



**Mini-Melting System**

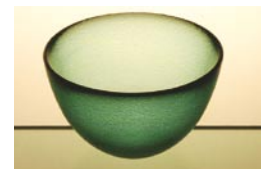
**Feeder Channel Colouring based on Glass Rod Raw Material**

**“Liquid in Liquid” - Feeder-Channel Colouring based on the Mini-Melting System in Combination with the Feeder Channel**

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COLOURING SYSTEM	Mini-melting system for coloured glass	Feeder Channel Colouring	“Liquid in Liquid”- Feeder-Channel Colouring
TYPES OF GLASS COMPOSITION	lead glass, soda-lime glass, recycling glass, borosilicate glass as well as coloured glass (oxidized and reduced glass conditions) and highly specialized clear glasses		
COLOURING PRINCIPLE	coloured glass is molten, refined and made available for moulding through the feeder head	a high-concentration coloured glass rod is fed into the colourless glass stream of the feeder channel	highly concentrated coloured glass is pre-molten and refined in a mini-melting system and fed into the colourless glass stream through an innovative feed pipe
RAW MATERIAL (COLOURS)	clear glass cullets and colour ingredients	high-concentration coloured glass rods	clear glass cullets and colour ingredients
COLOUR INTENSITY	full range of colour intensity	full colour range for solid glass items; light colour for low-weight and thin-walled (blown) glass items	full range of colour intensity
CAPACITY	between 250 kg and 1,5 t pull rate in 24 h	clear glass pull rates: up to 5 t in 24 h	clear glass pull rates: up to 20 t in 24 h



**THE PACKAGE INCLUDES**

	Mini-melting system for coloured glass	Feeder Channel Colouring based on Glass Rod Raw Material	“Liquid in Liquid” Feeder Channel Colouring based on the Mini-Melting System in Combination with the Feeder Channel
BASIC EQUIPMENT	<ul style="list-style-type: none"> <li>melting module</li> <li>refining module</li> <li>temperature regulation</li> <li>feeder head</li> </ul>	2 or more pipe-shaped channel segments (one colouring cell; one or more stirring cells)	2 or more pipe-shaped channel segments (one colouring cell; one or more stirring cells)
COLOURING EQUIPMENT		<ul style="list-style-type: none"> <li>magazine for glass rods</li> <li>mechanism for the vertical movement of the glass rod</li> </ul>	<ul style="list-style-type: none"> <li>mini-melting system</li> <li>platinum feed pipe with inductive heating</li> </ul>
STIRRERS		<ul style="list-style-type: none"> <li>stirring equipment one or more stirrer mechanisms and stirrers</li> </ul>	<ul style="list-style-type: none"> <li>stirring equipment: one or more stirrer mechanisms and stirrers</li> </ul>

# Mini-Melting System

## APPLICATION

The mini-melting system has been developed for highly flexible low-volume melting (up to 1,5 t in 24 h) with change-over times reduced to a minimum. Target applications are flexible colour production and flexible melting conditions for clear glass, especially for low-volume production of technical glasses with varying requirements concerning glass characteristics for specific applications. The system features a full electronic control of all parameters in the melting and feeding process which is the pre-condition for a consistent and reproducible production process. Reproducibility is especially crucial for colour production and for a comprehensive process control in technical and optical glass production. High-concentration colour melting also allows to produce coloured glass rods in a fully automatic process to be used for the feeder channel colouring system.

## MODE OF OPERATION

The mini-melting system is based on highly specialized modular components for melting, refining, temperature regulation and feeding. Individual production steps are thus performed under optimal conditions and the components are highly specialized to specific functions – with regard to the basic layout, the glass contact material, the heating system etc. Since all heating systems are based on an electrical heating, a discontinuous as well as a continuous, fully electronically controlled melting process is achieved – which provides a highly accurate and reproducible melting and feeding process and perfect conditions for colour production.



## FEATURES

highly flexible production	<ul style="list-style-type: none"><li>• because innovative glass contact materials and heating systems increase the flexibility of glass-colour choice to a great extent, since reduced and oxidized melting conditions may be achieved</li><li>• because low-volume melting reduces job-change times to a minimum</li><li>• because a continuous melting process achieves higher productivity and provides the pre-condition for automation (in comparison with pot-furnaces for colour production)</li></ul>
large cost-savings	<ul style="list-style-type: none"><li>• because long-term and cost-intensive colour changes in high-volume furnaces are reduced from a couple of days to hours</li><li>• since electrical heating systems allow a highly efficient temperature insulation and reduces energy consumption</li><li>• the melting furnace allows to use cullet in combination with any colour ingredients (colour oxides as well as granulate), while standard forehearth-colouring is based on cost-intensive colour granulate</li></ul>
very high quality	<ul style="list-style-type: none"><li>• since high temperatures for melting and refining difficult glasses and colours (i.e. chrome-oxides) may be achieved</li><li>• due to a highly efficient refining zone</li></ul>
very high reproducibility	<ul style="list-style-type: none"><li>• because electrical heating systems for melting, refining and temperature regulation in the feeder allow an accurate and computer-aided control of all parameters</li></ul>

## Feeder Channel Colouring based on Glass Rod Raw Material

### APPLICATION

Feeding high-concentration coloured glass (glass rod colour raw material) into the pipe-shaped feeder channel provides extremely flexible colour production conditions. Since the colour is added immediately prior to feeding, the glass melting process and the forehearth are unaffected by the colouring process. Colour change times are reduced to a minimum, since the pipe-shaped feeder channel and feeder contain a minimum volume of glass.

