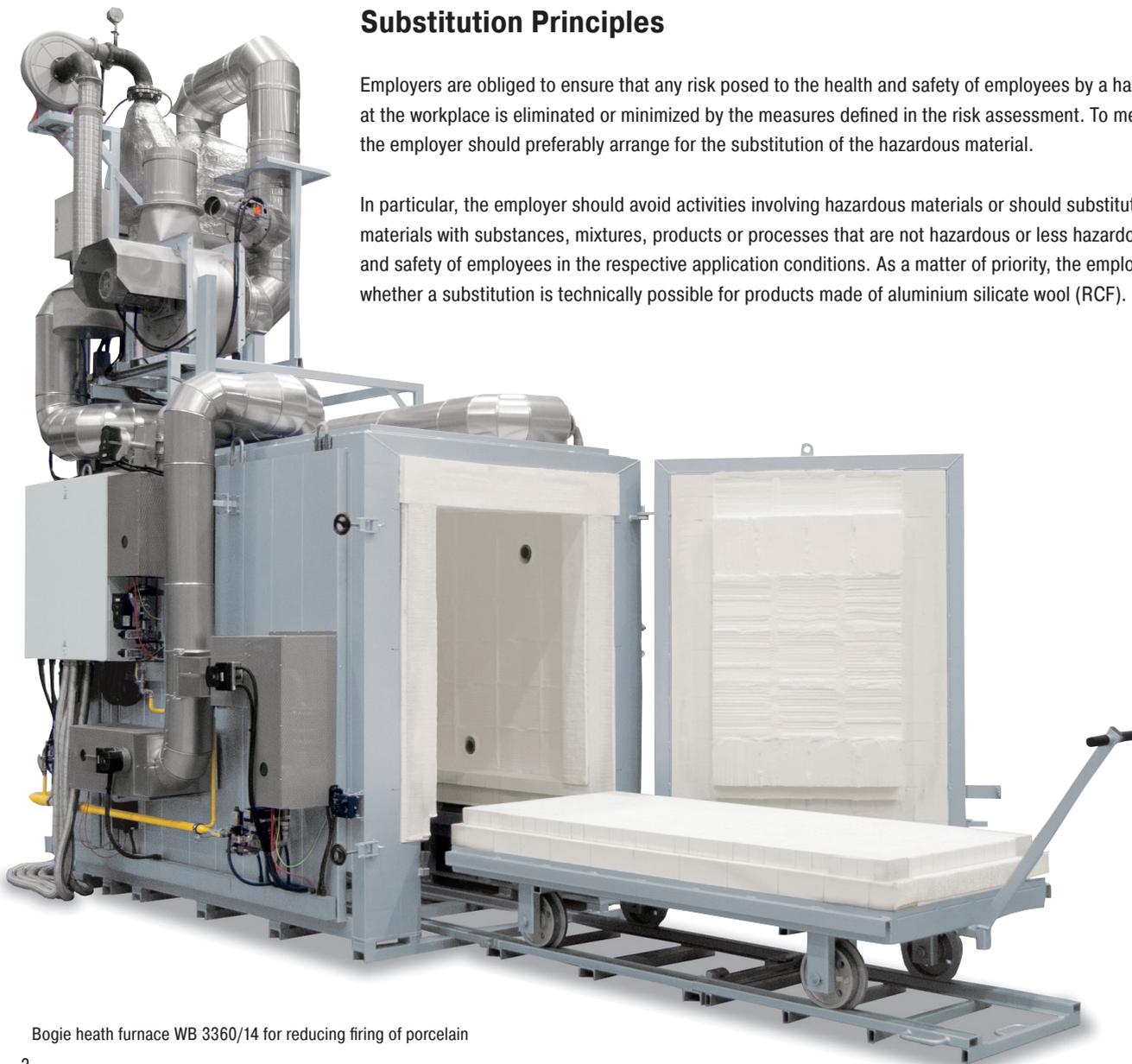
According to current scientific knowledge, a risk of cancer cannot be ruled out in the event of inhalation of these fibrous dusts. The fibrous dusts released are assessed as a category 2 or category 3 carcinogen in accordance with TRGS 905 "List of substances that are carcinogenic, mutagenic or toxic for reproduction". Accordingly, fibrous dusts from aluminium silicate wools (ASWs) are to be assessed as category 2 carcinogens (substances that are to be regarded as carcinogenic for people. There are sufficient indications for the assumption that exposure of a human to the substance may cause cancer).

Within the meaning of TRGS 905, under the term "all other inorganic fiber dusts" (number 2.3 para. 6 of TRGS 905), fibrous dusts of polycrystalline wools (PCW) are to be assessed as category 3 carcinogens (substances that are of concern because of a possible carcinogenic effect on people, but about which there is insufficient information for a satisfactory evaluation). Fibrous dusts from AES wools are not classified as carcinogenic. TRGS 558 "Activities involving high-temperature wool" describes protective measures for activities involving high-temperature wools.

