Advanced analytics of sinter plant operations to minimise particulate emissions

Engineering Doctorate - Matthew Hywell Thomas RSci AIMMM

Academic Supervisor – Dr Hollie Cockings
Industrial Supervisor – Jamie Barrett

Prifysgol Abertawe
Swansea University

TATA
TATA STEEL

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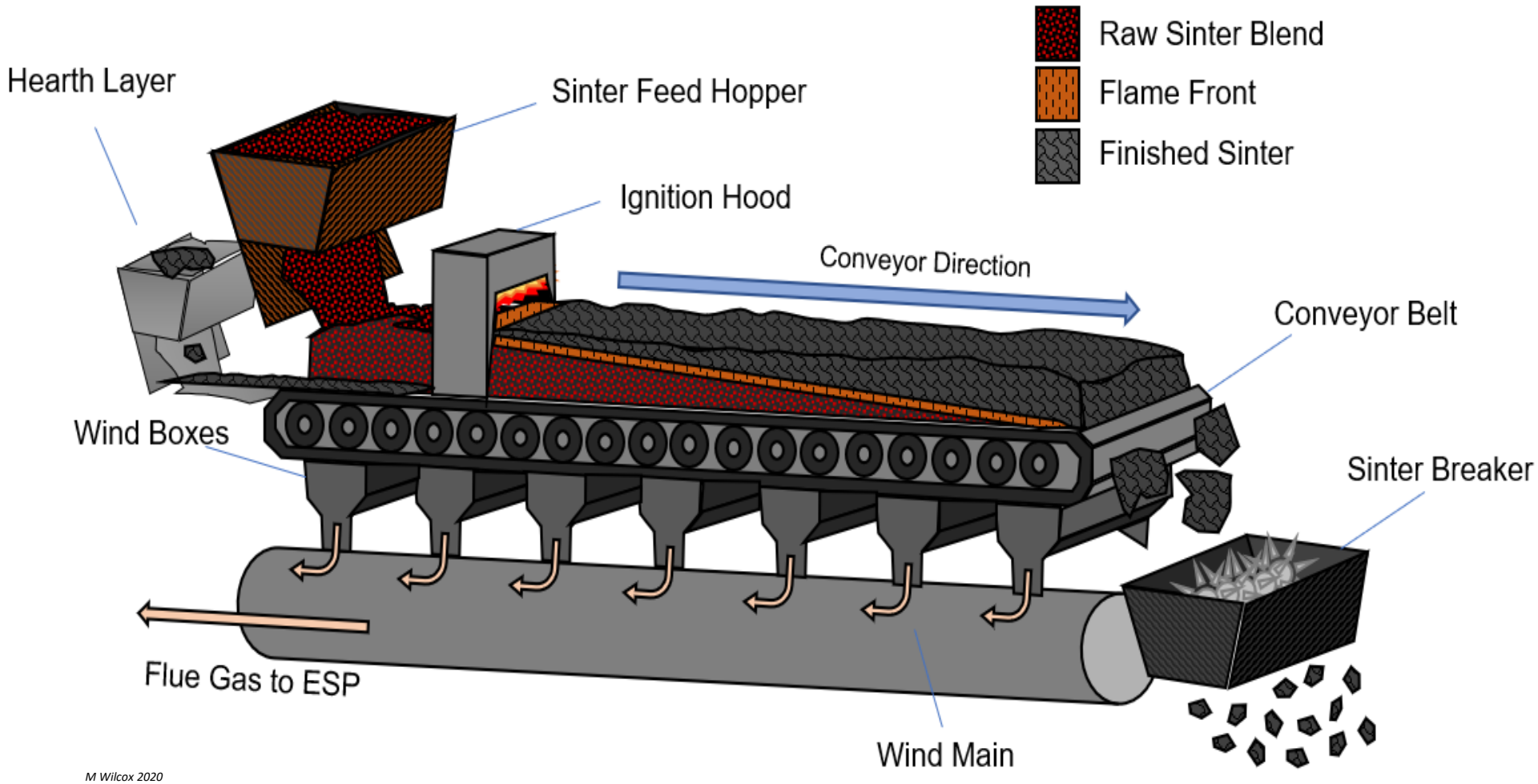
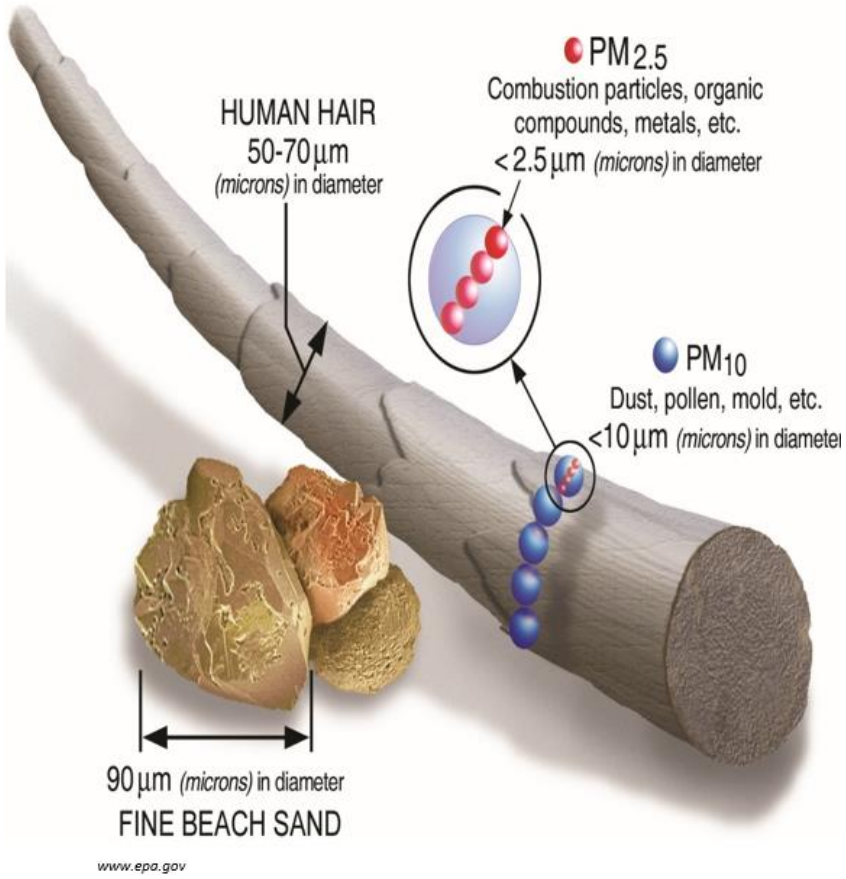
What is Sinter?



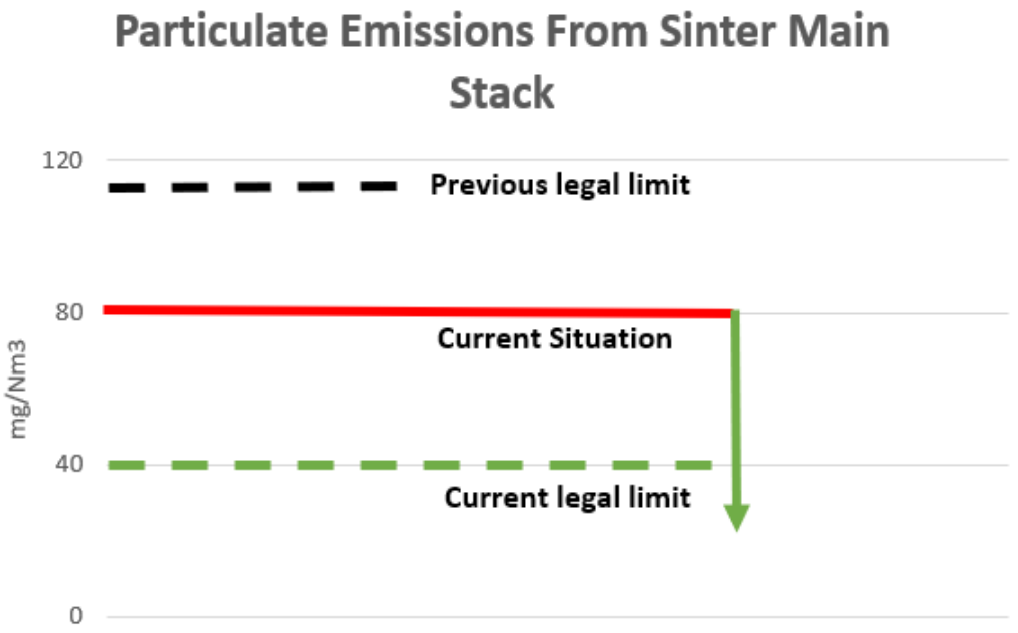
M Wilcox 2020

What is Particulate Matter (PM)?



