STAMPI PER PRESSOCOLATA
MOULDS FOR DIE CASTING

Die erosion model

DIE EROSION – Introduction

Die erosion can have a significant impact on the quality and efficiency of the production process. It can lead to increased downtime, reduced productivity, and higher maintenance costs.
Therefore, it is essential to prevent, monitor and manage the erosion.

There are several **causes of die erosion** in high pressure die casting (HPDC):

- **High temperature** can cause thermal fatigue and wear on the surface of the die over time.
- **High pressure** can cause erosion of the die surface due to the impact of the metal.
- **Chemical reactions** between molten aluminum and the die surface, especially with aluminum alloy with low content of iron.
-**Turbulent flow** of the molten metal can cause erosion of the die surface due to the impact and shear forces.
-**Cavitation**: the rapid formation, growth and collapse of bubbles in the molten metal.
-**Poor die design** can lead to increased erosion of the die surface.

DIE EROSION – Case Study

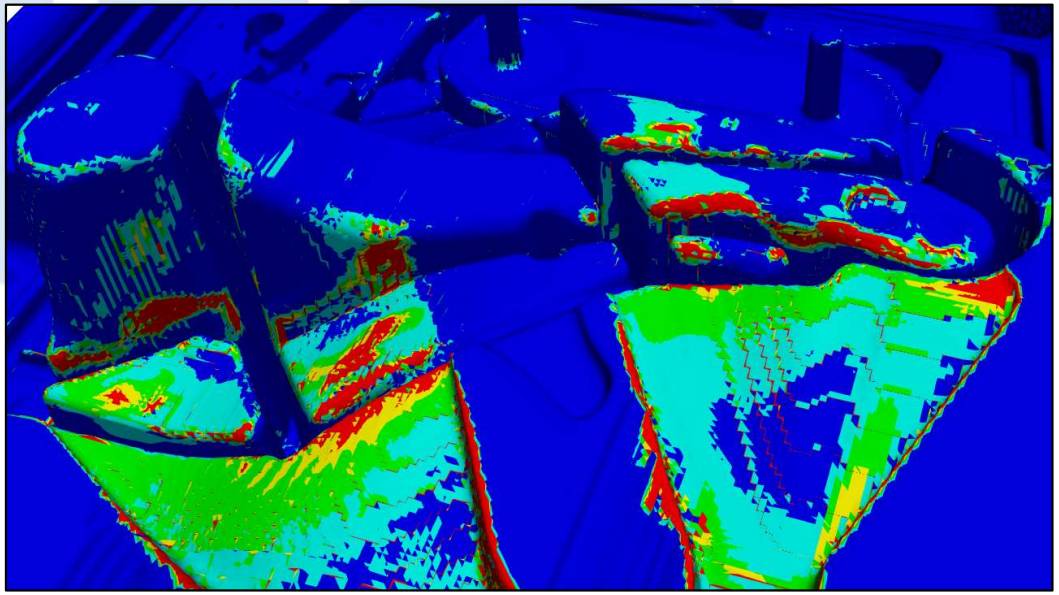
We received from one of our customers the task of **fixing the erosion of a die** already in production. We investigated the issue based on damage sow on the die and Flow 3D Cast 2022 simulation.

We used the standard outputs from the simulation to **create a model** that could give us results that **fit the observed damages**. Subsequently, we optimize the gates geometry by verifying through simulation that the problem was actually solved.

DIE EROSION – Model development

Concerning the die erosion, casting simulation can help with:

- **Predict areas of high erosion** by analyzing the flow of molten metal and identifying areas of high velocity, pressure and turbulence.
- **Optimize the gate and runner system** to minimize turbulence and avoid areas of high velocity and pressure that can cause erosion, adjusting the size and shape of the gates and runners.
- **Adjust the process parameters** to reduce the impact of erosion.



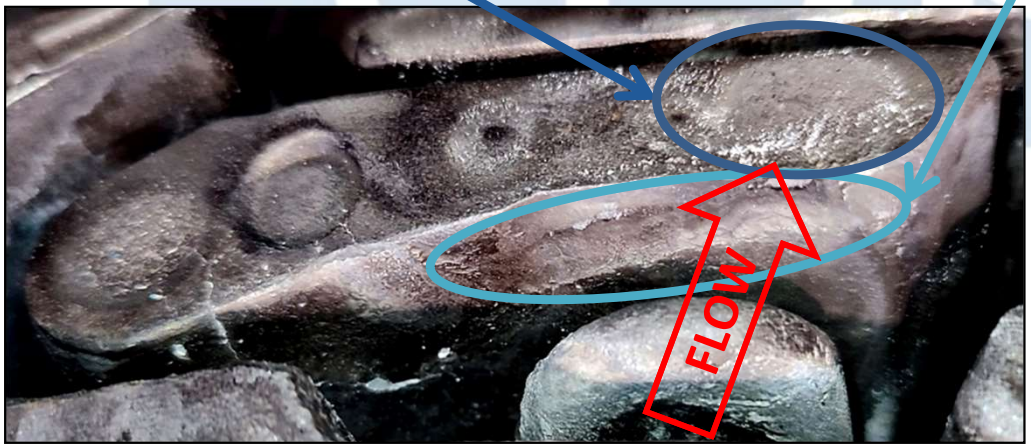
In HPDC erosion can occur when molten metal and solid particles suspended (such as oxides, solidified metal other impurities) impact the die surface during the injection process.

