Bibliografia:
1. Monografia IARC tom 43: "Man-made Mineral Fibres and Radon"
2. Monografia IARC tom 81: "Man-made Vitreous Fibres"
3. Dyrektywa 97/69/WE w sprawie adaptacji dyrektywy RE 67/548/EWG

c.d.

Włókna o małej biotrwałości	Ogniotrwałe włókna ceramiczne	Włókna polikrystaliczne
Koszt zbliżony do włókien ceramicznych	-	Koszt znacznie wyższy od kosztu włókien ceramicznych
Duża dostępność	Duża dostępność	Ograniczona dostępność, lecz rośnie

Podsumowując: wymóg uzyskiwania zezwoleń na ogniotrwałe włókna ceramiczne najprawdopodobniej umożliwi ich stosowanie jeszcze przez jakiś czas w warunkach, w których będą bezwzględnie konieczne, zanim zapadnie ostateczna decyzja ECHA. Niemniej zezwolenia podlegają okresowym przeglądom; poza tym luka dzieląca rodzinę włókien o małej biotrwałości i włókien polikrystalicznych będzie wciąż malała. Potencjał techniczny włókien o małej biotrwałości nadal rośnie dzięki trwającym pracom działów badań i rozwoju; z kolei dostępność włókien polikrystalicznych będzie coraz większa, ponieważ trwają kolejne inwestycje w moce produkcyjne.

Należy również podkreślić, że włókna o małej biotrwałości i polikrystaliczne można łączyć ze sobą, ponieważ materiały o wysokim koszcie konieczne są tylko w obszarach o najwyższej temperaturze. Takie hybrydowe podejście do konstrukcji wykładzin izolacyjnych pieców może znacznie zmniejszyć całkowity koszt wykonania. Przewiduje się, że technologia zastosowań w tym obszarze stanie się kwestią kluczową w nadchodzących latach.

REACH: the regulation of RCF and future options for high temperature insulating fibre

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SUMMARY

Refractory ceramic fiber materials have been in use in the industry for 50 years. They changed the design concepts for furnaces, enabling the use of insulation materials with lower densities than conventional materials, bricks and concrete, at the same time being comparatively more energy-efficient. A recent proposal, included in the REACH regulation of the European Union, recommends creation of a licensing scheme for refractory ceramic fiber materials. Should this proposal be approved, entities using such materials in Europe would have to search for alternatives to refractory facings made of ceramic fiber.

1. Introduction – The Progressive Regulation of RCF

The development of RCF (Refractory Ceramic Fibre) in the 1950's introduced for the first time the possibility to use fibre insulation at temperatures above 700°C where previously hard insulating refractories such as bricks or castables had been used. The advantages of fibre insulation were recognised widely across the high temperature processing industry and RCF saw strong growth in its use through to the 1990's.

However, following the realisation that asbestos dust in the workplace could be harmful to health if inhaled, the respirable dust generated by the new manmade fibres was also investigated intensively by animal testing in the 1980's and 1990's. Based on this work, IARC classified RCF as a carcinogen type 2b in 1988(1) and confirmed this classification after a review in 2002(2). The European Union classified RCF as carcinogen type 2 in 1997(3).

With the introduction of REACH in 2007, RCF is coming under more regulatory pressure in the European Union. In 2010, RCF was designated a Substance of Very High Concern and added to REACH Annex XV which is commonly referred to as the "Candidate List for Authorisation". In June 2013, the ECHA included RCF in its 5th recommendation of substances to be added to Annex XIV, the Authorisation List. The following table lists the main regulatory steps taken by the EU regarding RCF and summarises the obligations that these place on those using RCF as high temperature insulation.

	Regulatory Step	Consequences for the RCF user community
1997	Carcinogen 2	Warning labels applied to packaging, restriction on sale to the public, disposal restrictions, obligation to seek alternatives
2009	REACH registration	CLP package labelling introduced (CLP class 1b)
2010	REACH Annex XV	Obligation to supply information where articles contain RCF
2014?	REACH Annex XIV	Obligation to apply for Authorisation where RCF cannot be substituted.
2018?	Sunset date	RCF can only be supplied into authorised applications.

