

SEDEX - ONE PRODUCT FAMILY: VARIOUS PRODUCT CHARACTERISTICS FOR DIFFERENT REQUIREMENTS



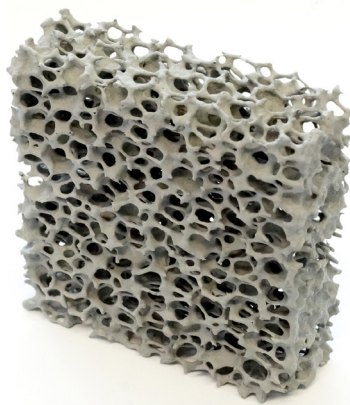
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In the industrial production of cast iron products, the use of SEDEX filters has established itself as the recognised "state-of-the-art" standard over the last few decades. The removal of non-metallic inclusions, and turbulence reduction achieved by SEDEX filters, are of great importance for economical casting production.

As part of the continuous improvement of SEDEX filters, various product features have been examined in detail. This resulted in the introduction of two new ceramic foam filters: SEDEX SUPER FLOW and SEDEX *ULTRA*, whose properties and potentials are discussed here in comparison to the well-established SEDEX filter.

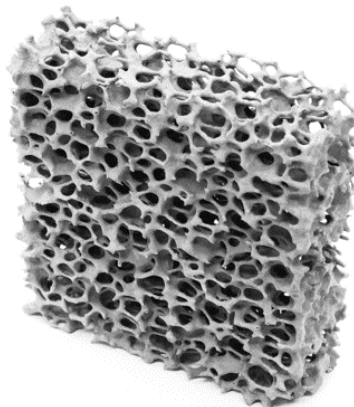
SEDEX FILTER

SEDEX filters have been used by the foundry industry for more than 25 years. During this time, the filter and its application have been continuously improved in co-operation with leading foundries around the world. The use of SEDEX foundry filters is a guaranteed way to produce quality, cost effective castings.



SEDEX SUPER FLOW FILTER

A new generation of SEDEX filter with a consistent open pore ceramic foam structure to remove slag /dross and other non-metallic inclusions from molten iron. Super SEDEX has improved foam structure which results in higher metal flow rates that allows use of higher porosity filters thus resulting in better filtration efficiency.



SEDEX ULTRA FILTER

SEDEX *ULTRA* filters represent the state of the art amongst filters for iron casting. There is a frame around the filter which significantly improves the handling and performance characteristics of the filter.



SOME BACKGROUND ON GATING AND FLUID DYNAMICS

The removal of non-metallic inclusions and molten metal turbulence reduction represent the two main features of ceramic foam filters within a gating system. However, these two features represent only a part of the success story of SEDEX filters. An additional, often underestimated, aspect is related to the concept of gating system design developed by Foseco. In contrast to conventional systems, these are downsprue controlled gating systems which reduce the metal velocity and thus minimise turbulence during mould filling. The control of the mould filling in terms of metal velocity and pouring time is performed by the flow determining cross-section usually placed in the downsprue. Based on well-established principles, the size of the filter must be selected so that the filter never becomes the controlling factor during the mould filling process which would then affect pouring time and flow rate.

There are some considerations in terms of pressure drop caused by different gating system components, including filters, and how they affect flow rate. These analysis are also used to characterise filters but clogging of the filters by the segregation of non-metallic inclusions is not taken into account.

Fig. 1 shows some of the components commonly used in the design of gating systems including tube, extension or reducer, elbow and L-piece. The respective effect on fluid dynamics can be calculated in terms of pressure drop caused by them.

Any change in flow results in a pressure drop; the pressure drop is caused by friction of the respective component and depends on its geometry, but also on the density and velocity of the flowing medium. The pressure drop leads to a reduction of the flow rate.

This also applies to wire screens. **Fig. 2** shows the pressure drop caused by wire screens as a function of wire diameter and mesh size [1]. At constant mesh size, the pressure drop increases with increasing wire diameter, the pressure drop increases with constant wire thickness and decreasing mesh size.

Considering ceramic foam filters, the characteristics wire diameter and mesh size of wire screens can be qualitatively transferred. The mesh size corresponds to the porosity and wire diameter to the

strand thickness. This explains why at constant strand thickness, and increasing porosity, the pressure drop increases and the flow rate decreases. On the other hand, at the same porosity, a reduction in the strand thickness results in a decrease in the pressure drop, which results in an increase in the flow rate.

