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(72) **Inventeurs/Inventors:**
JUBB, GARY ANTHONY, GB;
FREEMAN, CRAIG JOHN, GB

(73) **Propriétaire/Owner:**
THE MORGAN CRUCIBLE COMPANY PLC, GB

(74) **Agent:** OSLER, HOSKIN & HARCOURT LLP

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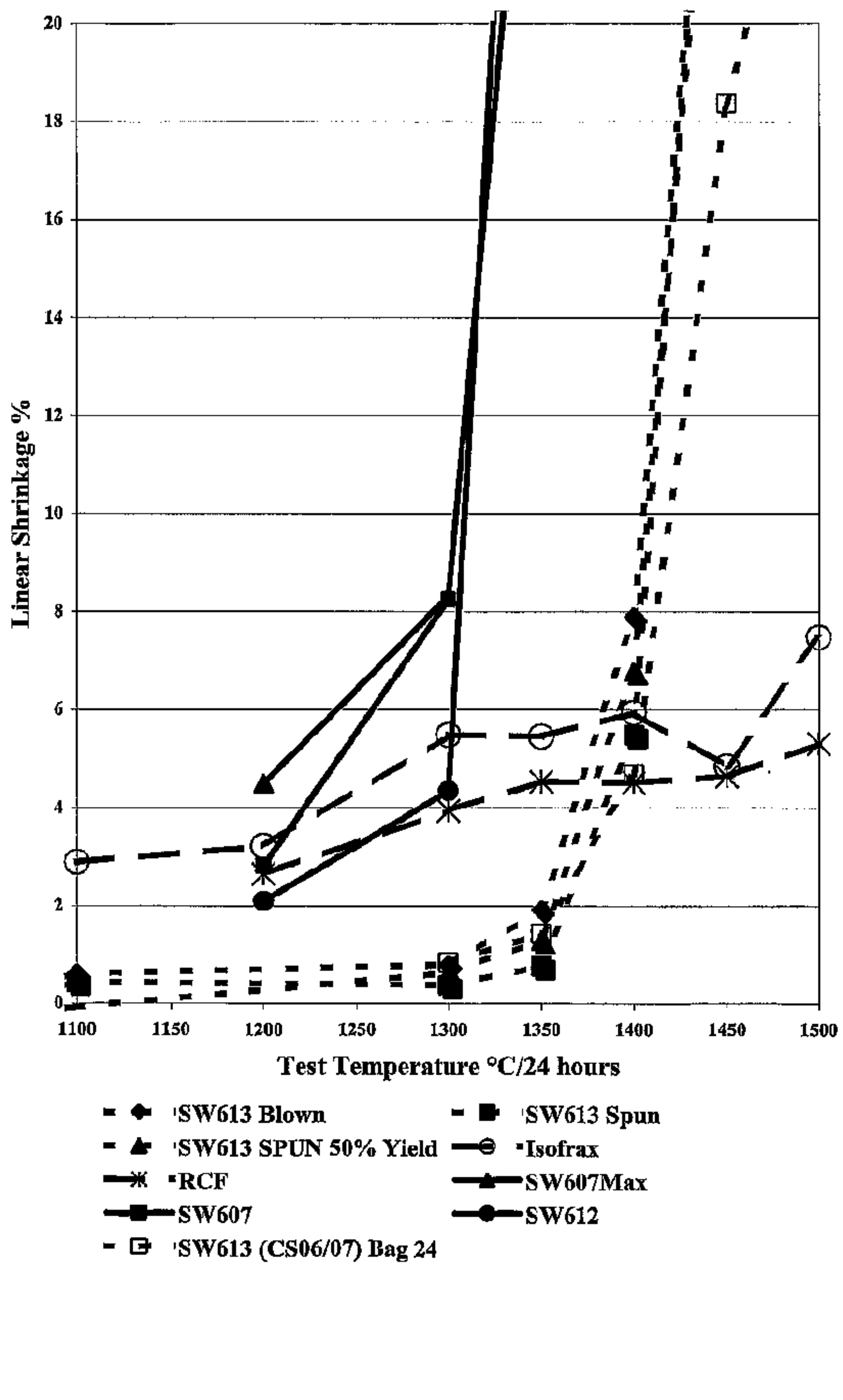

(57) **Abrégé/Abstract:**

Thermal insulation is provided for use in applications requiring continuous resistance to temperatures of 1260 °C without reaction with alumino-silicate firebricks, the insulation comprises fibres having a composition in wt% 65 %<SiO_2 <86 %, MgO <10 %, 14 % < CaO < 28 %, $A1_20_3$ <2 %, $Zr0_2$ <3 %, B_20_3<5 %, P_20_5 <5 %, 72 % <$Si0_2$+$Zr0_2$+B_20_3+5*P_20_5, 95 % < $Si0_2$ + CaO + MgO + $A1_20_3$ +$Zr0_2$ + B_20_3 + P_20_5. Addition of elements selected from the group Sc, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Y or mixtures thereof improves fibre quality and the strength of blankets made from the fibres.

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(71) Applicant *(for all designated States except US)*: **THE MORGAN CRUCIBLE COMPANY PLC** [GB/GB]; Morgan House, Madeira Walk, Windsor, Berkshire SL4 1EP (GB).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **JUBB, Gary, Anthony** [GB/GB]; c/o Morgan Group Technology Limited, Bewdley Road, Stourport-on-Severn, Worcestershire DY13 8QR (GB). **FREEMAN, Craig, John** [GB/GB]; c/o Morgan Group Technology Limited, Bewdley Road, Stourport-on-Severn, Worcestershire DY13 8QR (GB).

(74) Agent: **PHILLIPS & LEIGH**; 5 Pemberton Row, London, Greater London EC4A 3BA (GB).

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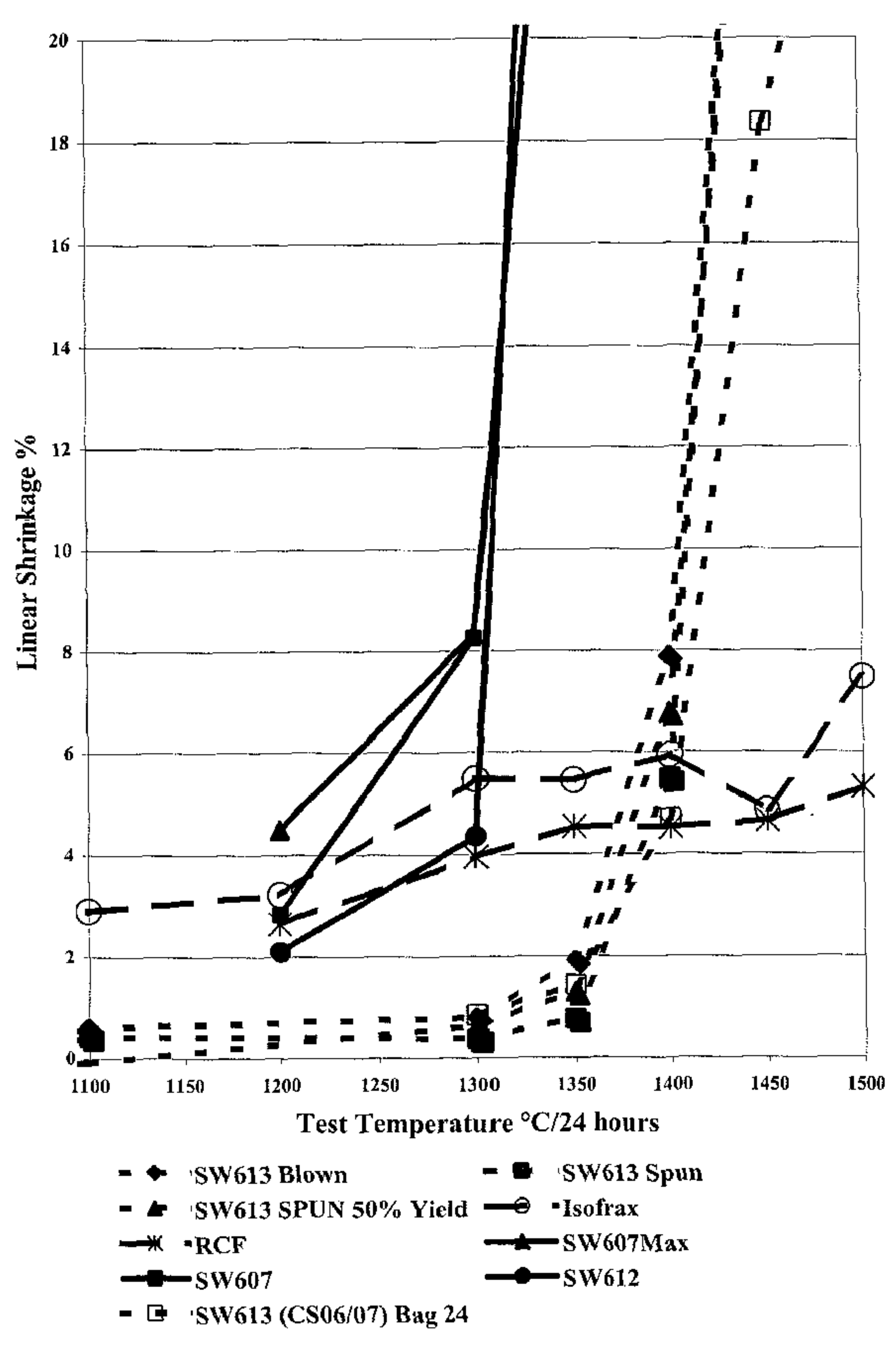
(54) Title: SALINE SOLUBLE INORGANIC FIBRES