Primary Components	Sources
NaCl	Sea salt
Element Carbon	Black carbon is formed by combustion of fossil fuels.
Trace metals	Generated by metallurgical processes, such as steelmaking, or by impurities found in or additives mixed into fuels used by industry.
Mineral Components	Coarse dust from construction and wind-driven dust.
Secondary Components	**Sources**
Sulphate	Formed by the oxidation of SO_2.
Nitrate	Formed by the oxidation of NOx.
Water	Components of the aerosol form PM.
Primary & Secondary	**Sources**
Organic Carbon	Primary organic carbon comes from traffic and industrial combustion sources. Secondary organic carbon comes from the oxidation of volatile organic compounds.

Current Situation – Emission Limit Value (ELV)

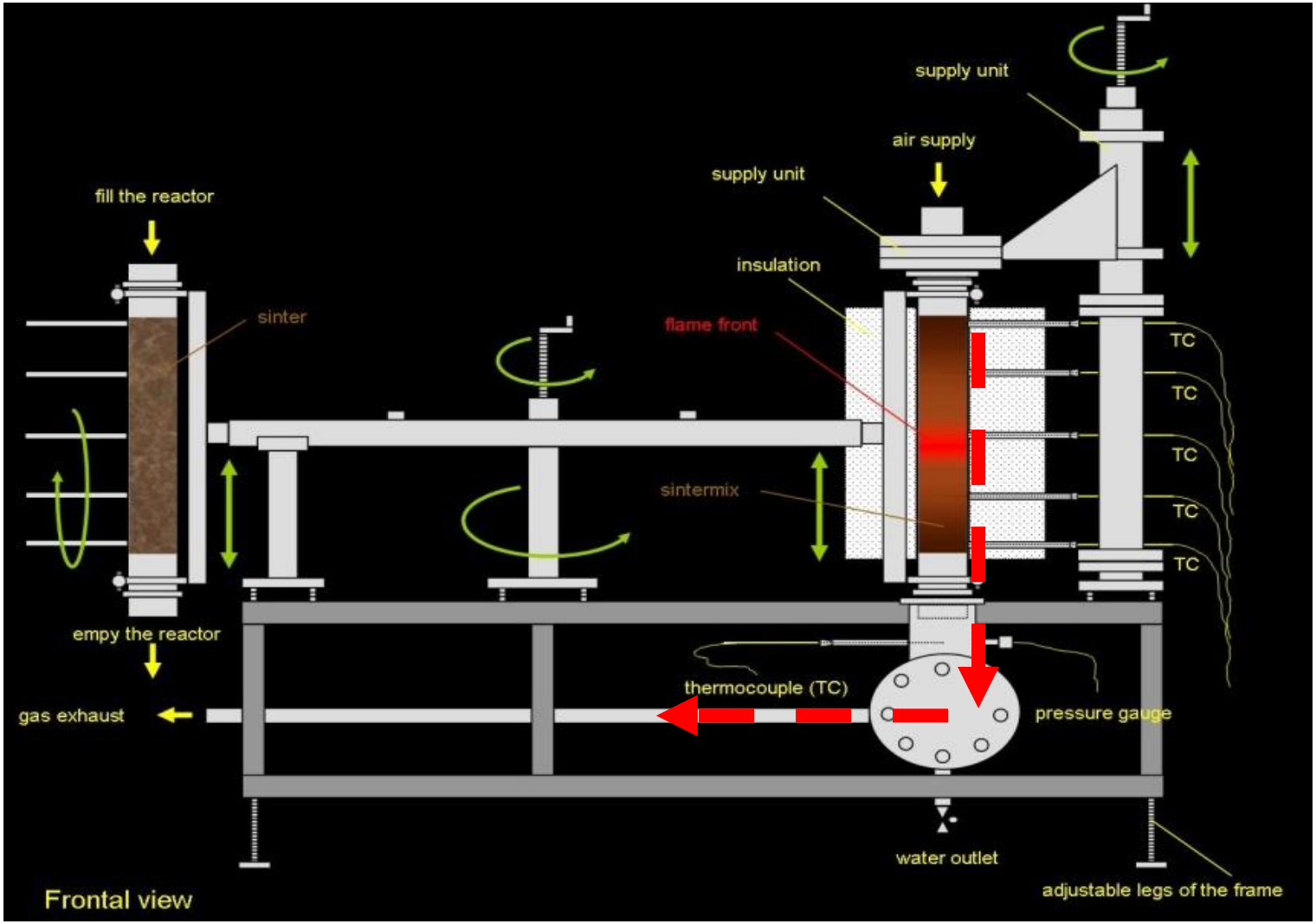


ELV DECREASE REQUIRED 50%

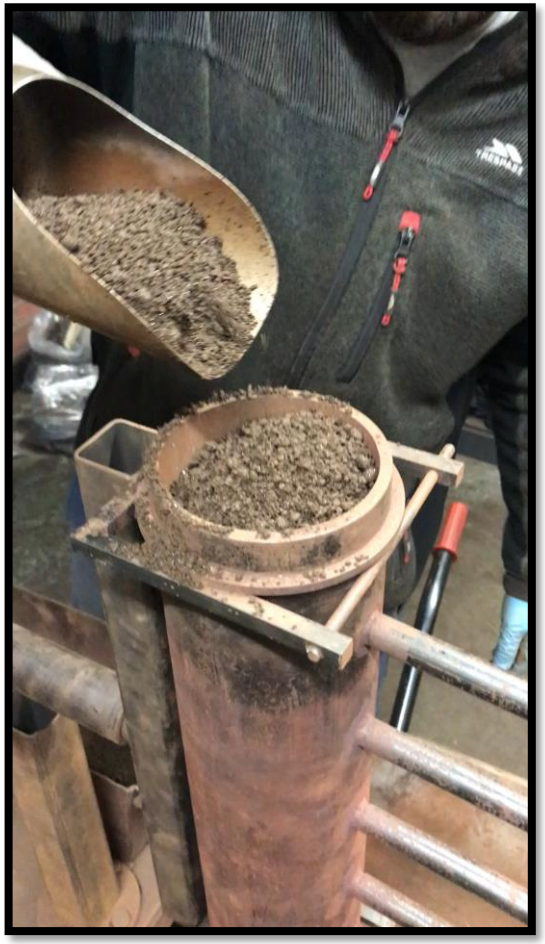
Current Situation - Abatements

COST SAVING OF £50 MILLION

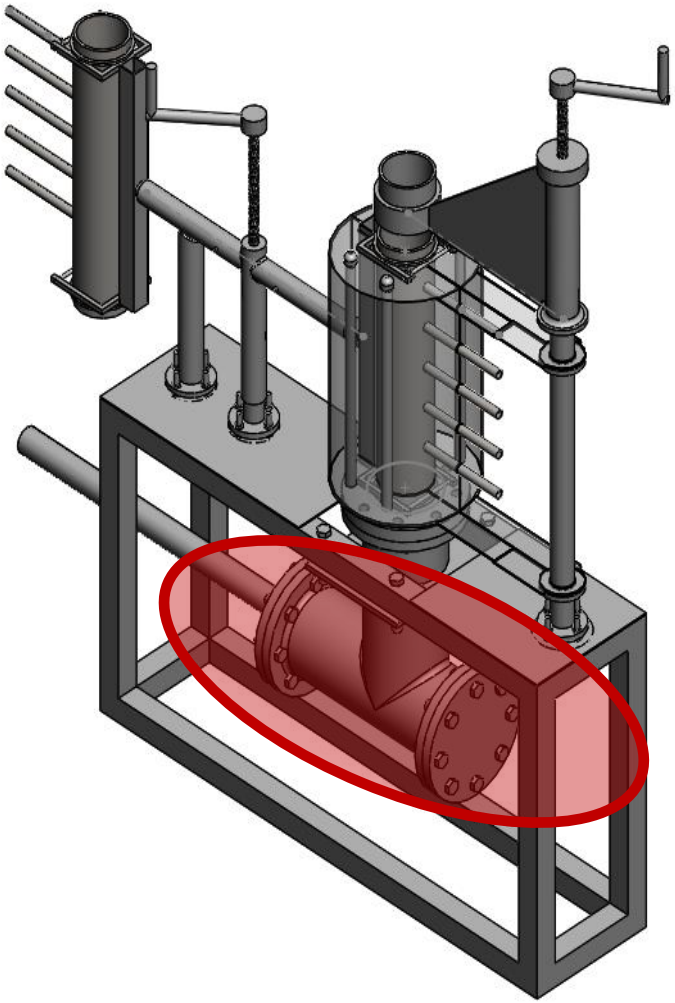
Sinter Pot (1)


supply unit
air supply
supply unit
fill the reactor
insulation
sinter
flame front
TC
TC
TC
TC
TC
sintermix
empy the reactor
thermocouple (TC)
gas exhaust
pressure gauge
water outlet
adjustable legs of the frame
Frontal view