IMPLICATIONS ON USE IN FOUNDRY PRACTICE

How does this affect SEDEX SUPER FLOW and SEDEX ULTRA, compared to the standard SEDEX? Both products represent weight-optimised developments of the SEDEX filter. Due to the lower filter weight, a lower strand thickness is achieved, which results in a reduction of the pressure drop and an increase of the flow rate at constant porosity.

With SEDEX ULTRA, however, the situation is somewhat more complex. In addition to the weight reduction, the frame formation leads to a redistribution of the ceramic within the filter structure. As a result, the SEDEX ULTRA shows an even smaller strand thickness compared to the SEDEX SUPER FLOW providing a further reduction in the pressure drop and increase in the flow rate. The mechanical integrity of the filter structure is maintained by the frame.

The influence of weight reduction and frame formation on strand thickness, pressure drop, and flow capacity is shown schematically in **Fig. 3**. **Fig. 4** compares the water flow characteristics of the various products in different porosity ranges.

Figure 4 shows the flow rate decreasing with increasing porosity for standard SEDEX. In addition, the finer porosities 20 and 30 ppi, can be used to illustrate how the reduction of the strand thickness of the further developed SEDEX filters affects the flow rate. At the same porosity, the SEDEX SUPER FLOW shows on average a flow rate approx. 8 % higher than standard SEDEX.

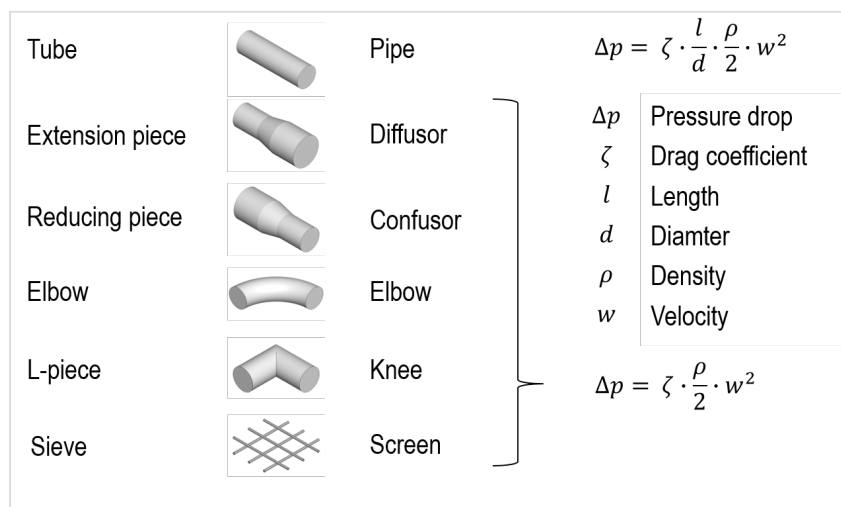


Figure 1: Pressure drop due to various gating system and fluid dynamic components

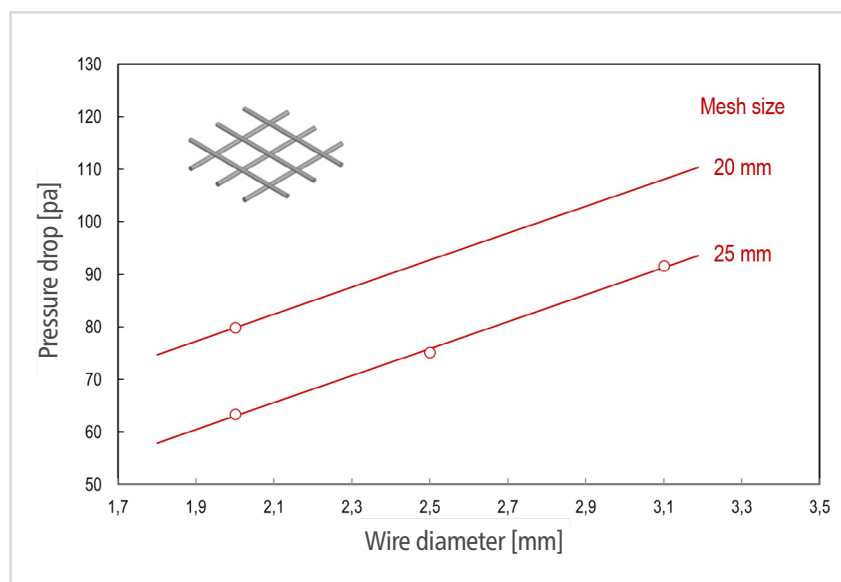


Figure 2: Pressure drop caused by wire screens as a function of wire diameter and mesh size [1]

With SEDEX *ULTRA*, this is even more pronounced. Compared to standard SEDEX, the SEDEX *ULTRA* provides on average a 15 % higher flow rate at the same porosity.

