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In conjuction with ANKIROS / TURKCAST

«INDUSTRY 4.0 FOR ALUMINUM FOUNDRY: AN OPTIMAL MANAGEMENT OF THE PROCESS TO ENHANCE COMPETITIVENESS OF THE COMPANY»

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INDEX:

- **AZTERLAN presentation**
- **INDUSTRY 4.0 road map**
- **HPDC I 4.0:**
  - **Industrial situation**
  - **Proposed steps**
  - **Case studies**
- **Summary**

AZTERLAN PRESENTATION

140

14 PhD

14 M€

> 15 papers/year

3 spin offs

> 2,000 customers

15,500 m2

+45 YEARS GROWING SIDE BY SIDE WITH THE METAL-MECHANICAL INDUSTRY

1974
Testing Lab HH Maristas Occupational School

1986
Constitution of Azterlan Research Centre

1988
First conference in a World Foundry Congress

1997
Incorporation to the Basque Science Technolgy and Innovation Network

2006
Inauguration of the actual 6000m2 facilities

2011
Recognized as Technology Center by the Spanish Government

2012
Join IK4 Research Alliance.

2014
Organization of the 71st World Foundry Congress in Bilbao

2016
Multifocused Technology Centre in the BSTN

Best Technical Paper Award in the Metal Casting Congress (USA)

2018
Best Technical Paper Award in the 73rd World Foundry Congress (Poland)

2019
Members of BRTA

2021
+ 9500 m2 new facilities

Azterlan started working in foundry oriented Artificial Intelligence in 2005

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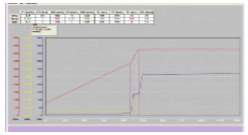
Investment

HPDC MACHINE
Injection curve



V1, p1, V2max, P3, CP, RT, BT, …

HPDC CELL + Peripherals

Dosing furnace, cooling management, die spraying, die sensors, vacuum, …

HPDC PLANT

More than 2500 variables 40- 95 seconds in each HPDC Cell

I 4.0
All information everywhere

Visual control, stadistical analysis, Artificial inteligence

Complexity

The different implementation steps

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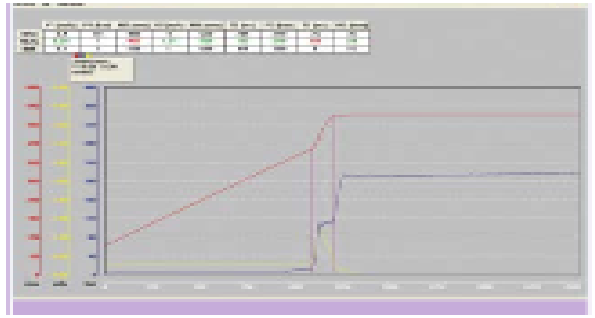
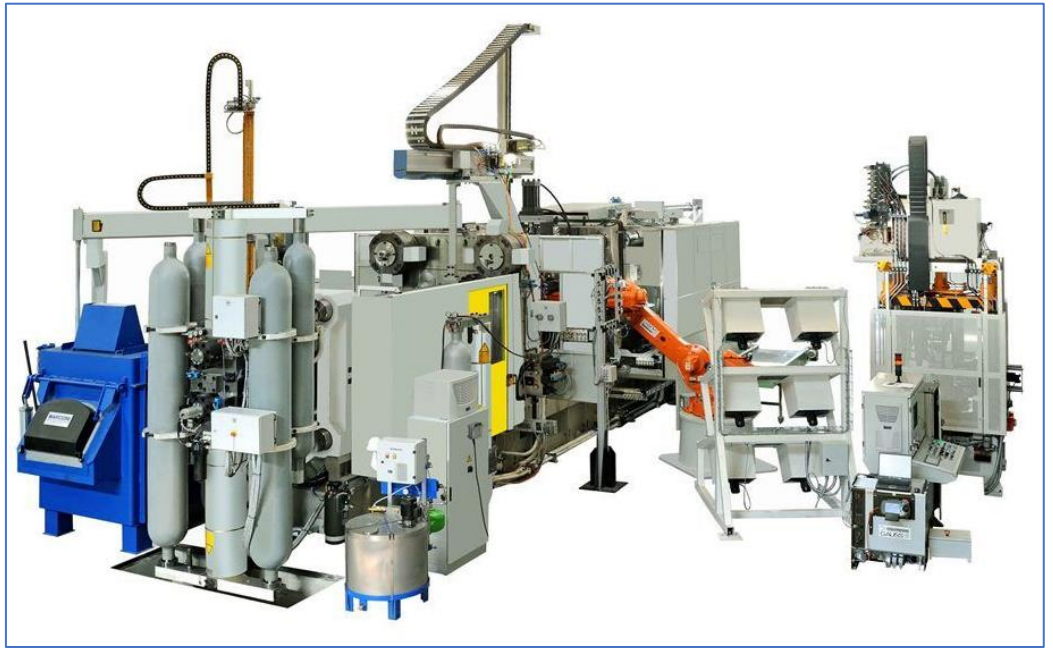
HPDC Industrial status:

- The HPDC machine presents the basic parameters: V1, V2, Pressure, Stroke, …
- It is able to discard the shot by comparing the variables to the control limits.



