SEDEX ceramic foam filter applications on regular production castings in Japan

This paper publishes for the first time SEDEX filter applications on actual production castings in Japanese iron foundries. Previously, Foseco Japan has not made public details of SEDEX filter applications in order to maintain strict customer confidentiality. However, with the focus of world attention on Osaka, Japan, during the 57th World Foundry Congress in 1996, and users have welcomed the opportunity to demonstrate the unique applications for SEDEX filters which have been developed for commercial use in the Japanese Foundry industry.

Background of SEDEX filter application in Japan

SEDEX ceramic foam filters based on silicon carbide were initially imported from Foseco Germany and introduced to the Japanese iron foundry industry in 1983. Initial customer reaction was that SEDEX filters were too expensive, and Foseco Japan’s application technology and experience with the product was insufficient to persuade customers to carry out appropriate trials to demonstrate the true worth of SEDEX filters. Typically, they were regarded by customers as stainer cores and simply replaced an existing stainer core at the same location in the runner system, without due concern for filtration capacity, metal flow rate and filter strength. This resulted in a number of unsuccessful trials.

At the same time in Europe, Foseco Germany, working in co-operation with Georg Fischer GmbH, Mettmann, had established the necessary application technology and began to increase sales volume. By the beginning of 1984, SEDEX filters had been adopted for use in mass produced NH2 resist turbo charger housing castings. Trials on crankshaft, brake caliper and other ductile iron high volume production castings were also underway at a number of other foundries.

Close liaison with Foseco Japan, Foseco Germany and Foseco’s central research and development facility in Birmingham, England ensured a rapid transfer of the necessary application technology gained in Europe to Japan. A Japanese SEDEX filter application technology manual was completed by the end of 1985, followed by successful product introduction to more than 15 foundries, each taking more than 2,000 pieces per month. However, this initial success should be compared to sales to Georg Fischer GmbH, Mettmann, who were already taking over 250,000 pieces per month.

The use of SEDEX filters in Japanese foundries has since increased dramatically and domestic filter production was started in 1986. At present, SEDEX filters are sold to more than 250 Japanese foundries.

Figure 1 shows SEDEX filter sales in Japan divided into the proportions sold for each type of metal. Ductile iron still moulding several medium sized cylinder blocks in a moulding flask of limited dimensions was printed in "JACT NEWS" May, 1990. By quoting from this article – by kind permission of the author and publisher – several case studies are presented in which SEDEX filters have been adopted during intensive work to improve cycle time, reduce reject rate and increase production rate.

Example of SEDEX application in cylinder block production

The foundry wanted to assess the possibility of changing from two to four castings per mould to gain the substantial increase in moulding capacity and productivity. Two systems were developed for the production of four castings per mould; these are:
- Separate System for small blocks;
- Two Units Docking System for larger blocks.

Separate System

The four cylinder blocks are placed in the moulding flask as figure 2. The metal is poured from one down sprue at the centre and distributed into the four runners.

Fig 2 Sketch of “Separate System”.

The metal flows into casting cavity from a bottom runner through each in-gate installed inside or at the side of the cover core.

The casting is a cylinder block for a small engine of approx. 30 kg as cast weight. The total pouring weight is up to approx. 150 kg (Reference: Photo 1-a, 1-b, 1-c and 1-d).
Two Units Docking System

Approximately 70% of the moulding flask area capacity is utilized — as figure 3. This method has been extremely difficult compared with "SEPARATE SYSTEM" because of larger poured weight, so much generated gas volume from cores, and larger metal flow rate.

The down sprue is installed at the joint of the two cores for two cylinder blocks, and molten metal is distributed into each runner from the sprue base.

As the name suggests, this is the method with two down sprues installed in one pouring basin.

There is no moulding sand in between the docking cores facing each other and the core is fixed by only its outside edges.

The "Two Units Docking System" is applied to several types of cylinder block and one of them is shown in photograph 2.