Substitution Principles

Employers are obliged to ensure that any risk posed to the health and safety of employees by a hazardous material at the workplace is eliminated or minimized by the measures defined in the risk assessment. To meet this obligation, the employer should preferably arrange for the substitution of the hazardous material.

In particular, the employer should avoid activities involving hazardous materials or should substitute hazardous materials with substances, mixtures, products or processes that are not hazardous or less hazardous to the health and safety of employees in the respective application conditions. As a matter of priority, the employer must check whether a substitution is technically possible for products made of aluminium silicate wool (RCF).



Bogie heat furnace WB 3360/14 for reducing firing of porcelain

A substitution should be examined within the framework of an overall assessment based on the entire lifecycle of the possible products used. Products made of aluminium silicate wool must always be substituted if

- the technical properties (application temperatures, thermal-insulation properties, long-term behavior and service life) are equivalent and
- lower overall health risks exist for employees throughout the entire life cycle.

Further reasons for considering the use of substitute solutions can include costs, environmental-protection aspects and energy and resource efficiency. It must be emphasized, however, that higher costs incurred for a substitute solution do not automatically result in a “do not use” assessment. In particular, if the substances to be substituted pose a high risk, greater weight must be attributed to the reduction of risk.

The result of the substitute selection must be documented in the risk assessment and disclosed to the competent authorities on request. Products that do not contain fibers classified as category 1 or 2 carcinogens while satisfying the requirements with regard to application temperature and other application conditions can be used as fibrous substitutes with a lower health risk.

Implementation of the Substitution of Aluminum Silicate Wool Products in Industrial Furnace Design

Due to their good insulation ability aluminum silicate wool fibers (RCF) were typically used for operating temperatures ranging between 900 ° C and 1400 ° C for many years. By classifying these fiber materials in category 2, it is mandatory to examine the possibilities of substitution and to initiate, where it is technically possible. As described above, only the argument of higher costs is not sufficient to continue to hold on to RCF.



Fully automatic drop-bottom furnace plant, consisting of two drop-bottom furnaces, movable water bath and several loading and unloading positions

AES-fiber materials, which are classified as non-critical, can often not be used as the only substitute for aluminum silicate wool due to their product characteristics. PCW fiber materials are the technical alternative in many cases. However, the significantly higher procurement costs of these high-temperature fibers complicate the transition.

The TRGS 619 in adapted interpretation has been applied in many European countries and outside Europe. In countries like France or the US State of California huge company groups have not allowed the use of carcinogenic fiber materials for many years already. After the revision of the TRGS 619 in 2013 manufacturers of insulating materials have responded and widened their product portfolio by mixing fibers (e.g. from PCW- and AES-materials) to close this gap. However, until now the international furnace industry has hesitated to make use of these substitution alternatives partially for technical but mainly for cost reasons.

The Nabertherm GmbH as one of the largest manufacturers of industrial furnaces with the unique broadest product range in the market has – from right in the beginning - intensively analyzed the possible substitution of aluminium silicate wool by suitable alternative materials.

Already in 2015 the first kiln series were delivered RCF-free from the Nabertherm GmbH. Successively, substitution possibilities were determined for all furnace families by the Nabertherm design team with 65 engineers. Almost every furnace model was touched and structurally modified so that RCF fibers are used neither in the hot side nor as rear insulation.

Now, Nabertherm can proudly report that the entire furnace range has been changed in close cooperation with leading international fiber suppliers. Today, almost no standard furnace, which is delivered to customers, is insulated with aluminum silicate wool (RCF-fiber material) anymore. Through alternative design solutions, substituting in most cases could be performed almost cost neutral. At least, costs are no reason, not to use non-carcinogenic fibers in the future. Only for very few applications, where no alternative to RCF-fibers is existing, classified fibers must be used. However, these are handled very restrictively and will be mutually agreed together with the customer.

The Nabertherm GmbH employs more than 450 employees at their manufacturing plant in Lilienthal/Bremen in Northern Germany. Every year, more than 7,500 kilns and furnaces for Arts & Crafts, Laboratory, Dental, Thermal Process Technology, Advanced Materials, Glass and Foundry with working temperatures between 30 °C and 3000 °C are produced and delivered.

As manufacturer of high-quality products - Made in Germany - and market leader in this segment, Nabertherm GmbH feels obliged, particularly in health-related issues, to position itself at the top of the industry and offer leading products with respect to quality and safety.

Text sources: abstracts from the German TRGS 619, Edition May 2013



Tube furnace RSH 50/500/11



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