- BT: Biscuit Thickness (mm)
- CP: Commutation point (mm)
- FB: Stroke until metal reaches the gate (mm)
- OF: Opening force (KN)
- P1: 1st phase pressure (bar)
- PN: Intensification pressure (bar)
- PS: Specific intensification pressure (bar)
- PXN: Intensification pressure kept in time (bar)
- S2: Filling stroke (mm)
- S3: Intensification stroke (mm)
- SG: Plunger total stroke (mm)
- TG: Filling time (ms)
- TN: Intensification build up time (ms)
- TZ: Cycle time (s)
- V1: 1st phase velocity (m/s)
- V2: 2nd phase velocity (m/s)
- VA: Velocity at gate (m/s)
- ...



This has been the competitive way to work until now.

HPDC Industrial status:

- A standard **HPDC foundry** is likely to have **different HPDC machines** from different machine producers and from different generations.
- **Monitoring** systems are machine **builder proprietary**.
- Variables definition, calculation and accuracy **varies among machines**.
- **Data is limited** to standard parameters, and data is difficult to upgrade.

Consequence:

- **Data is nor homogeneous nor standardized so Data is not comparable.**
- **There is no solid ground to build a sound INDUSTRY 4.0 project.**

HPDC Industry 4.0:

First issue to address: Get reliable, accurate, homogeneous, standardized basic data in all machines:

- Reliable and accurate:
  - **Sensors** need to be **top quality**.
  - Sensor implementation strategy must be thoughtfully designed. In other words, how to put a sensor **closer to the relevant phenomena** that needs to be controlled and how to assure sensor's life in doing so.

- Standardized:
  - **Signals must be always processed the same way**. For instance, actual switch point from first to second phase or intensification build up time is not calculated the same way from one machine to another. And those are basic variables.

- Comparable:
  - Once data is accurate and **standardized**, it can be compared among different production cells and time periods.

- Adaptable Scope:
  - Basic **data will depend in investments and manpower**, and it will certainly be further implemented in time.
  - But as a very minimum, injection curve and some temperatures should be considered.

HPDC Industry 4.0:

Second issue to address: The solution must be **scalable**:

- Scalable in **investments:**
  - Investments have to be modulated and adapt to the company's possibilities and needs.

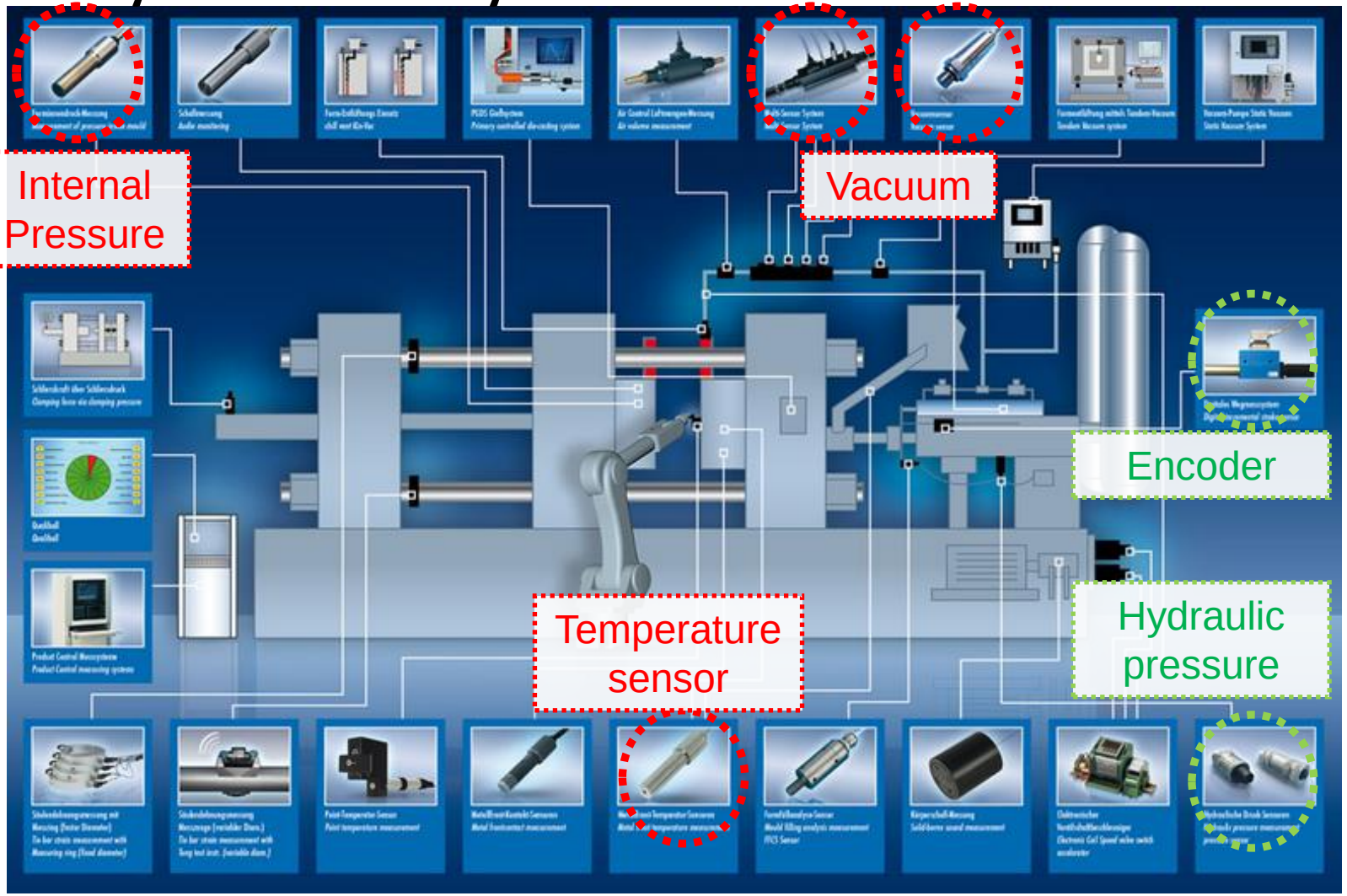
- Scalable **technically**:
  - The amount of variables and data need to start in a basic level so process engineers are not overloaded.
  - But the amount of sensors should be limited only by technology and be able to be implemented in later steps as knowledge will demand.

