
PSR
WE INTRODUCED THE
SYSTEM 5oo FOREHEARTH
25 YEARS AGO
HERE ARE 25 THINGS
WE THINK YOU SHOULD KNOW
Parkinson-Spencer Refractories Ltd... specialists in glass conditioning

The art of good glass making starts in the feeder forehearth.

Introduction

25 years may seem a long time but it's a relatively short time in the life of PSR.

Founded in 1800 as a partnership between the Parkinson and Spencer families, the business has evolved from the mining of coal and fireclay through the manufacture of firebricks, furnace blocks and glass melting pots, to today's business focussed exclusively on the design and supply of refractories and engineered equipment for the glass conditioning process.

The mantra 'From throat to gob, that's our job' sums up precisely what we do: from the feeder expendable refractories we manufacture for the gob feeder, to the refractories and equipment we manufacture for the forehearth and distributor, it's a complete package that combines knowledge, experience and attention to detail.

Eight generations later, and 25 years since we introduced the System 5oo forehearth, our 25th 'forehearth' anniversary is a good time to celebrate, and is an opportunity to focus on the things that keep us at the forefront of the glass conditioning process.

David Parkinson
Managing Director

01

The PSR System 5oo forehearth was introduced in 1992.

Designed and developed as a new concept from the ground up, the System 5oo forehearth combines advanced technology with radical thinking and, with more than two decades of continuous incremental development, it remains the most effective glass conditioning system for glass container manufacture.

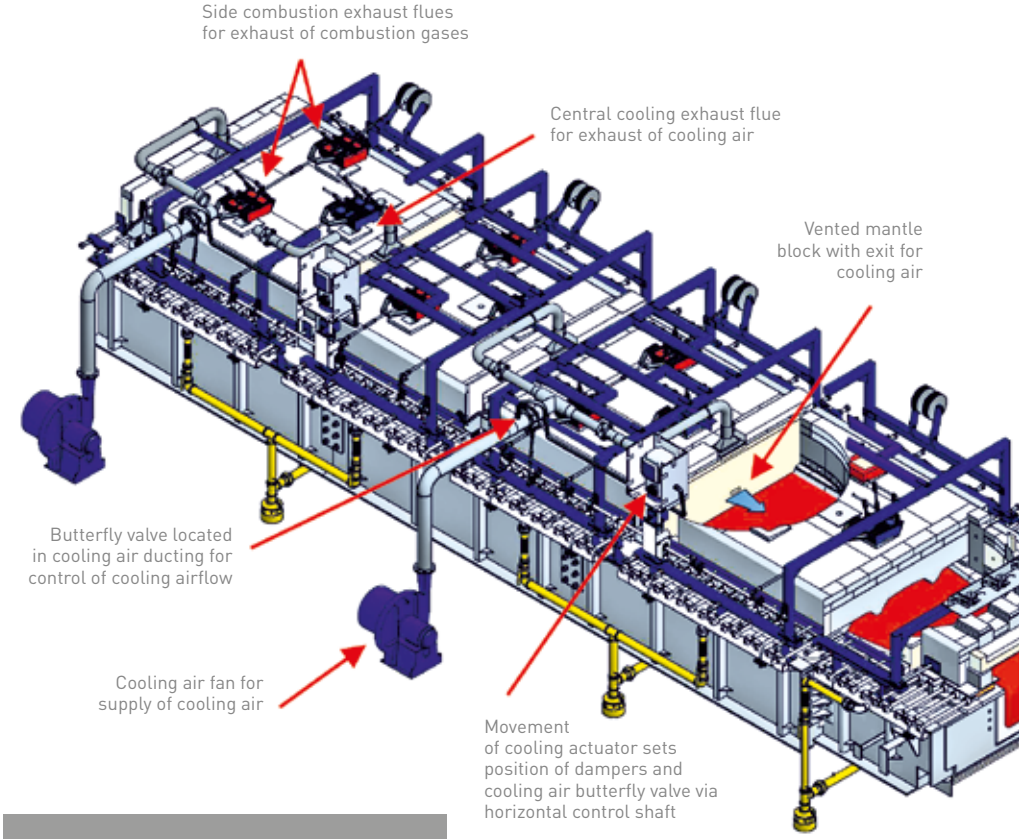
02

Fully synchronised control of the cooling and combustion functions.

