



# FLUORIDE EMISSION FREE FEEDING SYSTEMS SOLUTIONS



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Fluoride compounds have been used in foundries since the 1950s to initiate exothermic reactions in aluminum. Recently, there has been increased focus on fluorides, particularly their presence in feeder sleeves. Concerns include their impact on casting integrity and environmental legislation regarding fluoride disposal.

To address these issues, a range of fluoride-emission-free formulations have been developed, providing the same performance as their conventional counterparts. In order to achieve these results extensive research and trials have been carried out.

## INTRODUCTION

Fluoride compounds have been used to initiate the exothermic reaction of Aluminium since Foseco introduced exothermic feeder sleeves in the 1950's. However, in recent years, foundries have paid increasing attention to fluorides in general and particularly the presence of fluorides in feeder sleeves has attracted some attention.

Initially the focus was on the impact of fluoride on casting integrity and the potential risk of surface defects such as "fish eye". Fluoride can enter the sand system from several sources such as the bentonite added to green sand, and of course the small amounts of fluoride present in exothermic sleeves.

Although the quantities of fluoride present are very low and measured as a fraction of a percent, under certain extreme circumstances, fluoride levels in the sand system can build up and, in such cases, the contribution from exothermic sleeves can be critical.

More recently attention has focused on environmental legislation. Regulation on the disposal of used foundry sand is tightening, and levels of potential land fill contaminants are strictly controlled.

Fluoride is increasingly specified as one of these "controlled" materials, and the presence of water leachable fluoride in sufficient quantities can have a significant impact on sand disposal costs.

For high strength ram-up spot feeders FEEDEX\* FEF (Fluoride Emission Free) has been developed to consistently provide the same level of exothermic performance as conventional FEEDEX HD1. FEEDEX FEF is a new formulation for high density exothermic ram-up feeder sleeves, which eliminates the conventional initiator for the exothermic reaction.

FEEDEX FEF is designed to improve casting yield and feed performance and provide an identical modulus to the equivalent FEEDEX HD1. The table below compared the critical properties of the standard and FEEDEX FEF variants (Figure 1).

External laboratories have been used to test both formulations, FEEDEX HD1 and FEEDEX FEF to quantify and validate the water leachable fluoride content. (Figure 2).

Property	Unit	FEEDEX HD1	FEEDEX FEF
Density (GF - test body)	[g/cm <sup>3</sup> ]	1.51	1.61
density product	[g/cm <sup>3</sup> ]	1.42	1.52
permeability		180	170
CCS (GF - test body)	[kN]	> 25	> 25
Burn time, ox. *	[s]	110	225
T-max, ox.	[C]	1610	1509
t > 1150, ox.	[s]	320	291
T-max, red. *	[C]	1380	1449
t > 1150	[s]	275	288

Figure 1. Data represent typical values as measured on a standard laboratory sample.

	Sleeve Condition	Water leachable fluoride * [mg/l]
FEEDEX HD1	Not burned	50
	Burned	15
FEEDEX FEF	Not burned	1.2
	Burned	1.1

Figure 2. Water leachable fluoride content of burned unburned feeder sleeve material

The exothermic burn profiles of FEEDEX products are carefully designed and optimised as it is critical to match the heat output of the feeder sleeve to the solidification time of the feeder.

Performance of the FEEDEX FEF has been shown to be equal to conventional FEEDEX HD1 ram-up feeder sleeves. (Fig 3).