HPDC Industry 4.0: Scalable in Investment

A mobile HPDC specialized measuring system can be move among different machines.

For ease of use, machines are prepared with a cabinet that centralizes all sensor connections, so moving the HPDC specialized measuring system is only move and plug.

HPDC Industry 4.0: Technically Scalable



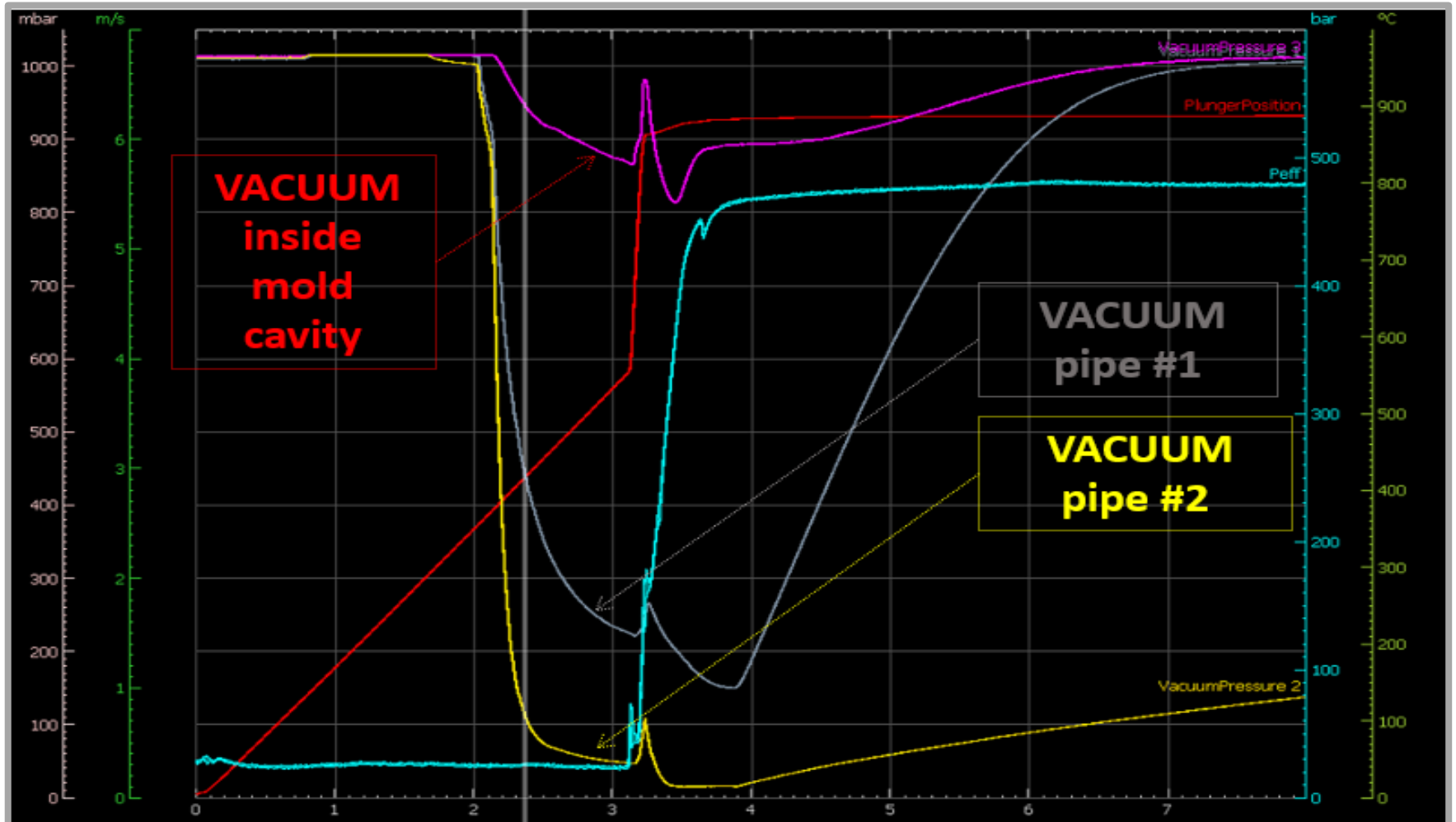
HPDC Industry 4.0: Vacuum critical variables