The System 5oo forehearth uses hot face longitudinal cooling, whereby cooling air is passed along the forehearth under the roof blocks between the lobes in the central part of the forehearth roof, cooling the glass by radiation to the cooler refractory roof block surface.

Separate side combustion flues and dampers are provided for exhaust of the combustion gases whilst a separate central flue and damper is provided for exhaust of the cooling air. An actuator positions the dampers via control shafts and linkages, and in the same movement positions a butterfly valve in the cooling air supply to control the flow of the cooling air.

Separation of the cooling and heating functions optimises cooling capacity. Synchronisation of the damper movements with the cooling airflow ensures a positive internal pressure is always maintained inside the forehearth.

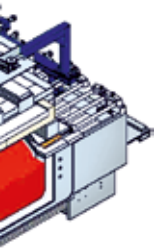


03

Sub-zoning provides greater cooling capacity.

In the System 5oo forehearth, conventional cooling zone lengths are subdivided into cooling sub-zones so that spent cooling air is exhausted sooner, allowing a fresh supply from the same cooling fan to be introduced in the adjacent sub-zone to continue the cooling process.

Cooling section sub-zones increase cooling capacity and, with lower cooling air volumes, reduce the risk of over-cooling at the air entry point.

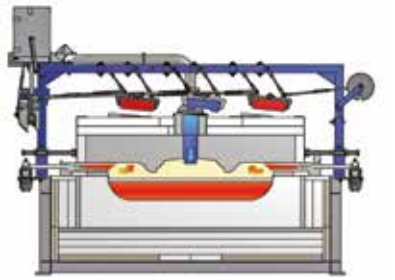


04

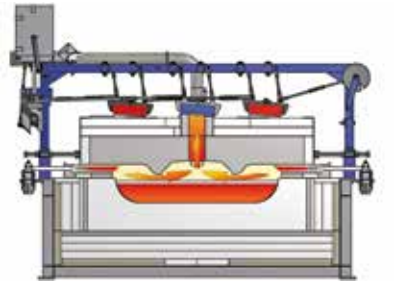
Faster response times than other forehearths and distributors.

The length of time it takes to make temperature adjustments between job changes is subject to applicable process parameters. The System 5oo forehearth is the only forehearth to successfully modulate the cooling and combustion dampers in synchronisation with the cooling air.

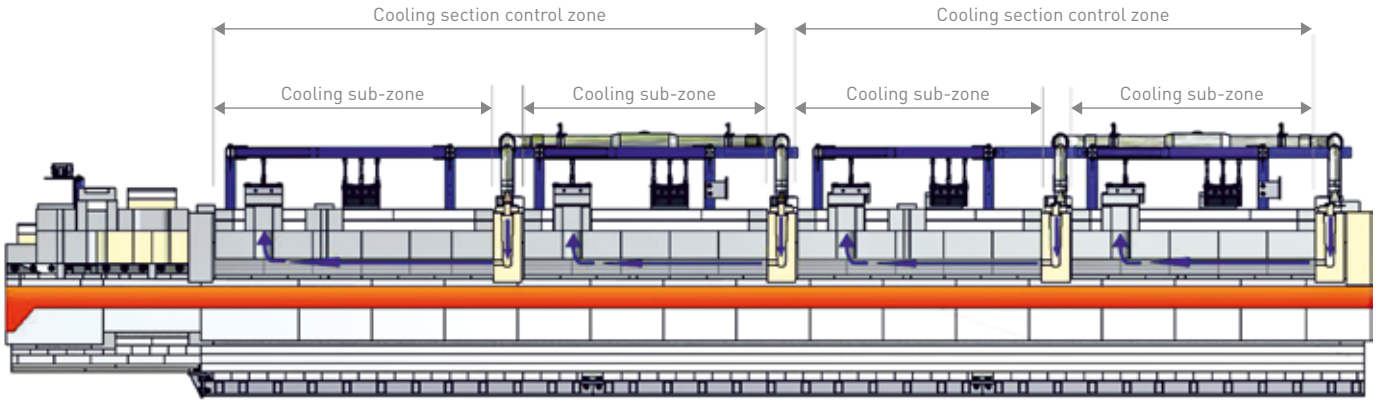
At maximum cooling the side dampers are open, allowing the combustion to be exhausted from the side flues. The central damper is also open, allowing the cooling air to exhaust through the central flue. With the cooling airflow at maximum, the centre of the glass flow is rapidly cooled. At maximum heating the side dampers are closed, the cooling air is at minimum, and the combustion is exhausted through the partially open central flue, enabling the entire forehearth width to be heated rapidly.