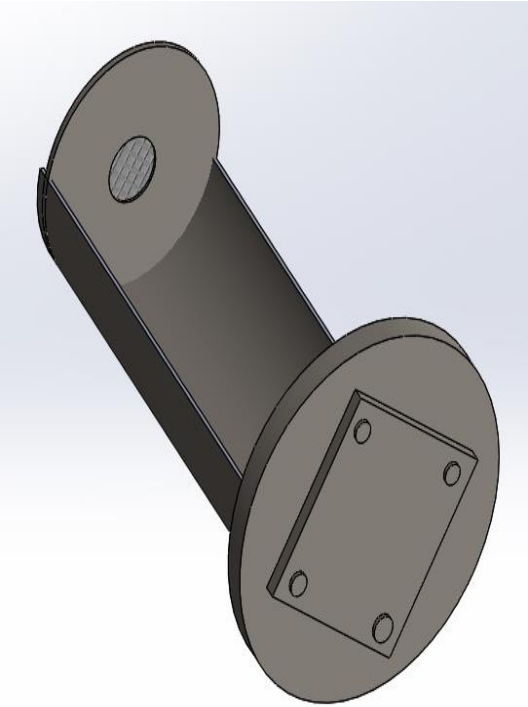
Sinter Pot (2)

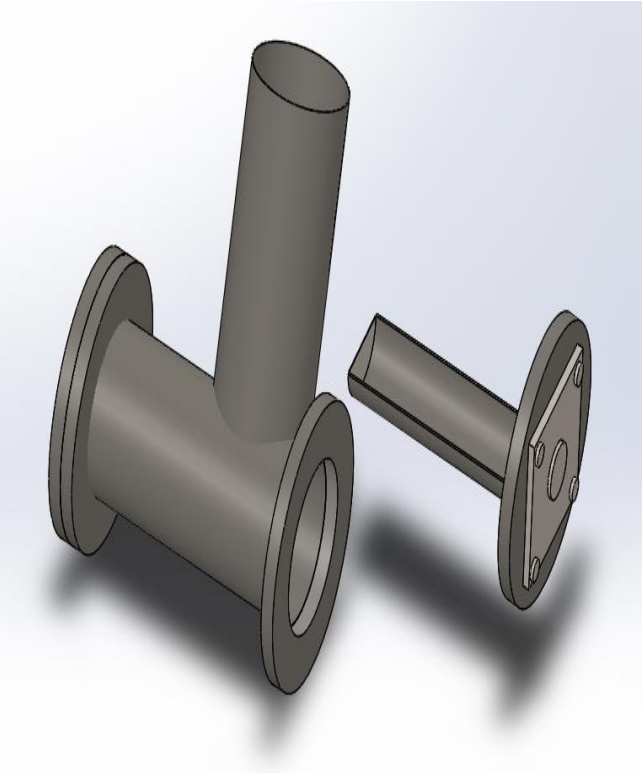


Installation of PM Capture Device (1)

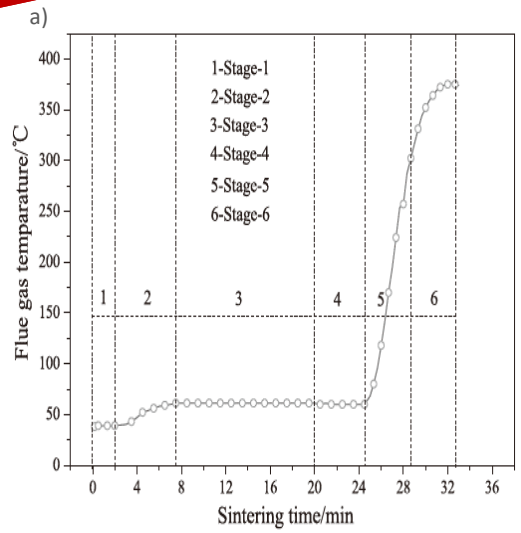


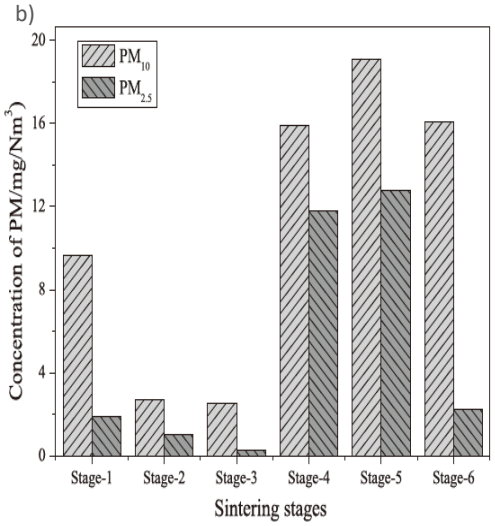
Installation of PM Capture Device (2)