INDUSTRY 4.0 PROJECT

Vacuum pressure sensor (x3)

1. Vacuum Pipe #1
2. Vacuum Pipe #2
3. Inside mold cavity

- ❑ **Vacuum in the cavity ≠ vacuum in the pipe**



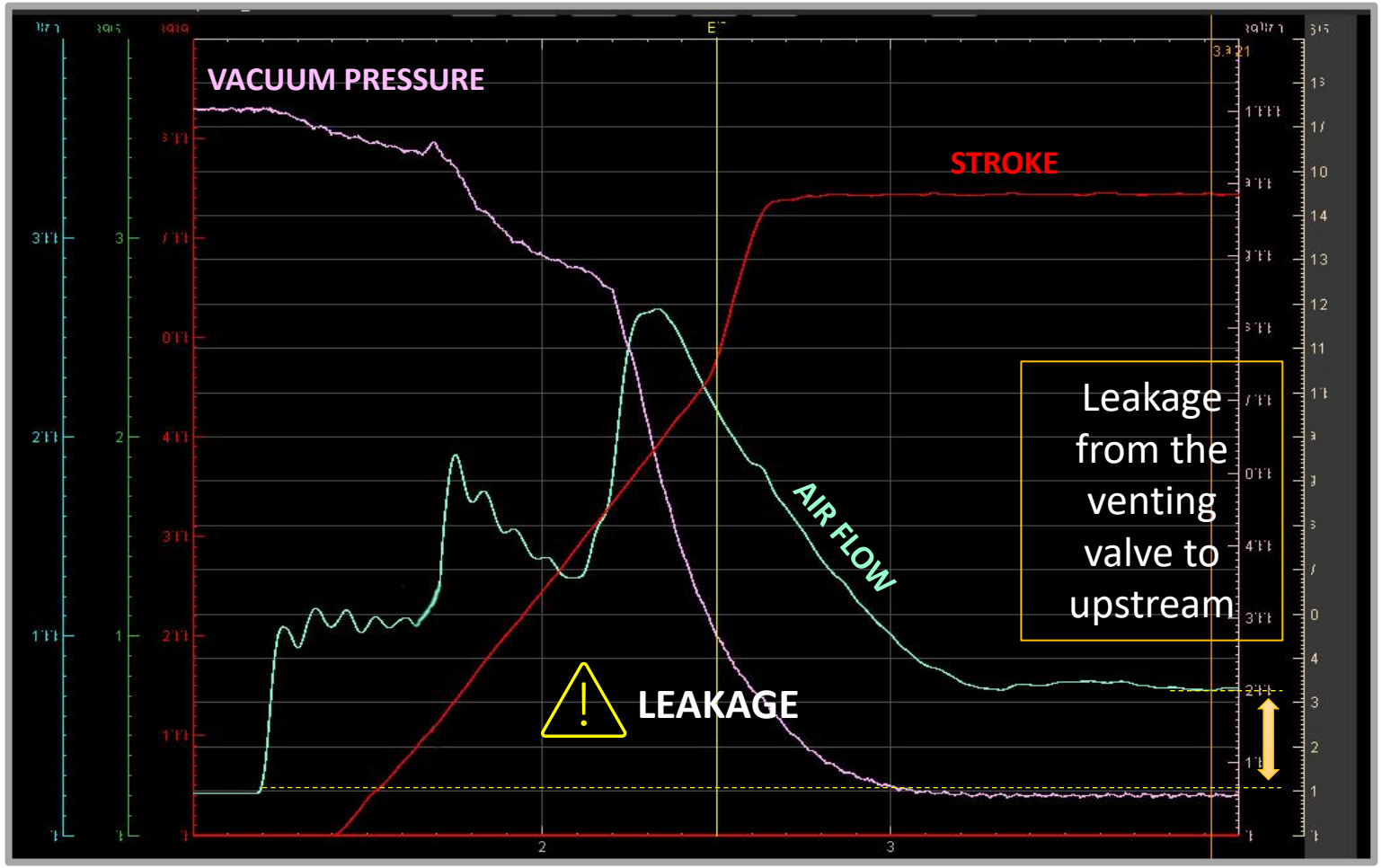
HPDC Industry 4.0: Vacuum critical variables

