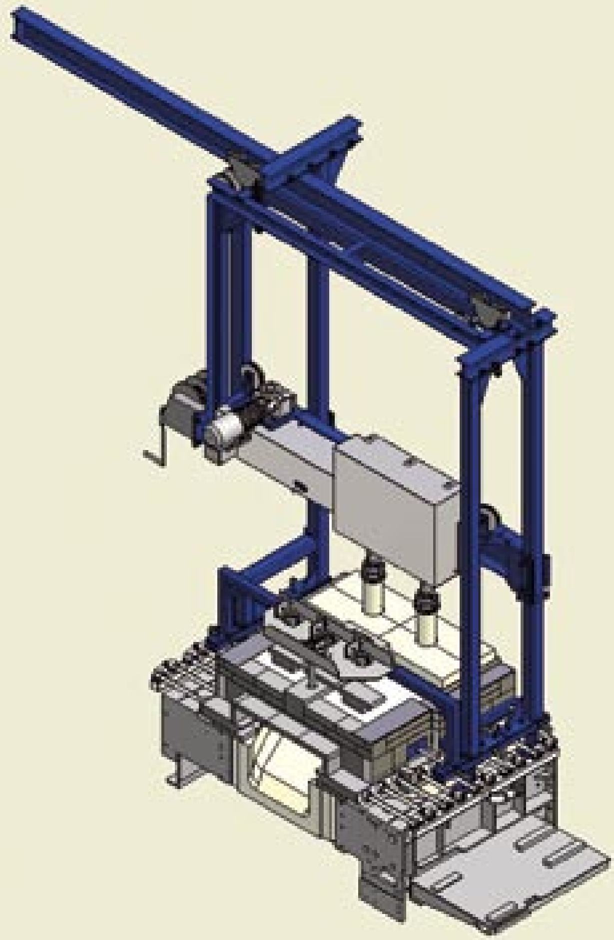
SPECIAL STIRRER SYSTEMS FROM PSR

Stirrer systems from PSR are designed to suit a specific purpose, whether it be the dispersal of 'cat-scratch' cord, improvement to chemical or thermal homogeneity, or the mixing of colours in a colouring forehearth.

The systems are supplied complete consisting of the stirrer support frame with pull out mechanism and hoist, stirrer assembly with air-cooled carbon bearings and stainless steel stirrer chucks, stirrer drive motor and stirrer speed control panel.

The design is such that the same frame and mechanism can be easily converted between different stirrer centres.

For equalising section stirrer systems a PSR water jacket for sealing the glass flow can also be incorporated into the same frame and lifting mechanism whereby, with the refractory stirrers removed, the water jacket can be bolted underneath the stirrer support frame enabling it to be raised and lowered by the stirrer hoist mechanism.



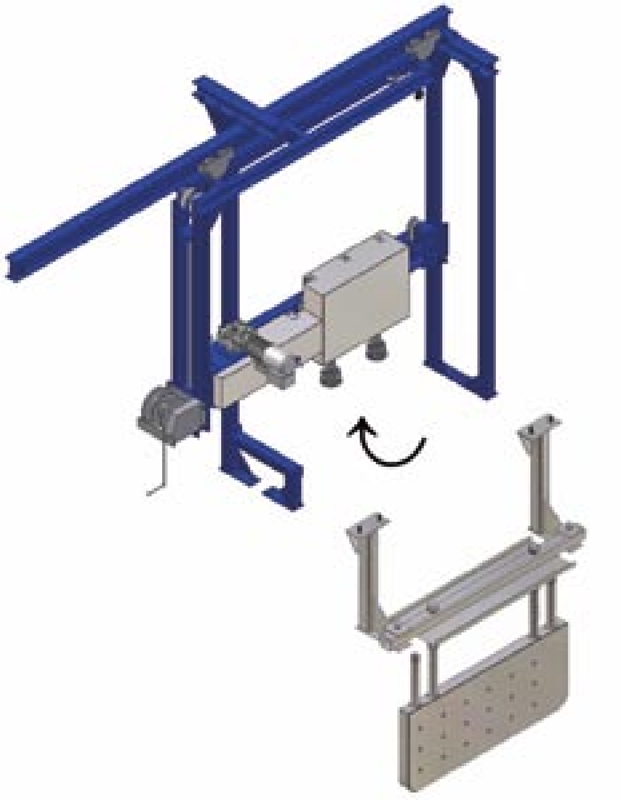
Typical installation of paddle type stirrers in the equalising section

Cat-scratch cord

One of the most popular applications for PSR's stirrer systems is the dispersal of "cat-scratch" cord, perhaps the most common visible defect in modern glass production.

