



12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye

**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**



**«Yenilikçi Rotoclene Prosesi ile Yüksek Performanslı Uygulamalar İçin Ultra  
Düşük Dökme Sıcaklıklarında Temiz Çelik Döküm»**

**«Clean Steel Castings At Ultra-low Pouring Temperatures For High Performance  
Applications Using The Innovative Rotoclene Process & Hollotex Shroud»**

**David Hrabina**  
**(FOSECO)**

## **5. Oturum / 5th Session**

**Oturum Başkanı / Session Chairman: Prof. Dr. Ali Kalkanlı**  
**(Orta Doğu Teknik Üniversitesi)**





12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**



## What is ROTOCLENE?

The “MTU” Metal Treatment Unit stirs the molten metal in the pouring ladle, homogenizing metal temperature whilst removing the bi-films and inclusions generated in the tapping process. It can be deployed in any ladle location.

The ROTOCLENE process combines metallurgical process knowledge from both foundry and steelmaking industries



FOSECO





12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**



# Metal Tapping



**METAL TAPPING**

MTU OPERATION

KEY BENEFITS

ANIMATION

SHROUD POURING

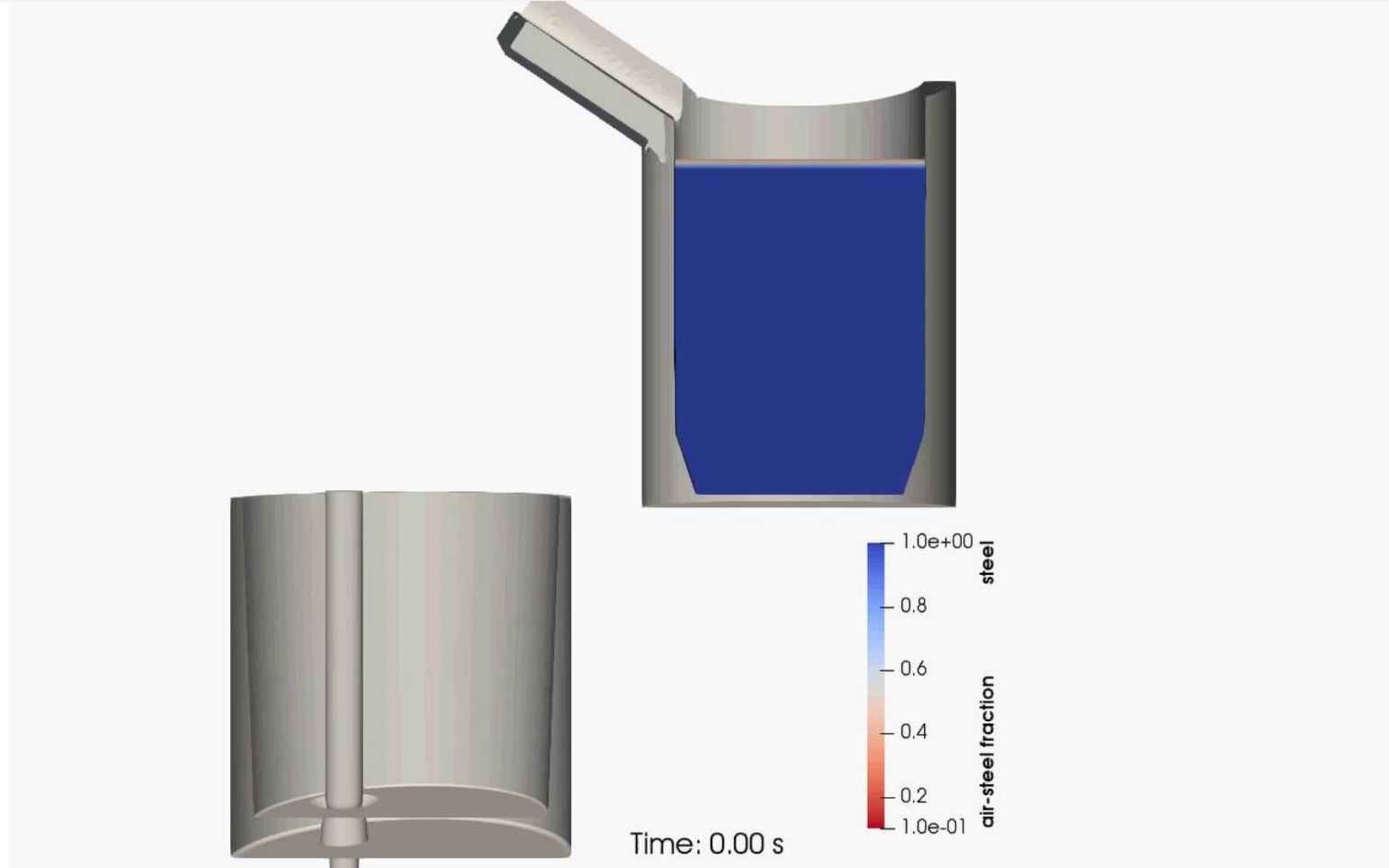


12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**



**CFD Simulation**  
**(air entrainment)**



**METAL TAPPING**

**MTU OPERATION**

**KEY BENEFITS**

**ANIMATION**

**SHROUD POURING**



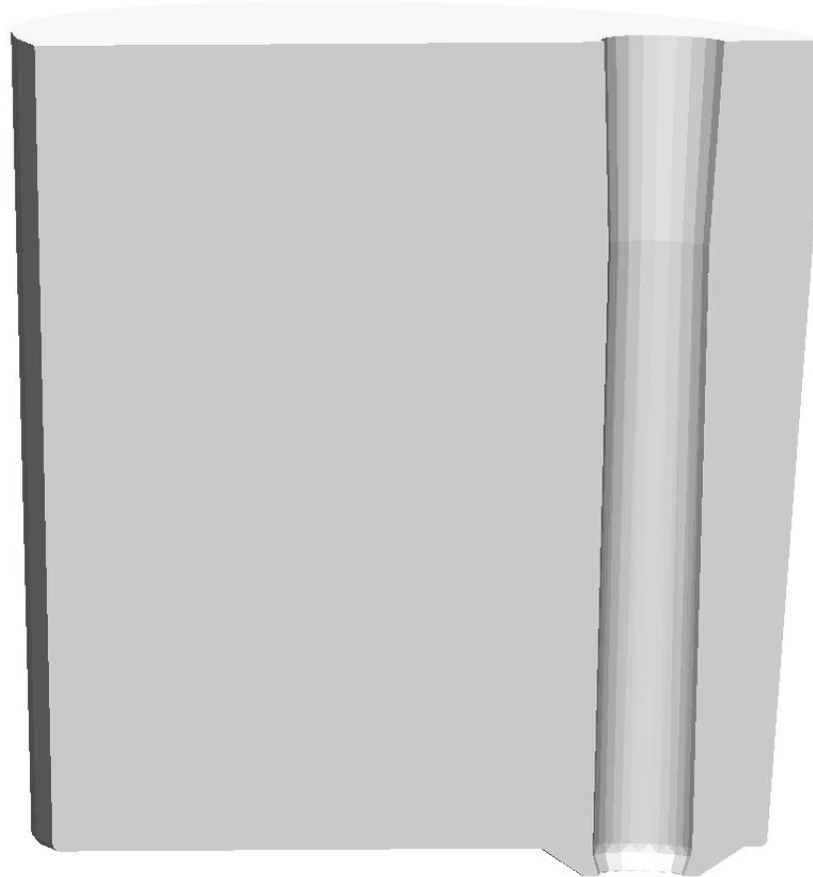
12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**