AIR FLOW

LEAKAGE DETECTION

<u>Vacuum leakage = Deficient closing surface along the parting line</u>

Different thermal expansion, wear, splash, DCM plate misalignment, etc.



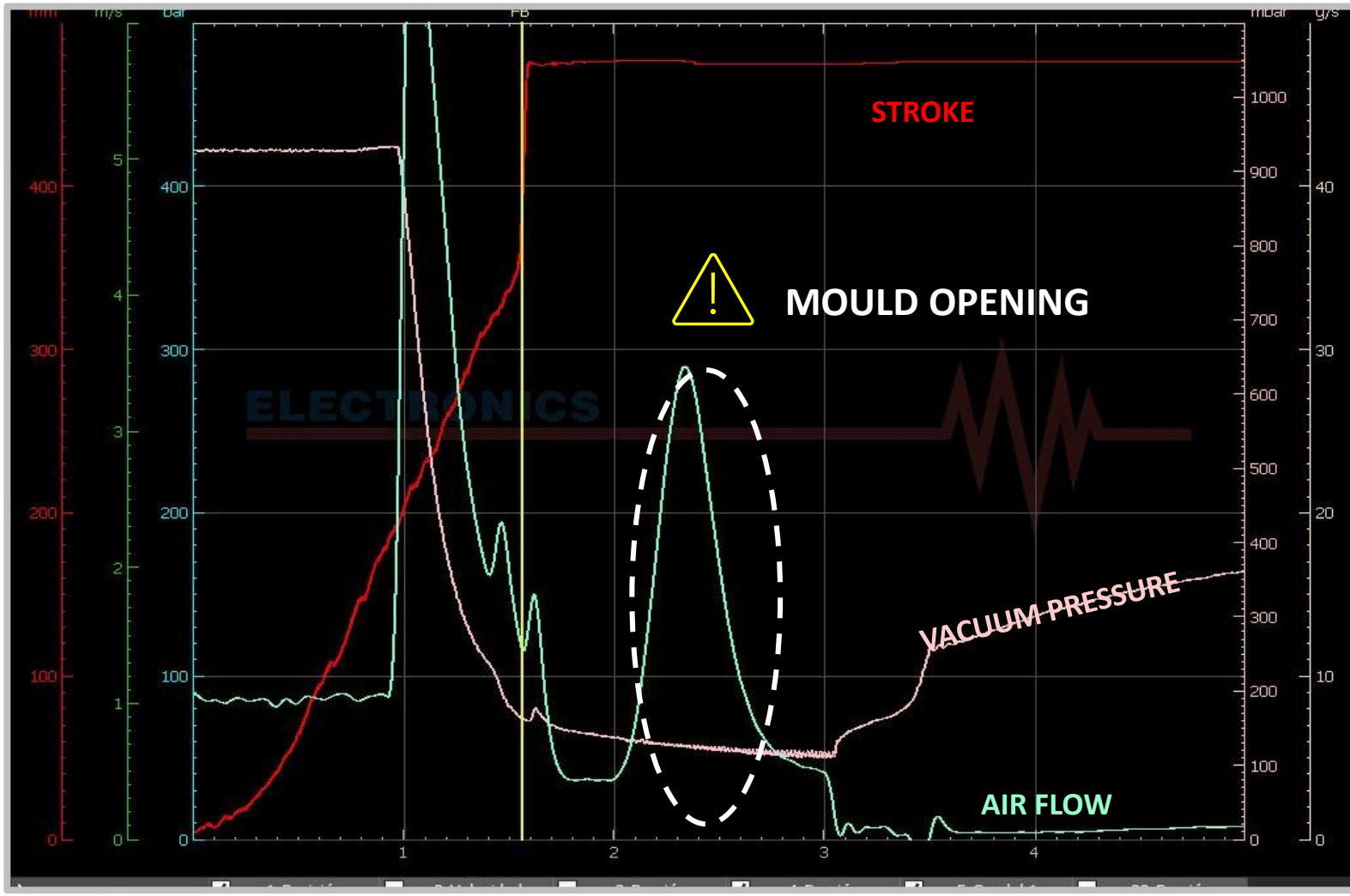
HPDC Industry 4.0: Vacuum critical variables

