9th Sulphur and Sulphuric Acid Conference

Zimplats SO_2 Abatement Plant Design



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HATCH

Predominant Smelter SO_2 Off-gas Cleaning Arrangements

Process		Gas Cooling		Hot Cleaning		Wet Cleaning		SO_2 Collection	Hatch Experience
Outokumpu Flash		Boiler		ESP		Scrubber + WESP		Acid Plant	BHP (Olympic Dam, Kalgoorlie Nickel Smelter) Rio Tinto – Kennecott
Inco Flash		Direct Quench		-		Scrubber + WESP		Acid Plant Liquid SO_2	Vale Inco Hayden
Mitsubishi Process		Boiler Spray Cooling		ESP		Scrubber + WESP		Acid Plant Liquid SO_2 Tail Gas Scrubbing	Kidd Creek Naoshima Port Kembla
Noranda/ Teniente		Spray Cooler Radiant Cooling		ESP		Scrubber + WESP		Acid Plant Liquid SO_2 Tail Gas Scrubbing	Horne Patrellios
Peirce-Smith Converting		Spray Cooling Radiant Cooling Direct Quench		ESP		Scrubber + WESP		Acid Plant	Zimplats Horne Gaspe
Ausmelt/ ISASMELT		Boiler Spray Cooler		ESP		Scrubber + WESP		Acid Plant	FMI - Miami Anglo Platinum (Valterra)
Electric Furnace		Spray Cooler		ESP		Scrubber + WESP		Acid Plant	Anglo Platinum (Valterra) Zimplats

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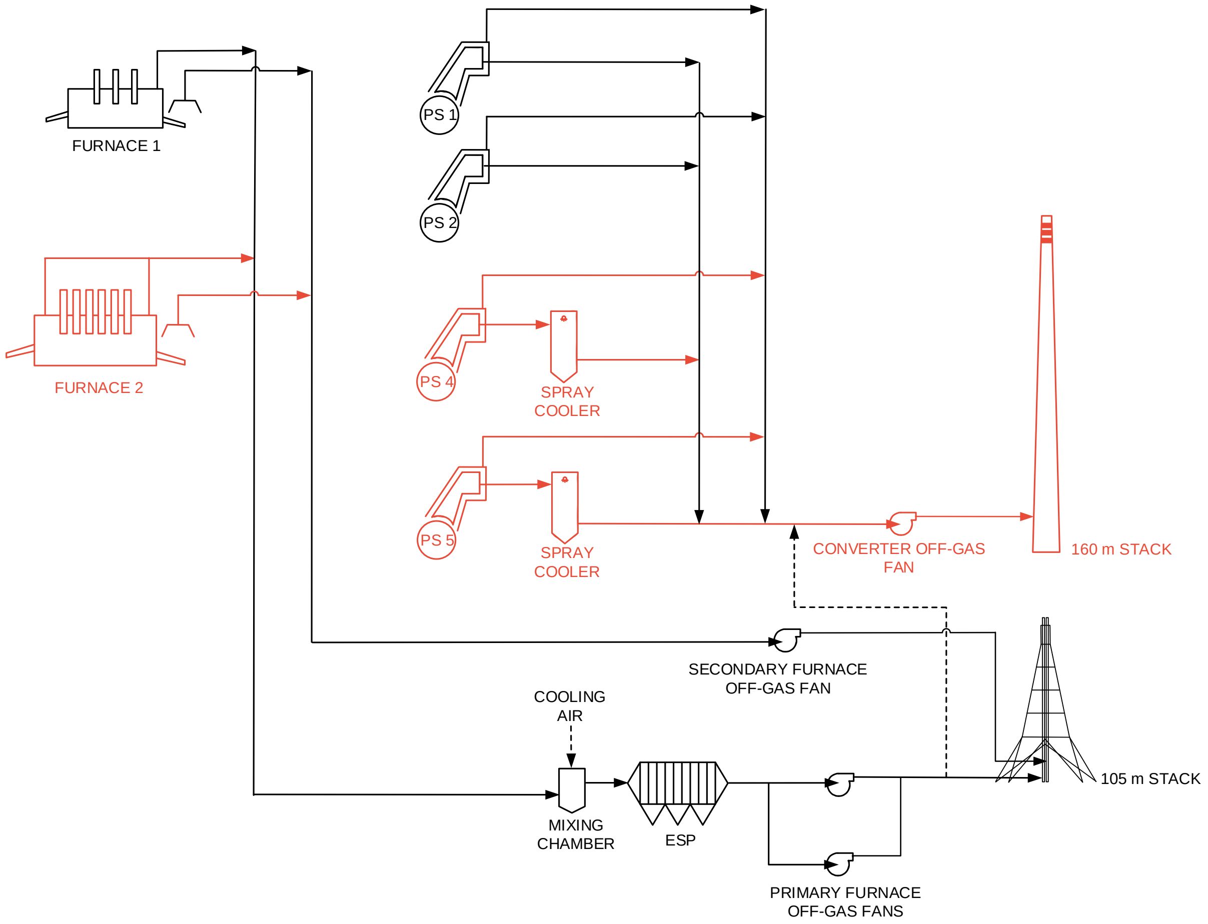
The Smelter Expansion and SO_2 Abatement Project