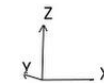
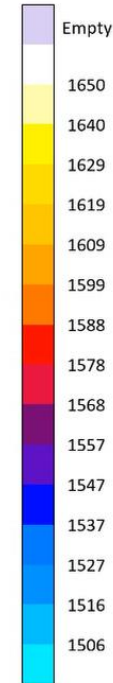


**Metal temperature  
varies across the ladle**

v05  
Solidification & Cooling, Temperature  
0.0ms, 0.00 %  
X-Ray: off



Temperature  
°C



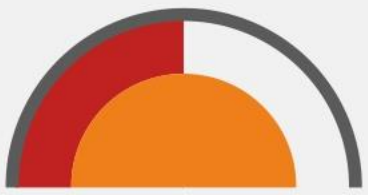
**METAL TAPPING**

**MTU OPERATION**

**KEY BENEFITS**

**ANIMATION**

**SHROUD POURING**



12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**



tüdöksad  
akademi



FOSECO

**MTU  
process Start**



METAL TAPPING

**MTU OPERATION**

KEY BENEFITS

ANIMATION

SHROUD POURING



12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**



**Rotor extraction &  
MTU removal**



METAL TAPPING

**MTU OPERATION**

KEY BENEFITS

ANIMATION

SHROUD POURING



12<sup>th</sup> International  
**Foundry  
Congress**

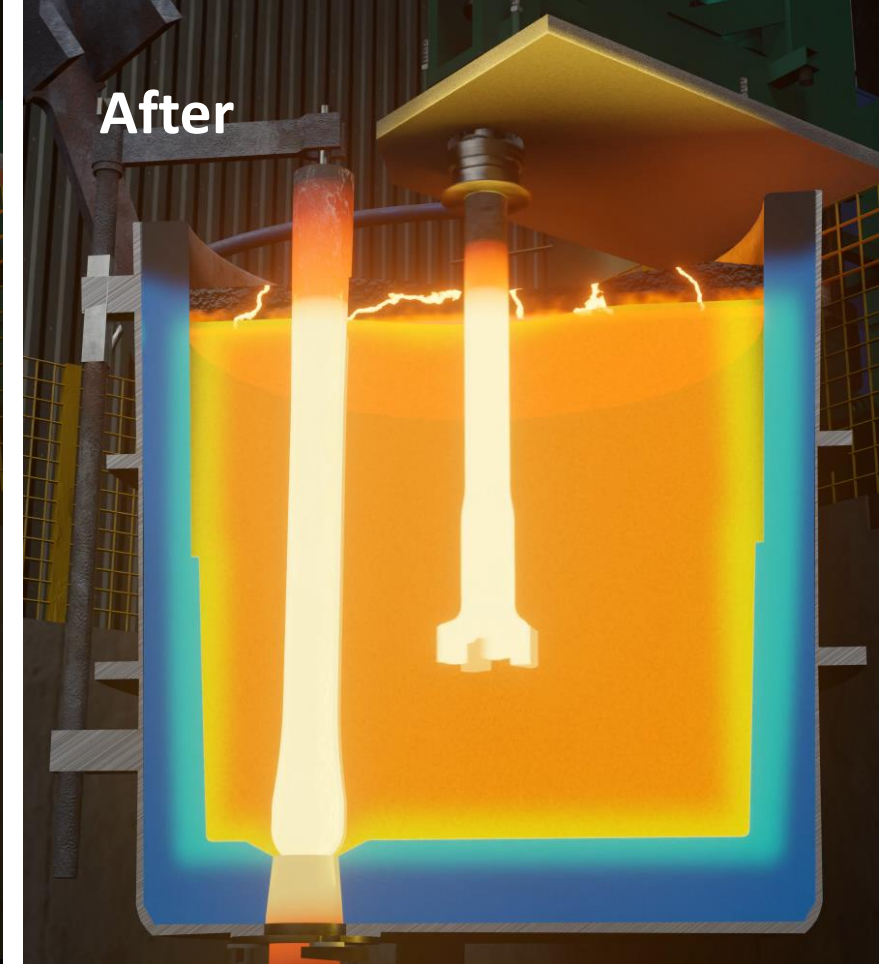
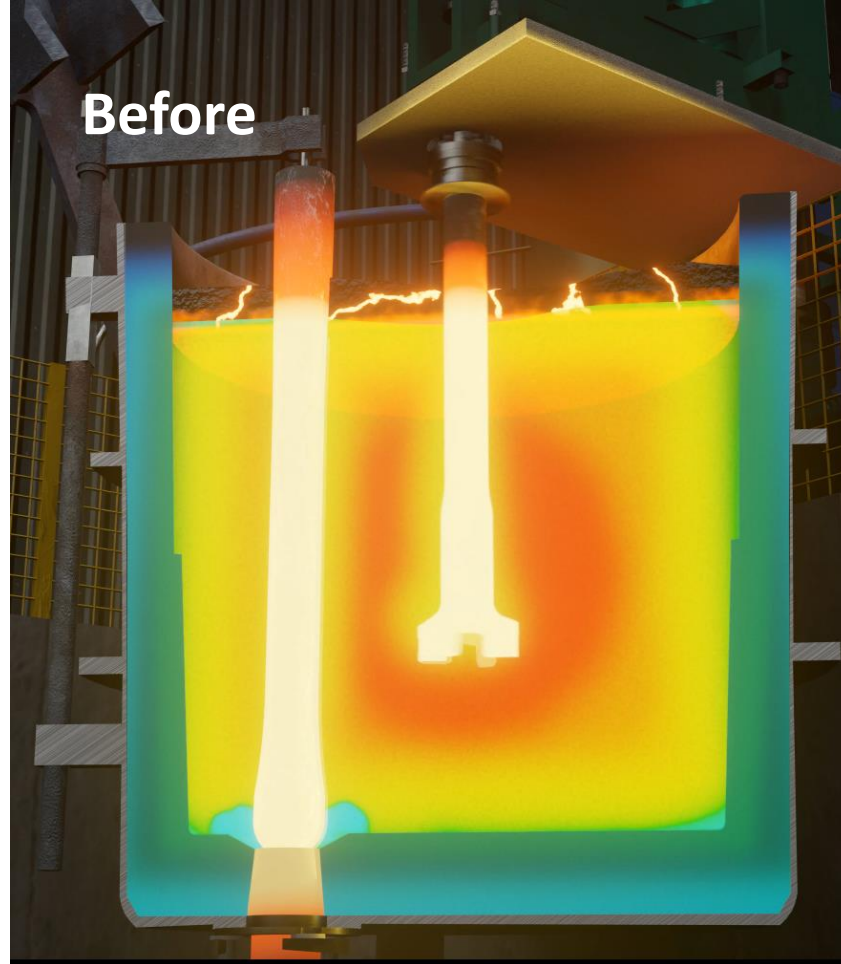
19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**