System 5oo forehearth at maximum cooling



System 5oo forehearth at maximum heating



98.4% and 99.2% thermal efficiency values on the 9-point and 5-point thermocouple grids on a project in Saudi Arabia

05

Our forehearths and distributors achieve better glass thermal homogeneity than our competitors' forehearths and distributors.

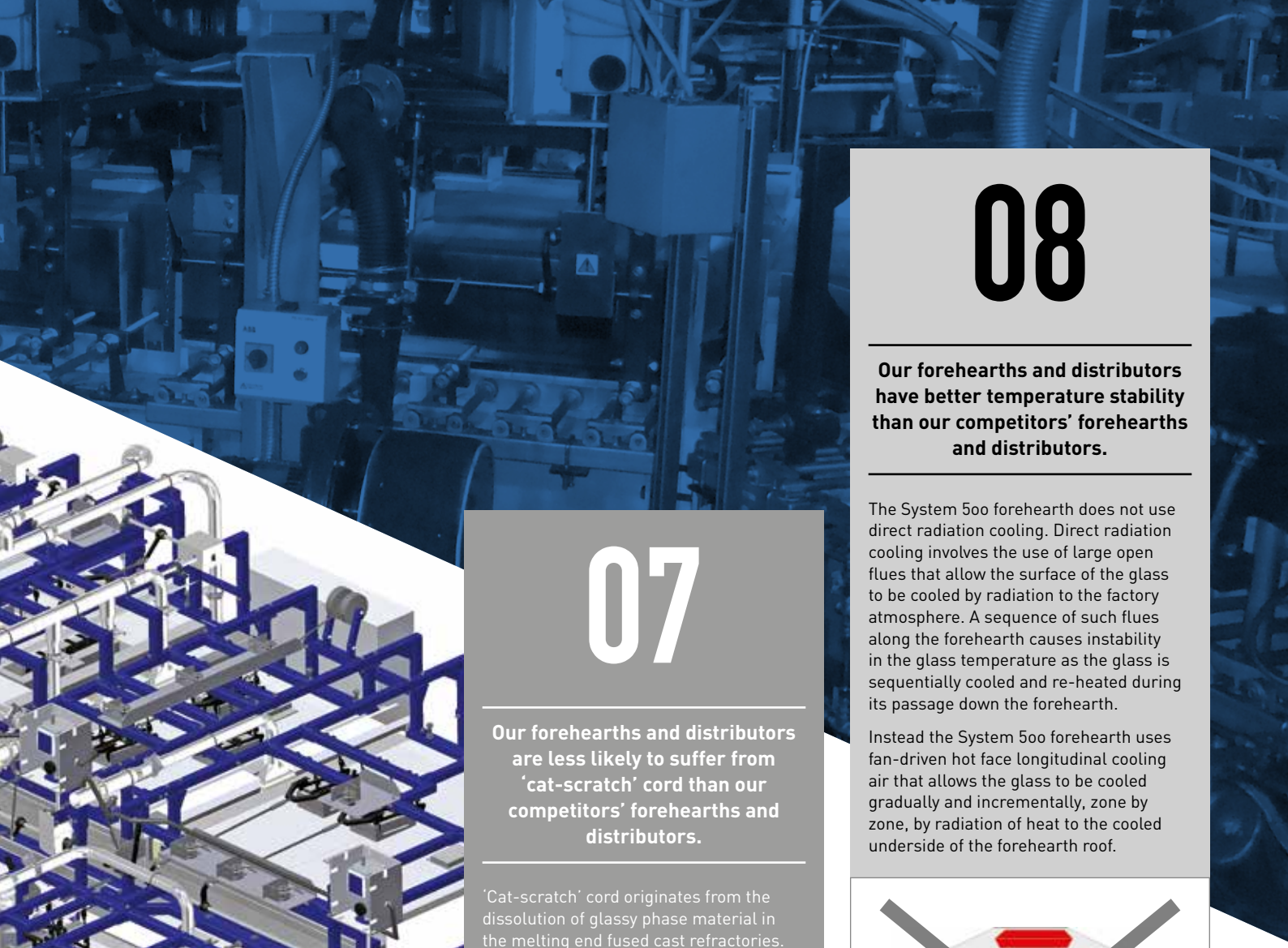
We don't make false claims about being able to achieve unrealistic levels of thermal homogeneity under all operating conditions. What we do is calculate the best configuration for the operating data provided. If our proposed layout is approved we will provide guarantees for thermal homogeneity, temperature stability and fuel consumption. If the client specifies a layout that we calculate cannot meet the operational requirements then we will say so and advise the operational limitations.