Air vacuum pressure and flow

1. Before injection
2. After injection

AIR FLOW

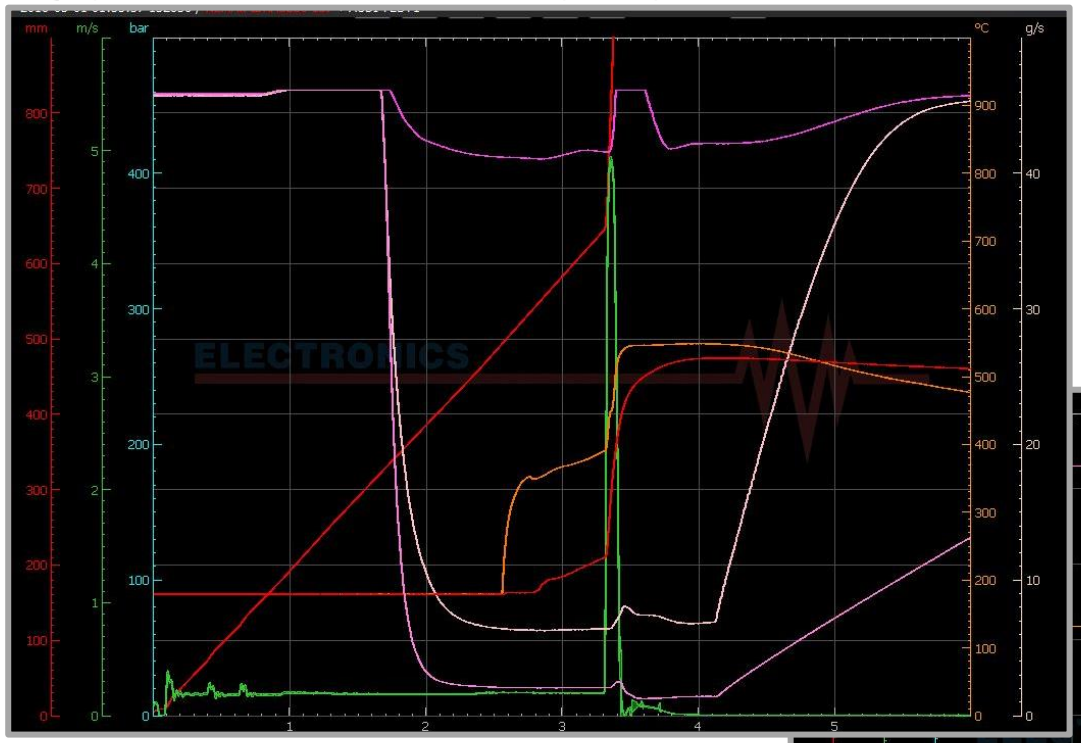
OPENNING OF THE MOULD DETECTION

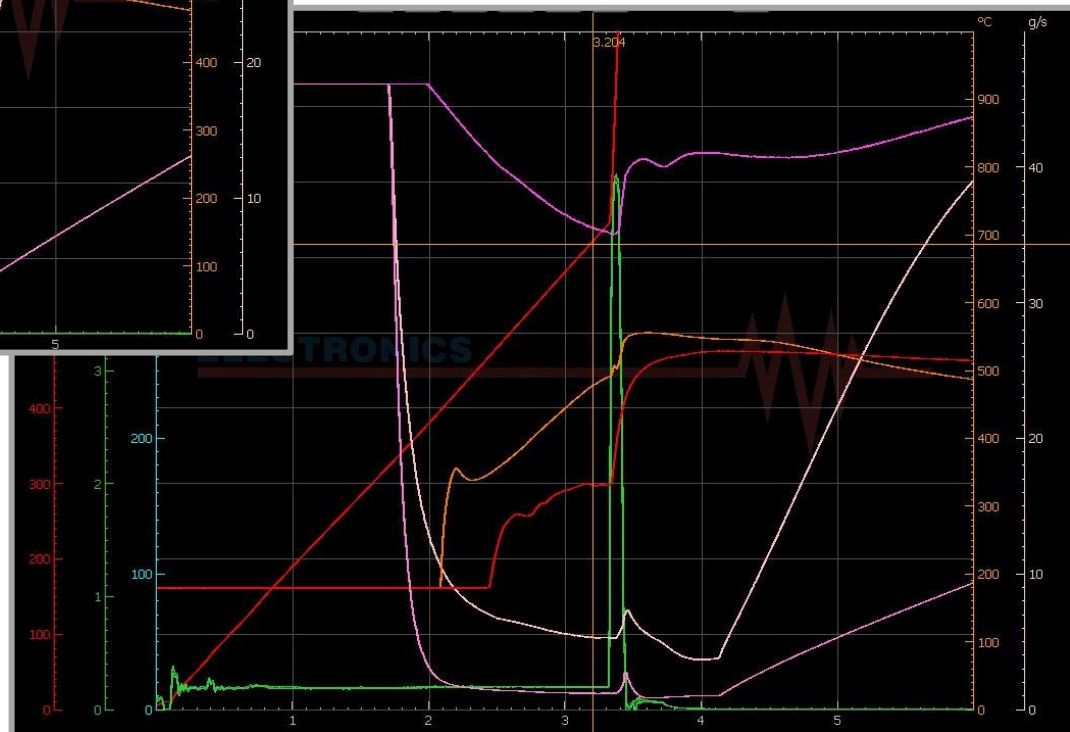


HPDC Industry 4.0: Filling pattern due to unproper vacuum

Metal front fast thermocouple (x2)