(57) Abstract: Thermal insulation is provided for use in applications requiring continuous resistance to temperatures of 1260 °C without reaction with alumino-silicate firebricks, the insulation comprises fibres having a composition in wt% 65 %<SiO_2 <86 %, MgO <10 %, 14 % < CaO < 28 %, Al_2O_3 <2 %, ZrO_2 <3 %, B_2O_3<5 %, P_2O_5 <5 %, 72 % <SiO_2+ZrO_2+B_2O_3+5*P_2O_5, 95 % < SiO_2 + CaO + MgO + Al_2O_3 +ZrO_2 + B_2O_3 + P_2O_5. Addition of elements selected from the group Sc, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Y or mixtures thereof improves fibre quality and the strength of blankets made from the fibres.

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SALINE SOLUBLE INORGANIC FIBRES

This invention relates to saline soluble, non-metallic, amorphous, inorganic oxide, refractory fibrous materials. The invention particularly relates to glassy fibres having silica as their principal constituent.

Inorganic fibrous materials are well known and widely used for many purposes (e.g. as thermal or acoustic insulation in bulk, mat, or blanket form, as vacuum formed shapes, as vacuum formed boards and papers, and as ropes, yarns or textiles; as a reinforcing fibre for building materials; as a constituent of brake blocks for vehicles). In most of these applications the properties for which inorganic fibrous materials are used require resistance to heat, and often resistance to aggressive chemical environments.

Inorganic fibrous materials can be either glassy or crystalline. Asbestos is an inorganic fibrous material one form of which has been strongly implicated in respiratory disease.

It is still not clear what the causative mechanism is that relates some asbestos with disease but some researchers believe that the mechanism is mechanical and size related. Asbestos of a critical size can pierce cells in the body and so, through long and repeated cell injury, have a bad effect on health. Whether this mechanism is true or not regulatory agencies have indicated a desire to categorise any inorganic fibre product that has a respiratory fraction as hazardous, regardless of whether there is any evidence to support such categorisation. Unfortunately for many of the applications for which inorganic fibres are used, there are no realistic substitutes.

Accordingly there is a demand for inorganic fibres that will pose as little risk as possible (if any) and for which there are objective grounds to believe them safe.

A line of study has proposed that if inorganic fibres were made that were sufficiently soluble in physiological fluids that their residence time in the human body was short; then damage would not occur or at least be minimised. As the risk of asbestos linked disease appears to depend very much on the length of exposure this idea appears reasonable. Asbestos is extremely insoluble.

As intercellular fluid is saline in nature the importance of fibre solubility in saline solution has long been recognised. If fibres are soluble in physiological saline solution then, provided the dissolved components are not toxic, the fibres should be safer than fibres which are not so soluble. The shorter the time a fibre is resident in the body the less damage it can do. H. Förster in 'The behaviour of mineral fibres in physiological solutions' (*Proceedings of 1982 WHO IARC Conference*, Copenhagen, Volume 2, pages 27-55(1988)) discussed the behaviour of commercially produced mineral fibres in physiological saline solutions. Fibres of widely varying solubility were discussed.

International Patent Application No. WO87/05007 disclosed that fibres comprising magnesia, silica, calcia and less than 10 wt% alumina are soluble in saline solution. The solubilities of the fibres disclosed were in terms of parts per million of silicon (extracted from the silica containing material of the fibre) present in a saline solution after 5 hours of exposure. The highest value revealed in the examples had a silicon level of 67 ppm. In contrast, and adjusted to the same regime of measurement, the highest level disclosed in the Förster paper was equivalent to approximately 1 ppm. Conversely if the highest value revealed in the International Patent Application was converted to the same measurement regime as the Förster paper it would have an extraction rate of 901,500 mg Si/kg fibre - i.e. some 69 times higher than any of the fibres Förster tested, and the fibres that had the highest extraction rate in the Förster test were glass fibres which had high alkali contents and so would have a low melting point. This is convincingly better performance even taking into account factors such as differences in test solutions and duration of experiment.

International Patent Application No. WO89/12032 disclosed additional fibres soluble in saline solution and discusses some of the constituents that may be present in such fibres.

European Patent Application No. 0399320 disclosed glass fibres having a high physiological solubility.

Further patent specifications disclosing selection of fibres for their saline solubility include for example European 0412878 and 0459897, French 2662687 and 2662688, PCT WO86/04807, WO90/02713, WO92/09536, WO93/22251, WO94/15883, WO97/16386 and United States 5250488.

The refractoriness of the fibres disclosed in these various prior art documents varies considerably and for these alkaline earth silicate materials the properties are critically dependent upon composition.

WO94/15883 disclosed a number of fibres that are usable as refractory insulation at temperatures of up to 1260°C or more. These fibres comprised CaO, MgO, SiO_2, and optionally ZrO_2 as principal constituents. Such fibres are frequently known as CMS (calcium magnesium silicate) or CMZS ((calcium magnesium zirconium silicate) fibres. WO94/15883 required that any alumina present only be in small quantities.

A drawback found in use of these fibres, is that at temperatures between about 1300°C and 1350°C the fibres undergo a considerable increase in shrinkage. Typically, shrinkages increase from about 1-3% at 1200°C; to, say, 5% or more at 1300°C; to >20% at 1350°C. This means that, for example, a temperature overrun on a furnace can result in damage to the insulation and hence to the furnace itself.

A further drawback is that calcium magnesium silicate fibres can react with, and stick to, alumina containing materials due to formation of a eutectic composition. Since aluminosilicate materials are widely used this is a major problem.

WO97/16386 disclosed fibres that are usable as refractory insulation at temperatures of up to 1260°C or more. These fibres comprised MgO, SiO_2, and optionally ZrO_2 as principal constituents. As with WO94/15883, this patent required that any alumina present only be in small quantities.

While these fibres do not show the dramatic change in shrinkage evident in the fibres of WO94/15883, they do show a significantly higher shrinkage at normal use temperatures typically having a shrinkage of 3-6% over the range 1200°C-1450°C. These fibres do not appear to have the drawback of reacting with and sticking to alumina containing materials, however they tend to be difficult to make.

The applicants have invented a group of fibres that have a lower shrinkage across a range of temperatures than the fibres of WO97/16386, while having a higher onset of increase in shrinkage, and a more gentle change in shrinkage, than the fibres of WO94/15883 and which also have a reduced tendency to react with and stick to alumina.

Accordingly, the present invention provides thermal insulation for use in applications requiring continuous resistance to temperatures of 1260°C without reaction with alumino-silicate firebricks, the insulation comprising fibres having a composition in wt%

$65\% < SiO_2 < 86\%$
$MgO < 10\%$
$14\% < CaO < 28\%$
$Al_2O_3 < 2\%$
$ZrO_2 < 3\%$
$B_2O_3 < 5\%$
$P_2O_5 < 5\%$
$72\% < SiO_2 + ZrO_2 + B_2O_3 + 5*P_2O_5$
$95\% < SiO_2 + CaO + MgO + Al_2O_3 + ZrO_2 + B_2O_3 + P_2O_5$.

