Steel casting for Vienna's new ultra-low-floor tram

Introduction

Siemens Verkehrstechnik is one of the largest suppliers of systems for trams and other railbound vehicles in the world. Siemens received an order for 150 new low-floor trams from the city of Vienna to be supplied from the end of 2006. Vienna actively supports the development of local public transport to encourage its citizens away from their cars. In order to do this, modern, innovative and more comfortable trams are required.

Figure 1 ULF tram from Vienna

Specification

This tram (figure 1), is equipped with the newest and most highly developed technology, electronics and microprocessor controllers and is a world leader in its field. Access height is only 19 cm (this is why the tram is also called "ULF" - Ultra-Low-Floor) and it is therefore very convenient for the passengers. The street surface and train floor are virtually at the same level and in combination with the high number of doors this guarantees quick entry and exit of passengers and very short waiting times at the tram stops.

The chassis is constructed as a portal frame (figure 2), which spans the passenger compartment above the hinges of the vehicle modules. With this construction the low step height is achieved. The assembled wheel arch is shown in Figure 3.

Figure 2 Row of portal frames

Figure 3 Assembled wheel arch

Technical Data

Gauge:	1.44m
Width:	2.40m
Length:	24.21m or 35.47m
Low floor part:	100%
Wheel diameter:	680mm
Undercarriages:	radial steered portal undercarriages
Passengers:	136 or 207
Motor capacity:	6x80 kW or 8x80 kW
Speed:	70 km/h max.

Wheel arch casting production

The FWH steel foundry in Mülheim/Ruhr (Germany) delivers the inner, outer and portal wheel arch for the ULF vehicles. FWH is a member of the Georgsmarienhütte Holding GmbH, a consortium of 43 companies. The foundry employs approximately 245 people.

The moulds for these three different wheel arch castings are manufactured in Mülheim on a highly innovative air-flow squeeze moulding machine on a pattern plate of 1200mm x 1000mm x 350/350mm size (figures 4 and 5).

Figure 4 Moulding of inner wheel arch

Figure 5 View at inner wheel arch cope mould

In order to create optimum conditions for mould filling, Magma simulation studies were carried out prior to casting. Figure 6 shows a simulation of the temperature distribution of the outer wheel arch directly after mould filling. Figure 7 shows a 3D version of the inner wheel arch.

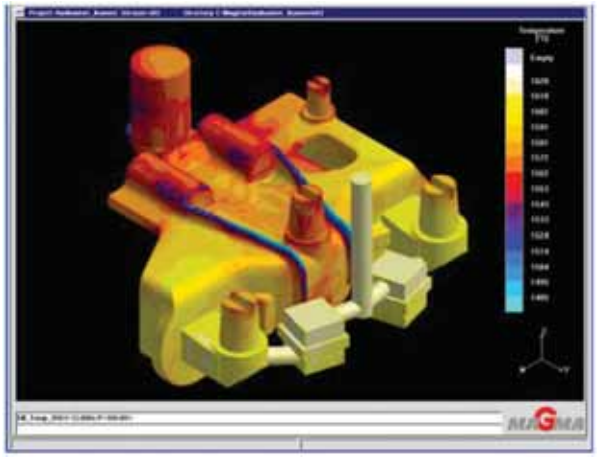

Figure 6 Simulation of temperature distribution

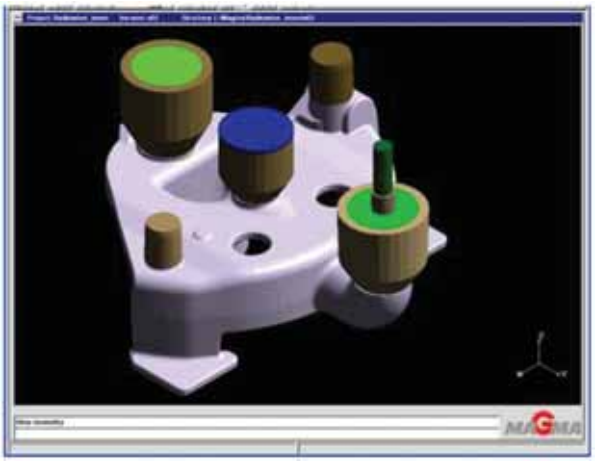

Figure 7 3D version of the inner wheel arch

The steel charge is heated in either an induction or an arc furnace and refined in a VARP converter (Vacuum-Argon-Refinement-Process), (figure 8). With this treatment, the molten steel is desulphurised and deoxidised in a vacuum. Sulphur, nitrogen, hydrogen and oxygen are thereby reduced to minimum levels.

Figure 8 Filling of VARP converter

Advantages:

- ❑ High yield point values
- ❑ High fracture toughness values
- ❑ Excellent welding ability
- ❑ Significant improvement of notched impact strength - also at lowest temperature
- ❑ Tighter mechanical-technological tolerances
- ❑ Higher creep resistance.

The unfinished castings (figure 9), are shipped from Mülheim to Augsburg where the finishing takes place. After that they are shipped to GGH-Radsatz GmbH in Oberhausen where the wheel arch sub-assembly is prepared (figure 10). The final assembly of the trams is done in Vienna at Siemens SGP Verkehrstechnik.

At the time of writing, more than 100 trams, each of them equipped with 12 or 16 of these FWH cast wheel arches are in use in Vienna.

Figure 9 Interior view of outer wheel arch

Figure 10 Sub assembled wheel arch

With the help of KALMINEX* sleeves and STELEX* PrO filters, FOSECO ensures that FWH is able to deliver highest quality castings to Siemens SGP Verkehrstechnik (figures 11 and 12).

Figure 11 Outer wheel arch raw casting

Figure 12 Inner wheel arch raw casting

Foseco products:
2 x STELEX PrO filters of 125x125x30/10ppi
1 KALMINEX X6 sleeve
1 KALMINEX 2000 ZP 6/9K
1 KALMINEX 2000 ZP 7/10K
2 KALMINEX 2000 ZP 10/13K

Pouring weight:	309 kg
Casting weight:	174 kg
Yield:	56.3 %
Pouring time:	9-10 sec
Filter capacity:	1.0 kg/cm²

Foseco products:
1 KALPUR* ST ZTAE 15/18 with STELEX PrO filter of Ø125x 30/10ppi
3 KALMINEX 2000 ZP6/9K
1 KALMINEX 2000 ZTA4
1 KALMINEX 2000 ZTA5
1 FEEDEX* V238

Pouring weight:	231 kg
Casting weight:	140 kg
Yield:	60.6 %
Pouring time:	7-8 sec
Filter capacity:	1.9 kg/cm²

Conclusion

FWH steel foundry and FOSECO are constantly working in close co-operation to find optimum solutions for steel casting problems. FWH was the first foundry in Germany to test STELEX PrO filters in January 2001 and the first to employ them in actual casting production.

References

Friedrichs Wilhelms-Hütte Stahlguss GmbH
-- Mülheim an der Ruhr -- Germany

Siemens SGP Verkehrstechnik -- Wien -- Austria

GGH-Radsatz GmbH -- Oberhausen -- Germany

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