1. Before the gate
2. After the gate

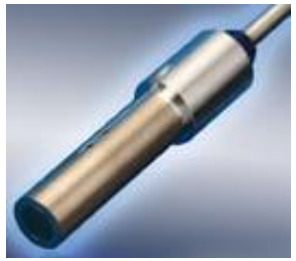




- **Inconsistent filling pattern/metal front**

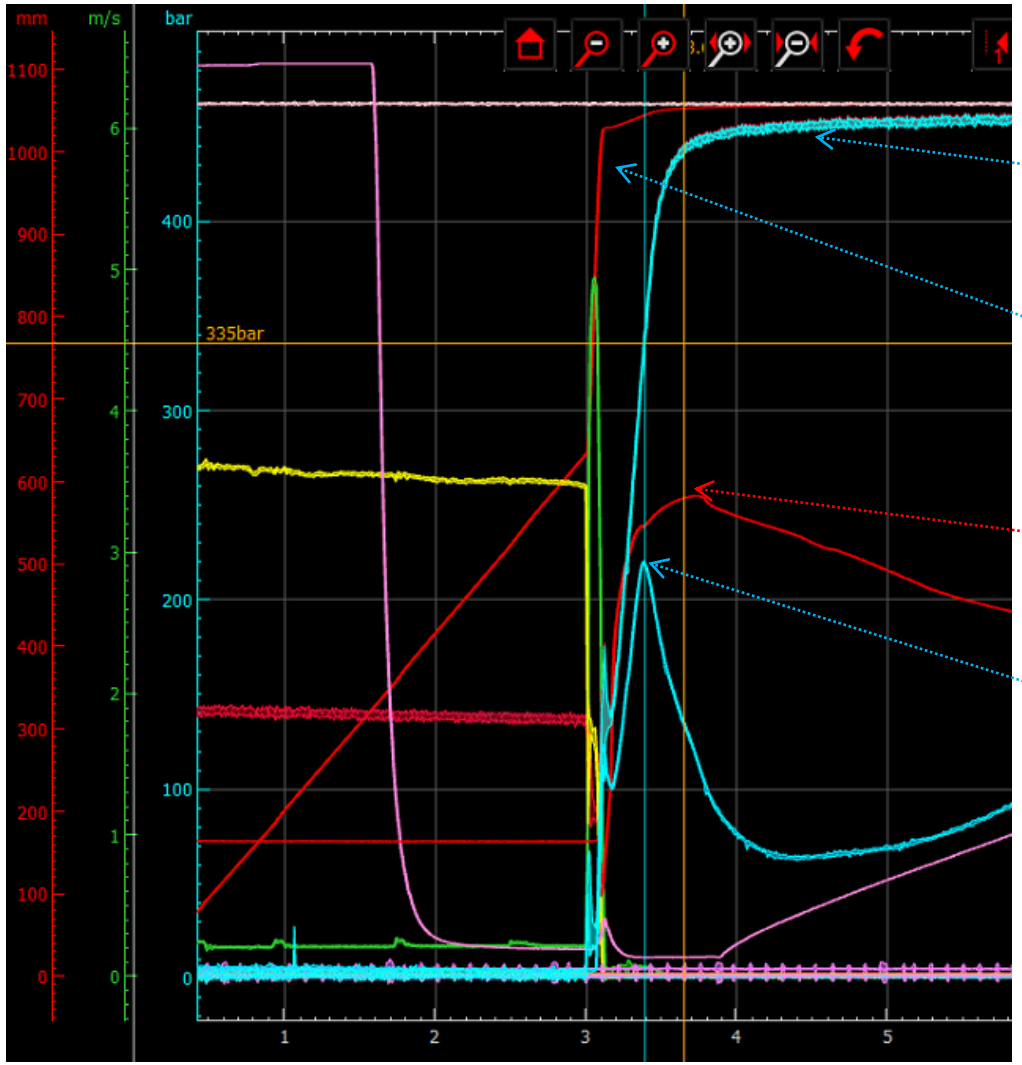
Despite having the same switching point, filling pattern (blue and green curves) is inconstant

HPDC Industry 4.0: Intensification pressure



Cavity fast tpressure sensor (x2)