A preferred range of compositions is:-

$72\% < SiO_2 < 80\%$
$18\% < CaO < 26\%$
$0\% < MgO < 3\%$
$0\% < Al_2O_3 < 1\%$
$0\% < ZrO_2 < 1.5\%$
$98.5\% < SiO_2 + CaO + MgO + Al_2O_3 + ZrO_2 + B_2O_3 + P_2O_5$.

A still more preferred range has the composition:-

$72\% < SiO_2 < 74\%$
$24\% < CaO < 26\%$

Additionally, the applicants have found that addition of small amounts of lanthanide elements, particularly lanthanum, improves the quality of the fibres, particularly their length and thickness, such that improved strength results. There is a trade-off in terms of slightly lower solubility, but the improved strength is of help, particularly in making such products as blankets, in which the fibres are needled to form an interlocking web of fibres.

Accordingly, the present invention comprises a silicate fibre comprising:-

$65\% < SiO_2 < 86\%$
$MgO < 10\%$
$14\% < CaO < 28\%$
$Al_2O_3 < 2\%$
$ZrO_2 < 3\%$
$B_2O_3 < 5\%$

$P_2O_5 < 5\%$
$72\% < SiO_2+ZrO_2+B_2O_3+5*P_2O_5$
$95\% < SiO_2 + CaO + MgO + Al_2O_3 + ZrO_2 + B_2O_3 + P_2O_5$.
$0.1\% < R_2O_3 < 4\%$
where R is selected from the group Sc, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Y or mixtures thereof.

The preferred elements are La and Y. Preferably, to achieve significant improvements in fibre quality, the amount of R_2O_3 is greater than 0.25%, more preferably > 0.5%, and still more preferably >1.0%. To minimise the reduction is solubility that occurs, the amount of R_2O_3 is preferably <2.5%, still more preferably <1.5% by weight. Very good results are obtained for a fibre having the composition in wt%:-

SiO_2:-	$73 \pm 0.5\%$
CaO:-	$24 \pm 0.5\%$
La_2O_3:-	1.3 – 1.5%
Remaining components:-	<2%, preferably <1.5%

Further features of the invention will become apparent from the claims in the light of the following illustrative description and with reference to the drawing Fig.1 which is a graph of shrinkage against temperature of some fibres according to the present invention in comparison with some commercial fibres.

The inventors produced a range of calcium silicate fibres using an experimental rig in which a melt was formed of appropriate composition, tapped through a 8-16 mm orifice, and blown to produce fibre in a known manner. (The size of the tap hole was varied to cater for the viscosity of the melt – this is an adjustment that must be determined experimentally according to the apparatus and composition used).

The fibres were tested and the results for fibres that are predominantly calcium silicate fibres with some MgO are shown in Table 1, in which:-

- shrinkage figures are shown as measured on a preform of fibre by the method (see below),
- compositions are shown as measured by x-ray fluorescence with boron by wet chemical analysis,
- total solubility in ppm of the major glass components after a 24 hour static test in a physiological saline solution is shown,
- specific surface area in m^2g,
- a qualitative assessment of fibre quality,

- and an indication of whether the preform stuck to an aluminosilicate brick (JM 28 bricks obtainable from Thermal Ceramics Italiana and having an approximate composition 70wt% alumina and 30wt% silica)

The shrinkage was measured by the method of manufacturing vacuum cast preforms, using 75g of fibre in 500cm^3 of 0.2% starch solution, into a 120 x 65mm tool. Platinum pins (approximately 0.1-0.3mm diameter) were placed 100 x 45mm apart in the 4 corners. The longest lengths (L1 & L2) and the diagonals (L3 & L4) were measured to an accuracy of $\pm 5\mu m$ using a travelling microscope. The samples were placed in a furnace and ramped to a temperature 50°C below the test temperature at 300°C/hour and ramped at 120°C/hour for the last 50°C to test temperature and left for 24 hours. On removal from the furnace the samples were allowed to cool naturally. The shrinkage values are given as an average of the 4 measurements.

The inventors found that those fibres having a silica content less than 72% by weight tended to stick to the aluminosilicate brick. They also found that high MgO content fibres (>12%) did not stick (as predicted from the properties of WO97/16386).

It is known that calcium silicate fibres having an intermediate level of MgO (12-20%) stick to aluminosilicate brick, whereas magnesium silicate fibres do not. Surprisingly, for the fibres of the present invention, such intermediate levels of MgO can be tolerated. Levels of <10% MgO, or <5% MgO give the non-sticking results required, but it appears preferable for refractoriness to have a maximum level of MgO at 2.5% by weight, and more preferably the amount should be below 1.75% by weight.

Table 2 shows the effect of alumina and zirconia on these fibres. Alumina is known to be detrimental to fibre quality and the first three compositions of Table 2 have over 2% Al_2O_3 and stick to aluminosilicate brick. Additionally, increased alumina leads to lowered solubility. Accordingly, the inventors have determined 2% as the upper limit for alumina in their inventive compositions.

In contrast zirconia is known to improve refractoriness and Table 2 shows that silica levels of below 72% can be tolerated if the amount of ZrO_2 is sufficient that the sum of SiO_2 and ZrO_2 is greater than 72% by weight. However, increasing zirconia lowers the solubility of the fibres in physiological saline solution and so the preferred level of ZrO_2 is less than 3%.

The effect of some other common glass additives is indicated by Table 3, which shows the effect of P_2O_5 and B_2O_3 as glass forming additives. It can be seen that

P_2O_5 has a disproportionate effect on the sticking properties of these compositions, as fibres with as low as 67.7% SiO_2 do not stick to aluminosilicate brick.

B_2O_3 also has an effect with fibres having as low as 70.9% SiO_2 not sticking. The inventors have determined that sticking to aluminosilicate brick tends not to occur for fibres meeting the relationship:-

$72\% < SiO_2 + B_2O_3 + ZrO_2 + 5^* P_2O_5$.

The inventors have assumed a maximum level for B_2O_3 and P_2O_5 of 5% by weight each.

Tables 1 to 3 show that minor amounts of other components may be included and the invention tolerates up to 5% of other ingredients, but preferably these other ingredients amount to less than 2%, more preferably less than 1%, since such other ingredients tend to make the fibres less refractory. (But see below for effect of specific lanthanide additives).

The above results were obtained on an experimental rig, with all of the uncertainties that entails. Production trials of the most favourable appearing fibres were conducted on two separate sites to allow both blowing and spinning of the compositions to be tried. Table 4 shows a selection of the results obtained (duplicates omitted) and shows that a very usable fibre results. The fibres tested in the production trials had compositions falling in the approximate range

$72\% < SiO_2 < 80\%$
$18\% < CaO < 26\%$
$0\% < MgO < 3\%$
$0\% < Al_2O_3 < 1\%$
$0\% < ZrO_2 < 1.5\%$
with $98.5\% < SiO_2 + CaO + MgO + Al_2O_3 + ZrO_2 + B_2O_3 + P_2O_5$.

It can be seen that the compositions with an MgO level of greater than 1.75% tended to have a higher shrinkage at 1350°C than those with a lower MgO level.

Fig. 1 shows in graphical form an important feature of the fibres of the invention and compares the shrinkage characteristics of the first three fibres and 5^{th} fibres of Table 4 (each referred to as SW613) with commercial fibres Isofrax® (a magnesium silicate fibre from Unifrax Corporation), RCF (a standard aluminosilicate refractory ceramic fibre), and SW607 Max™, SW607™, and SW612™ (calcium magnesium silicate fibres from Thermal

Ceramics Europe Limited).

It can be seen that Isofrax® and RCF have a shrinkage that is in the range 3-6% over the range 1200 to 1450°C. SW607 Max™, SW607™, and SW612™ have shrinkages in the range 2-5% at 1200°C but increase rapidly after 1300°C. The fibres of the present invention have a shrinkage of less than 2% up to 1350°C, drift up to 5-8% at 1400°C and accelerate thereafter.

The fibres of the present invention therefore have the advantage of a lower shrinkage than magnesium silicate, commercial calcium magnesium silicate, or RCF fibres at 1300°C; commence their increase in shrinkage at a higher temperature than commercial calcium magnesium silicate fibres; have a shallower rise in shrinkage with temperature than commercial calcium magnesium silicate fibres; and do not stick to aluminosilicate brick in the way commercial calcium magnesium silicate fibres may.

The fibres can be used in thermal insulation and may form either a constituent of the insulation (e.g. with other fibres and/or fillers and/or binders) or may form the whole of the insulation. The fibres may be formed into blanket form insulation.