tüdöksad  
akademi



**Metal temperature  
homogenization**



**METAL TAPPING**

**MTU OPERATION**

**KEY BENEFITS**

**ANIMATION**

**SHROUD POURING**





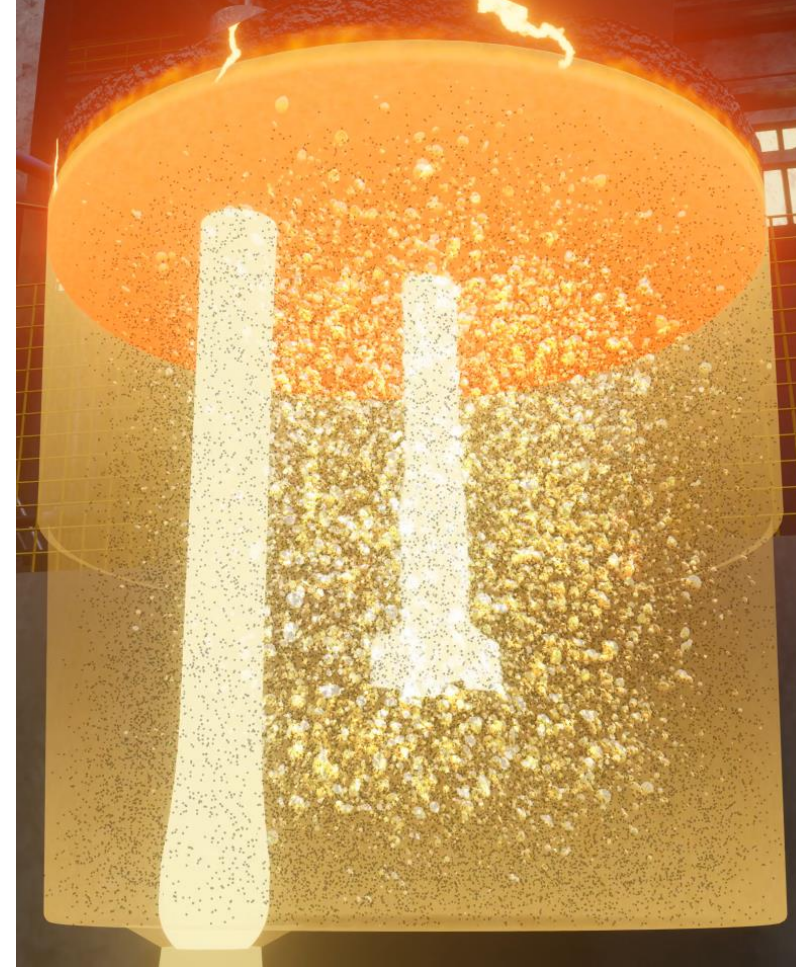
12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**



## Inclusions and Bi-films removal

The helical distribution of the argon bubbles swirling within the melt is around 20-30 times larger than vertical bubble flow generated by a traditional purge plug.



METAL TAPPING

MTU OPERATION

**KEY BENEFITS**

ANIMATION

SHROUD POURING



12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**

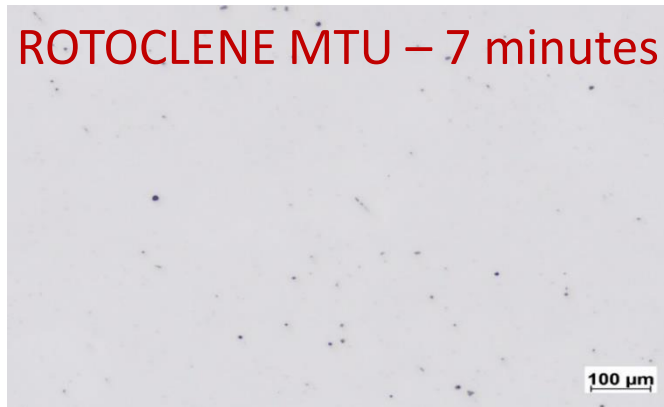


**Metal  
temperature  
homogenization**

Argon Purge Plug – 20 minutes



ROTOCLENE MTU – 7 minutes



	047 - Metal treated by Purging Plug at the ladle	092 - Metal treated by rotary treatment
Total Area Analyzed (mm <sup>2</sup> )	116.64	116.64
Total Number of Classified Features	4709	2142
Total Area Analyzed Features without unclassified (micrometer <sup>2</sup> )	49576	34942
<b>Si&gt;70</b>	143	81
<b>Al&gt;70</b>	208	107
<b>70&gt;Al&gt;50</b>	407	298
<b>Mn&gt;25 and S&gt;10</b>	2373	1426
<b>Mg&gt;25</b>	1	0
<b>Ca&gt;50</b>	2	7
<b>50&gt;Ca&gt;10</b>	1471	141
<b>Rest</b>	104	82