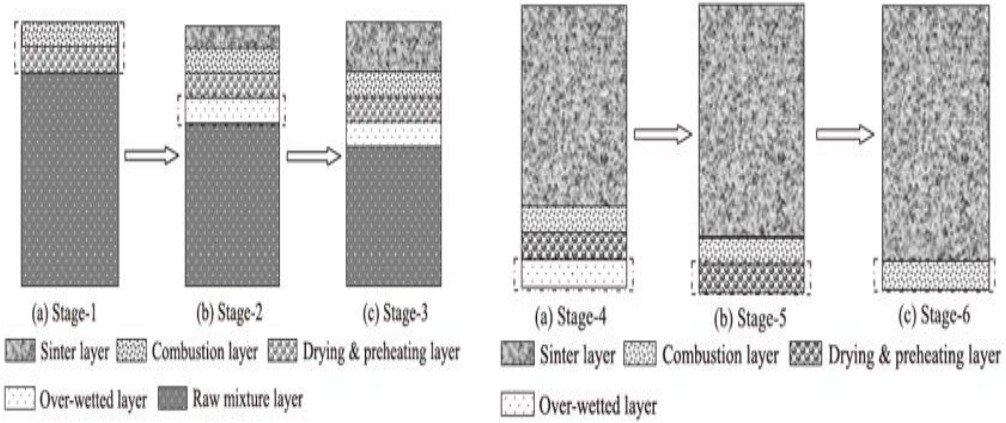




PM Characteristics During Sintering - Profile







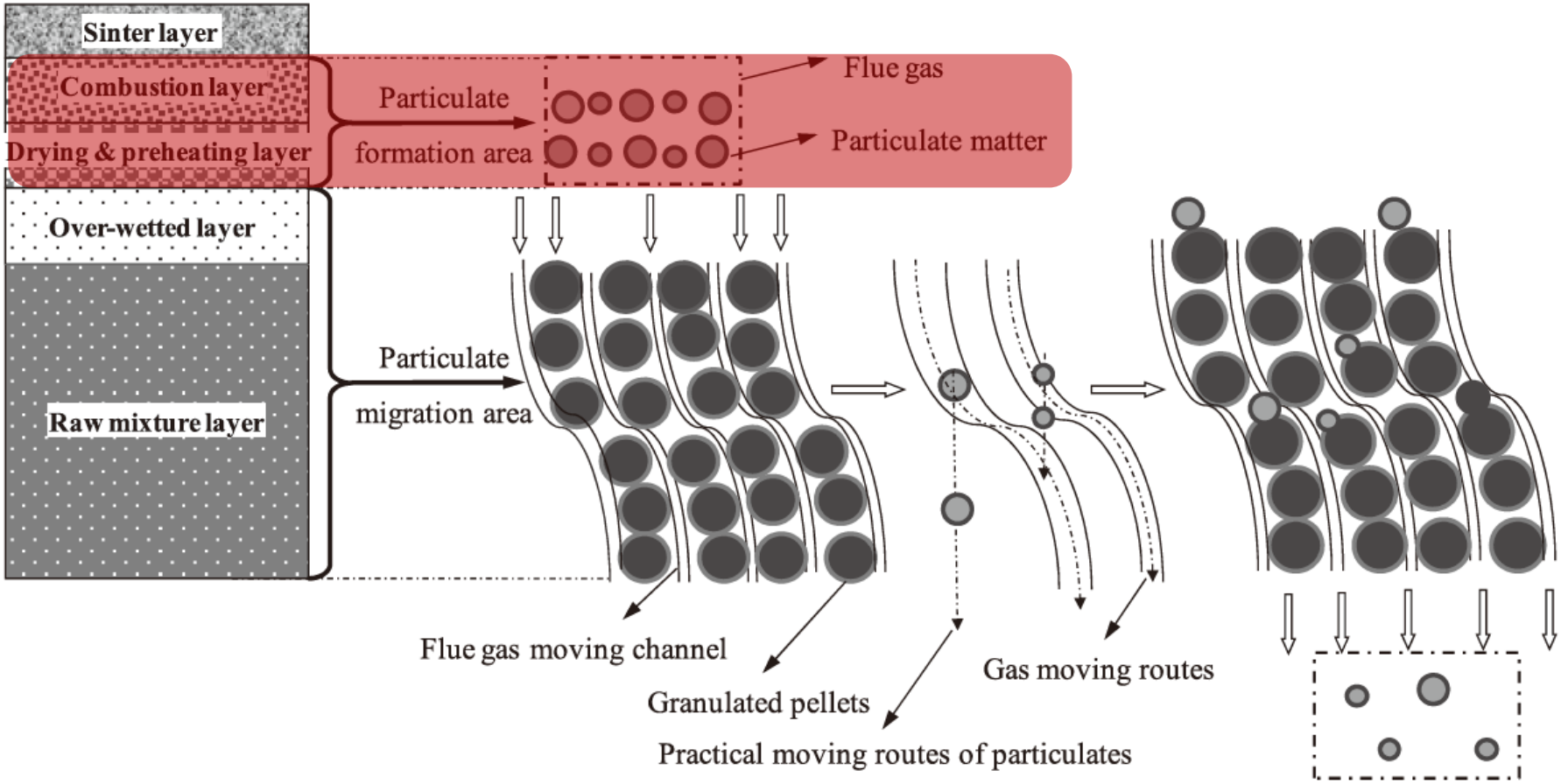
Main Components in $PM_{2.5}$

- Fe-Ca-O (Minerals Melting) → Fe_2O_3-CaO
- Al-Si-O (Fuel fly ash) → Al_2O_3-SiO_2
- K-Na-Pb-Cl (Chlorination) → K(Pb/Na)Cl
- Ca-K-Pb-S-O (Forming Sulfate) → $K_2(Ca/Pb)SO_4$

Min Gan 2015

Zhiyun JI 2016

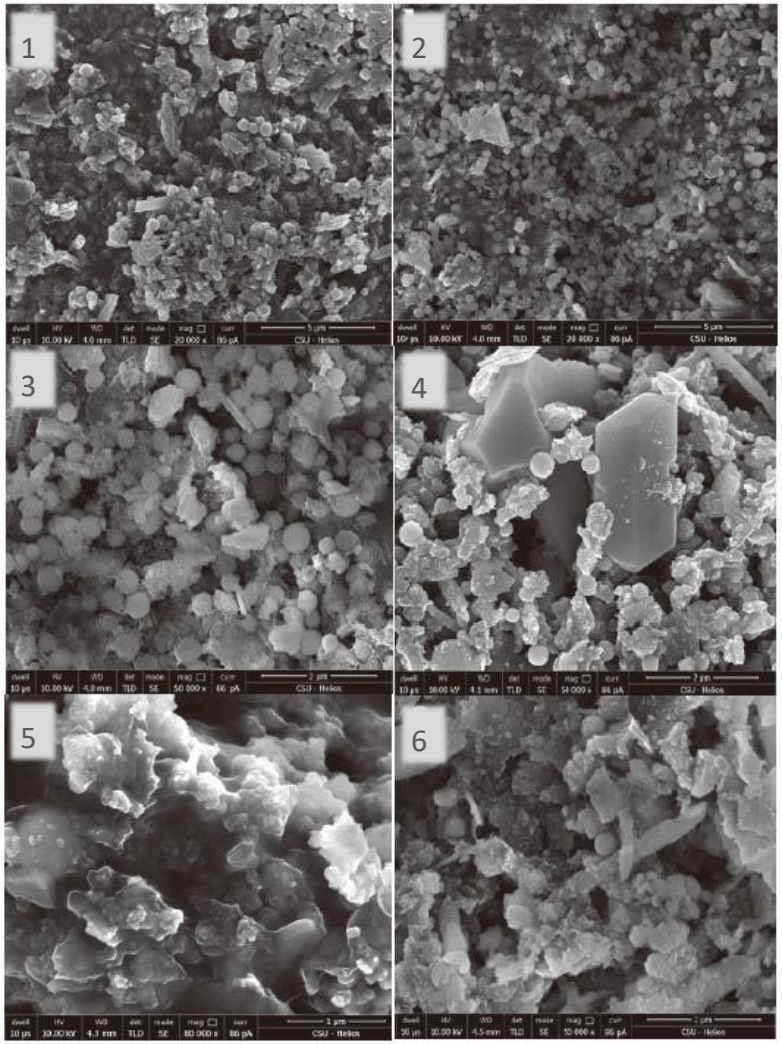
PM Characteristics During Sintering – Sources & Mechanisms



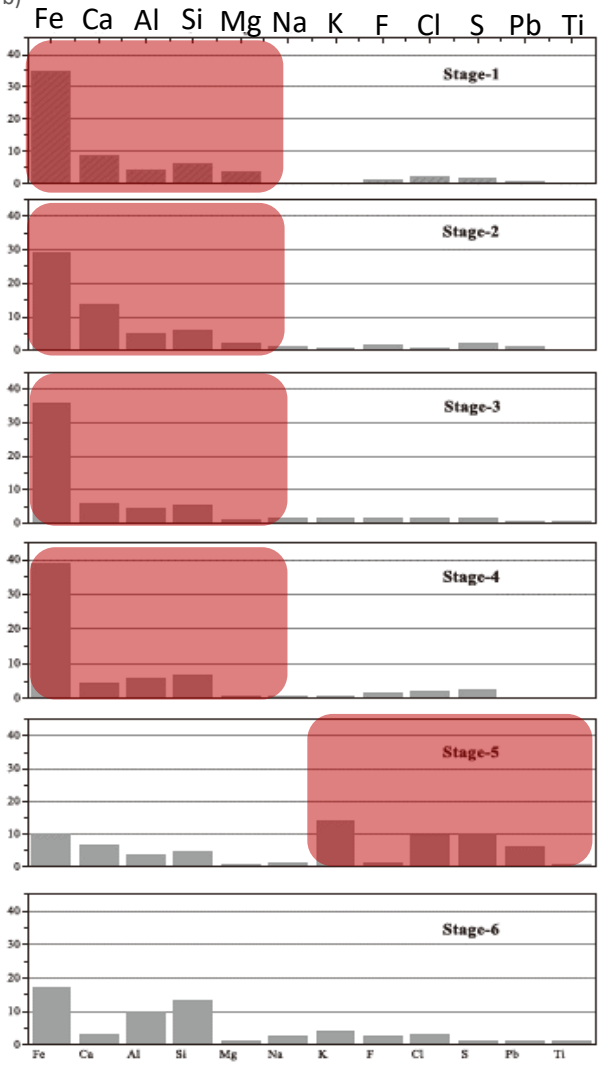
Min Gan 2015

PM Characteristics During Sintering – Chemical Composition

a)



b)