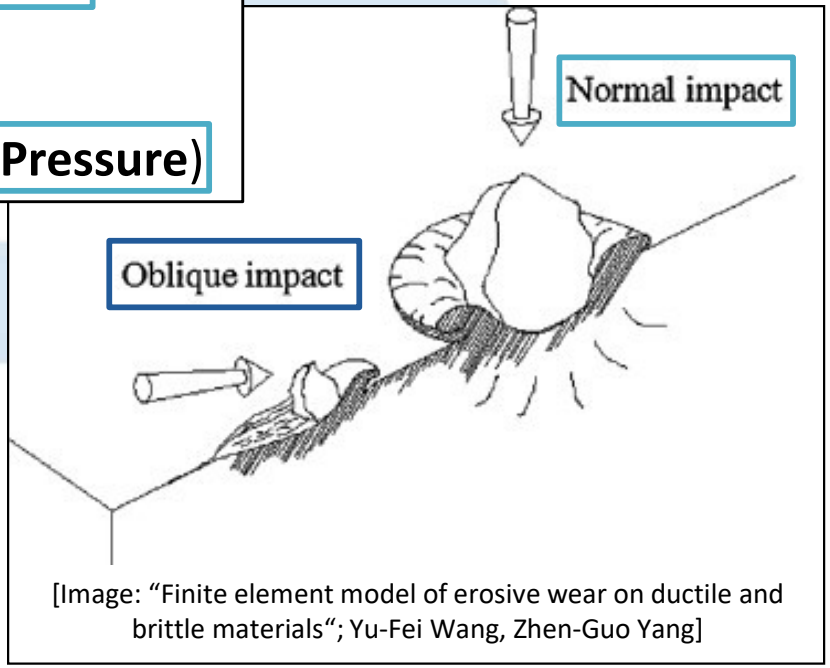
The angle of impact is an important factor in erosion in fact :

- at **low angles** of impact, the molten aluminum and the particles tend to slide along the surface, resulting in **abrasion** of the die.
- at **high angles** of impact, the flow causes die surface **fatigue** and **plastic deformations**.

Erosion = Low angles erosion + High angles erosion

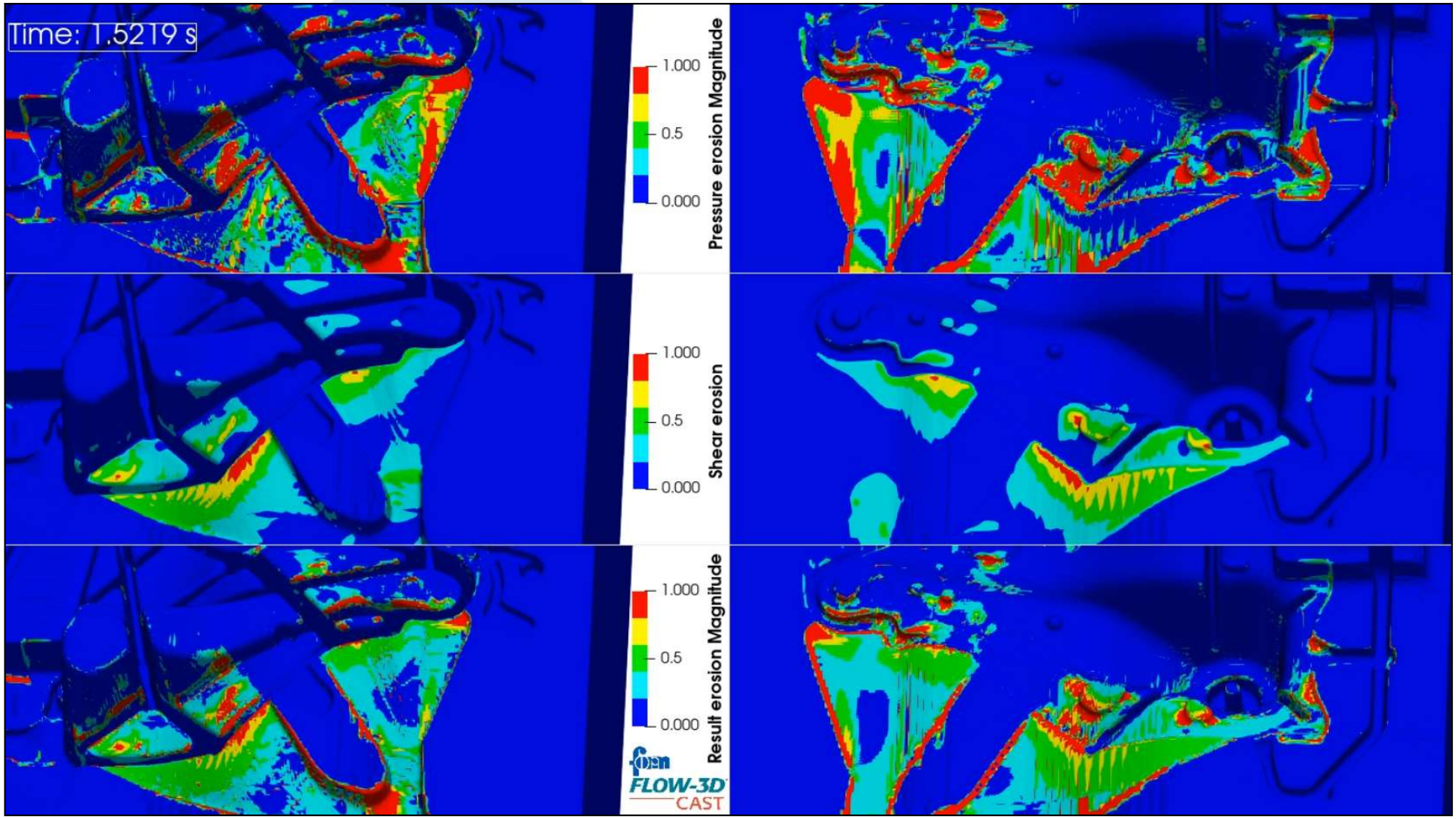
Erosion $\propto$ F_1(Velocity * Shear stress) + F_2(∇Velocity * Pressure)