METAL TAPPING

MTU OPERATION

KEY BENEFITS

ANIMATION

SHROUD POURING



12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye

**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**

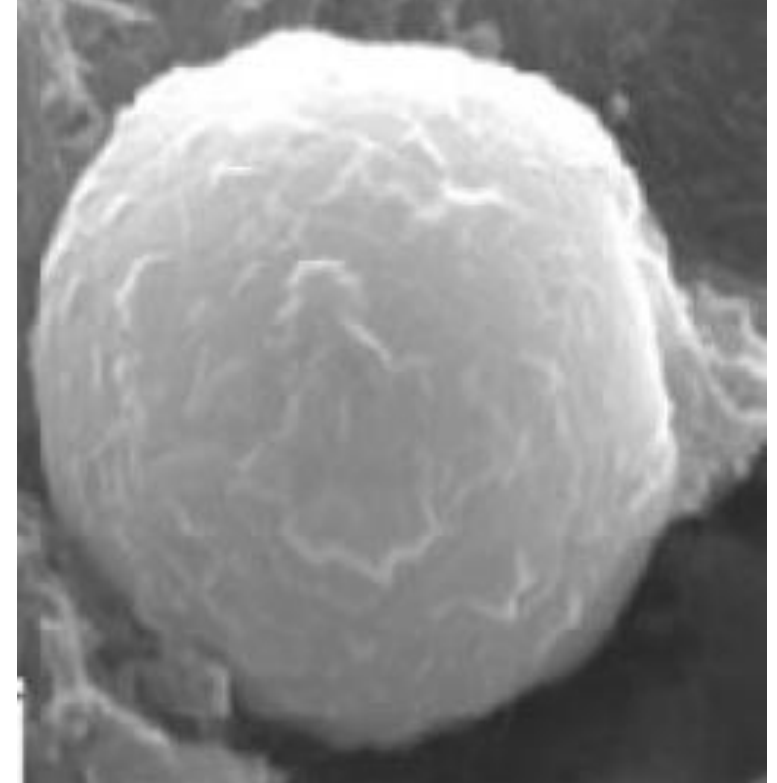
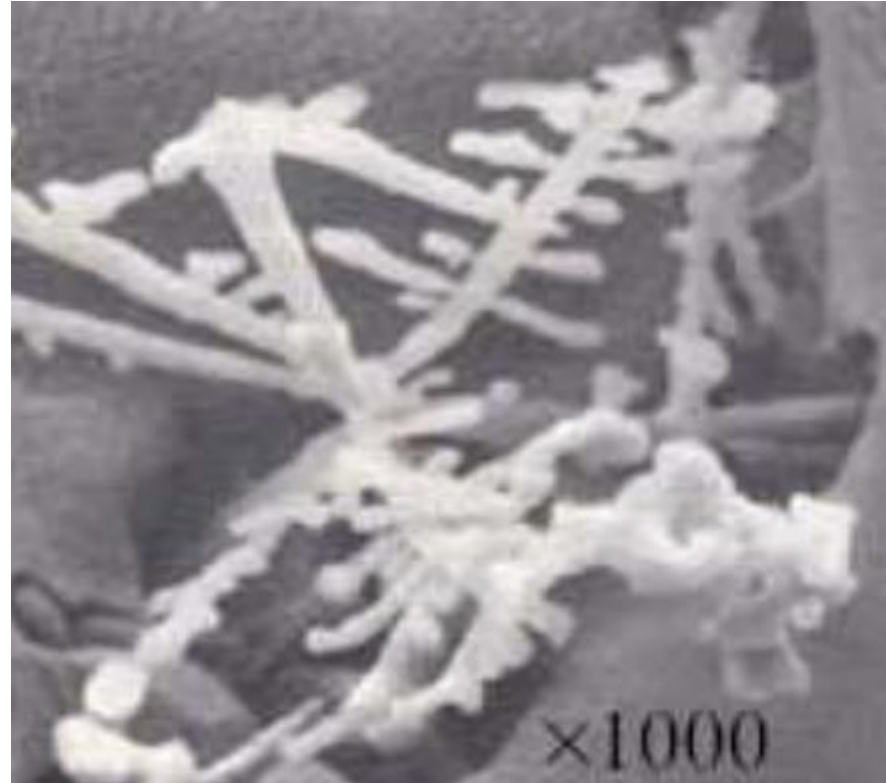


**tüdöksad**  
akademi



FOSECO

**Alumina inclusions  
modification by  
pure Ca**



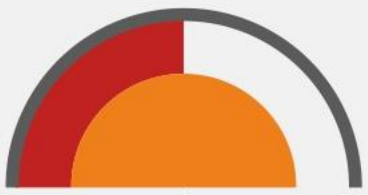
METAL TAPPING

MTU OPERATION

**KEY BENEFITS**

ANIMATION

SHROUD POURING



12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye

**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**



## Desulfurization by synthetic slag

Test No	Time	C	Mn	Si	P	S	Cr	Mo	Ni	Al	Al soluble
1	12:40	0,67	0,85	0,18	0,016	<b>0,017</b>	0,30	0,20	0,22		
2	13:08	0,31	0,16	0,00	0,002	<b>0,012</b>	0,09	0,27	0,20		
3	13:45	0,40	0,42	0,42	0,006	<b>0,007</b>	0,89	0,26	0,19	0,027	0,023
Final	14:37	0,45	0,82	0,52	0,008	<b>0,002</b>	1,13	0,26	0,19	0,033	0,031

*Test No1 – EAF just after smelting (6800 kg)*

*Test No2 – EAF after oxidation*

*Test No3 – EAF before tapping → 1% of synthetic slag Sulfamin 70 into the pouring ladle within tapping*

*Test No4 – Taken from the ladle after ROTOCLENE treatment at the end of pouring process.*