A problem found with the plain calcium silicate fibres described above was that the fibres tend to be short resulting in a poor quality blanket. A means of producing better fibre for blanket was required and the applicants conducted screening tests to investigate the effect on fibre quality of the addition of other elements as additives to the composition. It was found that lanthanide elements, particularly La and Y improved fibre quality. La was determined to be the most commercially interesting element and so after this initial screening test efforts centred on investigating the effect of La.

La_2O_3 was used as an additive in amounts of 0-4% to a fibre comprising 73.5% SiO_2 and balance CaO and minor impurities to determine the optimum amount. It was determined that addition of La_2O_3 improved fiberisation while not reducing refractoriness. The fibres did not react with alumina bricks. However, at the highest levels of La_2O_3 the solubility was reduced significantly. Accordingly a compromise level of 1.3-1.5% La_2O_3 was used for further tests on the fibre composition.

To check and define the optimum formulation in terms of refractoriness and fiberisation for the lanthanum containing material, a study was performed looking to the increase of silica from 67% to 78% SiO_2 in a material containing 1.3% La_2O_3 (kept constant), balance CaO + minor impurities MgO and Al_2O_3.

Increasing silica increases the refractoriness of the fibre, giving lower shrinkage, higher melting point and decreases reaction with alumina at high temperature.

The best compromise between refractoriness and fiberisation was found for a composition of :

SiO_2	73%
CaO	24%
La_2O_3	1.3-1.5%

Remaining impurities (Al_2O_3, MgO, others) <1.5%

This composition was tried on production scale manufacturing blanket having the composition "With La" shown in Table 4 below.

It was confirmed that this composition produced better fibres than an La free version ("No La" in Table 4). The fibres still not reacting with alumina brick, and having good refractoriness.

Better fiberisation was observed and evaluated by looking to the tensile strength of 25mm thick blanket having a density $128kg/m^3$.

Table 4

OXIDES	No La	With La
Na_2O	<0,05	0,18
MgO	0,89	0,46
Al_2O_3	0,64	0,66
SiO_2	**72,9**	**73,2**
K_2O	<0,05	0,08
CaO	25,5	23,6
Fe_2O_3	0,11	0,14
La_2O_3	0	1,3
LOI 1025°C	0,08	0,09
Total	100,1	99,7
Tensile strength 128-25 blanket (kPa)	**25-30**	**35-60**

It can be seen that the addition of only 1.3% La_2O_3 results in a considerable improvement in tensile strength, indicating a much improved fibre.

The applicants surmise that this effect of improving fiberisation is a viscosity or surface tension modifying effect applicable generally to alkaline earth silicate fibres, and so the invention encompasses the use of such additives generally in the amounts indicated above to improve fiberisation of alkaline earth silicate fibres.

Table 1, part 1

Comp.	Shrinkage %/24hrs 1300°c	1350°c	1400°c	1450°c	1500°c	1550°c	Composition (wt %) CaO	SiO_2	P_2O_5	Al_2O_3	B_2O_3	ZrO_2	MgO	Na_2O	K_2O	TiO_2	Fe_2O_3	ZnO	Total Solubility ppm	SSA m^2/g	Fibre Quality	JM 28 sticking
CS01/C		10.34	melted	melted			35.00	62.40		0.83			0.56	0.30	0.15		0.24		230.0	0.33	Coarse	Stuck
CS02/C		8.52	melted	melted			33.00	63.80		0.77			0.51	0.40	0.14		0.22		199.0	0.45	Coarse	Stuck
CS01/D		5.14					32.90	64.60		0.80			0.48	0.26	0.15		0.18		199.1	0.37	Coarse	Stuck
CS01	2.60	4.34	melted				33.80	65.00		0.80			0.51	0.21			0.21		235.0	0.47	Coarse	Stuck
CS10		4.25	19.51	melted			33.00	65.40		0.76			0.52	0.24	0.15		0.21		199.8	0.30	Coarse	Stuck
CS10 cons		4.25	14.12	melted			33.00	65.40		0.76			0.52	0.24	0.15		0.21		199.8	0.30	Coarse	Stuck
CS02	1.92	2.58	7.83	melted			31.90	66.50		0.77			0.49	0.31			0.20		218.0	0.59	Coarse	Stuck
CS02/D		3.85					31.20	66.60		0.75			0.46	0.25	0.14		0.20		208.1	0.42	Coarse	Stuck
CMS02	2.12	melted					18.30	66.90		0.31			14.40	0.17			0.14		213.2	0.42	Coarse	Stuck
CMS02/B	2.35	7.02	melted				18.30	66.90		0.31			14.40	0.17			0.14				Coarse	Stuck
CS03/D		11.87					28.90	69.30		0.70			0.44				0.19		215.0	0.54	Coarse	Stuck
CMS03	2.95	melted					16.80	69.40		0.30			13.40	0.11			0.14		280.1		Coarse	Stuck
CMS03/B	2.75	8.08	melted				16.80	69.40		0.30			13.40	0.11			0.14				Coarse	Stuck
CS15			5.67	34.47	34.02		28.00	69.70		0.61			0.53	0.19			0.20		241.9	0.41	Good fibre	Stuck
CS04/E		2.77	11.39	21.96			28.20	69.80		0.61			0.38	0.43	0.10		0.17		260.0	0.50	Lots of flake	Stuck
CS04/E cons		2.77	7.62				28.20	69.80		0.61			0.38	0.43	0.10		0.17		260.0	0.50	Lots of flake	Stuck
CS04	1.65	0.98	3.71	30.42			28.20	69.80		0.61			0.38	0.43	0.10		0.17		269.8	0.44	Lots of flake	Stuck
CMS04	2.35	melted					16.50	70.00		0.38			13.10	0.12			0.13				Coarse	Stuck
CS12		2.35	9.10	31.40			26.90	70.70		0.66			0.41	0.39	0.12		0.18		211.3	0.55	Good fibre	Stuck
CS12 cons		2.35	4.80	15.37			26.90	70.70		0.66			0.41	0.39	0.12		0.18		211.3	0.55	Good fibre	Stuck
CS16			9.37	35.35	34.37		27.20	71.00		0.61			0.49	0.16			0.17		283.1	0.55	Good fibre	Stuck
CS17			9.05	33.70	30.64		26.60	71.40		0.62			0.48	0.17			0.17		228.2	0.71	Good fibre	Stuck
CS18			7.92	32.00	30.02		26.20	71.60		0.75			0.49	0.20			0.18		248.8	0.71	Good fibre	Stuck
CS19			4.84	27.36	26.41		26.40	71.60		0.73			0.48	0.21			0.19		248.2	0.63	Good fibre	Stuck
CMS05	2.63	melted					15.10	72.00		0.97			11.40	0.23			0.12		125.2		Coarse	Stuck
CMS05/B	3.31	8.11	14.10				15.10	72.00		0.97			11.40	0.23			0.12				Coarse	Stuck
SACM01		4.01	3.56	4.79			3.17	78.00		1.60			17.00				0.21		160.0	0.37	O.K fibre	Not Stuck
SACM02			3.51				5.04	76.50		1.62			14.80	0.12			0.20		206.3	0.33	O.K fibre	Not Stuck
SACM03		5.46	8.63	10.38			7.71	75.80		1.77			13.10				0.65		170.5	0.46	O.K fibre	Not Stuck
CSMg01		7.36	21.14	28.33	37.44		23.60	72.90		0.61			2.61	0.11			0.16		223.6	0.66	Good fibre some shot	Stuck
CSMg03		2.24	7.17	12.61			20.20	75.70		0.57			2.61	0.20			0.18		231.3	0.38	Good fibre some shot	Not Stuck
CSMg02		7.14	12.13	16.17	27.03		21.60	75.20		0.54			2.59				0.14		210.6	0.63	Good fibre some shot	Stuck
CSMg07		7.38	20.47				23.00	73.80		0.49			1.81				0.17		250.1	0.42	O.k fibre	Not Stuck
CSMg06		6.23	25.18	12.34	29.97		24.20	72.30		0.51			1.79	0.13			0.18		268.1	0.53	Good fibre	Not Stuck
CSMg09		1.28	2.33				18.30	78.40		0.39			1.71				0.14		228.7	0.35	Shotty	Not Stuck
CSMg08		2.86	8.24	9.70	31.43		20.50	76.50		0.44			1.65				0.16		257.2	0.43	Good fibre	Not Stuck
CSMg10		1.85	1.80				17.30	79.40		0.28			1.61				0.15		248.3	0.22	Coarse shotty	Not Stuck
CS Fe_2O_3 01		1.94	8.72	19.79	26.24		22.60	74.40		0.57			0.72	0.23			0.44		279.9	0.49	O.k fibre	Not Stuck
CS Fe_2O_3 05		3.47	10.11	15.34	22.52		21.10	74.70		0.58			0.51	0.17			2.25		207.1	0.47	Shotty	Not Stuck
CS Fe_2O_3 02		1.43	3.64				21.90	74.80		0.56			0.50	0.22			0.65		285.5	0.30	Shotty	Not Stuck
CS Al 03		2.18	8.47	15.15	22.38		22.30	74.60		1.03			0.41	0.18			0.15			0.48	Good fibre	Not Stuck