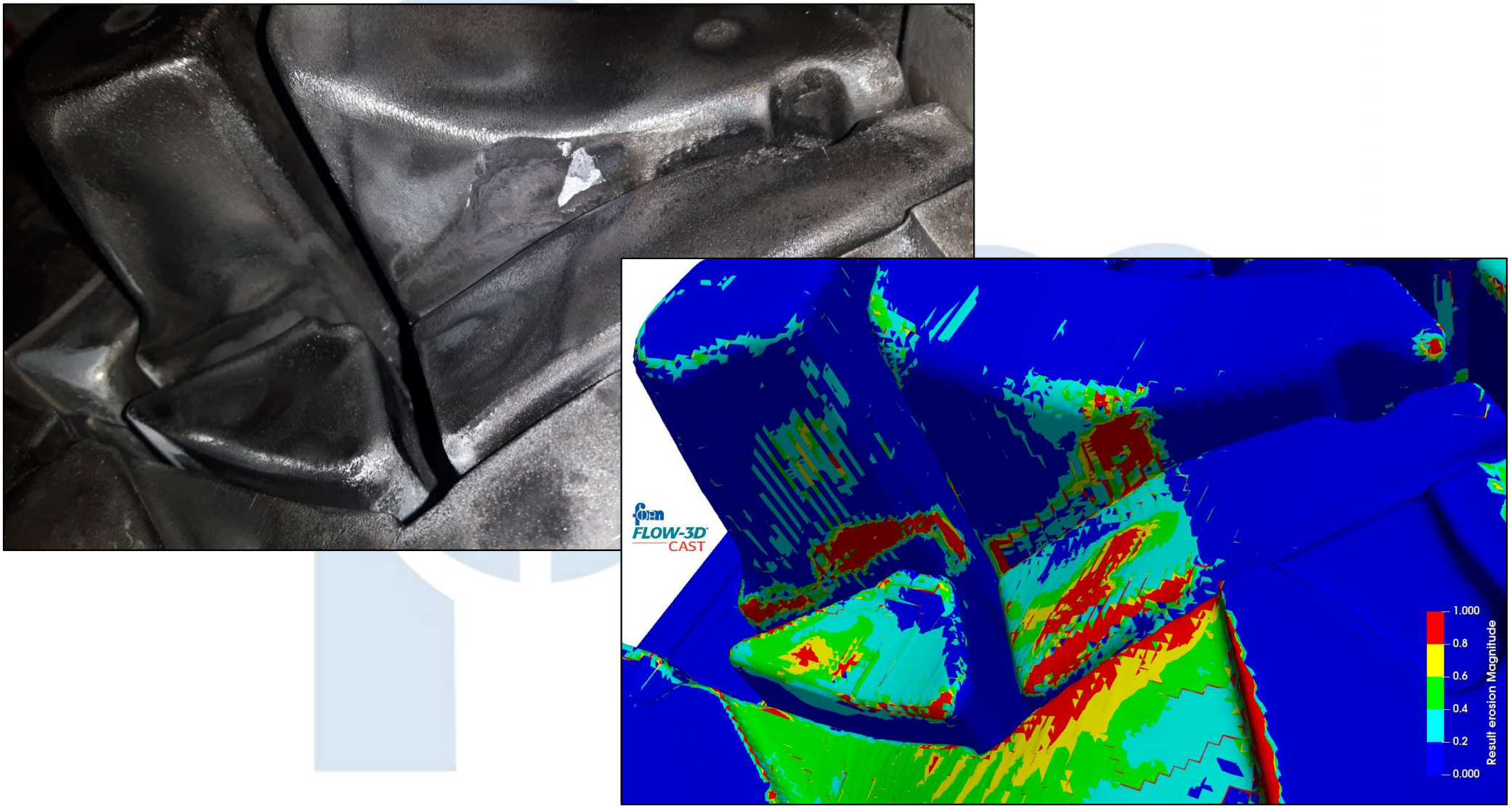


[Image: "Finite element model of erosive wear on ductile and brittle materials"; Yu-Fei Wang, Zhen-Guo Yang]

Contribution to erosion for high angles erosion (top), low angles erosion (middle) and sum of both components (bottom)



Detail of the die with high erosion and comparison with the result of the developed model