- Hydraulic pressure and intensification time ≠ Cavity pressure



Hydraulic pressure — 449bar

Pressure build up delay — 525ms

Cavity pressure #1 — 490bar

Cavity pressure #2 — 420bar

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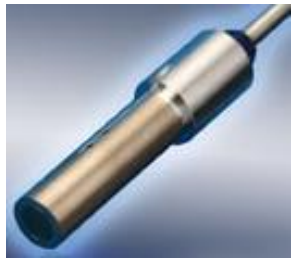
HPDC Industry 4.0: Intensification pressure



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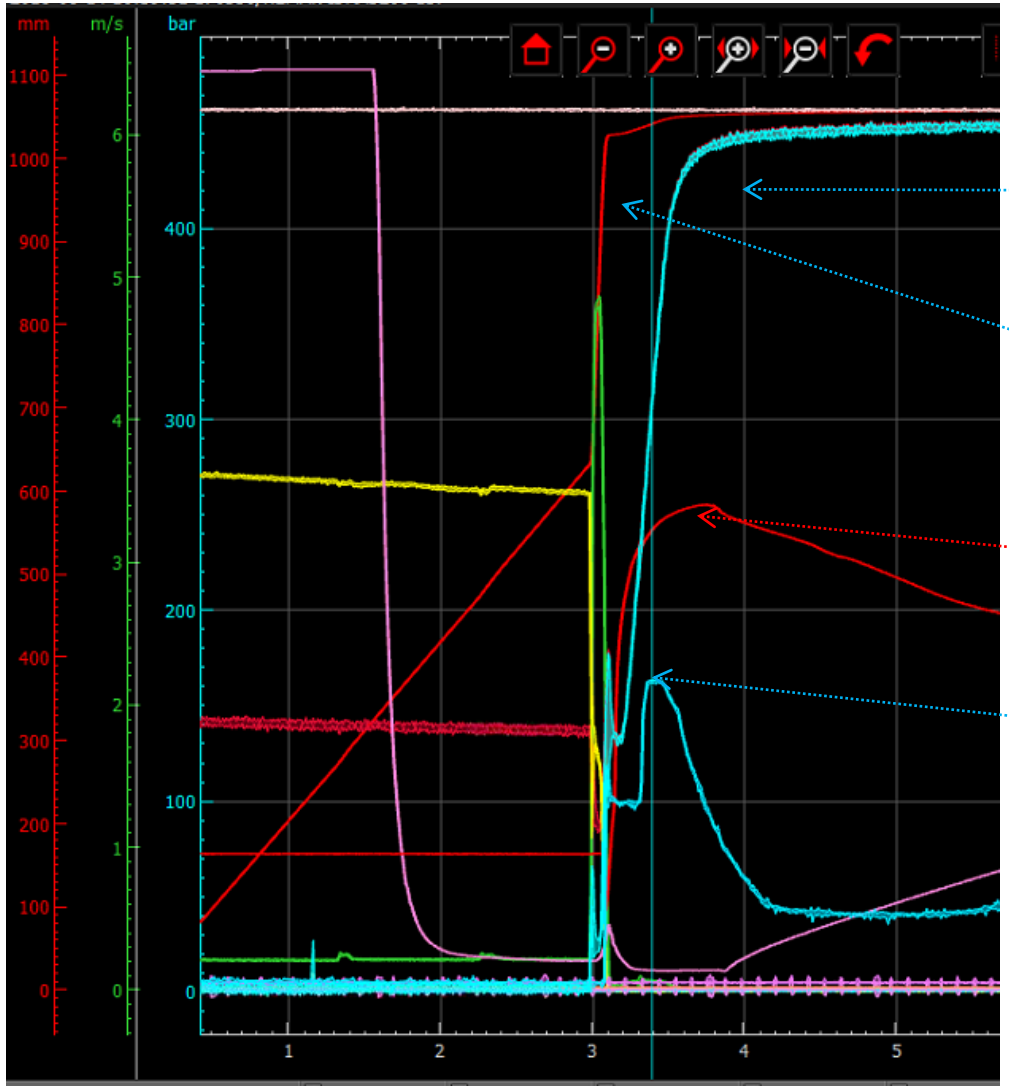

Hydraulic pressure — 449bar

Pressure build up delay — 569ms

Cavity pressure #1 — 490bar

Cavity pressure #2 — 317bar

Summary:

- HPDC is a **complex process involving many variables** that can benefit from INDUSTRY 4.0.
- Reliable, accurate, homogeneous, **standardized data is a must** in order to be compared and further treated.
- Basic **HPDC variables are not homogeneous** from one machine to another.
- Basic **HPDC variables fall short** representing what it is actually happening inside the cavity.
- The proposed solution demands:
  - A **HPDC specialized measuring system**.
    - Investment scalable.
    - Technically scalable.
  - Controlled by **foundry process engineers**.
- In short term, INDUSTRY 4.0 in HPDC can mostly help in process control, to be more precise, putting a HPDC **process back in standard reject levels**.

Thanks for your attention

İlginiz için teşekkürler

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