'Cat-scratch' is the name given to a defect that occurs on the surface of glass containers where the appearance can be as if a cat has scratched its claws along the surface of the glass. It is generally the result of 'cord', a high density, viscous glass enriched in alumina and zirconia which originates from the melting end glass contact refractories and settles out in the bottom of the furnace. This glass is denser than the parent glass and travels along the bottom of the furnace, the distributor and forehearths, appearing as a line or series of lines on the surface of the glass product.

One of the most confusing features of this problem is the way in which it comes and goes, and then appears on specific production lines and not on others. This can be explained by the peculiarity of glass flows within the furnace and the route by which this inhomogeneous cord finds its way to the forming process depends upon a number of variables. At higher temperatures it becomes more mobile, but it is also influenced by stronger directional pulls down a particular forehearth or forehearths.



With the refractory stirrers removed a PSR water jacket can be bolted to the underside of the stirrer support frame, enabling it to be raised and lowered with the same hoist.

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Paddle Type Stirrer Systems

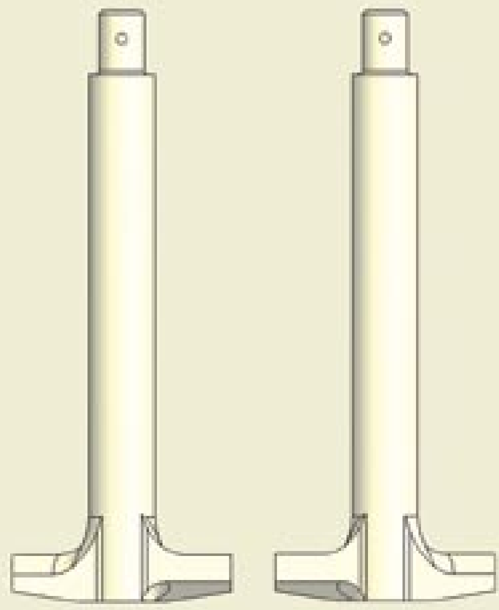
Paddle type stirrer systems have a wide sweeping area and are therefore most effective at stirring dense inhomogeneous material that is located at or near the bottom of the glass flow. 'Cat-scratch' cord is the most common material of this type and a PSR paddle-type stirrer system installed in the equalising section is one of the most effective ways of dispersing it.

The configuration of the stirrers for the dispersal of 'cat-scratch' cord depends upon the width and depth of the forehearth. Almost without exception however they should be located at the front of the forehearth rather than the rear. If located at the rear the denser glass will be able to re-form into cord again by the time it reaches the front of the forehearth.

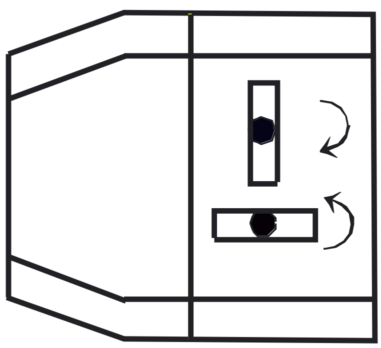
The stirrers should be configured to lift the denser glass from the bottom of the forehearth into the body of the base glass so that it becomes located in the centre of the gob rather than on the outside of the gob. Right hand-stirrers should be rotated clockwise and left-hand stirrers should be rotated anti-clockwise.

Although the 'cord' is still present in the glass, after mixing it becomes distributed throughout the base and sidewalls of the article during the forming process so that it is no longer readily visible in the finished product.