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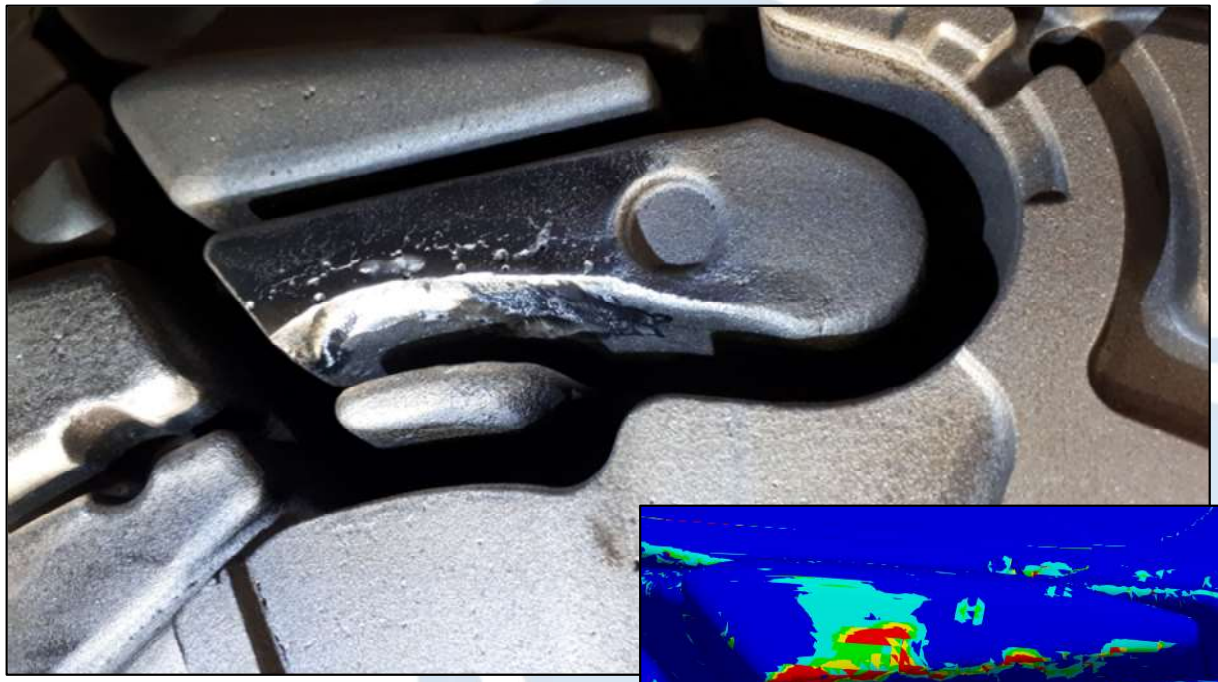