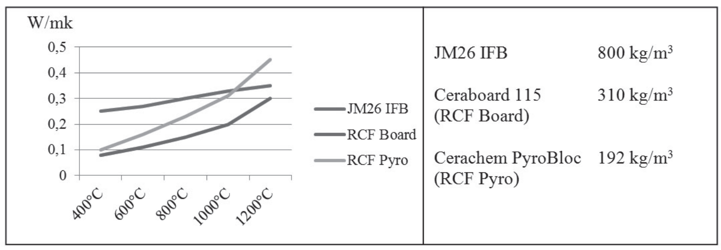
The process followed to place a substance on Annex XIV has several stages as is illustrated in the following table. For RCF, only the last stage in the process is now outstanding:

Date	Process Step
June 2013	ECHA make 5th recommendation for inclusion in Annex XIV (includes RCF)
July-Sept 2013	Public Consultation during which all stakeholders can submit comments
Oct 13 – Feb 14	Member State Committee review the input from the public consultation
Feb 14	ECHA pass the 5th recommendation to the European Commission
? 2014	European Commission review and decide on inclusion in Annex XIV XIV

It must be emphasised that the European Commission has not yet confirmed that RCF will be placed on Annex XIV. However, this paper will explore the alternatives for RCF users assuming that Authorisation is confirmed.

2. The Advantages of Fibre Insulation

From the beginning, the low density of fibre insulation has been its clear advantage when designing a furnace. This is best illustrated by comparing the thermal conductivity curves of three standard Thermal Ceramics® products:



The fibre PyroBloc® module has only one quarter of the density of the Insulating Fire Brick (IFB) with the same classification temperature. This results in much less stored energy allowing more efficient operation of cycling furnaces. The low density and the fibrous structure of the fibre module also eliminate the risk of thermal shock and allow a furnace to be heated and cooled more rapidly. These two factors are the main reason why fibre insulation has replaced IFB solutions in many areas over the last 50 years.

It can also be seen that below 1000°C, fibre insulation has lower thermal conductivity than IFB. It is for this reason that fibre products are often chosen for back up insulation installed behind an IFB or castable hot face.

Insulating Fire Bricks do offer certain advantages that are not available with fibre and they still play an important role in the construction of furnaces. Continuous process furnaces, where the energy stored in the lining is less important, will often use IFB to achieve a long service life. Also, the relatively low porosity of IFB means that they will perform well in conditions where the furnace atmosphere is contaminated. Nevertheless, fibre solutions are now preferred for a large part of the furnace market.

On the basis of the comparison between fibre and IFB alternatives, it is clear that in many

Petrochemical heater – a classic IFB application: continuous operation.

Ceramic sanitary ware – a typical fibre application: cyclic operation

cases RCF must be replaced by alternative fibre solutions if the performance advantages offered by RCF are to be retained. This is a key point and must be considered when assessing the alternatives to RCF in the context of REACH Authorisation.

3. Alternative Fibre Technology

There are two classes of fibre technology which offer an alternative to RCF, low bio-persistent fibres and polycrystalline wools.

The first of these is the new family of fibres with low bio-persistence. Fibres in this category must meet clear requirements which are also set down in the European Directive which classified RCF (3).

The regulation applies the lesser carcinogen classification (type 3) to manmade vitreous (silicate) fibres with random orientation and with alkaline oxide and alkaline earth oxide (Na_2O + K_2O + CaO + MgO + BaO) content greater than 18% by weight. By contrast, RCF, classified as a carcinogen type 2, has less than or equal to 18% of the specified oxides.