- Flask Size:
  1300(L) x 980(W) x 320/320(H)
- As Cast Weight:
  54 kg (4 Castings/Flask)
- Total Poured Weight: Max. 300 kg
- Cycle Time of Production Line: 42 sec.
- Poured Metal: Gray iron containing a small amount of alloy
- SEDEX Filter: 2 Pieces/Flask (20 ppi)

Photo 1-a: Two SEDEX filters and four shell cores of the cylinder blocks are set into the drag box.

Photo 1-b: Two shell cores are set by machine.

Photo 1-c: Four cylinder block castings and runners.

Photo 1-d: The runner system.

Photo 2: One of the "Two Units Docking System"
The benefits from using SEDEX filters in each of these modified processes is shown below:

Photo: 4-a, 4-b, 4-c and 4-d show moulding line by "Two Units Docking System". The very small area backed up by moulding green sand can be observed, and its thickness is about 70-80mm.

Several problems have appeared through the production of four castings of cylinder block per flask by "The Two

BEFORE USING
SEDEX FILTERS
SEDEX: NONE
Pouring time: 14-16 sec
Total Poured Weight: 128-130 kg

USE OF SEDEX FILTERS
SEDEX (20 ppi): 1 pc
Pouring time: 15-17 sec
Total Poured Weight: 140-150 kg

TWO UNITS DOCKING SYSTEM or SEPARATE SYSTEM
SEDEX (20 ppi): 2 pcs
Pouring time: 17-18 sec
Total Pouring Weight: Approx. 300 kg

RESULT
Difference of defect ratio due to inclusion (dross/slag) before the use of SEDEX Filter and after the use of SEDEX Filter.
- Repair ratio by welding: Decreased to 1/8
- Defect ratio after machining: Decreased to 1/10

RESULT
By changing 2 Pcs/Flask to 4 Pcs/Flask, even though pouring yield is slightly reduced due to a larger pouring basin, the productivity is raised by about 40% - a significant improvement.

Photo: 3-a, 3-b
Reference: Photo: 4-a, 4-b, 4-c, 4-d

Photo: 3-b

Photo 4-a: Cope mould

Photo 4-b: Drag mould

Photo 4-c: Another "Fixed Two Units" core is being set by machine.

Photo 4-d: Pre-set line for core assembling.

Units Docking System". Therefore, several countermeasures have been taken. Quoted in this paper are two examples which were published in "JACT NEWS".

The elimination of sand inclusion defects

Sand inclusions were found due to the erosion of the mould surface following the increase in poured metal weight.

![Diagram](Fig. 4)
Sand inclusions found on producing four castings of cylinder block per flask occur due to the mould surface of the runner system being attacked due to increased weight of poured molten metal – see figure 4.

In case of four cylinder block limited flask by "Two Units Docking System" because the poured molten metal weight becomes approximately 300 kg per flask and also the pouring metal flow rate becomes 18-17 kg per flask sec; complete countermeasure was not expected with modifications of the moulding sand system and runner system; ceramic foam filter SEDEX (20 ppi) has been adopted.

At present, sand inclusions at the internal bore of the engine block have been almost eliminated since adoption of SEDEX filter.

Fig. 5, photo 5-a, 5-b and 5-c show setting SEDEX in the core.

The elimination of blow hole defects

Figure 6 shows the distribution of blow defects which have occurred at the inside bore of the cylinder block. Many blow defects have occurred at the side of the down sprue.

Fig. 6
In this case, the flow rate of molten metal through each ingate is calculated by computer (OFAS). Ingate sizes are individually calculated so that flow rates for each ingate are identical as shown in figure 7.

Figure 7 shows the calculated result and flow rate of molten metal by the modified new ingate design. By adopting the new ingate system, the blow hole defects have been significantly decreased.

SEDEX (20 ppi) filter application for a six cylinder engine block

- Flask Size: 1300(L) x 980(W) x 320/320(H)
- Poured Weight: Approx. 160 kg
- As Cast Weight: 70 kg (2 Castings / Flask)
- Pouring Time: Max 20 sec
  See photo 6-a, 6-b, 6-c and 6-d.