Data Analysis – Fan Operation

Process Information (40 data tags over 9 years)

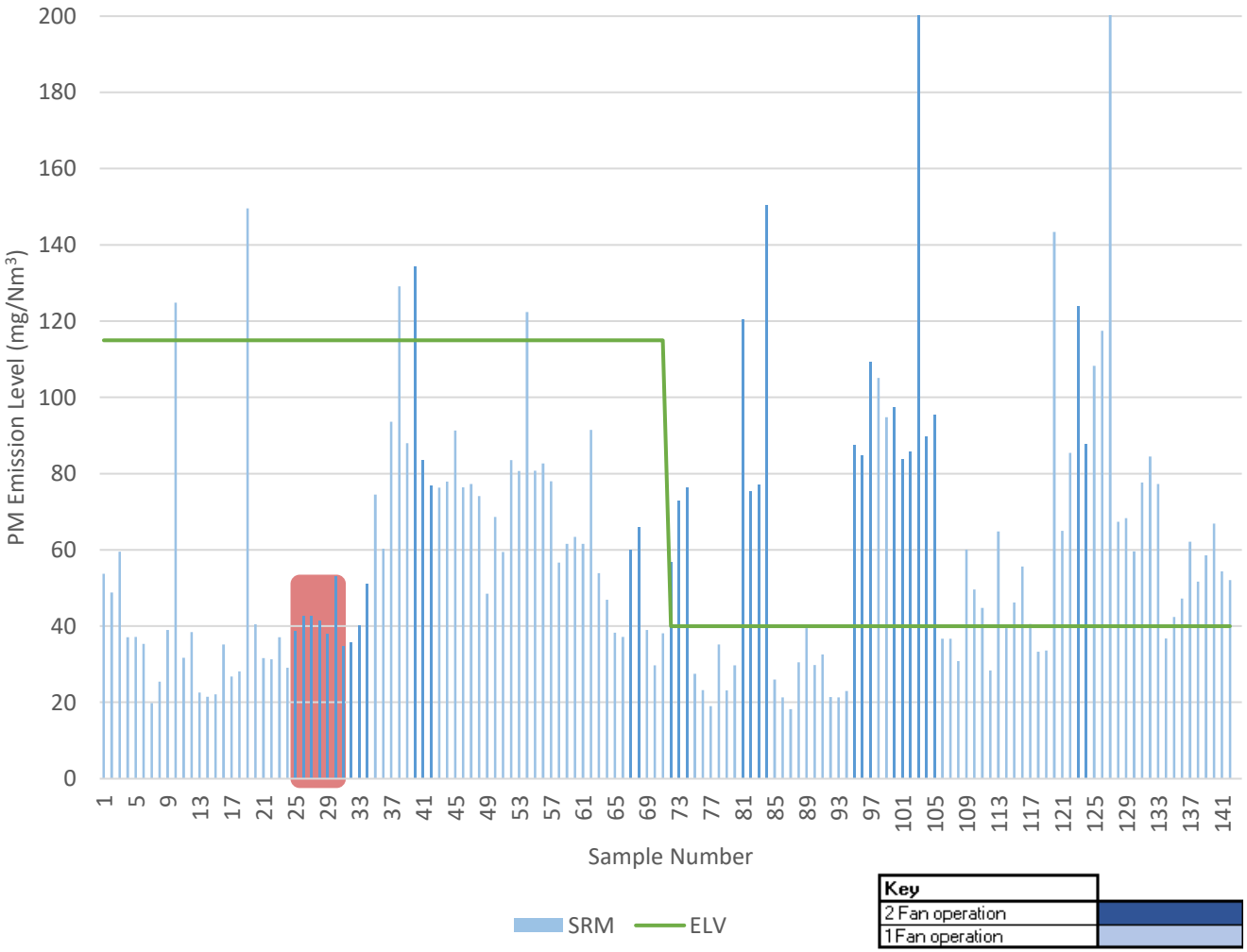
- Fan information, ESP fields, temperatures, strand data, production output and continuous emission monitors (CEMs).

Sampling Data (114 days with 14 parameters)

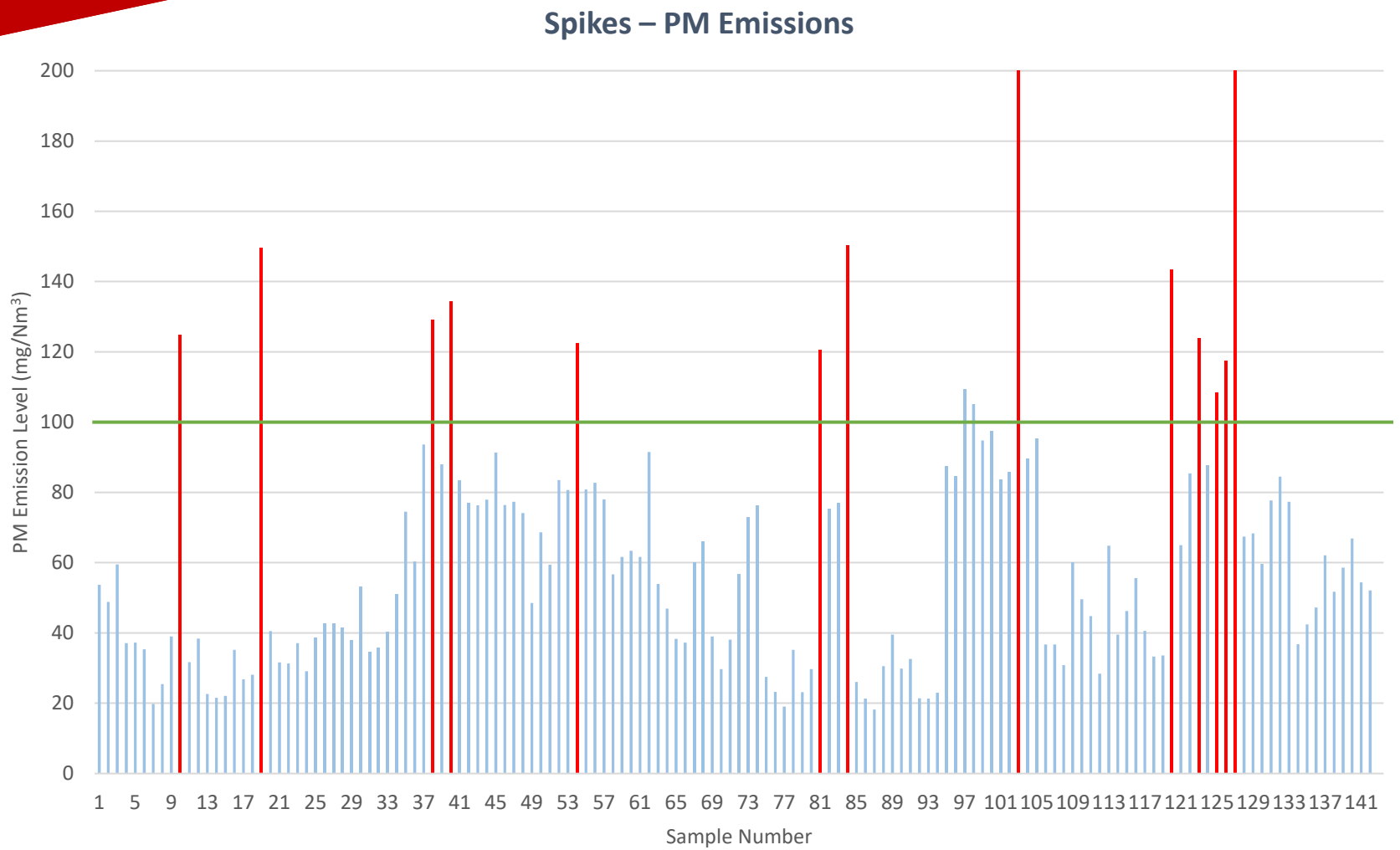
- PM concentration, velocity, flowrate, pressure and numerous gaseous concentrations.