06

Our forehearths and distributors use less energy than our competitors' forehearths and distributors.

We have converted many forehearths to our System 5oo design and, without changing the layout or combustion system, fuel savings as high as 50% have been reported.

This is achieved by automatic control of the combustion and cooling dampers, synchronisation with the flow of the cooling air, and better control of the internal forehearth pressure.



07

Our forehearths and distributors are less likely to suffer from 'cat-scratch' cord than our competitors' forehearths and distributors.

'Cat-scratch' cord originates from the dissolution of glassy phase material in the melting end fused cast refractories. This 'cordy' material is then drawn along with the glass flow depending upon the prevailing glass temperatures and tonnages and can collect and concentrate in cold stagnant areas. The System 5oo forehearth and distributor eliminates cold stagnant areas and clients using our forehearths and distributors report fewer 'cat-scratch' cord problems than those using the forehearths and distributors of our competitors.

08

Our forehearths and distributors have better temperature stability than our competitors' forehearths and distributors.

The System 5oo forehearth does not use direct radiation cooling. Direct radiation cooling involves the use of large open flues that allow the surface of the glass to be cooled by radiation to the factory atmosphere. A sequence of such flues along the forehearth causes instability in the glass temperature as the glass is sequentially cooled and re-heated during its passage down the forehearth.

Instead the System 5oo forehearth uses fan-driven hot face longitudinal cooling air that allows the glass to be cooled gradually and incrementally, zone by zone, by radiation of heat to the cooled underside of the forehearth roof.

We do not use direct radiation cooling

09

Our forehearths and distributors produce better amber glass than our competitors' forehearths and distributors.

Aggressive forehearth cooling with consequent re-heating can induce blisters in the production of amber glass. Poor glass thermal homogeneity in the forehearth can also induce white streaks in amber glass as the stagnant amber glass reverts to white flint glass. The System 5oo forehearth cools the glass gradually without re-heating and its better glass temperature distribution prevents the build-up of cold stagnant glass.

10

We do not design glass furnaces.

Furnace design is an entirely different discipline to forehearth and distributor design. We don't design furnaces. We are specialists in the design and manufacture of forehearths and distributors.

11

The distributor is an extension of the forehearth, not an extension of the furnace.

Furnace design should stop at the throat riser. The function of the distributor is heat conditioning and its design should be based upon forehearth technology, not furnace technology.

12

From throat to gob, that's our job.

We take the throat riser temperature, the glass colour(s), the tonnage range, the forehearth capacities and the gob temperatures, and we design the best layout to suit the client's requirements.

We calculate and optimise glass residence time, glass head loss and cooling capacity so that the temperature homogeneity and stability of the gob is as good as can be achieved.

13

We offer a unique package that combines refractories with engineering.

Our heritage is refractory manufacture and we manufacture a range of refractory materials specifically suited to the forehearth and distributor.

We do not source from inferior suppliers in order to satisfy short-term cost considerations.

The engineering is done in-house by our team of graduates and engineers and the equipment is built up and pre-assembled in our workshop.