Smelter Expansion at Zimplats SMC

- Zimplats owns and operates the SMC smelter complex and various concentrators and mines in Zimbabwe
- The requirement to increase the smelter concentrate throughput by almost 3 times:
  - Treat concentrates from a third module concentrator
  - 3rd Party sources such as Mimosa
  - Tailings scavenging facilities to improve overall metal recovery

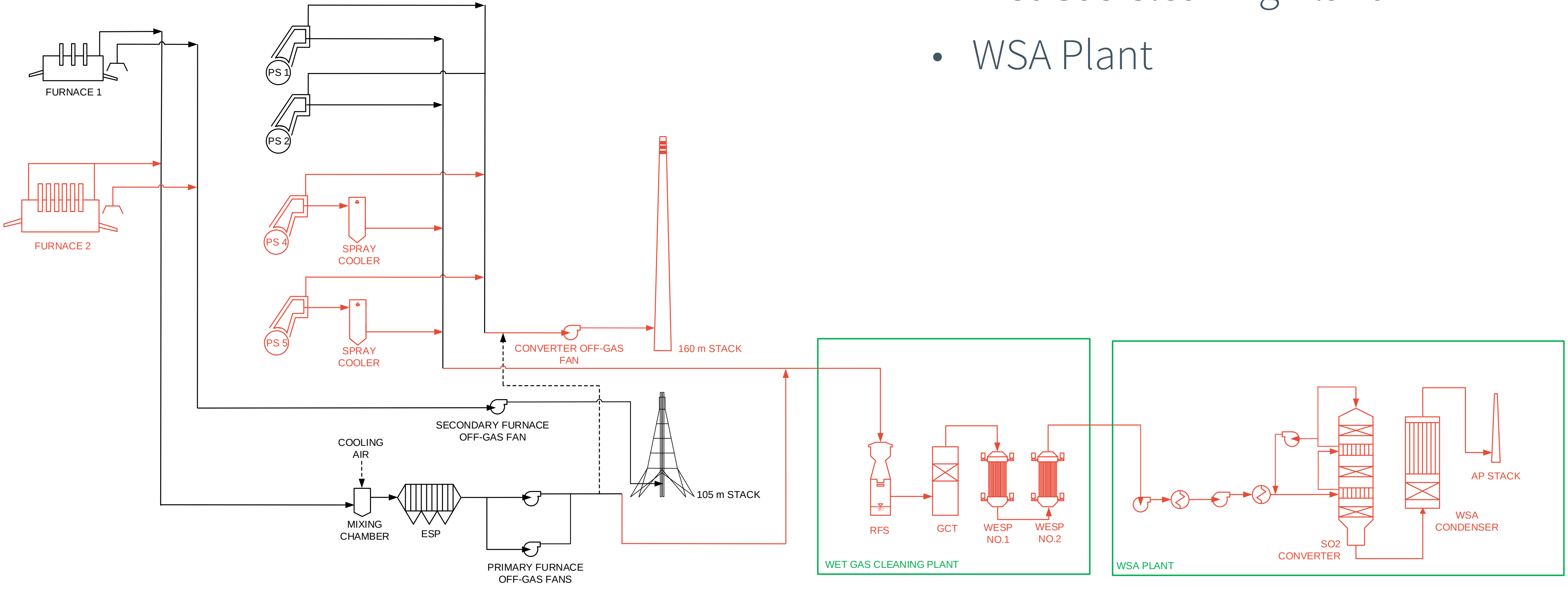
Smelter Expansion and Ramp-up Off-gas Handling



- New 38 MW electric furnace
- Two 12 x 24 ft Peirce Smith Converters
- Converter spay coolers
- 160 m tall stack