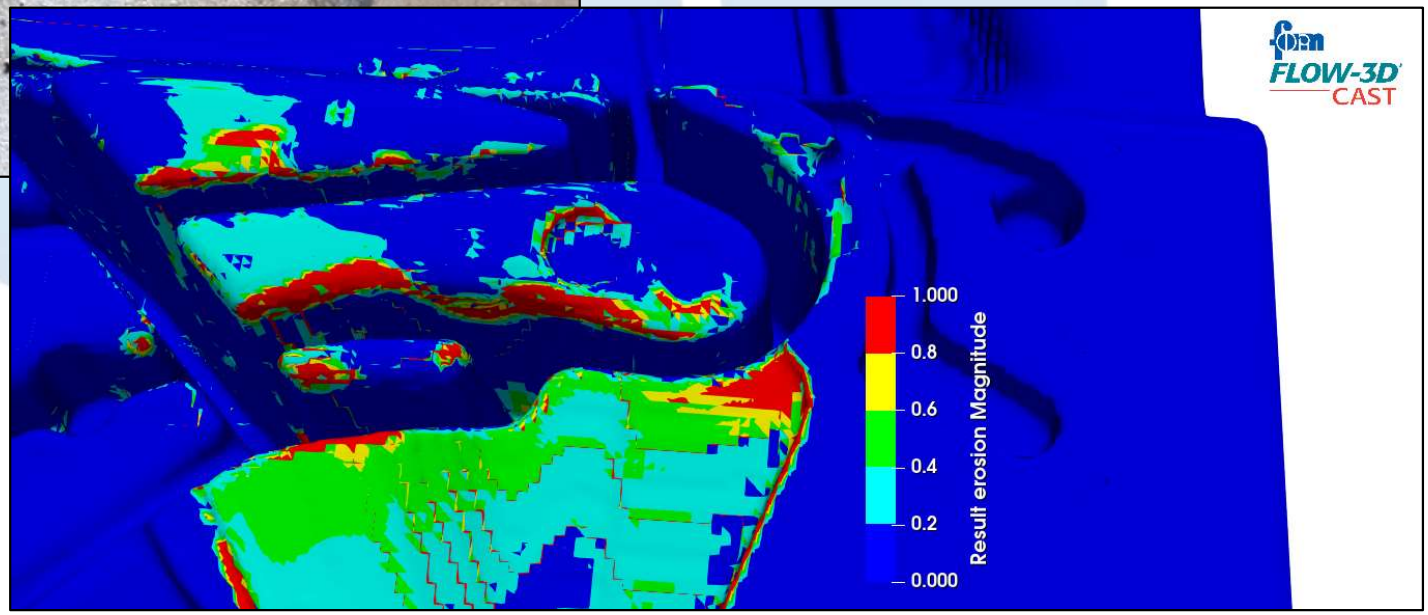

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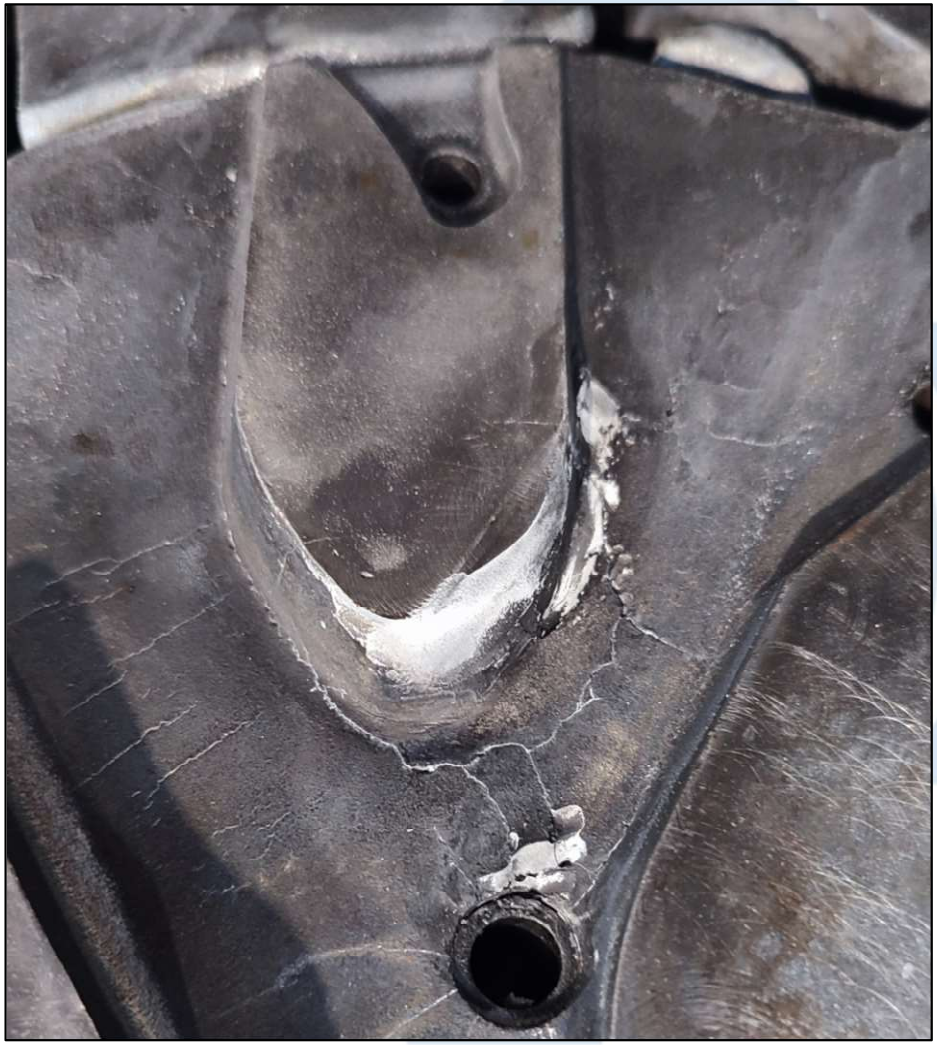