***Sulfur level reduced from 70 to 20ppm.***



METAL TAPPING

MTU OPERATION

**KEY BENEFITS**

ANIMATION

SHROUD POURING



12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**

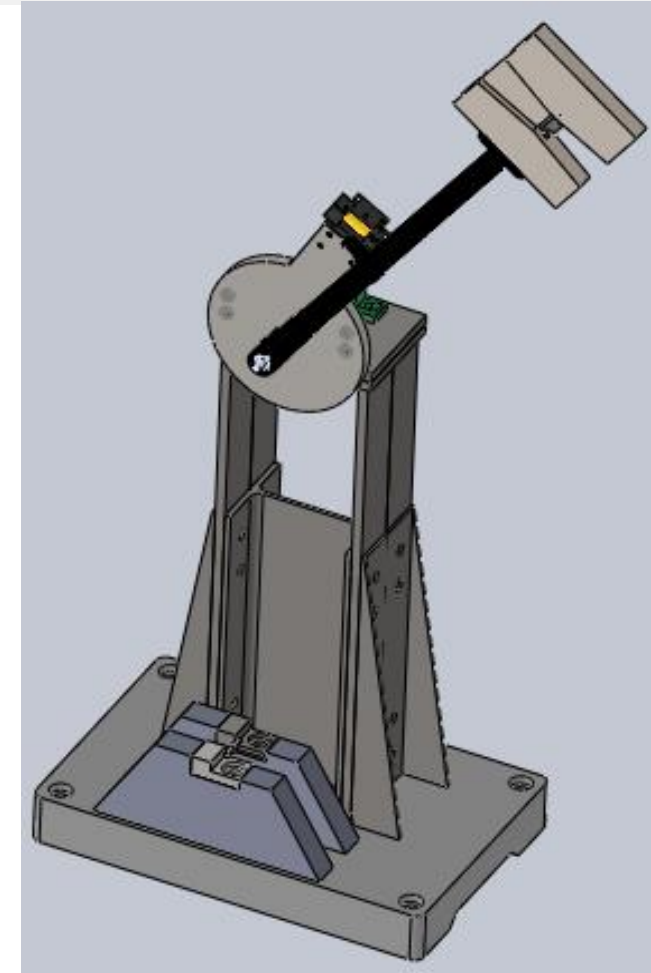
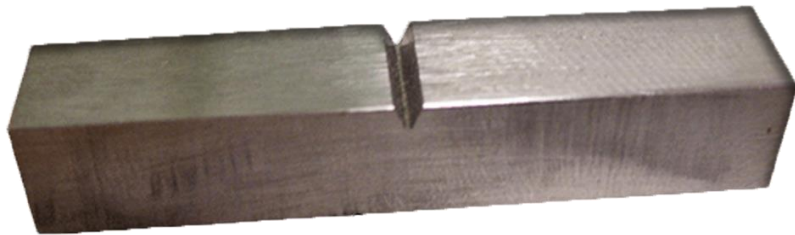


## Mechanical properties increase

Modified G20Mn5+QT (QT to minimum 621 MPa)

Thickness of the test block attached to casting 80mm

	No. tests	KV <sub>2</sub> -30°C	
		Average	Median
Purge Plug	723	46	44
ROTOCLENE	54	56	57