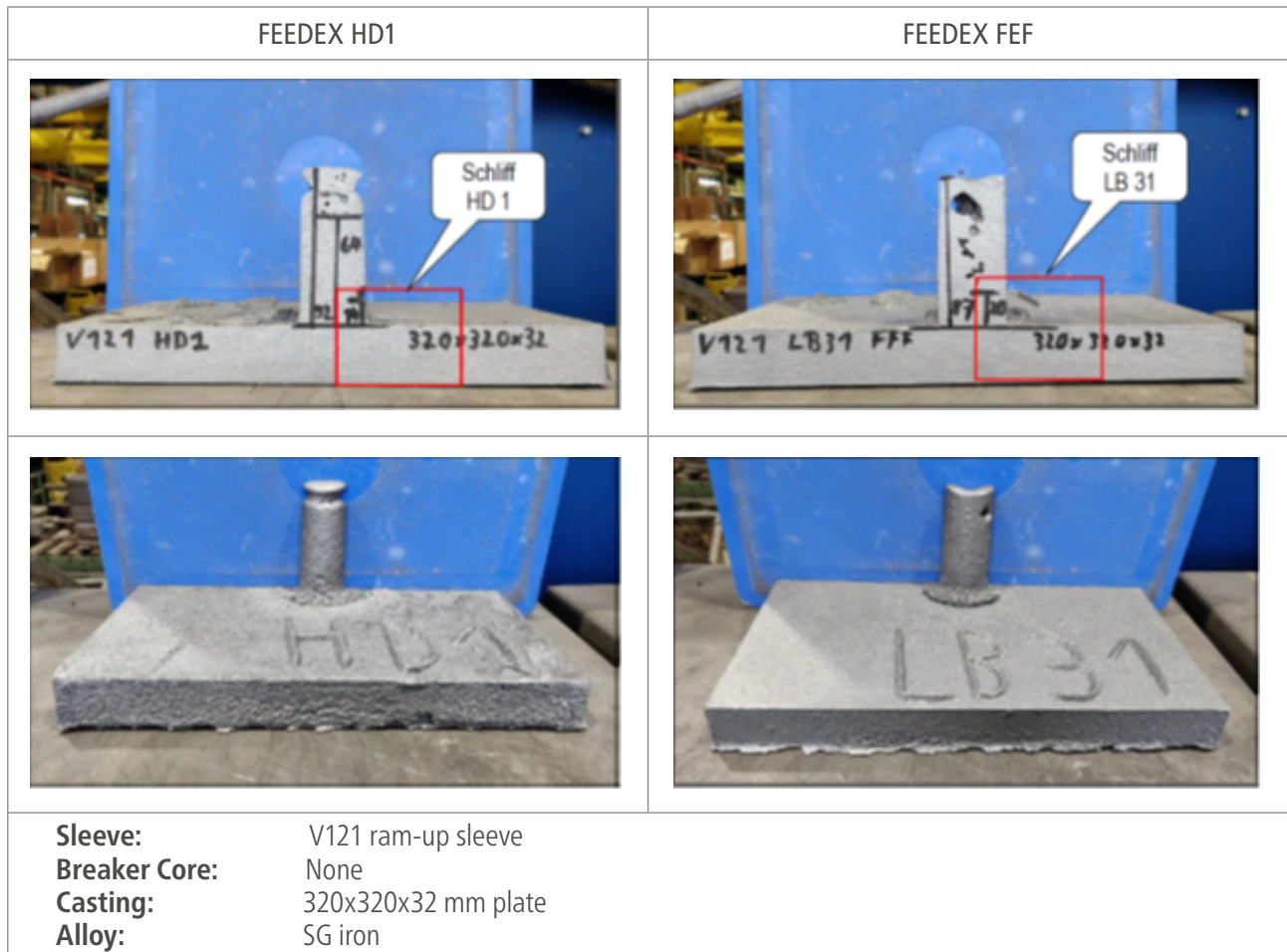


Figure 3. Comparative Ductile Iron plate tests with FEEDEX HD1 and FEEDEX FEF

Similar efforts were also made to develop a fluoride free insulating exothermic slurry form recipe. Extensive research and trials resulted in a fluoride free version of KALMINEX\* 2000.

KALMINEX\* 2000 FF is the only commercially available fluoride free, exothermic slurry form recipe in the market today. Fluoride free KALMINEX 2000FF feeder sleeves are highly effective in reducing riser size and providing consistent feeding performance in both iron and steel applications.

For foundries using the KALMINEX 2000FF products, the absence of fluoride enables the reduction of disposal costs for waste moulding sand. There is no requirement to use or pay for special disposal as the feeder sleeves contain zero fluoride.

Analogue to the tests conducted during the development of FEEDEX FEF a comprehensive range of tests were conducted to validate the performance of KALMINEX 2000FF (relative to the standard product).

These included,

- physical and thermo-physical laboratory measurements,
- step test castings in produced in green sand (Iron)
- steel cube castings and ductile iron plate castings to compare feed performance

Results confirmed KALMINEX 2000 FF has similar physical and thermo-physical properties compared to the standard formulation. (Figure 4).

	KALMINEX 2000	KALMINEX 2000FF
Density [gm/cc]	0.59	0.61
Compression strength [k.N]	3.9	4.7
Gas permeability [ml/min*cm <sup>3</sup> ]	30.6	32.7
Moisture content [%]	0.49	0.46
Ignition time [sec]	16.8	20.4
Burn time [sec]	86	127
Maximum temperature / GF body [°C]	1610	1646
Time over 1150 °C / GF body [sec]*	180	202

Figure 4. Comparative physical and thermo-physical tests

\*single tests



Extensive casting tests proved a comparable performance in application (Fig. 5a + 5b)