If the flow rates of the porosity 10, 20 and 30 ppi shown in **Fig 4** are compared across the board, it can be seen that 20 ppi SEDEX SUPER FLOW and SEDEX *ULTRA* filters show values at the same or higher level than 10 ppi SEDEX filters.

The same situation is established when comparing 30 ppi SEDEX SUPER FLOW and SEDEX *ULTRA* with 20 ppi SEDEX. Due to the formation of the frame and the associated lower strand thickness, SEDEX *ULTRA* filters show higher flow rates than SEDEX SUPER FLOW filters at equivalent porosity.

These flow characteristics enable the use of finer filters in foundry practice resulting in an improved filtration efficiency and thus a reduction of reject rate. In the case of SEDEX SUPER FLOW, the aim is to apply a finer filter of the same size and flow capacity compared to SEDEX filters.

The special flow characteristics of the SEDEX *ULTRA* also enable the use of smaller filters, which reduce the level of rejects and thus the cost of casting production. In addition, the SEDEX *ULTRA* filter has particularly favourable properties for the automated insertion of filters into the mould due to its closed frame.

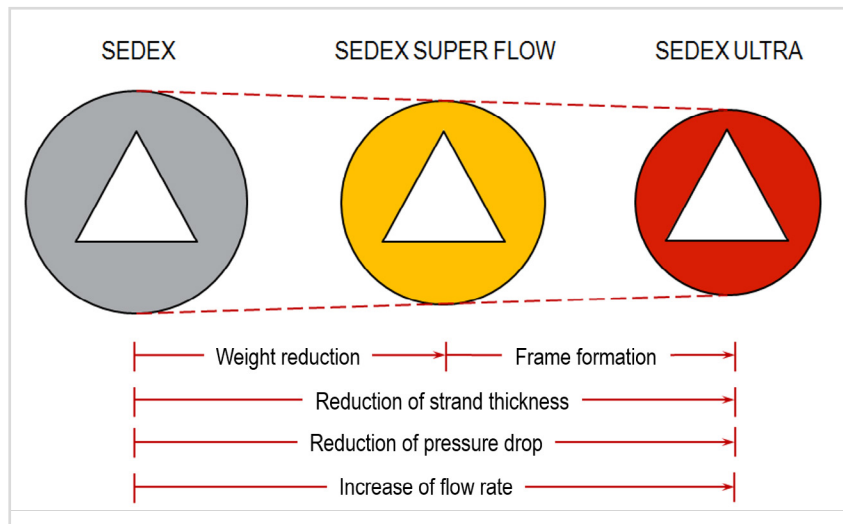


Figure 3: Reduction of the strand thickness of ceramic foam filters by weight reduction and frame formation, and their influence on pressure drop and flow rate (schematically)