Forehearth channel blocks in PSR-333

Refractory Materials Composition and Properties

		SiO2	Al2O3	ZrO2	Fe2O3	TiO2	CaO	MgO	Na2O	K2O
		%	%	%	%	%	%	%	%	%
VC-40	Slip cast	54.0	41.0		1.75	1.1	0.25	0.21	0.30	0.1
VC-60	Slip cast	37.0	60.0		1.0	1.0	0.05	0.10	0.50	0.20
SM-62 **	Slip cast	36.78	61.41		0.64	0.43	0.05	0.08	0.03	0.29
LW-40	Pressed	53.0	40.0		1.00					
P-56	Pressed	>20	>60	>9	<1.5					
P-60	Pressed	38.0	60.0		0.8	0.15	0.14	0.11	0.03	0.3
P-333V	Pressed	17.6	65.0	15.3	0.87	0.25	0.12	0.05	0.34	0.12
PSR-311	Slip cast	8.0	91.0		0.12	0.40	0.06	0.08	0.39	0.17
PSR-315	Slip cast	13.0	68.0	18.0	0.13	0.10	0.05	0.01	0.30	0.14
PSR-315FG *	Slip cast	10.0	71.5	18.5	0.05	0.04	0.05	0.02	0.21	0.04
PSR-333	Slip cast	15.0	73.0	11.1	0.2	0.17	0.1	0.1	0.3	0.15
PSR-333FG	Slip cast	15.6	69.0	13.6	0.79	0.32	0.05	0.04	0.32	0.09
PSR-925 *	Slip cast	0.11	76.11	23.1	0.02	0.07	0.03	0.02	0.12	0.01
PSR-993	Slip cast		99.7							

*** material under development**
**** 0.1% creep in compression 50 hours @ 1425°C (0.2MN m-2)**

All values are average and subject to change without notice.

Bulk density	Cold compressive strength	Apparent porosity	Refractoriness	Reversible thermal expansion 20-1000°C	Thermal conductivity	Application
KG m-3	MPa	%	°C	%	Wm-1K-1	
2199	66.4	18	1717	0.5	1.44 @ 600°C 1.57 @ 1000°C 1.60 @ 1200°C	Furnace blocks
2400	90	22	1800		1.99 @ 600°C 1.91 @ 1000°C 1.87 @ 1200°C	Furnace blocks
2450	101	20	1809	0.52	1.98 @ 600°C 1.90 @ 1000°C 1.86 @ 1200°C	Forehearth and distributor superstructure, spout covers and burner blocks
1220	15	45			0.65 @ 200°C 0.65 @ 600°C 0.72 @ 1000°C	Semi–insulation furnace blocks
>2450	48.4	<27	>1775	0.60		Forehearth brickwork
2500	90	15	1800			Forehearth brickwork
2820	56.7	21	1775	0.63		Colourant forehearth brickwork
2635	90	27		0.7		Zircon free expendables
3111		20	1775			Spouts, tubes and stirrers
3000		22	1775			Long life orifice rings
2820	87.3	21	1745	0.63	2.02 @ 600°C 1.87 @ 1000°C 1.80 @ 1200°C	Standard feeder expendables
2625	87.3	27	1745	0.63		Orifice rings
3450		14-16	1804			Extra long life feeder expendables
3270	474	14-15		0.8		Forehearth channels, distributor glass contact blocks and spouts

14

Refractory re-linings?
Use our expertise to upgrade.

As a primary refractory manufacturer we can supply forehearth and distributor refractories for most types of forehearth design. We can supply this on a refractories only basis but you can also use our expertise to modify or upgrade any or all of your peripheral equipment.

15

Our ceramic burner nozzles reduce forehearth maintenance.

Conventional steel burner nozzles have a tendency to block up over time as dirt particles nucleate inside and around the burner nozzle. This affects fuel efficiency, firing capacity and forehearth performance. Ceramic burner nozzles operate at higher temperatures and the tendency to block up is significantly reduced.

With every new PSR forehearth now supplied with ceramic burner nozzles, maintenance is greatly reduced.

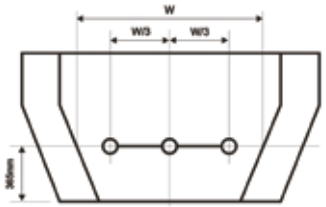
16

Our forehearth control strategy optimises the 9-point and 5-point thermal efficiency values.

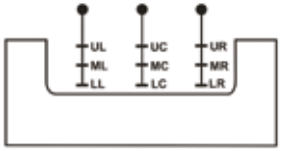
Using horizontal temperature values from the 9-point thermocouple grid at the front of the forehearth, separate side-to-side firing in the forehearth cooling sections optimises the side-to-centre temperatures.