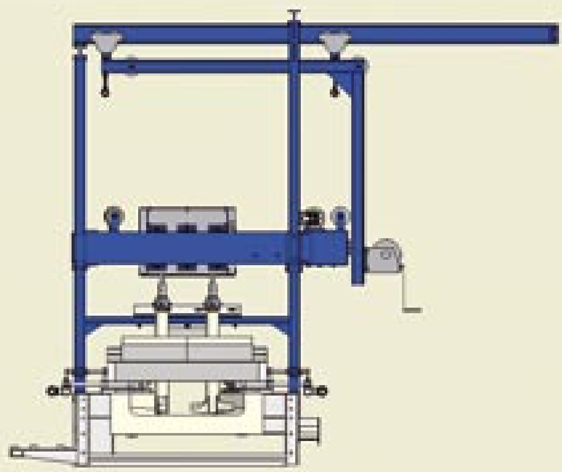
The occurrence of 'cat-scratch' cord is now becoming so prevalent that the equalising section of every new forehearth from PSR is pre-configured for the subsequent installation of stirrers. This includes the provision of cut-outs in the roof blocks with cover tiles to close the position, together with pre-configuration of the superstructure steelwork to enable a stirrer support frame to be retro-fitted quickly and easily if required.



Paddle type stirrers Left & Right hand as illustrated



Typical arrangement of paddle type stirrers in the equalising section



Rear view of paddle type stirrers in the equalising section

Screw-Type Stirrer Systems

Whereas paddle-type stirrer systems give better coverage of dense inhomogeneous material at the bottom of the forehearth, screw type stirrers can provide better mixing throughout the body of the glass because of their better vertical movement of the glass.

In narrow forehearths, where there is insufficient room for paddle type stirrers, screw-type stirrers are often the only solution.

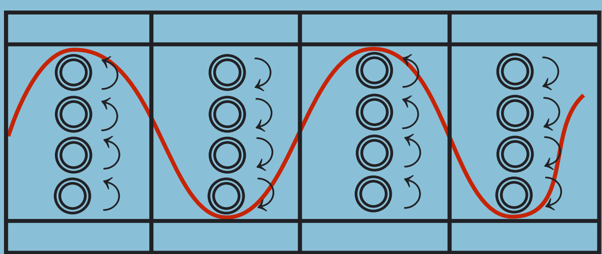
However in wide forehearths, and particularly in colouring forehearths, screw type stirrers can also be highly effective.

With sloping channels, such as in some special equalising section configurations, vertically mounted paddle type stirrers cannot be used because they cannot sweep the bottom of the glass flow effectively. In such cases screw-type stirrers must be used, arranged across the channel width to give maximum stirring movement.

For efficient mixing screw type stirrers must be arranged closely together and their screw threads and directions of rotation correctly configured. The stirrers should be configured to lift the glass and therefore right hand-stirrers should be rotated clockwise and left-hand stirrers should be rotated anti-clockwise.

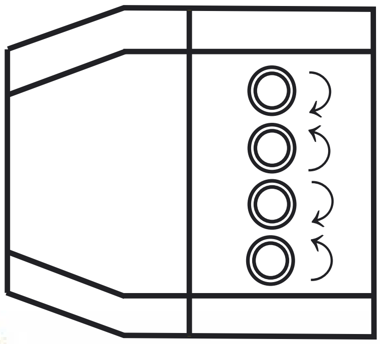
In an equalising section screw-type stirrers should generally be arranged in pairs with all the stirrers having the same centre distance. Each stirrer in a pair should be counter rotated to mix and lift the glass passing between the pair. A careful balance must be maintained between stirrer speed and glass viscosity as excessive shear force can encourage blister and cause refractory breakage.

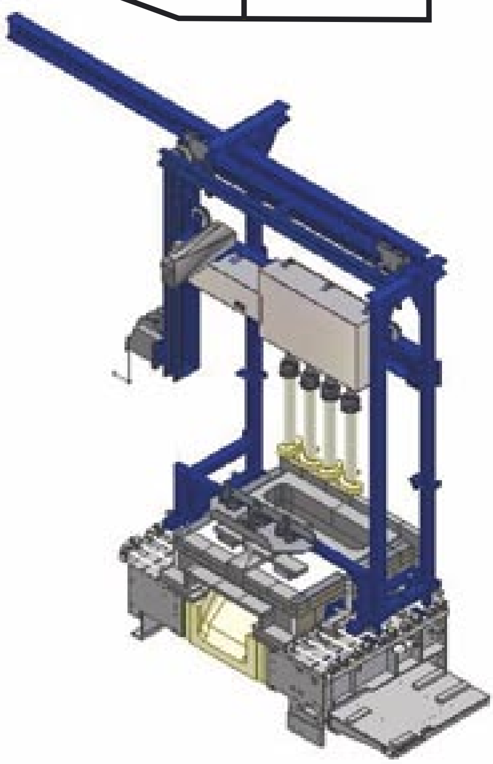
In colouring forehearths all the stirrers in each bank should be rotated in the same direction with alternate banks being rotated in opposite directions. This will encourage the glass flow to 'snake' between stirrer banks as illustrated below, providing greater residence time for the mixing of the frit.