Figure 5a. Ductile iron casting test with KALMINEX 2000 ZP 6/9K/11Q versus KALMINEX 2000 FF FZP 6/9K/11Q on a 250 x 250 x 25 mm plate. Both sleeves showed comparable feed safety margin

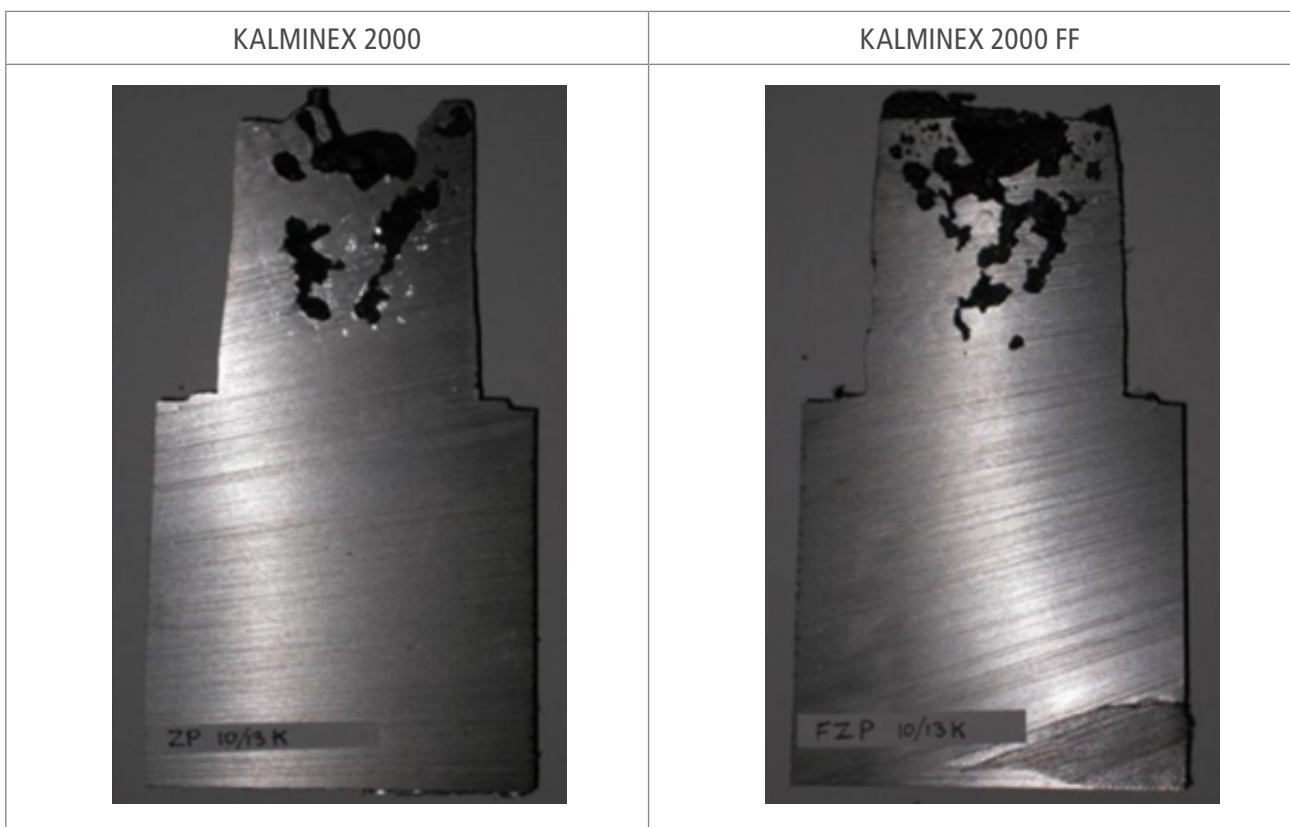


Figure 5b. Carbon steel casting test with KALMINEX 2000 ZP 10/13K versus KALMINEX 2000 FF FZP 10/13K on a 150mm cube, again both sleeves with comparable feed safety margin.

Tests were established to determine the contamination effect of varying concentrations of burned sleeve residue in re-used greensand. Results were assessed by monitoring the incidence of casting surface quality defects. The addition rate was increased in incremental steps of 3% from 0 to 9%. A nominal addition of

3 % feeder sleeve residue in the sand, already represents many times the level typically encountered in most foundries.