PHOTO 6-a: Cope Pattern

PHOTO 6-b: Drag Pattern

PHOTO 6-c: Showing Castings and Runners

PHOTO 6-d: The Runner System

SEDEX (10 ppi) filter application for a six cylinder crankshaft

This crankshaft is used with the previous cylinder block. SEDEX filter trials started at the beginning of 1984. In those days, this crankshaft had been produced by forging. So, the aim was to produce by a ductile iron casting to compete with the forging product. Since November 1984, it has become a ductile iron casting.

- Flask Size: 1050 (L) x 750 (W) x 300/300 (H)
- Spherokizing Treatment: + G. F. + Convertor (It.)
- Pouring Time: Max. 30 sec
- As Cast Weight: 33.8 kg
- SEDEX (10 ppi): Filter for two castings
The SEDEX trials history for a six cylinder crankshaft are shown below; photo: 7-a, 7-b, 7-c, 7-d.

**Before Using SEDEX**

![Photo 7-a](image)

Pouring Yield: 63%
Pouring Time: 26-29 sec

**First trial with SEDEX**

![Photo 7-b](image)

Failure:
Missrun and pit hole defects occurred due to pouring time increased to 35-60 sec.

**Second trial with SEDEX**

![Photo 7-c](image)

Pouring Yield: 64%
Pouring Time: 27-36 sec.

**Third trial modified application**

![Photo 7-d](image)

Pouring Yield: 67%
Pouring Time: 25-30 sec.

The following photos show the current application. See 8-a, 8-b, 8-c and 8-d.

![Photo 8-a: Top View](image)

![Photo 8-b: Bottom View](image)

![Photo 8-c: Cope Mould](image)

![Photo 8-d: Drag Mould](image)
This graph illustrates the difference in dross inclusion defect levels using strainer cores and SEDEX filters. Both foundry and machining shop defect levels are reduced to 1/10th of their previous level when SEDEX filters are used.

Other interesting data obtained during this trial is shown below in figures 9 and 10.

By using SEDEX filters, the %Mg is increased, but slag inclusion defect level did not increase. See figure 9.

When using SEDEX filters, a decrease in pouring temperature gives an increase in pouring time. See figure 10.

Example of SEDEX filter application for the “Inmold® process”

The “Inmold process” technology was developed in the UK. The spheroidising treatment is carried out in the mould rather than in the ladle. The concept of the process is illustrated in figure 11. The reaction chamber is situated between the down sprue and casting cavity of the mould. As metal passes through the reaction chamber, it reacts with the treatment agent and then passes via normal runners and ingates into the casting cavity.

In Japan there are only a few instances of foundries utilising the Inmold process. This is due to practical difficulties in obtaining an even magnesium recovery and nodule count in different sections of one casting, or between each casting when producing multiple castings from one mould. This leads to an extensive requirement for quality assurance testing.

One of the major problems to be overcome is that of dross defects. With the “Inmold process” treatment, reaction dross is formed within the treatment chamber and cannot be physically removed as in ladle spheroidising treatments. Most “Inmold process” dross defects are macro and appear on the as cast or machined surfaces. Sizes are reported to be up to 2-4mm.

As a countermeasure to prevent these dross defects, two examples of SEDEX filter applications follow. It is remarkable that the main runner system after the reaction chamber can now be placed in the drag. See 9-a, 9-b, 9-c, 10-a, 10-b and 10-c.

**Crankshaft**
- As Cast Weight: 12.6kg (8 Castings/Flask)
- SEDEX (10 pp): 4 Pcs/Flask

**Defect Ratio**
- Below 1.8% at Foundry Shop
- Below 0.5% at Machining Shop

**Camshaft**
- As Cast Weight: 8kg (12 Castings/Flask)
- SEDEX (10 pp): 6 Pcs/Flask

**Defect Ratio**
- Below 2.2% at Foundry Shop
- Below 0.5% at Machining Shop
Example of SEDEX filter application for the V-process

- Ductile Iron Pipe Fitting Casting
- Flask Size: 1500 x 1500 x 310/310
- Pour Weight: approx. 200 kg/flask
- SEDEX (10 ppi): 3 pcs/flask

SEDEX filters are used for the elimination of internal cross inclusions. Photo 11-a, 11-b and 11-c shows that the V-Process vacuum film covers the drag pattern and mould.