Using vertical centre temperature values from the 9-point thermocouple grid at the front of the forehearth, cooling section temperature set points are automatically adjusted to optimise the top-to-bottom temperatures.

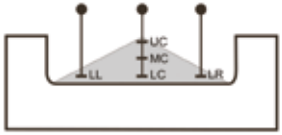
With one strategy optimising the side-to-centre temperatures, and the other strategy optimising the top-to-bottom temperatures, these two strategies combined constantly monitor and adjust the forehearth settings to facilitate very high glass thermal homogeneity values at the spout entry.



PSR standard thermocouple positions



9-point thermocouple grid



5-point thermocouple grid

Distributor glass contact blocks in PSR-993

17

Our combustion system maintains a constant air to gas ratio throughout the firing range.

Unique to PSR, our multi-ratio air/gas combustion mixer has a number of mechanically set stops that allow our engineers, or your maintenance crew, to fix the air to gas ratio at a number of positions throughout the firing range. Once set, the mixer need only be checked and re-adjusted, if necessary, at times of forehearth maintenance.

Multi-ratio mixer

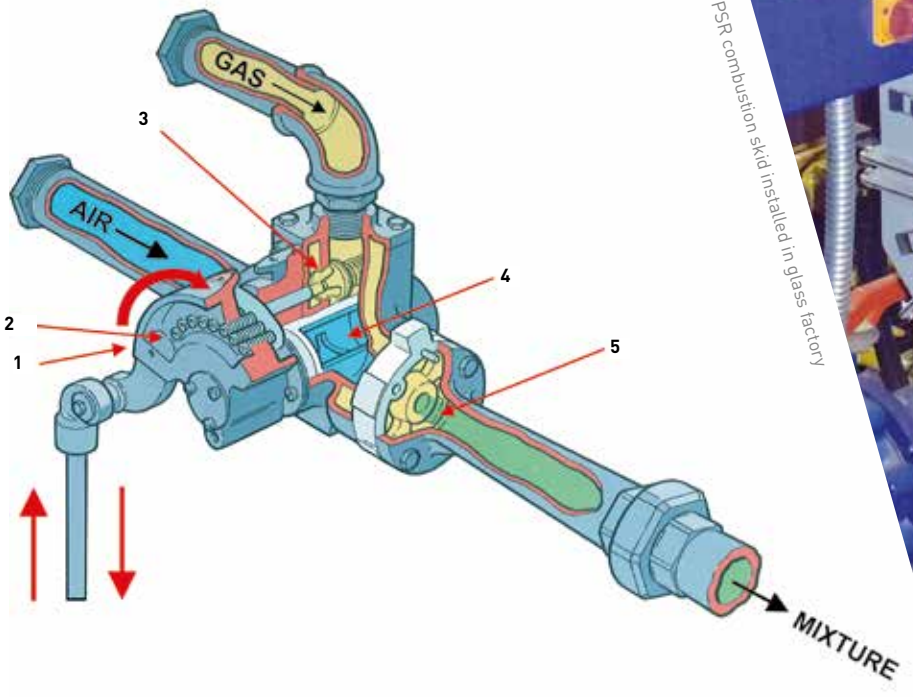
1 Movement of the actuator (not shown) rotates the mixer carriage.

2 As the mixer carriage rotates, the position of the adjustment screws on the strip cam determines the position of the plunger.

3 The position of the plunger located in the gas inlet controls the flow of gas entering the mixer.

4 The port valve in the combustion air supply opens simultaneously with the rotation of the mixer carriage, adjusting the flow of combustion air entering the mixer.

5 The combustion air passes through the centre of the orifice plate, the gas passes around it, and both are then entrained together and thoroughly mixed in the venturi tube.



PSR combustion skid installed in glass factory

18

Feeder expendables – the link between the forehearth and the forming process.

Container glass manufacture is a continuous production process and feeder expendable refractory parts must demonstrate longevity, reliability and dimensional accuracy in order to minimise downtime and unscheduled stoppages. The manufacture of quality feeder expendables has been our business for more than 40 years.

19

Feeder expendables – slip cast not chemically bonded.