Smelter Expansion at Final SO_2 Abatement

- Wet Gas Cleaning Plant
- WSA Plant



Process Design Criteria Development

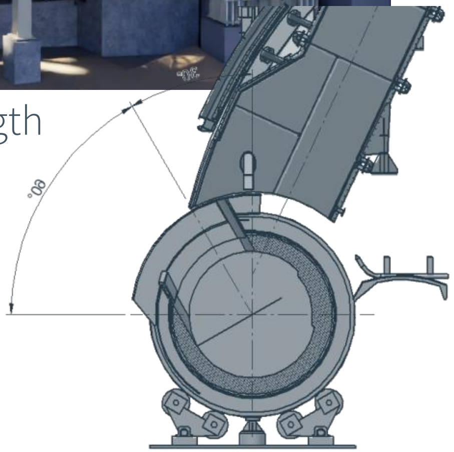
Smelter SO_2 Off-gas Sources

Electric Furnace

- Steady off-gas flow and SO_2 strength
- Labile sulphur liberated from minerals
  - $Ni_9Fe_8S_{15} \rightarrow 3Ni_3S_2 + 8FeS + S$
  - $2CuFeS_2 \rightarrow Cu_2S + 2FeS + S$
  - $Fe_7S_8 \rightarrow 7FeS + S$
- Typically, ~3 vol% SO_2

Peirce-Smith Converter

- Cycled off-gas flow and variable SO_2 strength
- $FeS + 1.5O_2 \rightarrow FeO + SO_2$
- Typically, ~6 vol% SO_2