Raw Materials (168 parameters)

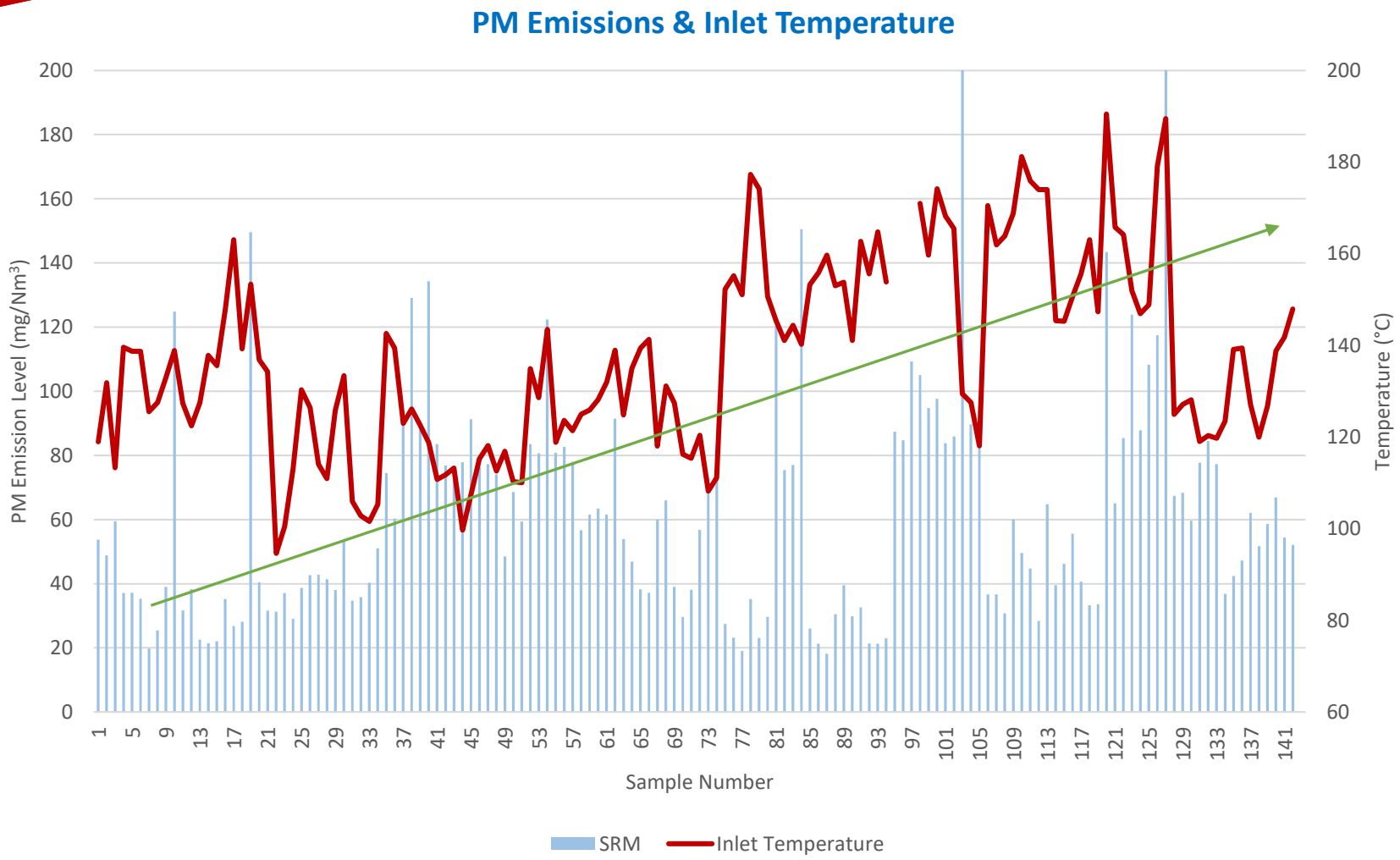
- Predicted chemistry composition, screen sizing's, and the raw materials including amount of reverts used