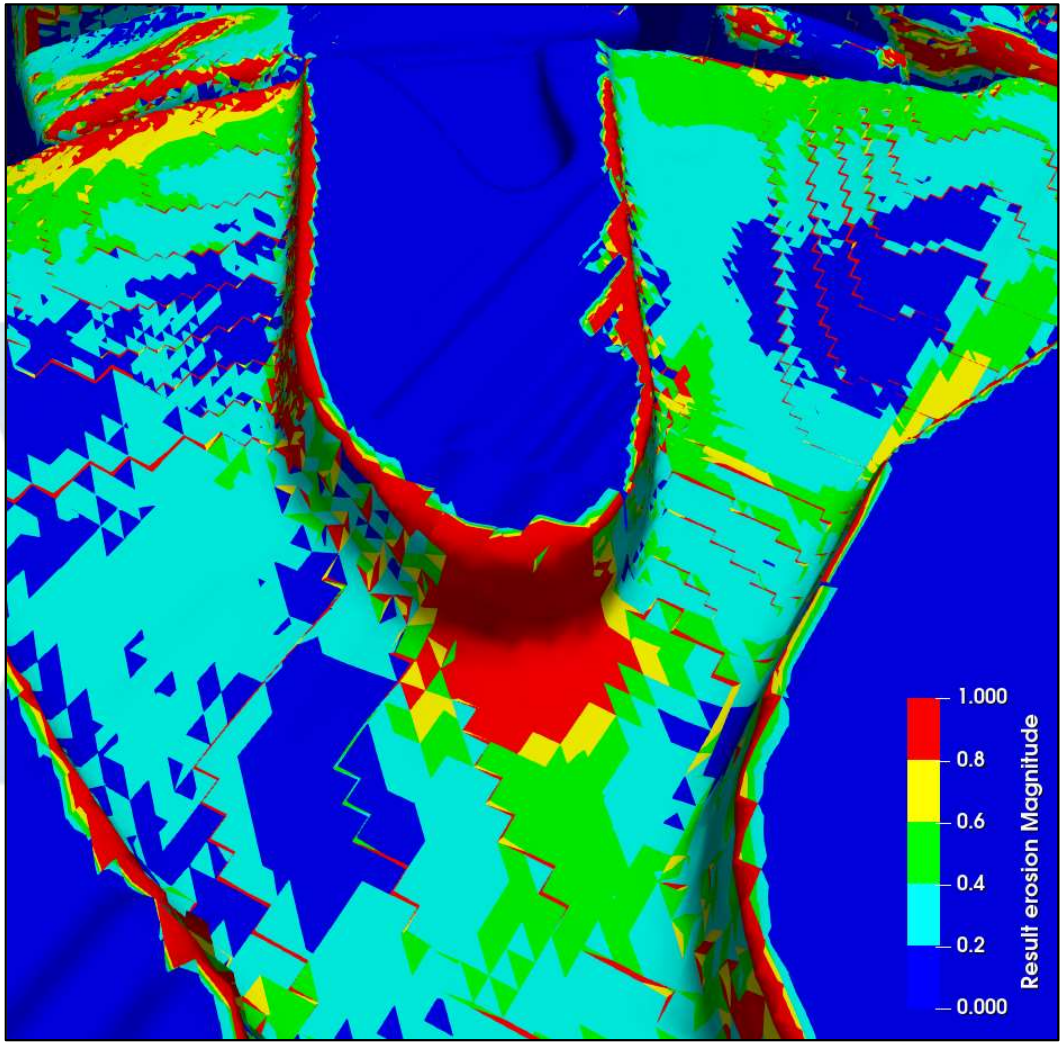

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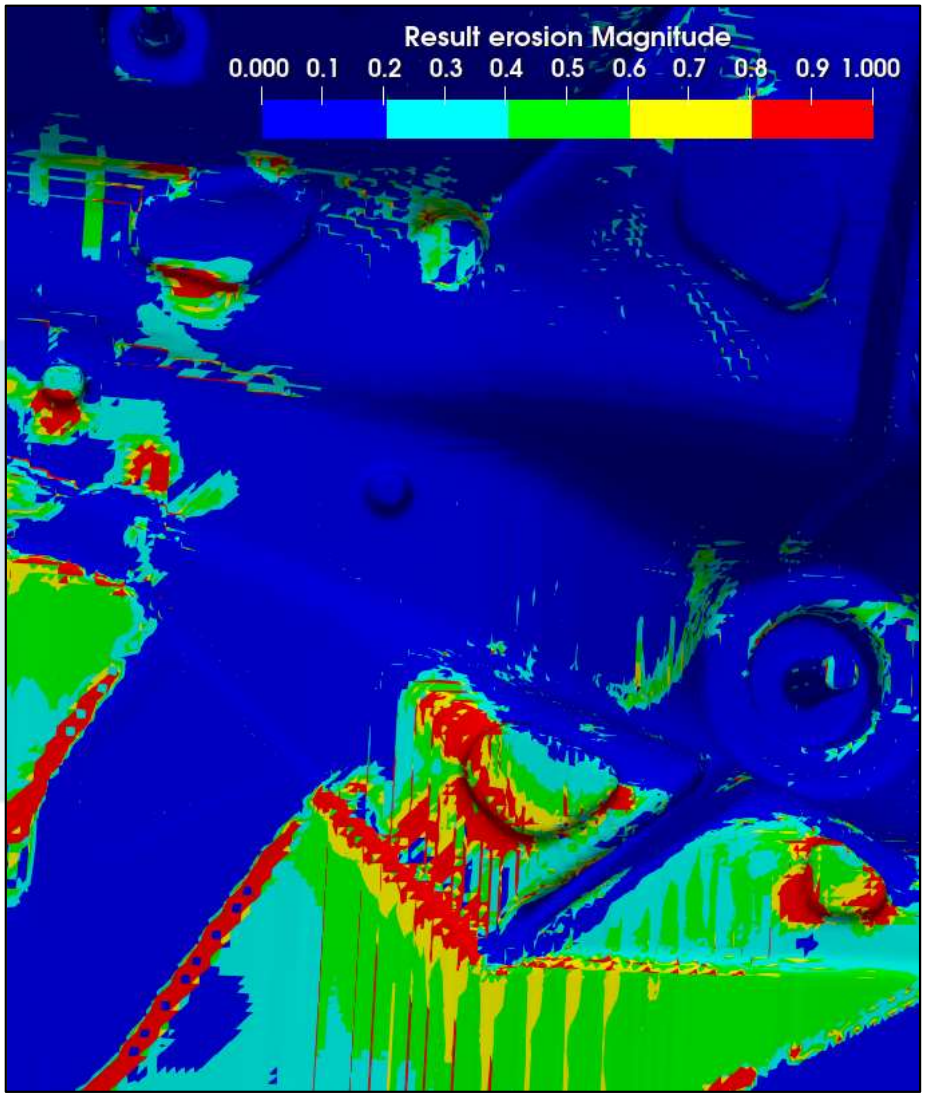

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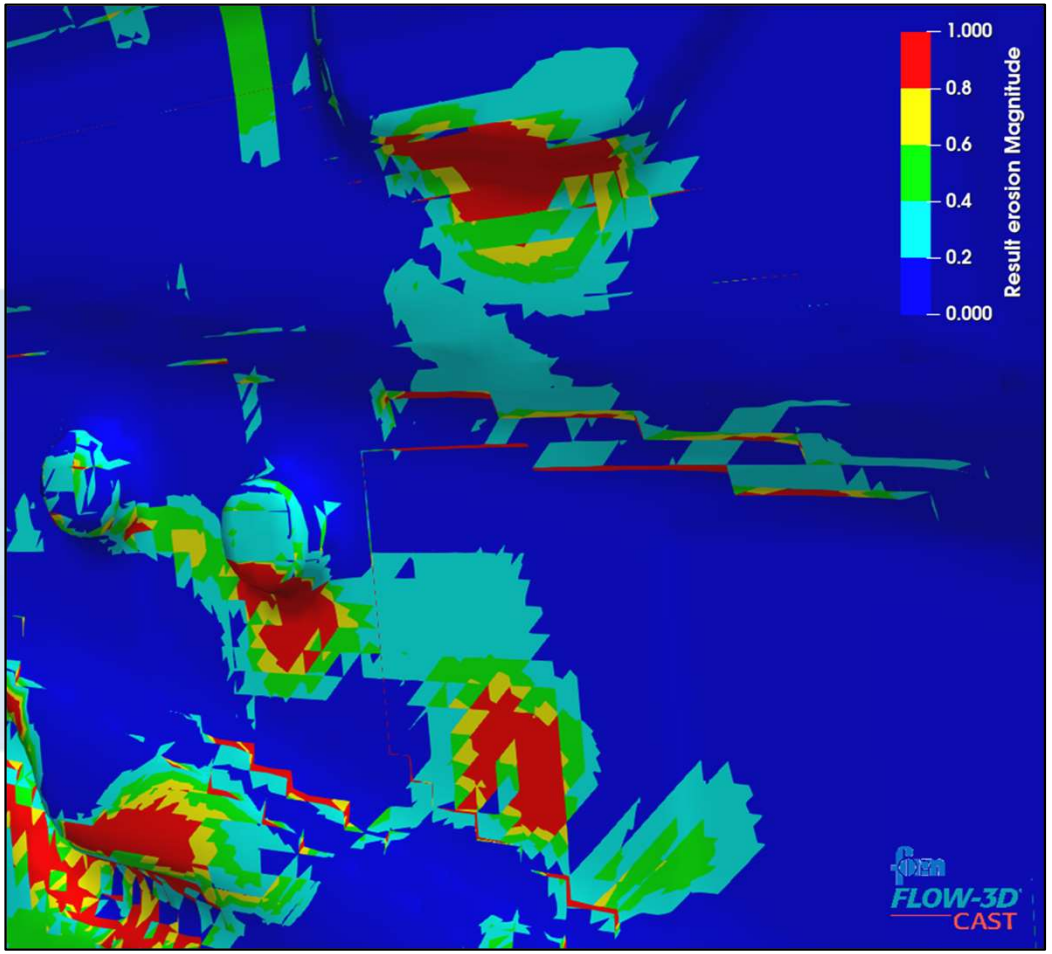