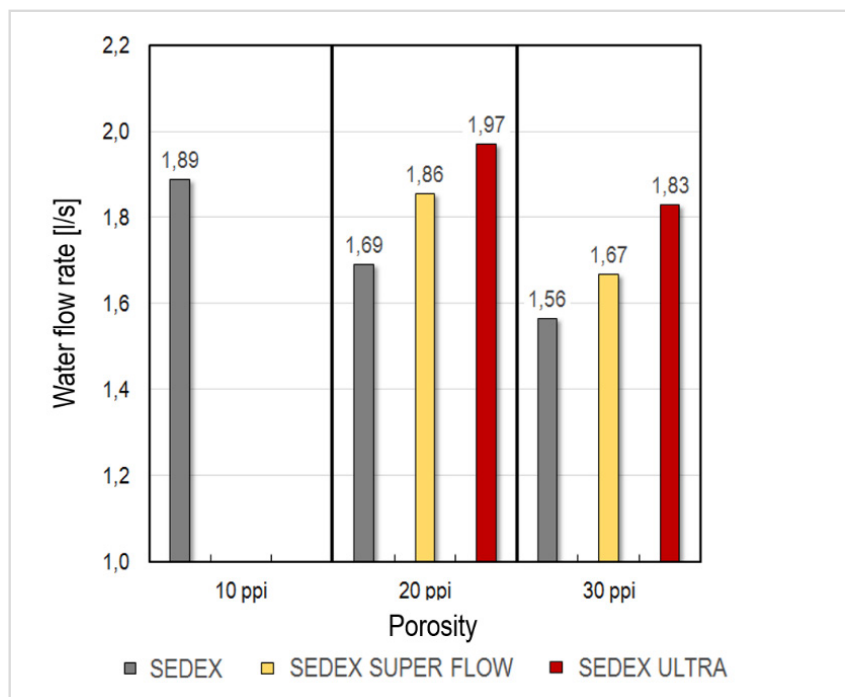


Figure 4: Water flow rate of the different SEDEX products at 10, 20 and 30 ppi (50x50x22 mm)



The advantages of the further developed SEDEX SUPER FLOW and SEDEX *ULTRA* filters can be summarised as follows:

SEDEX SUPER FLOW Filters:

- More open filter structure due to reduced strand thickness
- The ability to use finer filters of the same size
- Reduction of the reject rate through improved filtration efficiency

SEDEX *ULTRA* filters:

- Particularly open filter structure due to reduced strand thickness
- The ability to use smaller and finer filters
- Reduction of casting reject rate due to improved filtration efficiency
- Reduction of returns due to the use of smaller filters
- Increased productivity due to improved handling

Within the scope of this article, the flow characteristics of the various products and their possible applications are discussed. An essential requirement for such development work is to ensure other important product characteristics such as dimensional accuracy, cold compressive strength and the thermal shock resistance (as determined by the Impingement test) are not negatively affected. The basics of quality assurance for SEDEX filters have already been reported in the past [2]. In addition, the requirements for ceramic foam filters are defined by the BDG directive P100 [3].

APPLICATION EXAMPLES

SEDEX SUPER FLOW - REDUCTION OF REJECT RATE THROUGH THE USE OF FINER FILTERS

The use of finer SEDEX SUPER FLOW filters, and the resulting improved filtration efficiency, can be demonstrated in an example of steering knuckles made from ductile iron (**Fig. 5**).

Originally, these components with a poured weight of 43.0 kg were manufactured using two SEDEX 50x50x22/10 ppi (specific through flow 0.86 kg/cm²) at a pouring time of 8 s. On this application, the magnesium treatment process used is of particular importance. The treatment is carried out by the in-mould process, which can be problematic due to possible filter blockages. In this application a maximum specific flow capacity of 1.0 kg/cm² is recommended for SEDEX filters. Under these circumstances, 10 ppi SEDEX filters with a thickness of 15 or 22 mm are commonly used.

Despite these critical application conditions, when switching to SEDEX SUPER FLOW 50x50x15/20 ppi, the pouring time of 8 s was maintained, and the castings were manufactured reliably. The reject rate was reduced by approx. 40 % of the original level. As a result of these very positive experiences, the entire casting programme of the foundry was converted to the use of SEDEX SUPER FLOW filters.

SEDEX ULTRA - REDUCTION OF RETURNS BY USING SMALLER FILTERS

Practical experience has shown, due to the special flow characteristics of SEDEX ULTRA filters, a higher filter capacity can be achieved. Depending on the application, this allows a reduction in filter area by up to 20 %. At the same time finer porosity filters can be used compared to the original application of SEDEX filters (for example 20 ppi filters instead of 10 ppi).

The example of a flywheel made from ductile iron, shown in **Figs. 6 to 8**, demonstrates how the use of SEDEX ULTRA filters can improve yield by reducing filter area. **Fig. 6** shows the initial situation with a conventional gating system without a filter. The pouring time for this casting layout was 15.5 s with a poured weight of 25.0 kg.

Initially, a SEDEX 50x50x15/20 ppi filter was used, since SEDEX ULTRA filters were not yet available at that time (**Fig. 7**). Due to the introduction of SEDEX the scrap rate reduced significantly. Furthermore, the poured weight was decreased to 23.7 kg (0.95 kg/cm²) and the pouring time was reduced to 10.5 s increasing productivity significantly. The savings achieved in terms of rejects, pouring time and the resulting massive increase in productivity are only few examples demonstrating the benefits of ceramic foam filters and the success story of SEDEX filters.