**METAL TAPPING**

**MTU OPERATION**

**KEY BENEFITS**

**ANIMATION**

**SHROUD POURING**



12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**

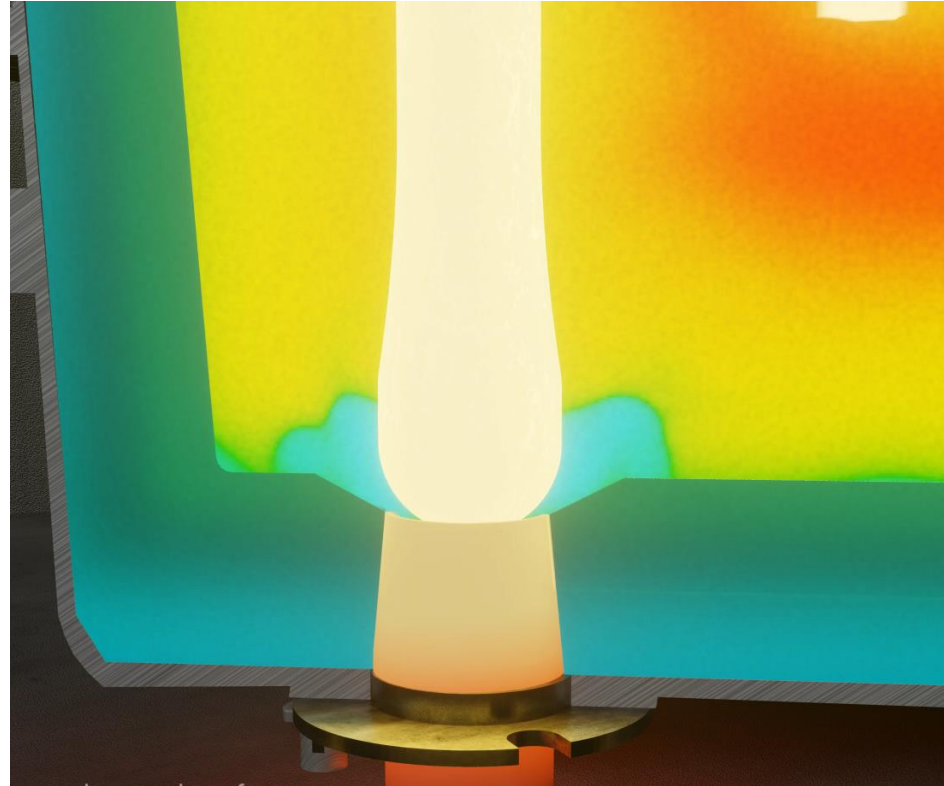


**tüdöksad**  
akademi



FOSECO

**Elimination of  
cold spots  
facilitates a  
reduction in  
pouring  
temperature**



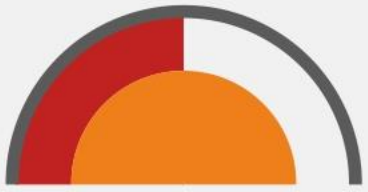
METAL TAPPING

MTU OPERATION

**KEY BENEFITS**

ANIMATION

SHROUD POURING

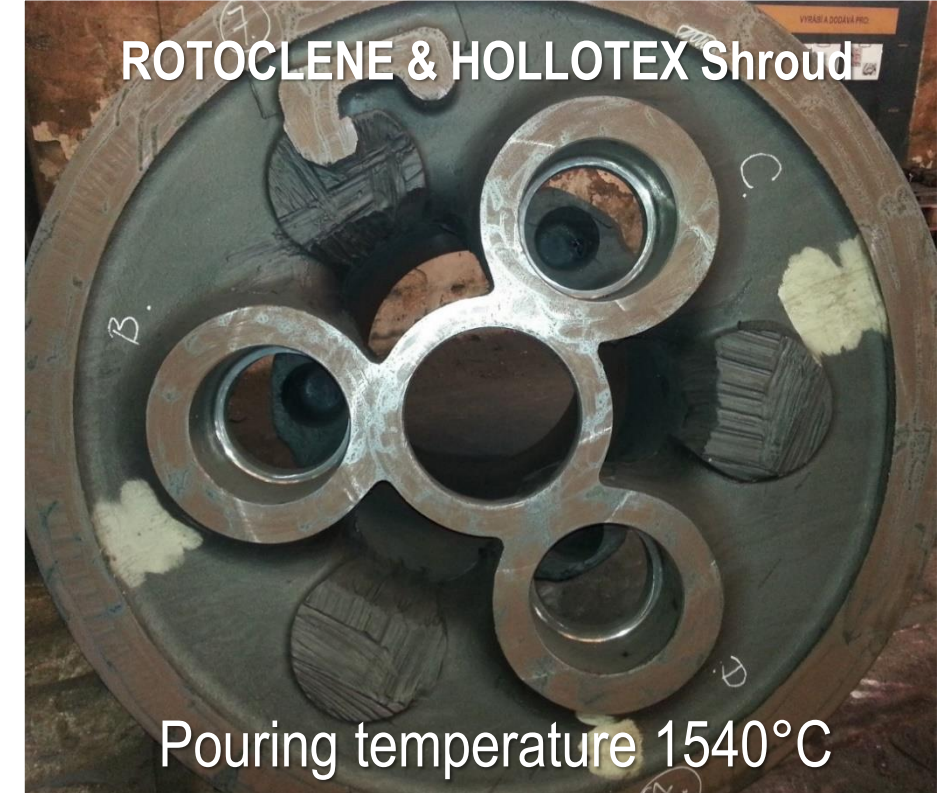


12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**



**Significantly shorter  
lead times are  
achieved through a  
reduction in rework**



METAL TAPPING

MTU OPERATION

KEY BENEFITS

ANIMATION

SHROUD POURING

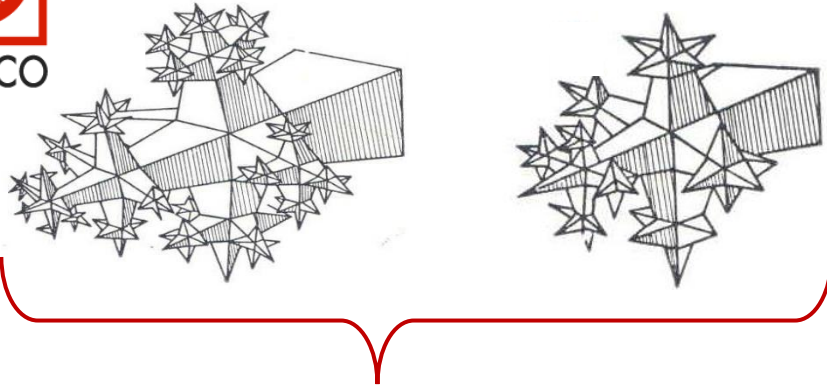


12<sup>th</sup> International  
**Foundry  
Congress**

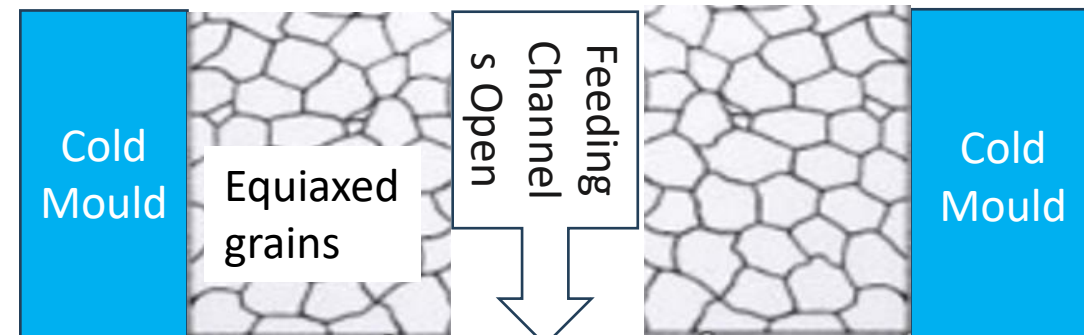
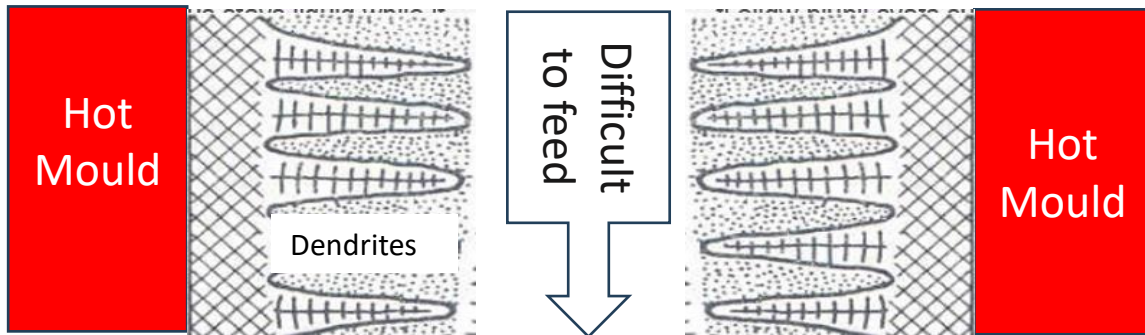
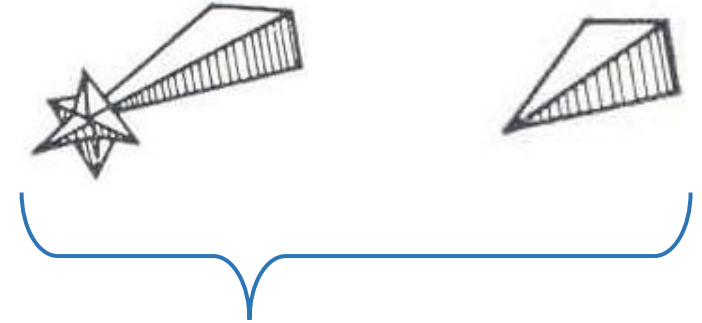
19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**



## Solidification - dendrite growth principle



Superheat leads to extended solidification time. Longer time for dendrites to grow and block feeding distances. Porosity among dendrites would be detected by X-Ray or ultrasonic inspection