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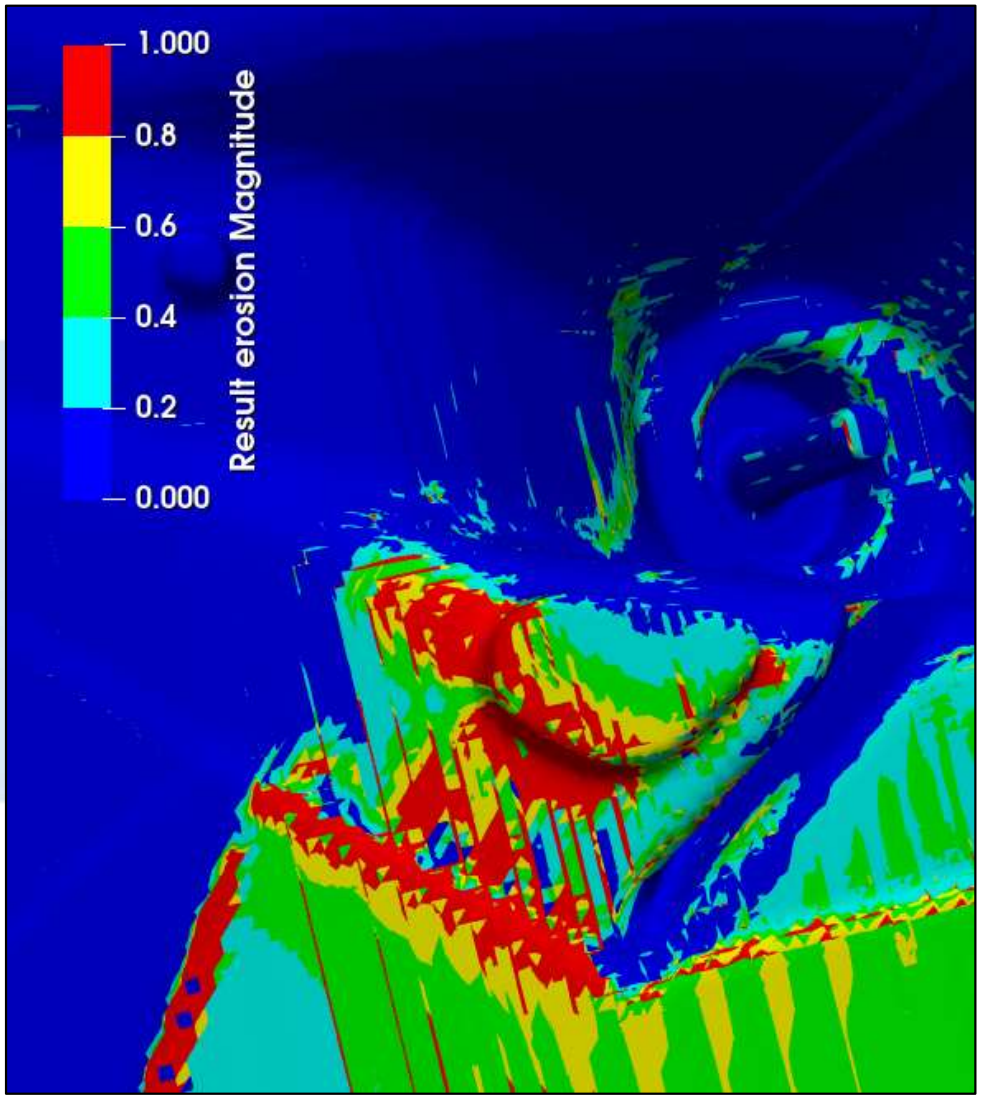