A few years later, SEDEX ULTRA 40x40x15/20 ppi (**Fig. 8**) was introduced, this equates to a reduction of filter area by 36 %. Apart from the modification to the filter print for the new filter size, the gating system was unchanged. This measure resulted in a further reduction in poured weight by 0.2 kg (1.47 kg/cm²) at the same pouring time. Based on an annual production of 50,000 flywheels, the reduction of the poured weight by 0.2 kg resulted in a return reduction of 10,000 kg.

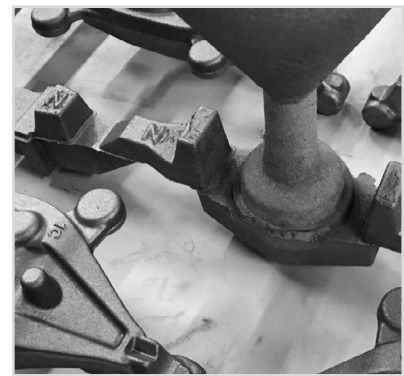


Figure 5: Steering knuckles made from ductile iron

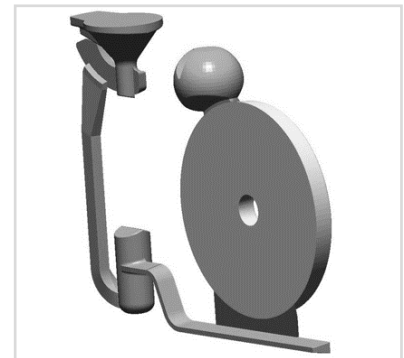


Figure 6: Flywheel made from ductile iron - Initial situation without filter

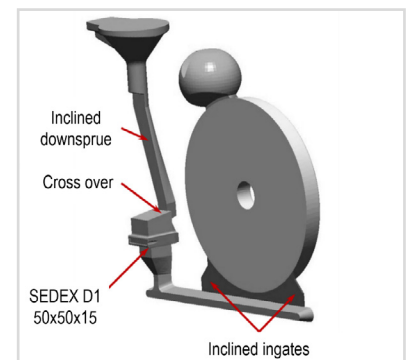


Figure 7: Flywheel made from ductile iron - Layout with filter using SEDEX 50x50x15/20 ppi

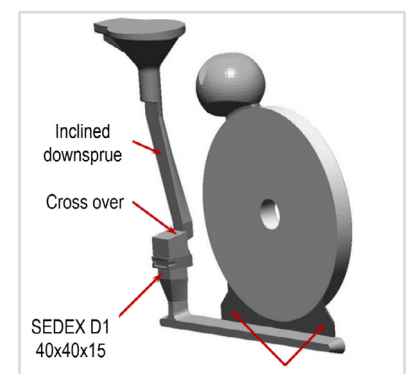


Figure 8: Flywheel made from ductile iron - Layout with filter using SEDEX ULTRA 40x40x15/20 ppi

Depending on the size of the filter used and the filter print, the potential savings that can be achieved by using SEDEX *ULTRA* filters can vary. **Table 1** shows the possible savings in terms of weight and cost for different filter sizes based on the widely-used filter print SEDEX FP4.

The situation shown in **Table 1** is visualised in **Fig. 9**. The original SEDEX 60x60x22/10 ppi is replaced by a SEDEX *ULTRA*

55x55x15/20 ppi. In this case, the filter area is reduced by 16 %. The corresponding filter print shows a by 0.5 kg lower weight, which corresponds to a cost reduction of approx. 0.13 € (melting and treatment costs 0.25 €/kg). Assuming an annual consumption of 200,000 filters, this equates to a savings for the foundry of 100,000 kg returns worth 25,000 €.

SEDEX		SEDEX <i>ULTRA</i>		Reduction	
FP4	Weight [kg]	FP4	Weight [kg]	Weight [kg]	Costs [€]
50x50x22	1.53	45x45x15	1.15	0.37	0.09
50x75x22	2.38	55x55x15	1.52	0.86	0.22
60x60x22	2.02	55x55x15	1.52	0.50	0.13
50x100x22	3.2	67x67x15	2.55	0.66	0.17
100x50x22	2.89	67x67x15	2.55	0.35	0.09
75x75x22	3.46	67x67x15	2.55	0.91	0.23

Table 1: Weight and cost savings on ductile iron by using smaller SEDEX *ULTRA* filters based on the filter print SEDEX FP4 (melting and treatment costs 0.25 €/kg)