Slip casting is a process that uses a pourable mix in which refractory particles of pre-determined grain sizes are suspended in water by the addition of deflocculants. The mix (slip) is cast into gypsum moulds that absorb the water, creating a homogeneous ceramic body, with fine particles densely packed at the interface with the mould. After drying, the ceramic shape is sintered at high temperature, creating a strong ceramic bond as the silica and alumina react to form mullite. The dense, closed surface texture is highly resistant to glass penetration and corrosion.

20

Feeder expendables – manufactured under licence to Bucher Emhart Glass.

PSR is the only worldwide refractory licensee of Bucher Emhart Glass, the leaders in gob feeder technology. Being a licensee means that we have full access to all original refractory design drawings. We don't need to copy parts or make assumptions about dimensional details. Having access to the correct tolerances ensures that our refractory parts will integrate correctly with your mechanical parts.

21

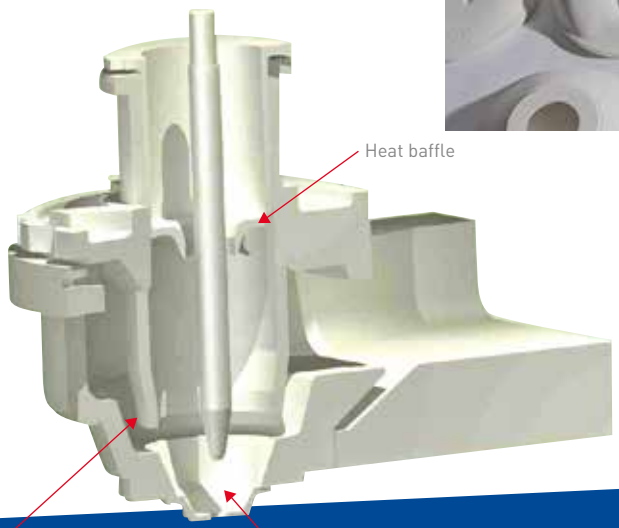
Metering spout refractories.

Metering spout refractories are a special design of feeder expendable refractory from Bucher Emhart Glass. Now including the 585 feeder range, PSR has full access to all the original refractory manufacturing drawings.

Manufactured under licence to

BUCHER
emhart glass

Section through Metering Spout System



22

Orifice rings – slip cast not pressed.

Pressing is an alternative method of manufacture for orifice rings. Not at PSR. Our orifice rings are only slip cast, guaranteeing a dense surface texture and homogeneous ceramic body.

23

**PREFORMS –
another innovation from PSR.**

It is almost 20 years since PSR introduced the concept of pre-formed orifice insulation and since that time the use of PREFORMS has become an industry standard method of orifice ring insulation. Now manufactured from bio-soluble grade fibres, the use of PSR PREFORMS remains the cleanest, most insulating, most convenient and most hygienic method of orifice ring insulation.