Table 1, part 2

Comp.	Shrinkage %/24hrs 1300°c	1350°c	1400°c	1450°c	1500°c	1550°c	Composition (wt %) CaO	SiO_2	P_2O_5	Al_2O_3	B_2O_3	ZrO_2	MgO	Na_2O	K_2O	TiO_2	Fe_2O_3	ZnO	Total Solubility ppm	SSA m^2/g	Fibre Quality	JM 28 sticking
CS13		1.46	3.00	23.16			24.00	74.30		0.55			0.39	0.17			0.17		156.0	0.56	Shotty	Not Stuck
CS Fe_20_3 04		1.79	9.03	14.51	19.78		21.60	74.90		0.52			0.39	0.16			1.47		239.7	0.41	Good fibre	Not Stuck
CS Fe_20_3 03		2.43	12.43	20.53	24.24		21.90	74.70		0.52			0.38	0.21			1.06		241.0	0.47	Good fibre	Not Stuck
CS05	1.21	1.79	4.14	melted			26.40	72.20		0.55			0.33	0.19	0.10		0.16		262.0	0.45	Lots of flake	Not Stuck
CS06/E		1.56	6.03	21.81	30.16		24.00	73.90		0.52			0.33	0.28			0.15		222.0	0.34	Lots of flake	Not Stuck
CS06/E cons		1.56	4.02	10.54	13.75	16.96	24.00	73.90		0.52			0.33	0.28			0.15		222.0	0.34	Lots of flake	Not Stuck
CS Al 02		1.48	2.41	13.51	18.28		23.10	74.70		0.48			0.33	0.19			0.14			0.59	Good fibre	Not Stuck
CS07/E		1.50	2.14	10.00	5.19	5.81	22.20	76.50		0.53			0.33	0.11			0.15		177.9	0.29	O.K fibre	Not stuck
CS14/B		2.22	6.23				22.60	75.00		0.58			0.30	0.12			0.17		137.3	0.55	Shotty	Not Stuck
CS08/E		2.03	1.34	3.10	7.72		19.50	78.90		0.70			0.27			0.16	0.18		160.0	0.32	Coarse	Not Stuck
CS06/B			2.66	melted	12.00		24.30	75.00		0.39			0.26	0.15			0.12		172.0	0.55	Lots of flake	Not Stuck

Table 2

Comp.	Shrinkage %/24hrs 1300°c	1350°c	1400°c	1450°c	1500°c	1550°c	Composition (wt %) CaO	SiO_2	P_2O_5	Al_2O_3	B_2O_3	ZrO_2	MgO	Na_2O	K_2O	TiO_2	Fe_2O_3	ZnO	Total Solubility ppm	SSA m^2/g	Fibre Quality	JM 28 sticking	Total SiO_2+ ZrO_2
CAS01		17.62	18.45				24.50	71.70		2.78		0.45	0.28	0.12			0.12		30.3		Coarse	Stuck	72.15
CAS02		10.19	24.18				22.60	73.50		2.52		0.91	0.25	0.11			0.15		20.1		Coarse	Stuck	74.41
CAS03		5.42	14.63	14.56			20.40	75.70		2.32		1.05	0.23	0.11			0.12		47.4	0.20	Coarse	Stuck	76.75
CS03/C		6.02	melted	melted			31.50	65.60		0.83		0.14	0.47	0.36	0.14		0.23		222.0	0.31	Coarse	Stuck	65.74
CZrS02		15.01	31.08				27.40	65.80		0.70		3.85	0.40	0.37	0.12		0.19		107.2	0.39	Good fibre	Stuck	69.65
CZrs03		7.39	30.64				25.60	68.00		0.67		3.96	0.37	0.25	0.11		0.21		64.2	0.21	Good fibre	Stuck	71.96
CS11		4.96	19.95	34.81			29.00	68.90		0.75		0.13	0.47	0.30	0.13		0.19		200.5	0.50	Coarse	Stuck	69.03
CS11 cons		4.96	11.42	22.67			29.00	68.90		0.75		0.13	0.47	0.30	0.13		0.19		200.5	0.50	Coarse	Stuck	69.03
CZrS07		-0.29					17.90	74.70		0.62		4.94	0.24	0.48			0.17		24.3	0.22	Very shotty	Not Stuck	79.64
CZrS06		melted	7.97				19.00	74.90		0.71		4.45	0.28	0.42			0.13		42.5	0.25	Coarse	Not Stuck	79.35
CZrS04		2.56					24.50	70.60		0.72		3.29	0.36	0.35	0.11		0.17		69.4	0.21	Good fibre	Not Stuck	73.89
CS13 cons		1.46	3.56	12.88	16.60	28.58	24.30	73.30		0.57		0.73	0.31	0.26			0.20		156.0	0.56	Shotty	Not Stuck	74.03
CAS07		4.59	10.22				24.80	73.10		1.10		0.43	0.28	0.14			0.14		127.8	0.34	Coarse	Not Stuck	73.53
CSMg04		1.76	2.94				16.70	79.40		0.38		0.43	2.35				0.18		243.0	0.09	Coarse shotty	Not Stuck	79.83
CS08	1.24	1.30	1.74	3.37			19.80	78.50		0.45		0.34	0.25	0.16			0.14		201.5	0.20	Lots of flake	Not stuck	78.84
CS05/B	0.86	1.53	5.56				26.00	72.00		0.62		0.33	0.31	0.22			0.15		182.0	0.34	Lots of flake	Not Stuck	72.33
CS05/B cons		1.53	4.52	13.46			26.00	72.00		0.62		0.33	0.31	0.22			0.15		182.0	0.34	Lots of flake	Not Stuck	72.33
CS05/E		2.04	7.28	33.19	44.49		26.00	72.00		0.62		0.33	0.31	0.22			0.15		276.0	0.48	Lots of flake	Not Stuck	72.33
CS05/E cons		2.04	8.19	20.34	25.44	28.00	26.00	72.00		0.62		0.33	0.31	0.22			0.15		276.0	0.48	Lots of flake	Not Stuck	72.33
CS06	1.36	1.42	2.36	5.87	melted		23.40	73.30		1.77		0.27	0.32	0.14			0.14		244.6	0.32	Lots of flake	Not Stuck	73.57
CSMg05		1.67	1.26				16.40	79.80		0.35		0.14	2.46				0.13		237.2	0.11	Good fibre some shot	Not Stuck	79.94
CS07/B	0.86	1.50	2.17	10.00	15.00		22.20	76.60		0.52		0.12	0.26	0.11			0.12		104.0	0.23	Lots of flake	Not Stuck	76.72
CS07/B cons		1.50	1.31	2.93	5.19	5.81	22.20	76.60		0.52		0.12	0.26	0.11			0.12		104.0	0.23	Lots of flake	Not Stuck	76.72
CS07	1.08	1.06	1.15	3.34			22.30	76.90		0.35		0.10	0.24	0.17			0.11		203.5	0.25	Lots of flake	Not Stuck	77.00