Typical arrangement of 4 banks of quadruple screw-type stirrers in a 36" wide colouring forehearth.

Screw type stirrers Left & Right hand as illustrated.





Right and below: Typical arrangement of 4 screw-type stirrers in a 36" wide equalising section

Technical Services Division

Installation

Every new forehearth supplied by PSR comes pre-configured for the subsequent installation of stirrers in the equalising section should they be required.
Existing forehearths can be converted either at the time of repair or on-the-run. For on-the-run installations downtime can be kept to a minimum with typically only 4 hours interruption to production required for changing the equalising section roof blocks.

Refractories

The refractory specification of any stirrer installation is an important factor in its success.

• Cold repairs

For installations carried out during cold repairs PSR's standard SM-62 refractory quality can be used.

• Hot repairs

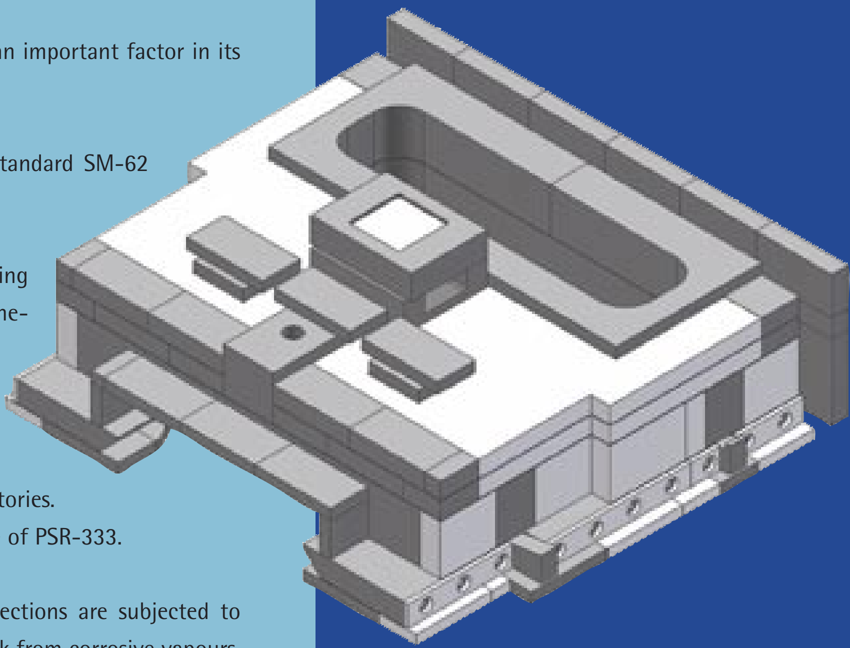
The installation of stirrers in the equalising section can also be carried out 'on-the-run'. This normally involves at least the replacement of the equalising section roof blocks and in such cases special consideration needs to be given to the 'hot-insertion' characteristics of the refractories. For such applications PSR recommend the use of PSR-333.

• Colouring forehearths

Superstructure refractories in forehearth colouring sections are subjected to high temperatures required for melting the frit and attack from corrosive vapours. For the superstructure refractories PSR recommend PSR-333. Colouring section channel blocks should normally be specified in fused-cast AZS.

• Stirrers

Stirrers must have both a high degree of corrosion resistance and a high tolerance to thermal shock. As standard PSR recommend PSR-333 for this application. PSR-315 is also available to special order.



Stirrer system refractories

(for detailed data see separate data sheets)

	SM-62	PSR-333	PSR-315	PSR-993
Application	• Standard forehearth superstructure	• Stirrers • Hot-insertion forehearth superstructure • Channel blocks • Colouring section superstructure	• Stirrers	• Channel blocks
Al_2O3 (%)	62	73	68	99
SiO_2 (%)	36	15	13	-
ZrO_2 (%)	-	11	18	-
Bulk density (kg m^{-3})	2450	2820	3111	3400
Apparent porosity (%)	20	21	20	11
Thermal shock resistance	Very good	Excellent	Very good	