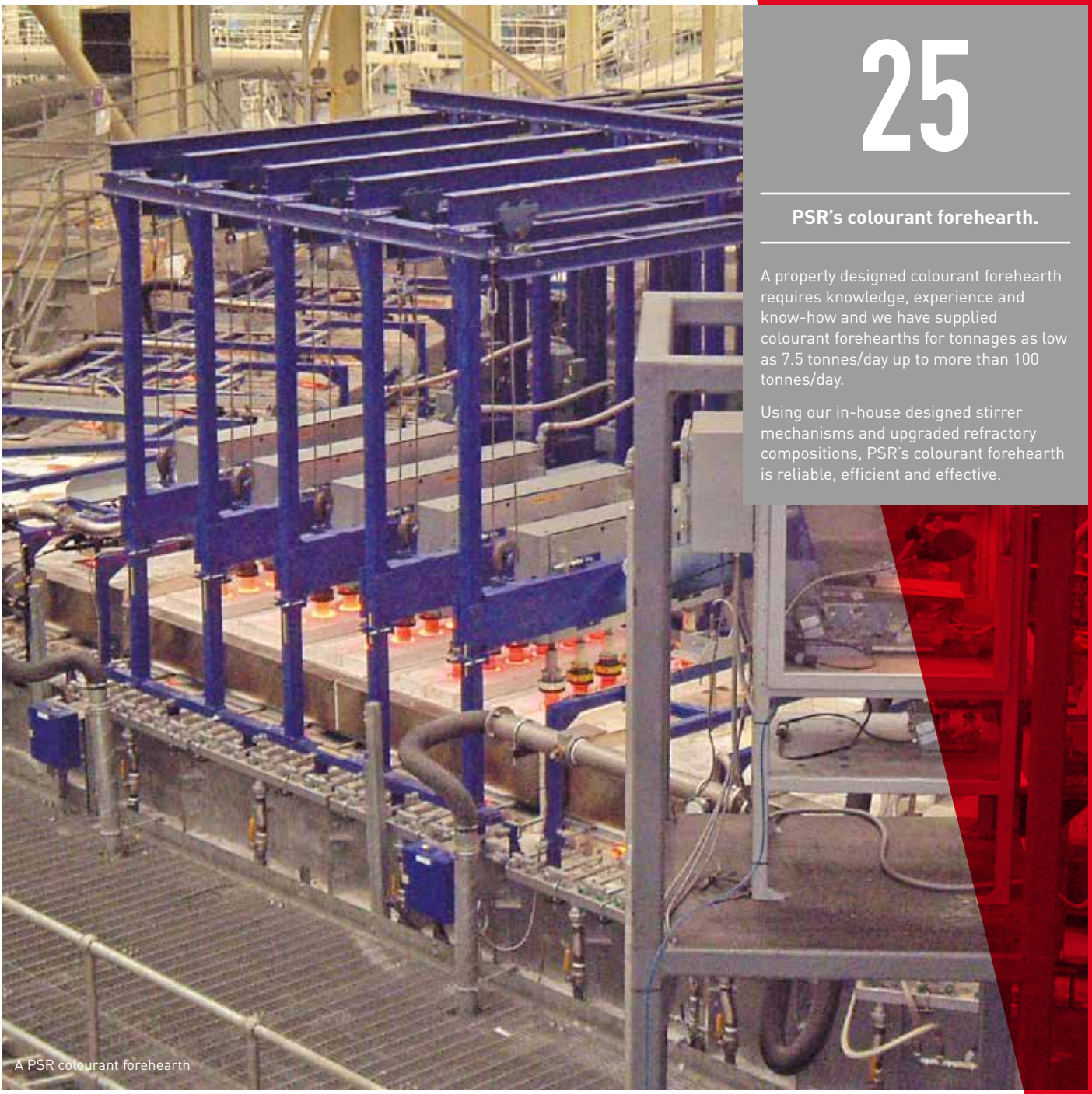
24

PSR's Cord Dispersal System (CDS) – take existing technology, reconfigure it and make it work.

The use of stirrers in the forehearth has been around for generations but until PSR re-visited this process glassmakers with 'cat-scratch' cord problems had to rely on glass draining systems that were not only ineffective but also wasteful and costly. PSR's re-design of the stirrer process with the use of counter-rotating overlapping paddle type stirrers, with re-engineered stirrer mechanisms, has largely rendered the drain redundant and our money-back guarantee remains unique in an industry where too often equipment is supplied that is not fit for purpose.

Often imitated, but not yet equalled, the CDS from PSR has solved 'cat-scratch' cord problems on more than 150 production lines and remains the only proven solution to the problem.

Paddle type stirrers being installed in a PSR CDS



A PSR colourant forehearth

25

PSR's colourant forehearth.

A properly designed colourant forehearth requires knowledge, experience and know-how and we have supplied colourant forehearths for tonnages as low as 7.5 tonnes/day up to more than 100 tonnes/day.

Using our in-house designed stirrer mechanisms and upgraded refractory compositions, PSR's colourant forehearth is reliable, efficient and effective.

Caring for the environment

We take pride in our work and are 100% committed to ensuring it is carried out in a manner that is kind to the environment. We have an environmental management system certified by Lucideon CICS Ltd to ISO 14001:2004. We also operate two wind turbines capable of generating up to two thirds of the factory's electrical power requirements.

Training and service

Glass conditioning is a complex part of the glass manufacturing process and our team of engineers is experienced in all areas of forehearth and distributor design and operation. In addition to regular forehearth commissioning we also provide the following services:

- Training
- After sales service
- Maintenance contracts

Quality guaranteed

Consistency of manufacture is essential for the maintenance of uniform production standards and we operate a quality management system certified by Lucideon CICS Ltd to ISO 9001:2008.

www.parkinson-spencer.co.uk

Find out more today

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