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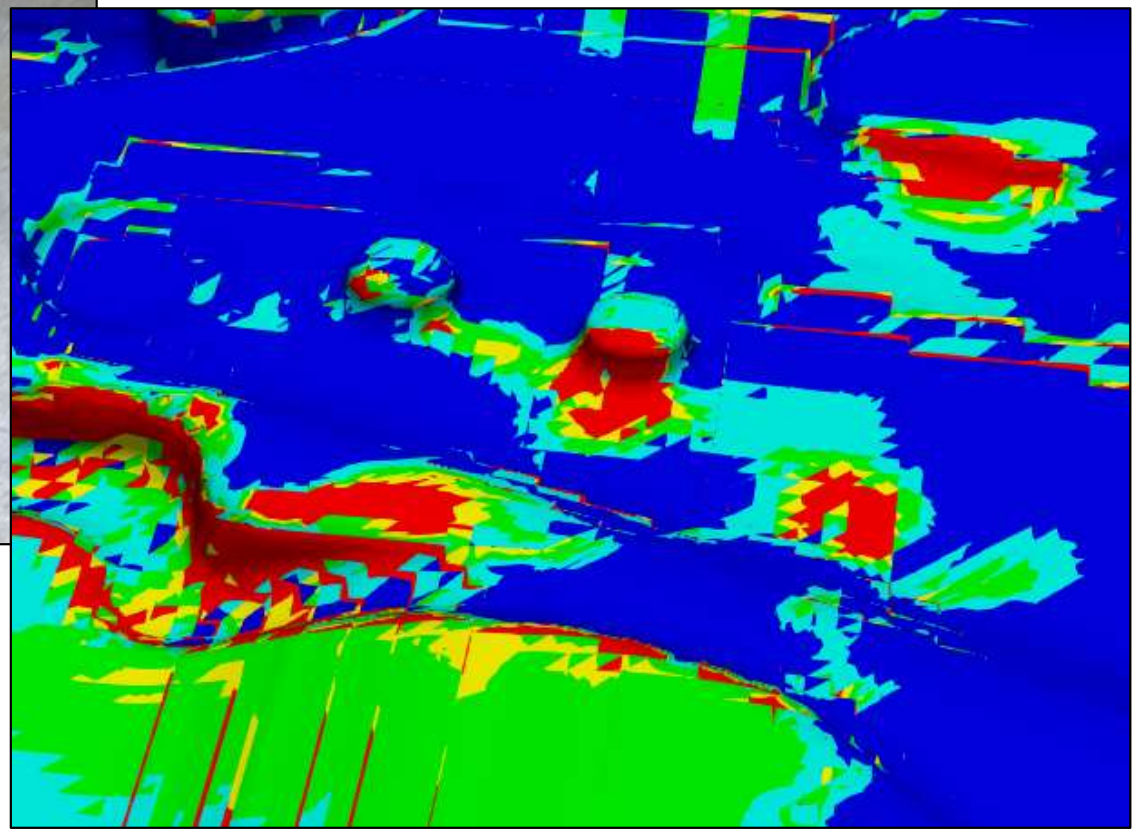
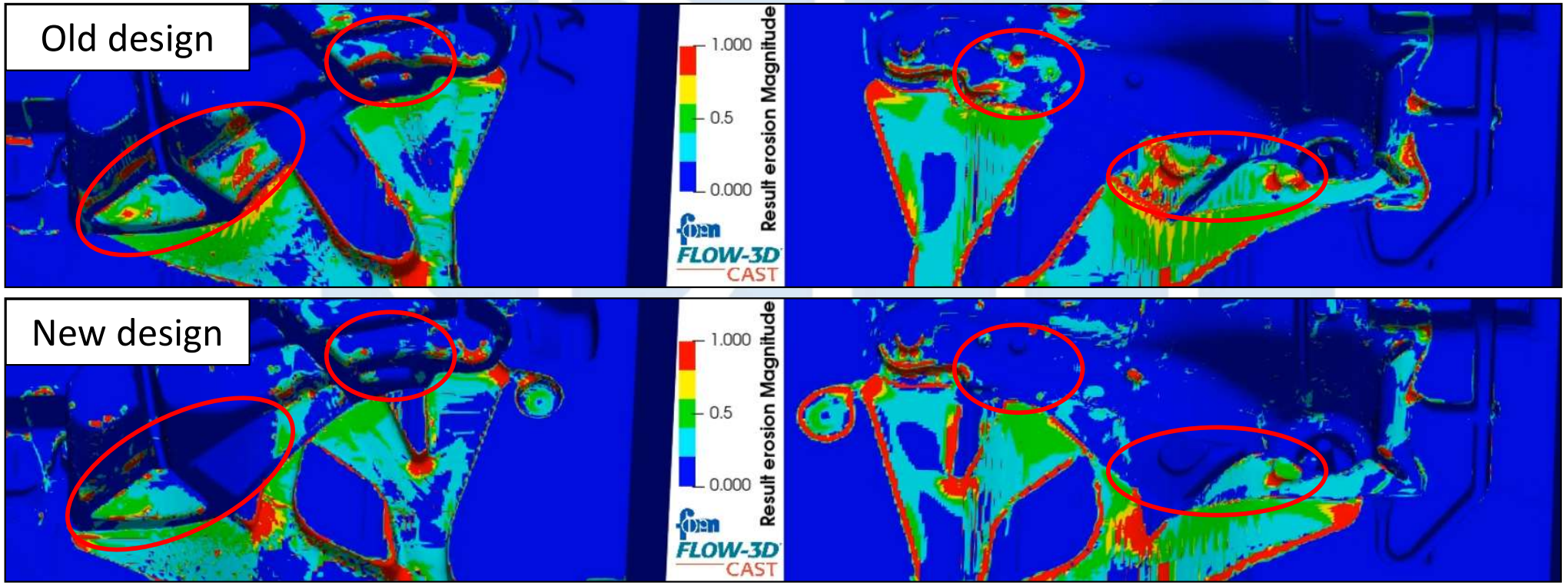


DIE EROSION – Solution

We've got from our customer orders for new inserts with the aim to improve/solve erosion by redesigning ingate design and taking care of all others casting quality requirements. Erosion in the most critical areas of the casting cavity has been **reduced or eliminated.** We were able to verify that the problem was solved before proceeding with the machining of new inserts. Below there is a comparison of die erosion before and after changes:



Conclusions

Erosion is a critical issue in the HPDC process that affects the quality and productivity of the process especially in casting of **structural elements** made of Al alloys with low steel content.

A **customized model** was developed using the standard outputs of Flow-3d cast simulations to predict and solve the erosion in the die.

The model help to **optimize the design** of the die and improve the process parameters to minimize the erosion rate.

Longer lifespan of the die and **improved quality** of the castings, results in **reduced downtime, increased productivity and efficiency.**

After a few months, our customer let us know that they have reduced the maintenance of this die from once every 5’000 shots to once every 25’000 shots, thus **maintenance interventions due to erosion have been reduced by 80%** during the life of the die.

THANK YOU !!

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