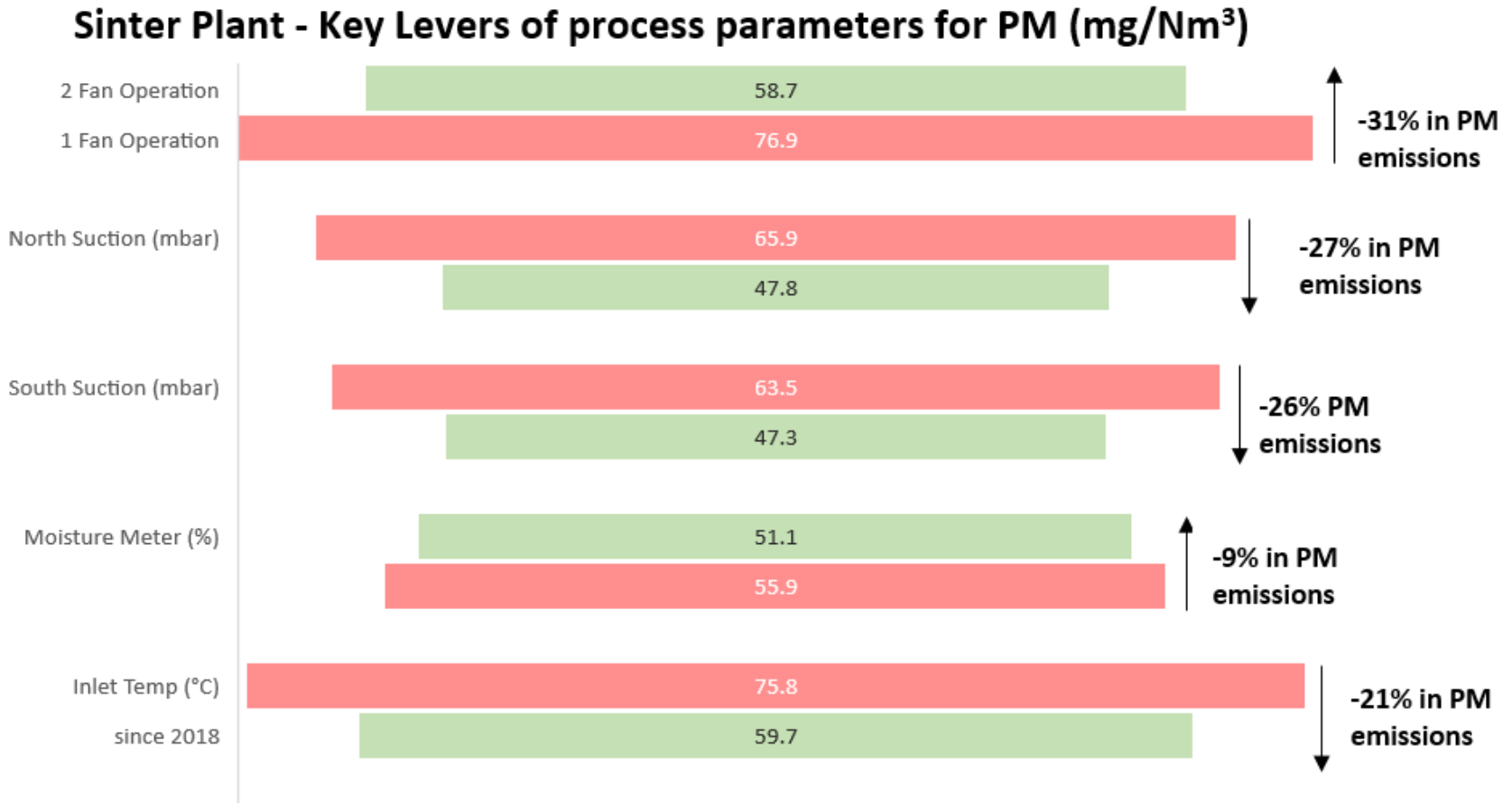
Data Analysis – Spikes



Data Analysis – Temperature

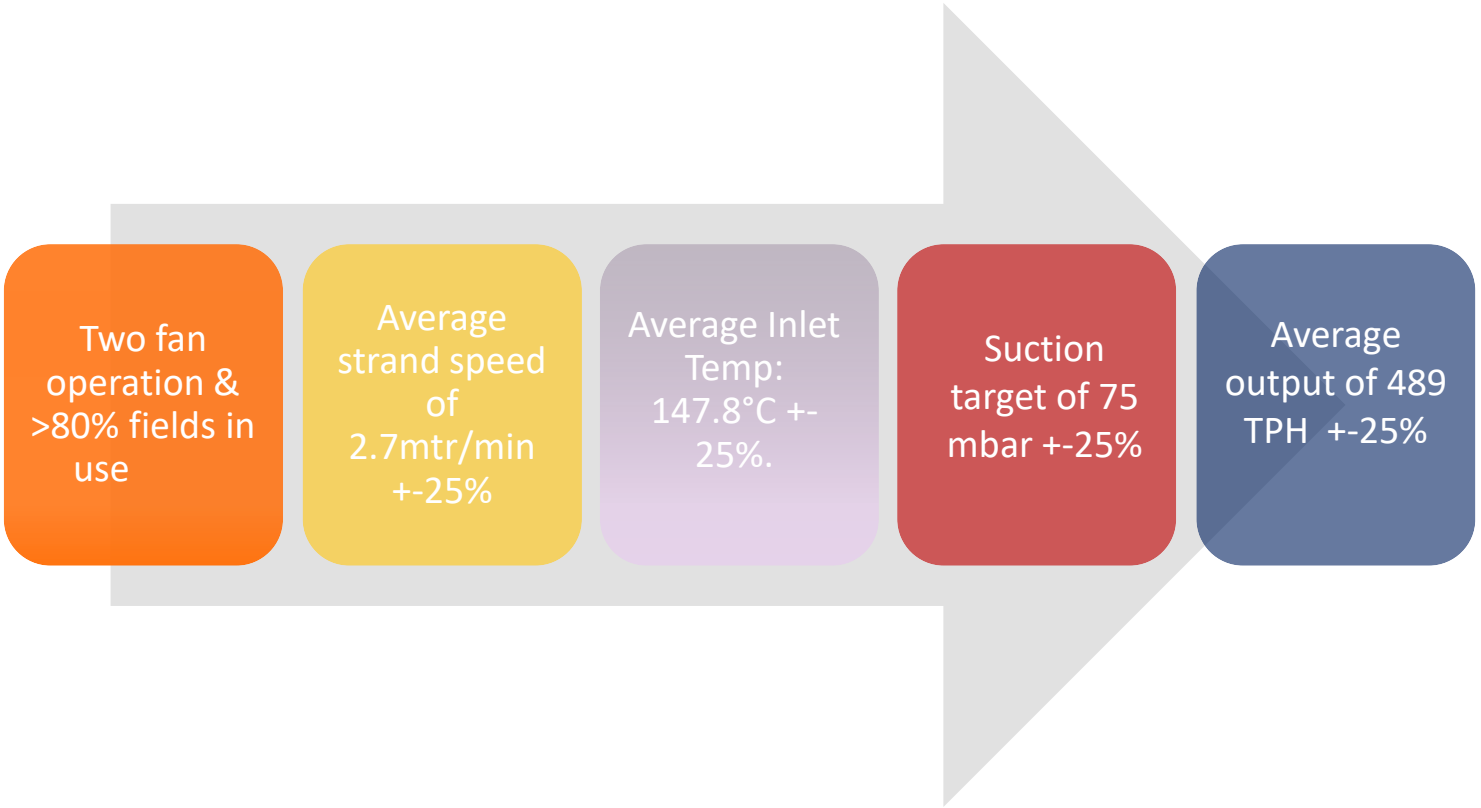


Data Analysis - Summary of Influence of Process Parameters

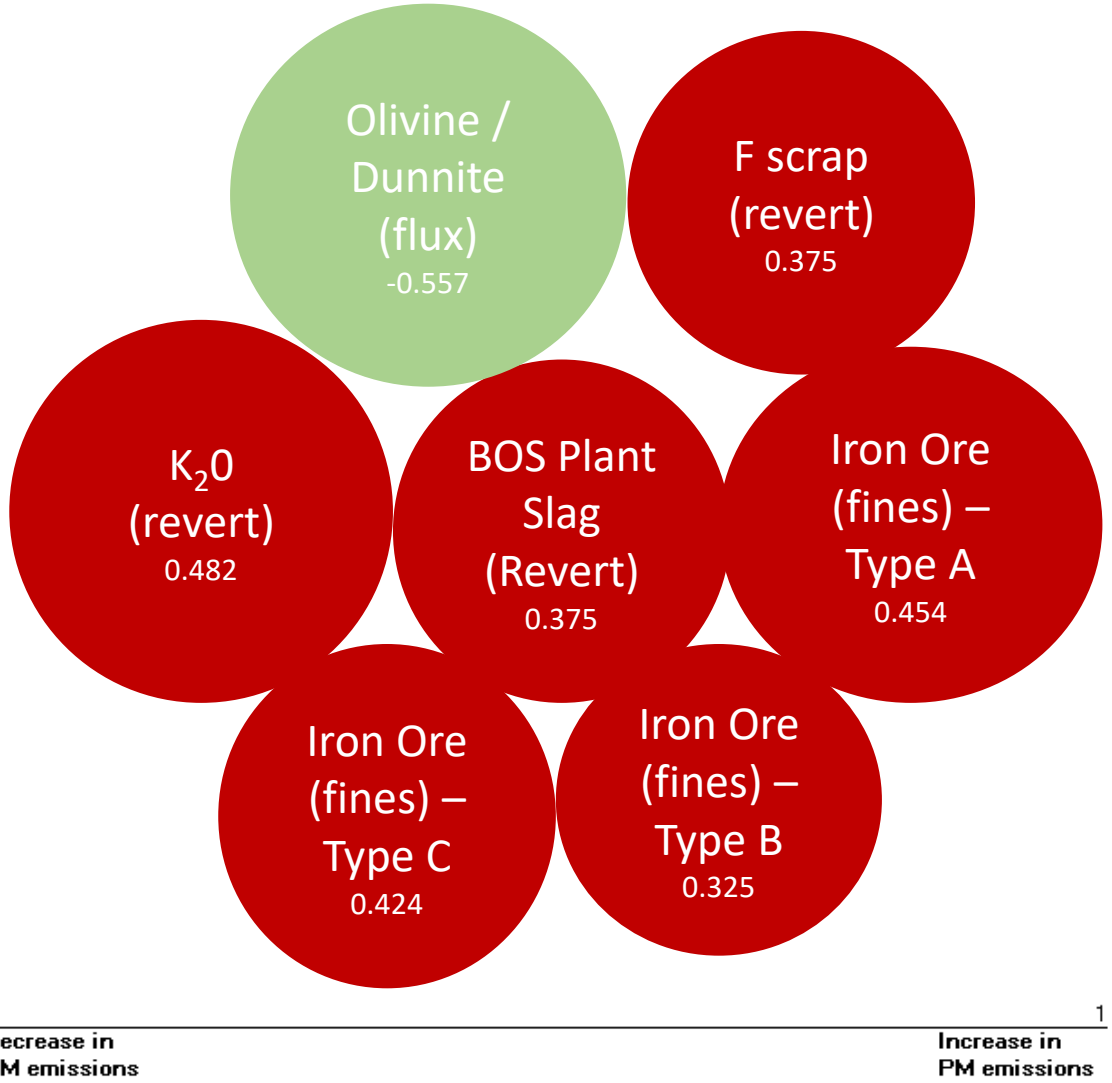


Suction mbar average	75 *mbar*
Moisture % average	6.1 *%*
Inlet temp (since 2018) average	149.9 *°C*