METAL TAPPING

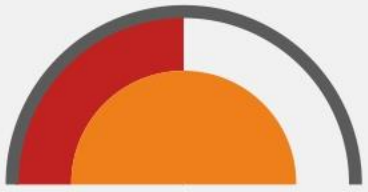
MTU OPERATION

KEY BENEFITS

ANIMATION

SHROUD POURING





12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye

**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**

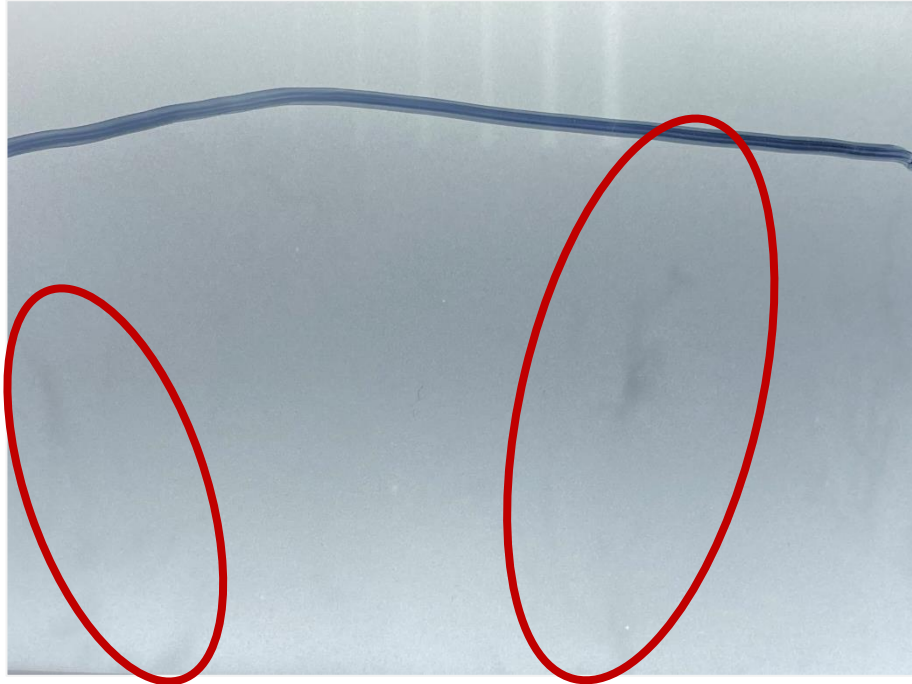


**tüdöksad**  
akademi



## Shrinkage and porosity reduction

Pouring temperature 1570°C



Pouring temperature 1540°C



METAL TAPPING

MTU OPERATION

**KEY BENEFITS**

ANIMATION

SHROUD POURING



12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**



**ROTOCLENE**  
**Animation**



**METAL TAPPING**

**MTU OPERATION**

**KEY BENEFITS**

**ANIMATION**

**SHROUD POURING**

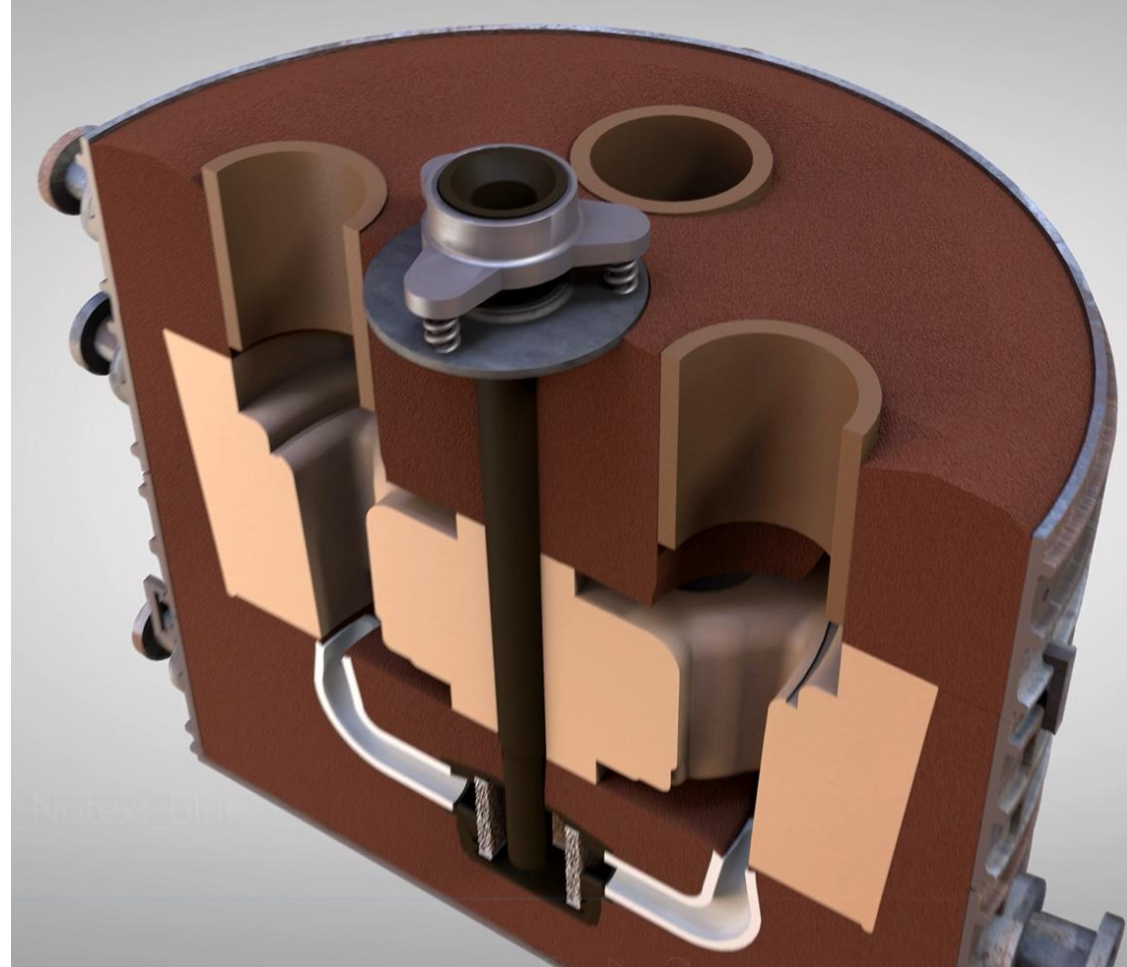


12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**



**Long Shroud  
assembly**



**METAL TAPPING**

**MTU OPERATION**

**KEY BENEFITS**

**ANIMATION**

**SHROUD POURING**

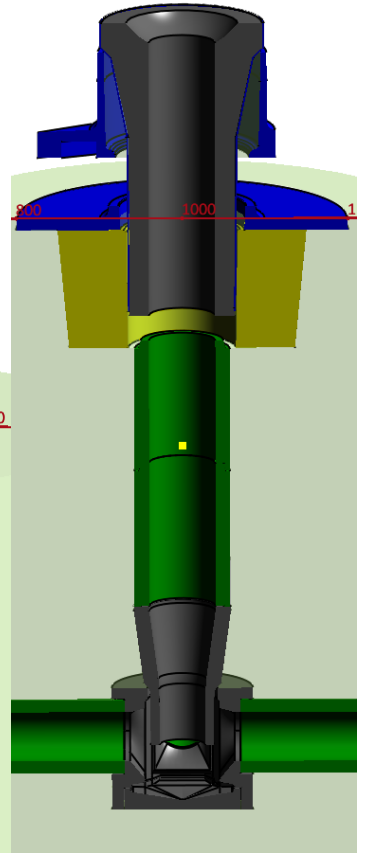
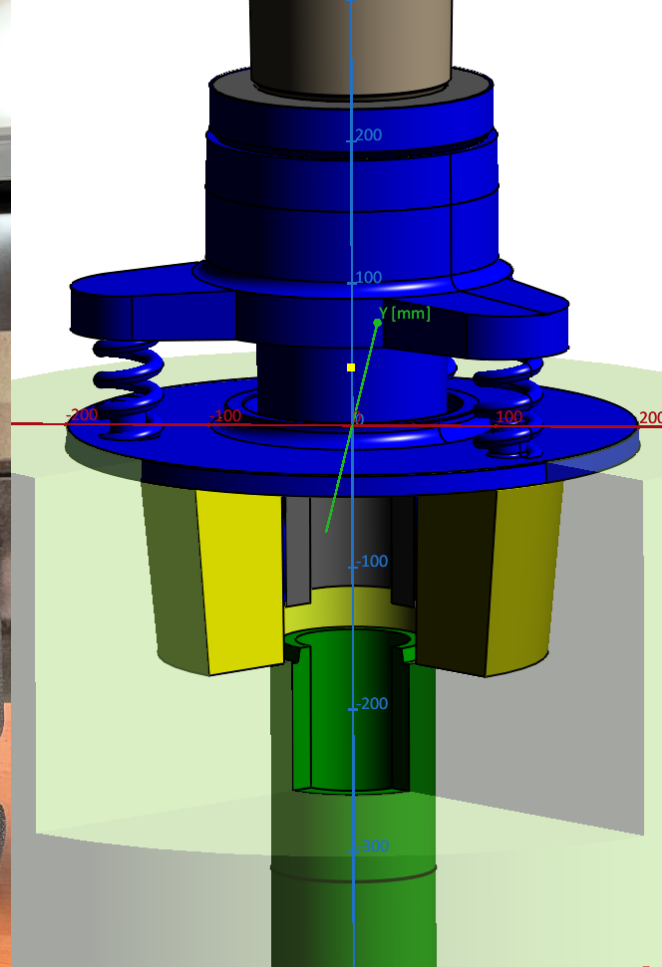


12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**



**Short Shroud  
assembly**



**METAL TAPPING**

**MTU OPERATION**

**KEY BENEFITS**

**ANIMATION**

**SHROUD POURING**



12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**



**Water modeling**

**Shrouded versus  
conventional**