Table 3, part 4

Comp.	Shrinkage %/24hrs 1300°c	1350°c	1400°c	1450°c	1500°c	1550°c	Composition (wt %) CaO	SiO_2	P_2O_5	Al_2O_3	B_2O_3	ZrO_2	MgO	Na_2O	K_2O	TiO_2	Fe_2O_3	ZnO	Total Solubility ppm	SSA m^2/g	Fibre Quality	JM 28 sticking	Total SiO_2 + B_2O_3 + ZrO_2 + $5*P_2O_5$
CBS04		3.54	6.97	7.16			18.00	77.90		0.43	2.03	0.70	0.31	0.17			0.24		64.0	0.16	Coarse	Not stuck	80.63
CBS03		3.47	10.32	16.43			20.40	75.20		0.48	2.12	0.84	0.33	0.18			0.18		73.0		Coarse	Not stuck	78.16
CPS02/B			4.02				21.40	75.00	1.54	0.48			0.32	0.13			0.16		336.0	0.27	Coarse	Not Stuck	82.70
CPS02		0.66	0.91	0.70			22.40	74.60	1.61	0.29	0.26	0.90	0.27	0.21			0.11		349.6	0.10	O.K fibre	Not Stuck	83.81
CPS02 cons		0.66	0.25	-0.21			22.40	74.60	1.61	0.29	0.26	0.90	0.27	0.21			0.11		336.8	0.10	Coarse	Not Stuck	83.81
CPS21		3.04					23.00	74.10	0.42	0.61			0.45	0.38	0.10		0.20		188.0	0.41	O.K fibre	Not Stuck	76.20
CBS05		4.14	9.98	14.71			21.20	73.90		0.54	3.11		0.32	0.16			0.17		117.0	0.35	Coarse	Not Stuck	77.01
CPS20		2.48	9.10				23.80	73.80	0.38	0.66		0.29	0.35	0.18	0.11		0.16		229.0	0.33	Good fibre	Not Stuck	75.99
CPS20cons		2.48	6.21	11.94	17.39	20.69	23.80	73.80	0.38	0.66		0.29	0.35	0.18	0.11		0.16		229.0	0.33	Good fibre	Not Stuck	75.99
CPS18/B		1.93	6.72	16.07			23.90	73.20	0.87	0.59			0.34	0.19			0.15		161.0	0.42	Shotty	Not Stuck	77.55
CPS17/B		2.39	6.36				24.70	72.80	0.88	0.65			0.36	0.17			0.16		152.0	0.58	O.K fibre	Not Stuck	77.20
CPS01/B		1.73	8.96	12.58			23.50	72.70	1.58	0.58			0.33	0.20			0.15		275.0	0.34	Good fibre	Not Stuck	80.60
CPS01/C		2.05	11.86	5.87	6.10		23.80	72.60	1.58	0.46			0.34	0.32			0.32		338.8	0.50	Coarse	Not Stuck	80.50
CBS02		4.93	18.32	23.28			22.90	72.60		0.70	2.16	0.30	0.33	0.24			0.15		85.0		Good fibre	Not stuck	75.06
CBS07		-0.29	6.10	14.69			24.30	72.20		0.38	1.38	0.84	0.27	0.18			0.13		90.0	0.32	Shotty	Not Stuck	74.42
CPS01		2.29	1.25	0.15			23.90	71.50	1.52	0.48	0.90	0.95	0.29	0.48			0.10		286.3	0.13	O.K fibre	Not Stuck	80.95
CPS01 cons		2.29	1.25	0.15			23.90	71.50	1.52	0.48	0.90	0.95	0.29	0.48			0.10		338.8	0.13	Coarse	Not Stuck	80.95
CPS17		2.86					25.20	71.50	0.90	0.66			0.37	0.37	0.11		0.28		241.0	0.49	Shotty	Not Stuck	76.00
CPS19		2.87	19.23	26.90			25.50	71.50	0.48	0.64		0.15	0.39	0.44	0.11		0.18		172.0	0.40	Good fibre	Not Stuck	74.05
CBS01		3.79	21.92				25.20	70.90		0.62	2.13	0.84	0.41	0.12			0.20		101.2	0.45	Good fibre	Not Stuck	73.87
CPS15/B		2.24	12.71	27.90	35.55		27.00	70.50	0.83	0.64			0.39	0.15			0.17		177.0	0.38	Coarse	Stuck	74.65
CPS16		3.96	20.90	27.90			26.00	70.20	0.89	0.69		0.23	0.38	0.53	0.11		0.18		181.0	0.54	Coarse	Not Stuck	74.88

Table 3, part 5

	Shrinkage %/24hrs						Composition (wt %)												Total Solubility	SSA	Fibre Quality	JM 28 sticking	Total $SiO_2 + B_2O_3 + ZrO_2 + 5*P_2O_5$
Comp.	1300°c	1350°c	1400°c	1450°c	1500°c	1550°c	CaO	SiO_2	P_2O_5	Al_2O_3	B_2O_3	ZrO_2	MgO	Na_2O	K_2O	TiO_2	Fe_2O_3	ZnO	ppm	m^2/g			
CPS15		2.76	13.37	28.94			26.70	70.00	0.93	0.69			0.43	0.38	0.12		0.20		166.6	0.61	Coarse	Not Stuck	74.65
CPS15 cons		2.76		14.74	17.67		26.70	70.00	0.93	0.69			0.43	0.38	0.12		0.20		166.6	0.61	Coarse	Not Stuck	74.65
CPS14/B		4.08	28.80				29.70	67.70	0.90	0.69			0.46	0.19	0.10		0.22		153.9	0.32	O.K fibre	Not Stuck	72.20
CS03	1.36	1.55	5.03	melted			30.20	67.60	0.15	0.87			0.42	0.21	0.11		0.18		240.5	0.61	Coarse	Stuck	68.35
CS03/E		3.81	18.22	melted	melted		30.20	67.60	0.15	0.87			0.42	0.21	0.11		0.18		260.0	0.47	Coarse	Stuck	68.35
CS03/E cons		3.81	13.67	28.02			30.20	67.60	0.15	0.87			0.42	0.21	0.11		0.18		260.0	0.47	Coarse	Stuck	68.35
CPS13		6.92	4.00	38.52			30.20	65.70	0.93	0.70			0.47	0.54	0.13		0.20		163.8	0.44	O.K fibre	Stuck	70.35
CPS14		1.90	13.10	melted			30.80	64.80	0.99	0.80			0.48	0.30	0.13		0.21		153.9	0.47	O.K fibre	Stuck	69.75
CPS14 cons		1.90	5.30	11.68	15.88		30.80	64.80	0.99	0.80			0.48	0.30	0.13		0.21		153.9	0.47	O.K fibre	Stuck	69.75
CPS12		8.72	5.93	melted			32.10	63.80	0.89	0.75			0.49	0.31	0.14		0.20		165.6	0.55	Lots of flake	Stuck	68.25
CPS11		15.72	10.06	melted			34.40	62.00	0.99	0.81		0.10	0.55	0.31	0.13		0.21		170.5	0.53	Good fibre	Stuck	67.05

Table 4

Comp.	Shrinkage %/24hrs 1300	1350	1400	1450°	1500°	1550°c	Composition (wt %) CaO	SiO_2	P_2O_5	Al_2O	B_2O_3	ZrO_2	Mg	Na_2	K_2O	TiO_2	Fe_2O	ZnO	Total Solubility ppm	SSA m^2/g	Fibre Quality	JM 28 sticking
50% YIELD		0.64	1.30	6.78	28.55	30.83	25.50	72.70		0.59			0.50			0.26	0.19		232.0	0.22	Very good	Not Stuck
SPUN		0.38	0.77	5.48	30.54	40.30	25.40	73.10		0.67			0.54				0.18		254.0	0.23	Very good	Not Stuck
BLOWN		0.80	1.30	7.89	29.43	39.64	25.30	73.10		0.54			0.55				0.22		196.8	0.47	Very good	Not Stuck
Blanket	0.61	0.90					23.00	74.60		0.56			0.43	0.22	0.12		0.17		240.7	0.16	Very good	Not Stuck
BAG 24		0.85	1.43	4.69	18.36	25.69	23.18	75.18		0.66			0.42				0.17		300.0	0.23	Very good	Not Stuck
BAG 7		0.57	0.84	2.22	22.32	26.70	24.26	73.95		0.63			0.45				0.19		117.0	0.16	Very good	Not Stuck
BAG 41		0.83	1.02	1.51	12.12	17.85	21.62	76.65		0.79			0.38				0.17		127.0	0.17	Very good	Not Stuck
BAG 46		1.56	0.96	1.36	7.69	12.84	18.70	79.80		0.81			0.43				0.14		62.0	0.17	Very good	Not Stuck
BAG 62		0.65	3.24	8.33	13.25	22.84	19.74	76.25		0.47		0.82	2.27				0.15		95.0	0.16	Very good	Not Stuck
No. 3		3.36	8.02				19.94	75.35		0.37		1.11	2.99				0.16		202.8	1.15	Very good	Not Stuck
No. 4		2.54	8.12				20.81	75.45		0.39		1.05	2.87				0.16		210.2	0.61	Very good	Not Stuck
No. 5		1.96	6.55				20.61	75.28		0.36		0.99	2.70				0.16		229.4	0.88	Very good	Not Stuck
Blanket 1st	0.54						23.80	74.20		0.62			0.77						205.2	0.41	Very good	Not Stuck
Blanket Last	1.13	1.37	6.00	16.21	28.76	melted	25.01	72.89		0.57			0.92						264.4	0.15	Very good	Not Stuck
Blanket 1st		1.28	1.79	2.56	27.17	25.11	23.80	74.20		0.62			0.77						205.2	0.41	Very good	Not Stuck
Blanket Last		1.06	1.35	1.71	21.38	31.51	25.01	72.89		0.57			0.92						264.4	0.15	Very good	Not Stuck
Bulk Hi Speed		1.52	1.81	13.71	24.15	24.56	24.90	72.20		0.72			0.82						267.5	0.15	Very good	Not Stuck