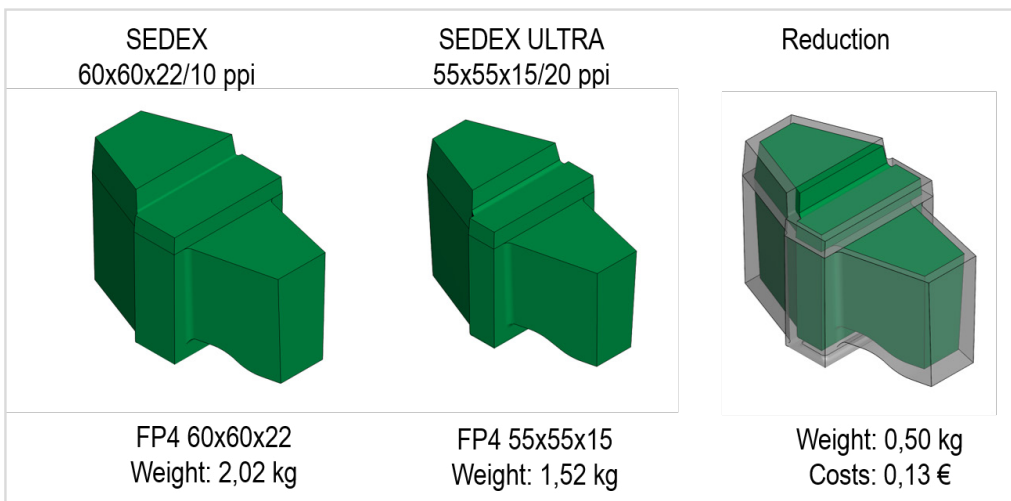


Figure 9: Saving of returns and costs by using smaller and finer SEDEX *ULTRA* filters

SEDEX *ULTRA* - IMPROVED HANDLING CHARACTERISTICS

The following example of a carrier made from ductile iron at a poured weight of 11.4 kg illustrates the favourable handling characteristics of the SEDEX *ULTRA* filter due to the four-sided closed frame.

Originally, the carrier shown in **Fig. 10** was manufactured using a SEDEX 40x40x15/10 ppi with a pouring time of 5 s (0.71 kg/cm²). By changing to SEDEX *ULTRA* 40x40x15/10 ppi, the insertion of the filter in the mould by the core setter was more reliable. As a result, the number of moulds produced was increased from 300 to 330 pieces/h improving productivity by 10 %.

In addition, this carrier also demonstrated a reduction of the reject rate by the use of finer SEDEX *ULTRA* filters. During the project, the filter was converted to the finer SEDEX *ULTRA* 40x40x15/20 ppi. Despite the finer porosity of 20 ppi, the desired pouring time of 5 s was maintained. The use of the finer 20 ppi SEDEX *ULTRA* filter resulted in a 50 % reduction of the reject rate.

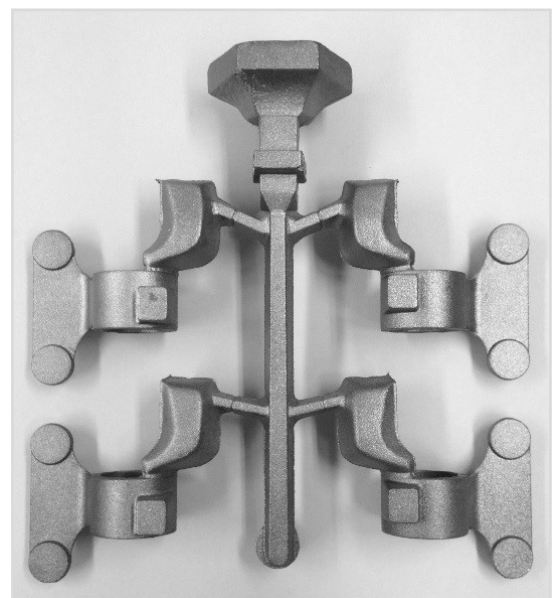


Figure 10: Carrier made from ductile iron - Improved handling by use of finer SEDEX *ULTRA* filters

SUMMARY

The use of SEDEX filters, which has been well established for many years, has made a significant contribution to the economical and reliable production of cast iron products. The further developments presented reveal further possibilities with regards to filtration efficiency and return reductions. The physical background has been discussed with the help of fluid dynamics and flow rate data. SEDEX SUPER FLOW filters allow the use of finer filters of the same size. In addition to improved handling properties, SEDEX *ULTRA* filters allow the use of smaller and finer filters.

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