Results confirm the neutrality of the KALMINEX 2000 FF contaminated sand compared to the standard product. (Fig. 6)

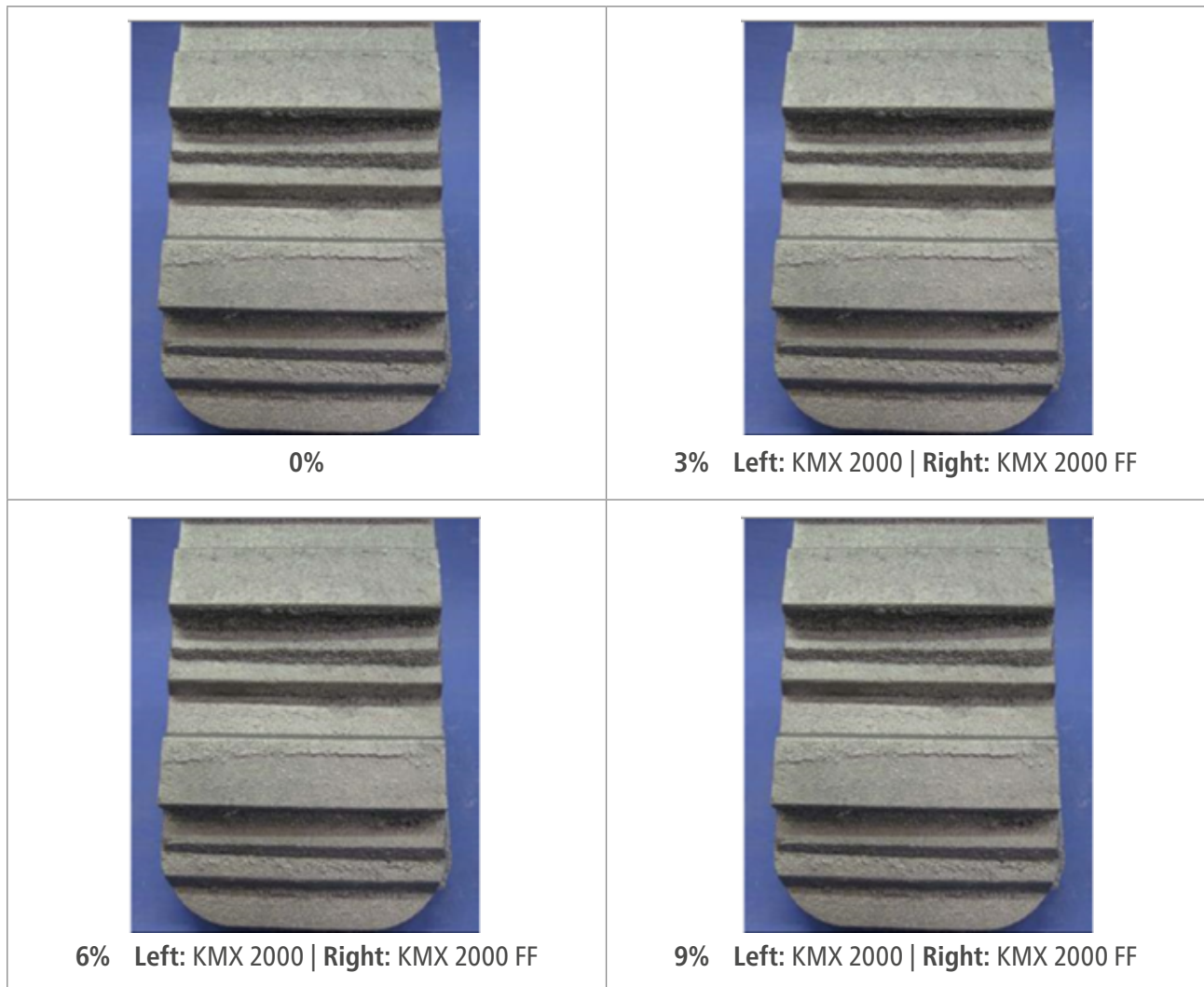


Figure 6. Neutrality of the KALMINEX 2000 FF contaminated sand compared to the standard product

## SUMMARY

In summary, both formulations FEEDEX FEF and KALMINEX 2000 FF proved to be interchangeable with their conventional counterparts in terms of their thermos-physical properties and feed performances.

With the confidence gained by these tests, several customer trials were conducted which validated the results generated previously. The similar properties of FEEDEX FEF and KALMINEX 2000 FF with their standard product counterparts, enables foundries to easily convert from standard feeder sleeve products to fluoride emission free formulations.

There remain many environmental challenges ahead for foundries, including targets to reduce VOCs. FOSECO remains committed to work in partnership with our customers to develop the products they will require in the future in order to satisfy increasing regulation, whilst remaining commercially competitive.

## ABOUT THE AUTHOR

Christof has worked for Foseco since 1998.

In his job as European Product Manager for Feeding Systems, Christof acts as an interface between customers, development and production.

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