Photo 11-a: Shows the outlet core print for SEDEX filter and runners on the drag pattern.

Photo 11-b: SEDEX filters and cores are set on the drag mould wrapped with film.
Photo 11-c: Shows the whole drag pattern wrapped with film.
Photo 11-d: Shows the top view of whole castings and runner system.

Example of SEDEX filter application for furan mould

SEDEX filters for furan moulds are typically of a larger size compared with SEDEX filter applications for mass production of green sand moulds.

Due to the importance of obtaining the lowest reject ratio, reduced welding repair ratio and reduction of the machining allowance, because of comparatively large casting size, SEDEX filters are frequently applied to increase overall speed of production.

SEDEX filters are often used in trials to test new casting designs in the laboratory.

In the case of SEDEX filters for larger castings the preferred method is to use more, smaller SEDEX filters than to use fewer larger filters. This increases the overall filtration capacity and gives a greater safety factor for situations where there may be high cross levels.

Maximum poured weight for SEDEX filter application to date is a 10MT gray iron liner casting by using 24 pcs of SEDEX 75 x 75 x 22.

Valve casting – ductile iron casting (FCD 45)

- As Cast Weight: 130 kg
  - 2 Castings per Flask
- SEDEX (10 ppi): 3 Pcs per Flask
- Pouring Weight: approx. 320 kg
- Pouring Time: 40 sec

The adoption of SEDEX filters, significant welding repair work had to be carried out due to core defects caused by the very short runner system in the limited flask area.

After using SEDEX filters, core defects were almost zero.

Photo 12-a shows two runners and six ingates.

Photo 12-b shows core print design for three SEDEX filters on the drag flask – two same sized SEDEX filter and one smaller sized SEDEX filter are employed.

Tool machine base casing – gray iron casting (FC 30)

- As Cast Weight: 1000 kg
  - (2 Castings per Flask)
- Flask Size: 2500 x 2500 x 300/100H
- SEDEX (20 ppi): 10 pcs per 2 Castings-Flask
- Pouring Weight: approx. 2500 kg
- Pouring Time: max. 30 sec.

One pouring basin – 1500 x 500 x 300 H – and two down sprue tubes (70/2) are employed. SEDEX filters are positioned so that metal does not impinge vertically on to them. See fig. 12, fig 13 and photo 13-a, 13-b, 13-c, 13-d.

Fig 12: Whole layouts are shown.

Fig. 13: Ingate layouts are shown.
**Ductile iron plate casting**

- Casting Size: 2000 x 2000
- SEDEX (10 ppi): 8 pcs/casting
- Poured Weight: approx. 1200 kg
- Pouring Time: 28 sec.

This type of ductile iron plate casting has a large surface and is difficult to produce due to dross defects of the casting surface. Much dross trapped on the runner in the front of SEDEX filter is observed. See photo: 14-c.
The following example of SEDEX filter application is for wider and larger sized castings, so 10 pcs of SEDEX 10 ppi per casting are used (Flask Size: 3000 x 3000 x 350/350). (Reference: Photo 15-a, 15-b, 15-c and 15-d.)

Photo 15-a: Top view

Photo 15-b: Cope mould

Photo 15-c: Drag mould

Photo 15-d: Bottom view

Compressor case casting – gray iron (FC 25)

- As Cast Weight: 150 kg
- Pouring Weight approximately 300 kg
- SEDEX (20 ppi): 2 Pcs per Flask
See fig. 14 and photo 16-a, 16-b.

Fig. 14: Runner system

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