### MODE OF OPERATION

The colouring equipment is mounted onto the pipe-shaped feeder-channel, which supplies the feeder with molten glass from the furnace. In the colouring cell, the glass rod is fully automatically fed into the horizontal colourless glass stream. The vertical movement of the glass-rod is performed by a servo-motor system which allows a highly precise and computer-aided control of the feeding speed for the glass rod. This guarantees long-term consistency and reproducibility of the colour intensity for the production process. The infrared radiation of the hot glass stream causes the glass rod to melt before it enters the glass stream, which enhances the colour distribution in the colourless glass. The colour cord is diffused by the laminar glass stream in the channel and passes through one or more stirring cells. The minimal surface of the pipe-shaped channel in combination with a highly efficient heating system provides optimal conditions for a highly efficient stirring process. The stirring plunger in the vertical glass flow of the feeder head further enhances colour homogeneity. Full electronic control of all movement and temperature parameters guarantee consistent glass homogeneity and highly reproducible colours.



### FEATURES

large cost-savings	<ul style="list-style-type: none"><li>• because long-term and cost-intensive colour changes in the furnace are reduced from a couple of days to a few hours</li></ul>
very high quality and colour homogeneity	<ul style="list-style-type: none"><li>• due to the fact that the infrared radiation causes the glass rod to start melting before having full contact with the surface any risk of creating bubbles caused by the colour feeding process is eliminated</li><li>• because highly innovative stirrers in combination with the laminar glass flow in the pipe-shaped feeder channel guarantee very consistent colour homogeneity</li></ul>
very high reproducibility	<ul style="list-style-type: none"><li>• because the electric heating system and servo-motor based glass-rod feeding system allows an accurate and computer-aided control of all parameters</li></ul>
low investment costs and easy integration into existing systems	<ul style="list-style-type: none"><li>• since a minimum of (mechanical) equipment and no additional heating equipment and heating control panel is required</li></ul>
reduced energy consumption due to short channel systems	<ul style="list-style-type: none"><li>• since the glass rod is subject to the natural diffusion in the colourless glass stream due to the fact that the infrared radiation of the colourless glass stream causes the glass rod to start melting before having full contact with the surface of the glass stream</li><li>• because the pre-melting process of the glass rod may be supported by an infrared heating system which may be easily integrated into the system in order to achieve higher pull rates with the same channel length</li></ul>

# “Liquid in Liquid”-Feeder-Channel Colouring based on the Mini-Melting System in Combination with the Feeder Channel

## APPLICATION

The compact structure of the mini-melting system allows the system to be installed onto the feeder channel in order to feed pre-molten concentrated coloured glass into the colourless horizontal glass stream of the pipe-shaped feeder channel. There are two application targets: the pre-melting of coloured glass allows to feed higher colour concentrations into the colourless glass stream or allows to colour higher pull rates of clear glass. Higher concentrations are especially necessary for thin-walled (blown) glass items or for low-weight glass items. For higher pull rates, the mini-melting furnace may also be installed onto standard u-shaped forehearth systems. Feeding liquid coloured glass into the liquid colourless glass stream allows to reduce the total channel or forehearth length and curbs energy consumption drastically.

## MODE OF OPERATION

The mini-melting system is mounted onto the pipe-shaped feeder-channel, which supplies the feeder with molten glass from the furnace. Highly concentrated coloured glass is pre-molten and refined in the mini-melting system. The liquid colour is added to the colourless glass stream through an innovative feed-pipe (“liquid in liquid”-colouring technology). A highly responsive temperature control for the feed-pipe allows to efficiently control the quantity of coloured glass which is added by fully electronically controlling the viscosity/time relation. This guarantees long-term consistency and reproducibility of the colour intensity for the production process. The colour cord is further diffused by the laminar glass flow in the channel and passes through one or more stirring cells. The minimal surface of the pipe-shaped channel in combination with a highly efficient heating system provides optimal conditions for a highly efficient stirring process.

## FEATURES

<p><b>large cost-savings</b></p>	<ul style="list-style-type: none"> <li>• because long-term and cost-intensive colour changes in high-volume furnace are drastically reduced</li> <li>• the melting furnace allows to use cullet in combination with any colour ingredients (colour oxides as well as granulate), while standard forehearth-colouring is based on cost-intensive colour granulate</li> </ul>
<p><b>very high quality and colour homogeneity</b></p>	<ul style="list-style-type: none"> <li>• due to facilitated melting of difficult colours requiring high temperatures (i.e. chrome-oxides) which provides higher colour homogeneity</li> <li>• since the pre-melting process in combination with a highly responsive temperature regulation in the feed-pipe allow the stirrers to mix the coloured glass and the colourless glass in the same viscosity area</li> <li>• since a very good colour distribution is achieved by feeding liquid coloured glass into the colourless glass stream by an innovative feed-pipe</li> <li>• because highly innovative stirrers in combination with the laminar glass flow in the pipe-shaped feeder channel guarantee very consistent colour homogeneity</li> </ul>
<p><b>very high reproducibility</b></p>	<ul style="list-style-type: none"> <li>• because the electrical heating systems for all production steps allow an accurate and computer-aided control of all parameters</li> </ul>
<p><b>reduced energy consumption due to short channel systems</b></p>	<ul style="list-style-type: none"> <li>• since a high colour distribution is achieved and colour homogeneity is guaranteed even in short channels due to the fact that liquid coloured glass is fed into the colourless glass stream by an innovative feed-pipe</li> </ul>
<p><b>optimal compatibility of coloured glass with the glass composition of the colourless glass</b></p>	<ul style="list-style-type: none"> <li>• since the melting process for the colour concentration may be perfectly adjusted to meet the requirements of individual glass composition requirements (i.e. lead percentage)</li> </ul>