For those fibres with >18% of the specified oxides, the regulation also allows, via Note Q, for animal testing to be used to demonstrate low bio-persistence and by this means gives complete exoneration from any carcinogen classification. Note Q allows 4 different testing methods to be used to achieve exoneration. The manufacturer is free to choose which of these routes to follow. The alternatives are shown in the following table:

	Test method to achieve exoneration under Note Q	Exoneration requirement
1	Short term bio--persistence test by inhalation	<10 days half life
2	Short term bio--persistence test by intratracheal instillation (IT)	<40 days half life
3	Intra-peritoneal test (IP)	No excess carcinogenicity
4	Long term inhalation test	Absence of relevant pathogenicity or neoplastic changes

Thermal Ceramics range of Superwool® fibres are all exonerated from classification by this method and the following table illustrates clearly how Note Q has ben applied to each of the Superwool fibre types:

Superwool fibre type	Soluble Oxides >18%	Note Q tests used
Superwool Plus	CaO and MgO	2 and 4
Superwool HT	CaO	2
Superwool (1400 grade)	K_2O	2

Fibres in the Superwool family are made using a similar manufacturing process to RCF and the range of products is similar. To date this low bio-persistent technology has not fully matched the range of applications covered by RCF. Temperatures above 1150°C or environments with significant pollution would be examples where RCF cannot yet be substituted reliably.

However, developments are moving forward. Superwool Plus and Superwool HT are fully commercialised products with a proven track record. Through developments in manufacturing technology, Superwool Plus has a thermal conductivity some 20% lower than RCF, making it much more highly insulating. Superwool 1400 grade is a new technology fibre which is still at the trials stage but which offers a higher use temperature up to 1250°C.

The second alternative to RCF is the family of polycrystalline wools. These fibres are similar to RCF in that they are based on Alumina and Silica. However the Alumina content is 72% or higher requiring a different manufacturing process. These fibres are produced at ambient temperature from a water based sol and then dried and fired to produce the resultant ceramic fibre. The end result is a fibre which has a very high temperature resistance, allowing applications up to 1450°C, and which is already crystallised within the fibre structure – hence the term polycrystalline.

The manufacturing process for polycrystalline fibres allows more accurate control of the fibre diameter than is the case with RCF. These fibres have therefore been developed to be low in fine fibre content and so less likely to produce respirable dust when being handled. As a result polycrystalline fibres are unclassified under REACH.

Fibre diameter control, as used in manufacturing polycrystalline fibres, is a different approach to reducing workplace risk compared with low bio-persistent fibres. Polycrystalline fibres aim to reduce risk by producing less respirable fibrous dust in the workplace, whereas the low bio-persistent fibres aim to reduce risk by ensuring any respirable dust is compatible with the lungs' natural clearance mechanisms. Both strategies for reducing the health risk associated with inhaled fibrous dust make these fibres possible alternatives to RCF.

4. RCF Substitution

The two families of fibres presented so far can between them satisfy all the application areas currently addressed by RCF. However, whereas low bio-persistent fibres have a similar cost to RCF and are available in sufficient volume, polycrystalline fibres are considerably higher in cost and available in lower volumes. This results from the high cost and relatively low productivity of the sol-gel manufacturing process that must be used.

The substitution possibilities for RCF are summarised in the following chart:

Low bio-persistent fibres	RCF	Polycrystalline fibres
Up to 1150°C	Up to 1250°C	Up to 1450°C
Sensitive to pollution	Less sensitive to pollution	Less sensitive to pollution
Capability increasing with R&D	Established technology	Higher capability than RCF
Similar cost to RCF	-	Much higher cost than RCF
Large volume availability	Large volume availability	Limited volume but growing

In summary, RCF Authorisation is likely to allow RCF to continue in use in the applications where it is essential for some time, subject to final decision making in the ECHA. However, authorisation is reviewed at regular intervals and it is likely that the gap between the low bio-persistent and polycrystalline families of fibres will continue to shrink. The technical capability of the low bio-persistent fibres is increasing through development and the availability of polycrystalline fibres is growing through additional investment in manufacturing capacity.

It should also be said that low bio-persistent fibres and polycrystalline fibres can be used in combination as the higher cost material is only required in the hottest temperature regions. This hybrid approach to designing furnace insulation can do much to limit the overall cost of the installation. Applications engineering in this area is likely to be a key topic in the coming years.

References:
1. IARC Monograph Vol 43: Man-made Mineral Fibres and Radon
2. IARC Monograph Vol 81: Man-made Vitreous Fibres
3. Directive 97/69/EC adapting Council Directive 67/548/EEC