**METAL TAPPING**

**MTU OPERATION**

**KEY BENEFITS**

**ANIMATION**

**SHROUD POURING**



12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**



**Water modeling**

**Shrouded pouring  
versus conventional**



**No air entrapment**



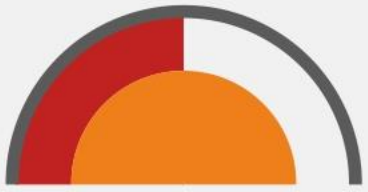
**METAL TAPPING**

**MTU OPERATION**

**KEY BENEFITS**

**ANIMATION**

**SHROUD POURING**



12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**



**Shrouded pouring**



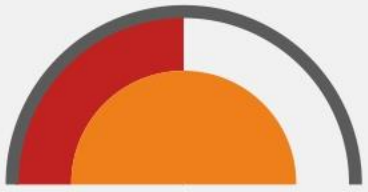
**METAL TAPPING**

**MTU OPERATION**

**KEY BENEFITS**

**ANIMATION**

**SHROUD POURING**

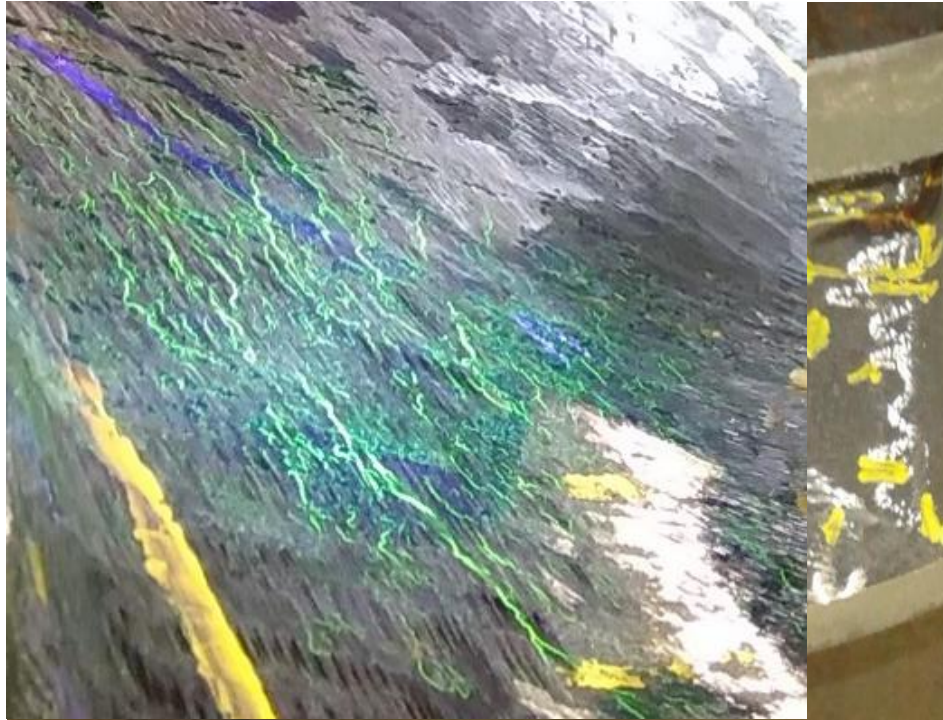


12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**



## Casting surface improvement



METAL TAPPING

MTU OPERATION

KEY BENEFITS

ANIMATION

SHROUD POURING





12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**



## Casting surface improvement



METAL TAPPING

MTU OPERATION

**KEY BENEFITS**

ANIMATION

SHROUD POURING



12<sup>th</sup> International  
**Foundry  
Congress**

19-21 September / Eylül 2024 Istanbul Expo Center, Istanbul - Türkiye  
**12. Uluslararası Döküm Kongresi**  
**12<sup>th</sup> International Foundry Congress**



## Ultra-low Pouring Temperature - Semiliquid

Pouring temperature under the liquidus



METAL TAPPING

MTU OPERATION

KEY BENEFITS

ANIMATION

SHROUD POURING