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A silicate fibre comprising in wt%:

$72\% < SiO_2 < 86\%$

$MgO < 10\%$

$14\% < CaO < 28\%$

$Al_2O_3 < 2\%$

$ZrO_2 < 3\%$

$B_2O_3 < 5\%$

$P_2O_5 < 5\%$

$95\% < SiO_2 + CaO + MgO + Al_2O_3 + ZrO_2 + B_2O_3 + P_2O_5$

$0.1\% < R_2O_3 < 4\%$

where R is selected from the group Sc, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Y or mixtures thereof.

2. A silicate fibre as claimed in Claim 1, in which R is La or Y or mixtures thereof.

3. A silicate fibre as claimed in Claim 2, in which R is La.

4. A silicate fibre as claimed in any one of Claims 1 to 3, in which the amount of R_2O_3 is greater than 0.25% by weight.

5. A silicate fibre as claimed in any one of Claims 1 to 3, in which the amount of R_2O_3 is greater than 0.5% by weight.

6. A silicate fibre as claimed in any one of Claims 1 to 3, in which the amount of R_2O_3 is greater than 1.0% by weight.

7. A silicate fibre as claimed in any one of Claims 1 to 6, in which the amount of R_2O_3 is $<2.5\%$, by weight.

8. A silicate fibre as claimed in any one of Claims 1 to 6, in which the amount of R_2O_3 is less than 1.5% by weight.

9. A silicate fibre as claimed in any one of Claims 1 to 8, having the composition in wt%:

$72\% < SiO_2 < 80\%$

$18\% < CaO < 26\%$

$0\% < MgO < 3\%$

$0\% < Al_2O_3 < 1\%$

$0\% < ZrO_2 < 1.5\%$

$1\% < R_2O_3 < 2.5\%$.

10. A silicate fibre as claimed in Claim 9, in which R comprises La.

11. A silicate fibre as claimed in Claim 10, having the composition in wt%:

SiO_2:-	$73 \pm 0.5\%$
CaO:-	$24 \pm 0.5\%$
La_2O_3:-	1.3 - 1.5%
Remaining components:-	$<2\%$.

12. A silicate fibre as claimed in claim 11, wherein the remaining components are less than 1.5% by weight.

13. Thermal insulation comprising silicate fibres as claimed in any one of Claims 1 to 9.

14. Thermal insulation comprising wholly fibres as specified in any one of Claims 1 to 12.

15. Thermal insulation as claimed in any one of Claims 13 to 14, in which the thermal insulation is in the form of a blanket.

16. Thermal insulation as claimed in any one of Claims 13 to 15, for use in applications requiring continuous resistance to temperatures of 1300°C without reaction with alumino-silicate firebricks.

17. Use as thermal insulation, of a body comprising fibres as specified in any one of Claims 1 to 12, in an application requiring continuous resistance to temperatures of 1260°C without reaction with alumino-silicate firebrick.

18. Use as claimed in Claim 17, in an application requiring continuous resistance to temperatures of 1300°C without reaction with alumino-silicate firebrick.

19. A method of improving the fiberisation of alkaline earth silicate fibres having a composition in wt%:

$65\% < SiO_2 < 86\%$
$MgO < 10\%$
$14\% < CaO < 28\%$
$Al_2O_3 < 2\%$
$ZrO_2 < 3\%$
$B_2O_3 < 5\%$
$P_2O_5 < 5\%$
$72\% < SiO_2 + ZrO_2 + B_2O_3 + 5*P_2O_5$
$95\% < SiO_2 + CaO + MgO + Al_2O_3 + ZrO_2 + B_2O_3 + P_2O_5$

by inclusion in the components of the fibre of R_2O_3 in amounts ranging from 1% to 4% by weight, where R is selected from the group Sc, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Y or mixtures thereof.

20. A method as claimed in Claim 19, in which R is La or Y or mixtures thereof.

21. A method as claimed in Claim 20, in which R is La.

22. Thermal insulation comprising fibres which have a composition in wt%:

$72\% < SiO_2 < 86\%$

$MgO < 10\%$

$14\% < CaO < 28\%$

$Al_2O_3 < 2\%$

$ZrO_2 < 3\%$

$B_2O_3 < 5\%$

$P_2O_5<5\%$

$95\%< SiO_2 + CaO + MgO + Al_2O_3 + ZrO_2 + B_2O_3 + P_2O5$.

23. Thermal insulation as claimed in Claim 22 in which the amount of MgO present in the fibre is less than 2.5%.

24. Thermal insulation as claimed in Claim 23 in which the amount of MgO present in the fibre is less than 1.75%.

25. Thermal insulation as claimed in any one of Claims 22 to 24, in which the amount of CaO is in the range $18\% < CaO < 26\%$.

26. Thermal insulation as claimed in any one of Claims 22 to 25, in which $98\%<SiO_2 + CaO + MgO + Al_2O_3 + ZrO_2 + B_2O_3 + P_2O_5$.

27. Thermal insulation as claimed in Claim 26, in which $98.5\%<SiO_2 + CaO + MgO + Al_2O_3 + ZrO_2 + B_2O_3 + P_2O_5$.

28. Thermal insulation as claimed in Claim 27, in which $99\%<SiO_2 + CaO + MgO + Al_2O_3 + ZrO_2 + B_2O_3 + P_2O_5$.

29. Thermal insulation as claimed in any one of Claims 22 to 28, having the composition:

$72\%<SiO_2<80\%$

$18\%<CaO<26\%$

$0\%<MgO<3\%$

$0\%<Al_2O_3<1\%$

$0\%<ZrO_2<1.5\%$

$98.5\%<SiO_2 + CaO + MgO + Al_2O_3 + ZrO_2 + B_2O_3 + P_2O_5$.

30. Thermal insulation as claimed in any one of Claims 22 to 29, having the composition:

$72\%< SiO_2<74\%$

$24\%<CaO<26\%$.

31. Thermal insulation comprising wholly fibres as specified in any one of claims 22 to 30.

32. Thermal insulation as claimed in any one of Claims 22 to 31, in which the thermal insulation is in the form of a blanket.

33. Use as insulation for its property of not reacting with alumino-silicate firebricks after 24 hours exposure to a temperature of 1260°C of thermal insulation comprising fibres which have a composition in wt%:

$72\% < SiO_2 < 86\%$

$MgO < 10\%$

$14\% < CaO < 28\%$

$Al_2O_3 < 2\%$

$ZrO_2 < 3\%$

$B_2O_3 < 5\%$

$P_2O_5 < 5\%$

$95\% < SiO_2 + CaO + MgO + Al_2O_3 + ZrO_2 + B_2O_3 + P_2O_5$.