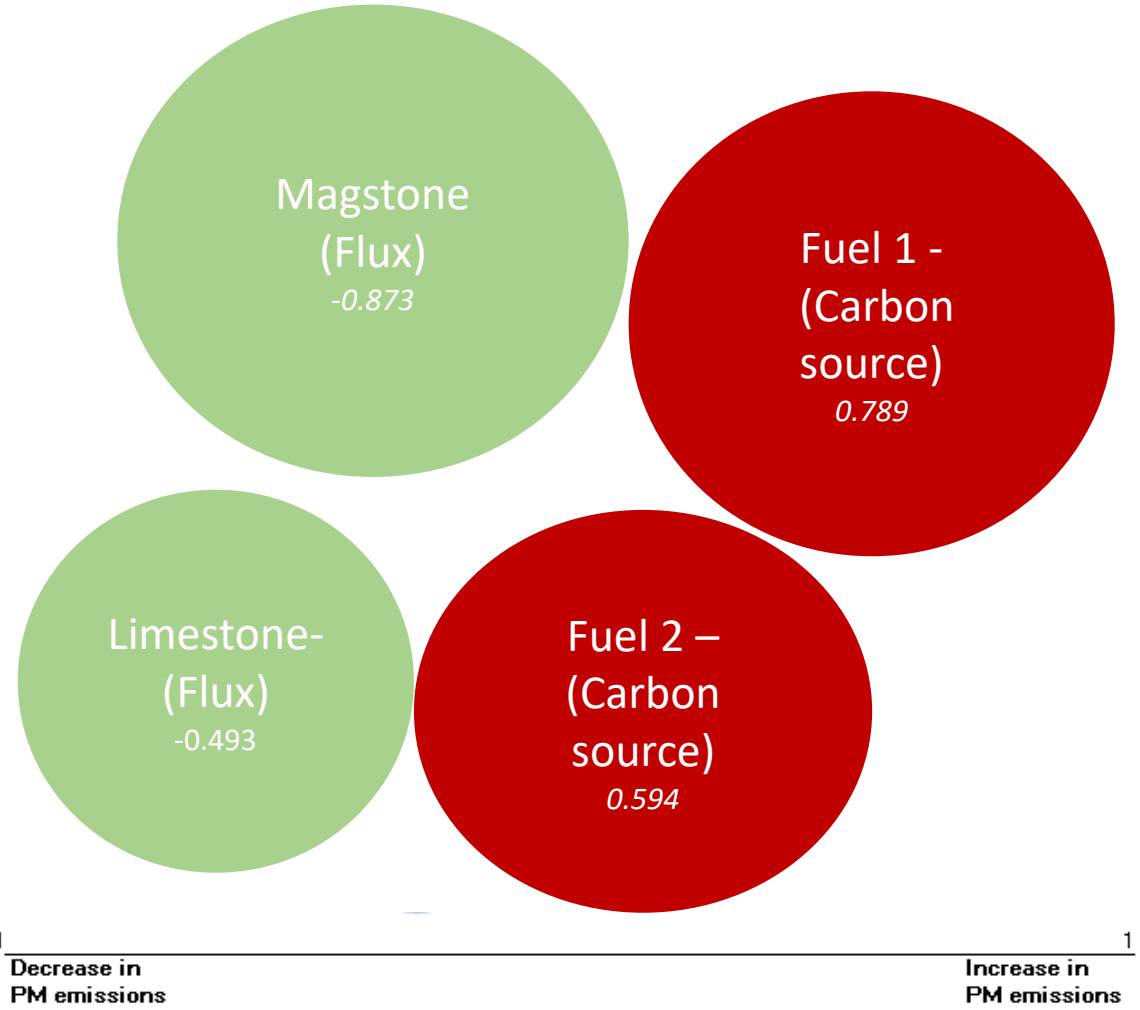
Data Analysis - Data Scrubbing



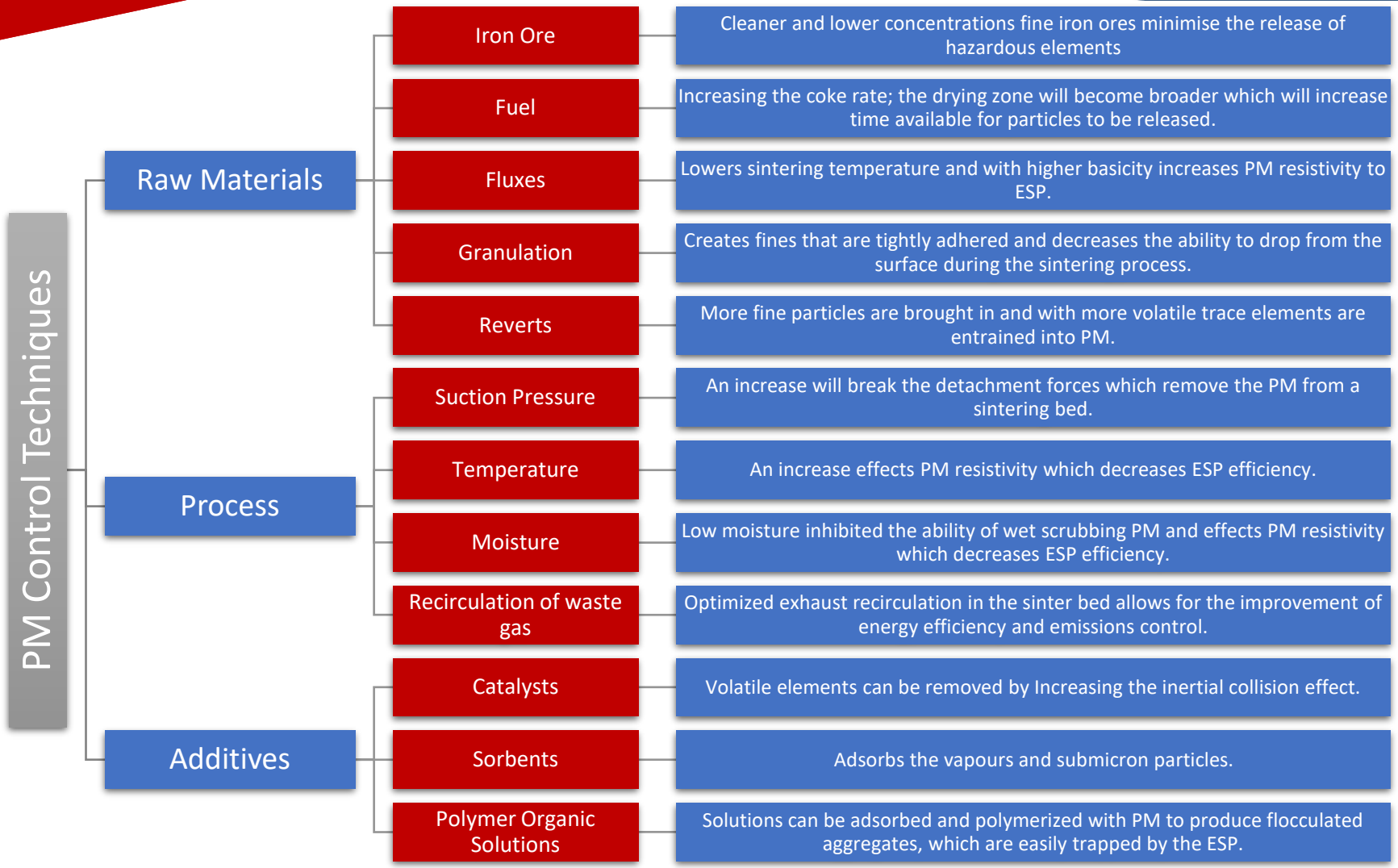
Data Analytics - Key levers of raw materials for PM emissions



Data Analytics – Raw materials effect on the inlet temperature



PM Control Techniques – Different Parameters



Summary

- Finding alternative ways to **decrease PM by 50%** to comply with ELV without the need of installing a fabric filter – Savings of **£50,000,000** CAPEX and improve air quality to the local community by 2022.
- Directly influencing raw material selection in the business by **influencing direct operations.**
- **Efficiency improving of the ESP** will generate would **decrease the quantity of waste product** and **produce cleaner/improved quality reverts** which would have a use positive ripple effect through the entire process.
- Analysed **over 9 years of data** from the sinter process, raw materials and sampling data: Key levers of dust emissions are fan operation, temperature, suction, moisture and raw materials used.
- Clear **understanding of PM characteristics** during sintering; profile, chemical composition, mechanisms, transformation paths and PM control techniques.
- An in-situ **PM capture device has been designed and installed** to capture airborne and deposited PM.

Future work

- Relate the data analysis from the sinter plant and PM knowledge gained to create experiments which has the largest impact to minimise PM on the sinter pot. Experimental ideas range from different iron ore PSD, washing reverts, use of pre-primary millscale and addition of Potassium Chloride in increments.
- Upscale experimental studies to full size plant trials.

Q&A

M2A COATED

Thank you, any questions?

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