34. A method of insulation in applications requiring that the insulation does not react with alumino-silicate firebricks after 24 hours exposure to a temperature of 1260°C comprising the use of thermal insulation comprising fibres which have a composition in wt%:

$72\% < SIO_2 < 86\%$

$MgO < 10\%$

$14\% < CaO < 28\%$

$Al_2O_3 < 2\%$

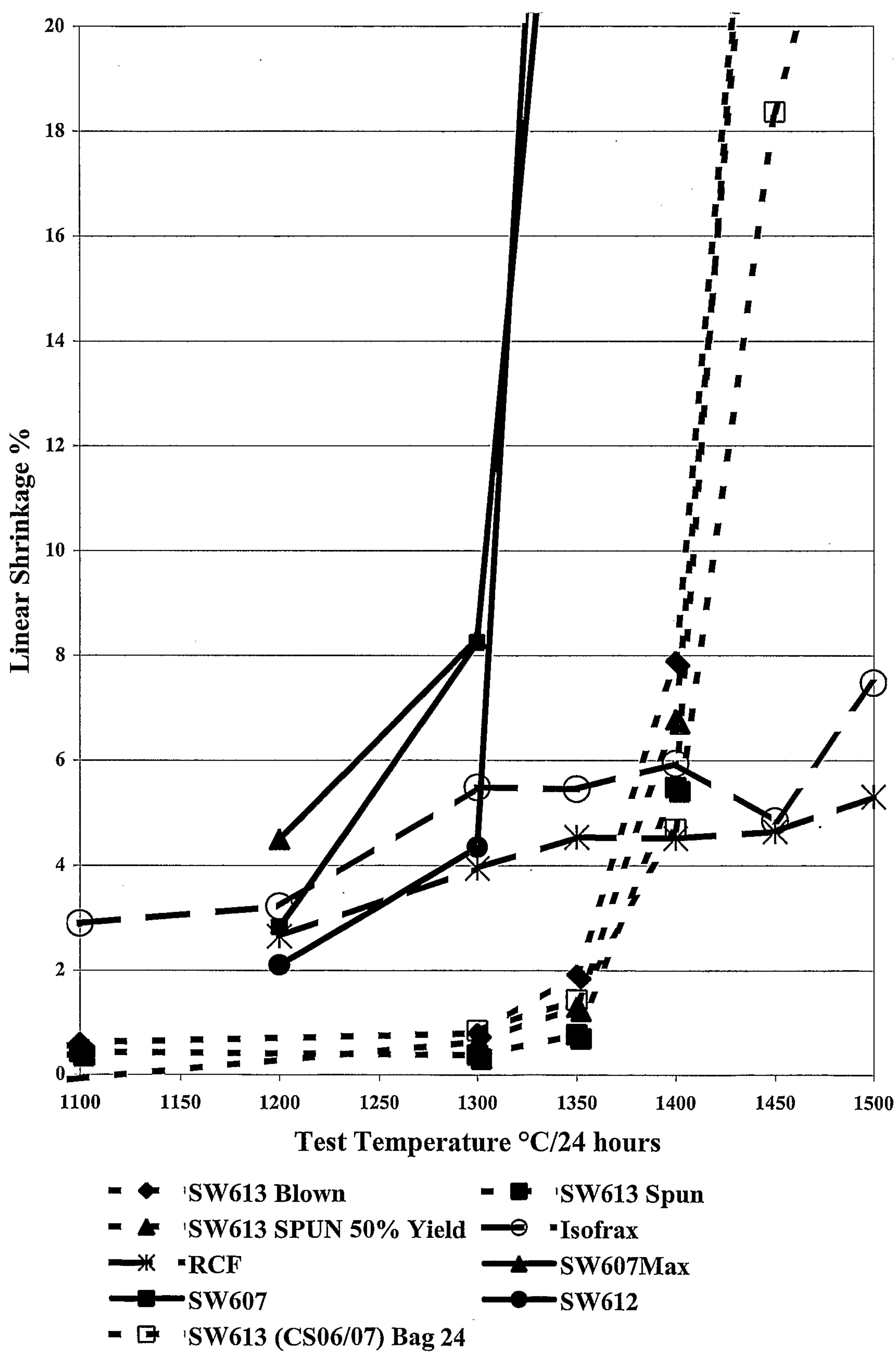
$ZrO_2 < 3\%$

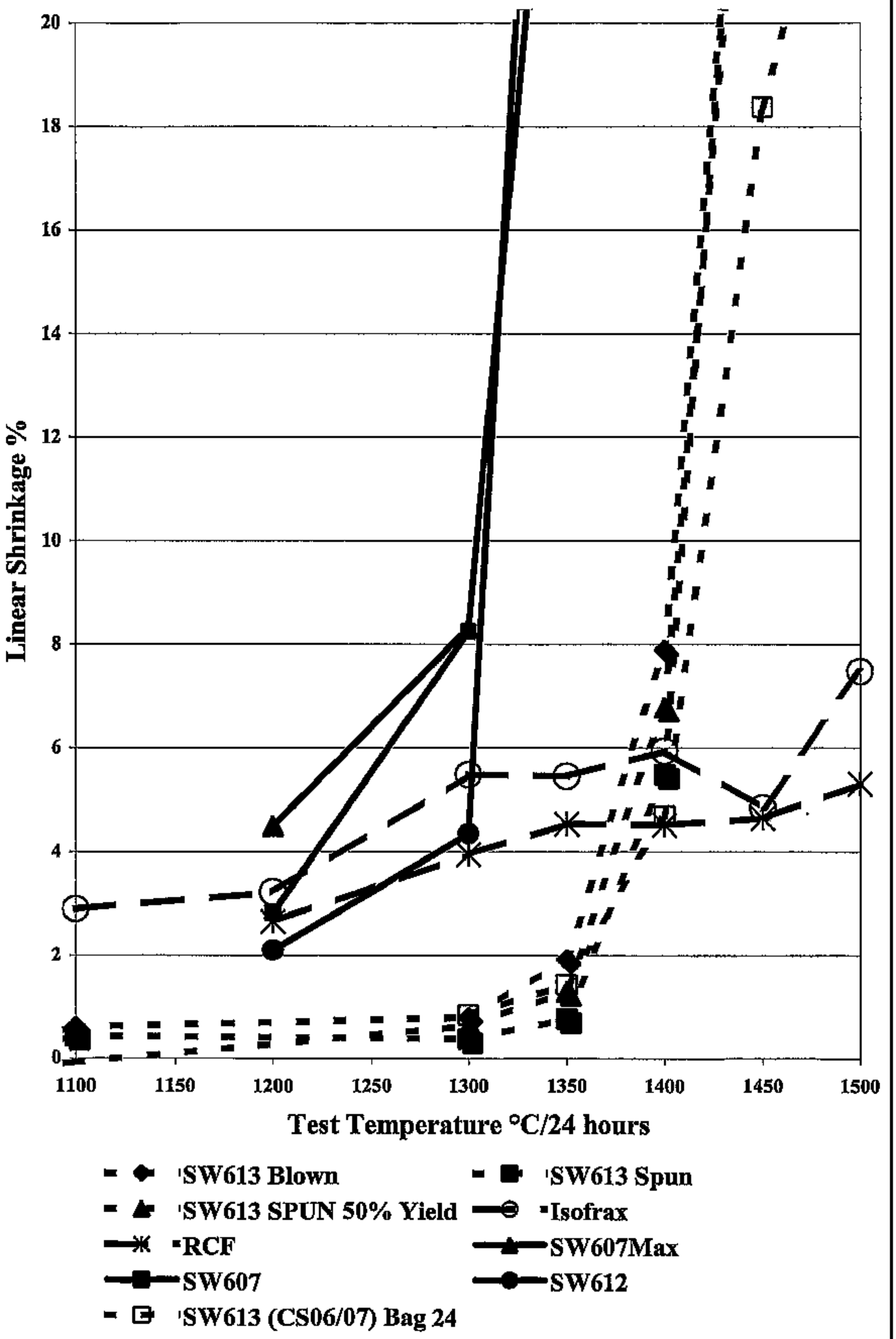
$B_2O_3 < 5\%$

$P_2O_5 < 5\%$

$95\% < SiO_2 + CaO + MgO + Al_2O_3 + ZrO_2 + B_2O_3 + P_2O_5$.

Fig. 1


Linear Shrinkage %
Test Temperature °C/24 hours
0
2
4
6
8
10
12
14
16
18
20
1100
1150
1200
1250
1300
1350
1400
1450
1500
SW613 Blown
SW613 Spun
SW613 SPUN 50% Yield
Isofrax
RCF
SW607Max
SW607
SW612
SW613 (CS06/07) Bag 24



20
18
16
14
12
10
8
6
4
2
0
Linear Shrinkage %
1100
1150
1200
1250
1300
1350
1400
1450
1500
Test Temperature °C/24 hours
SW613 Blown
SW613 Spun
SW613 SPUN 50% Yield
Isofrax
RCF
SW607Max
SW607
SW612
SW613 (CS06/07) Bag 24