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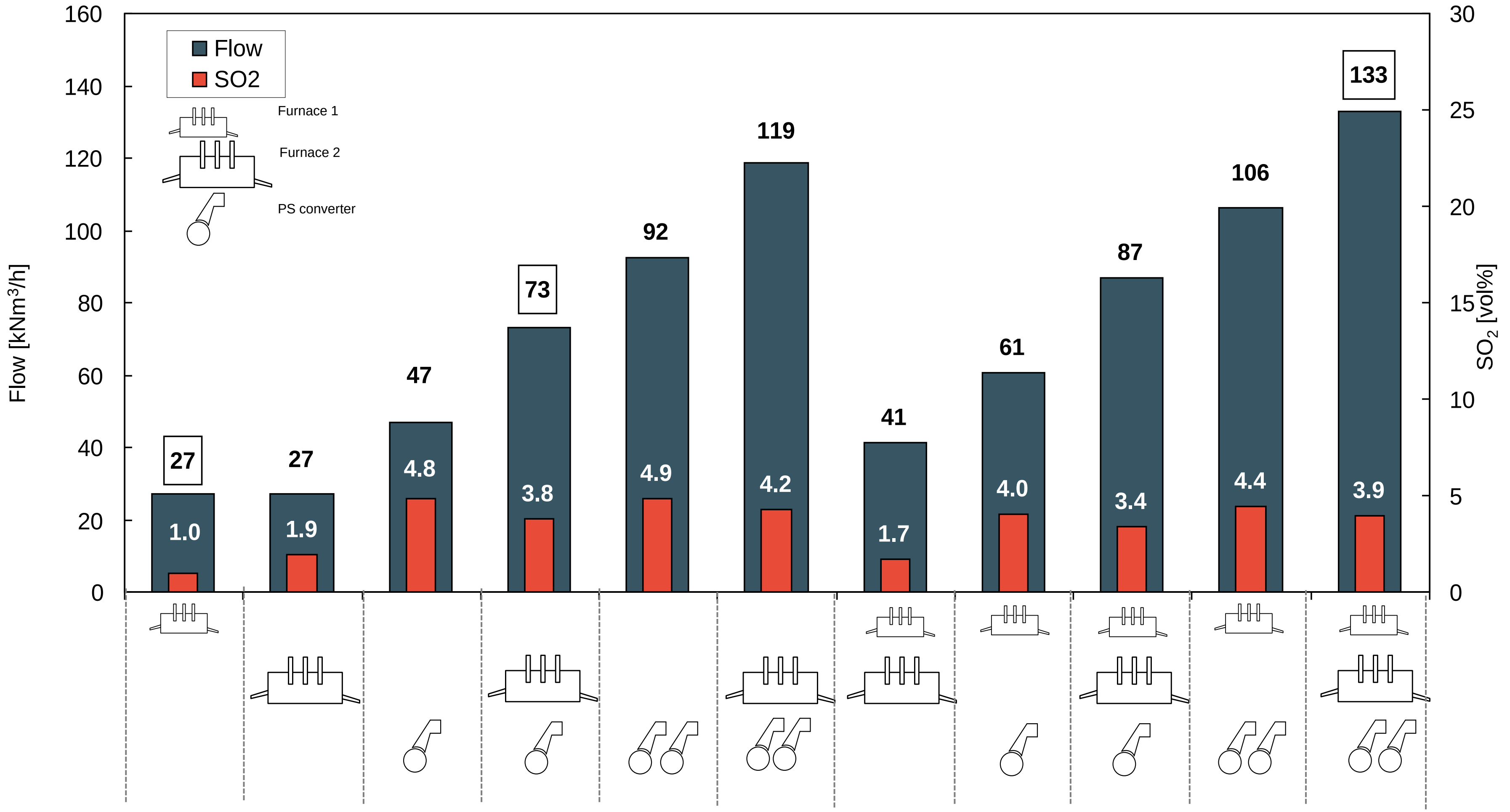
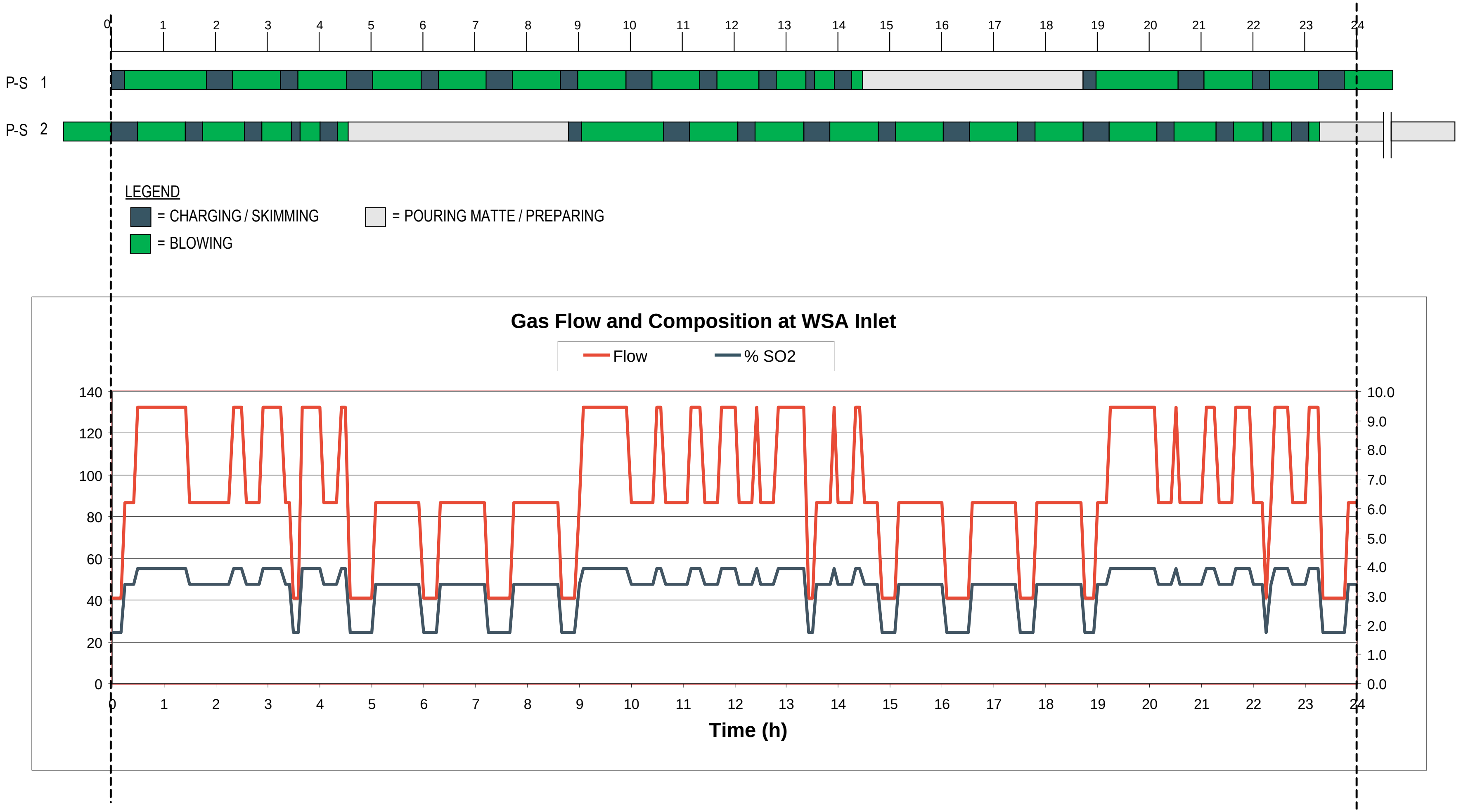
Acid Plant Inlet Profiles

- Combination of furnaces and converters create a wide flowrate and SO_2 concentration operating window



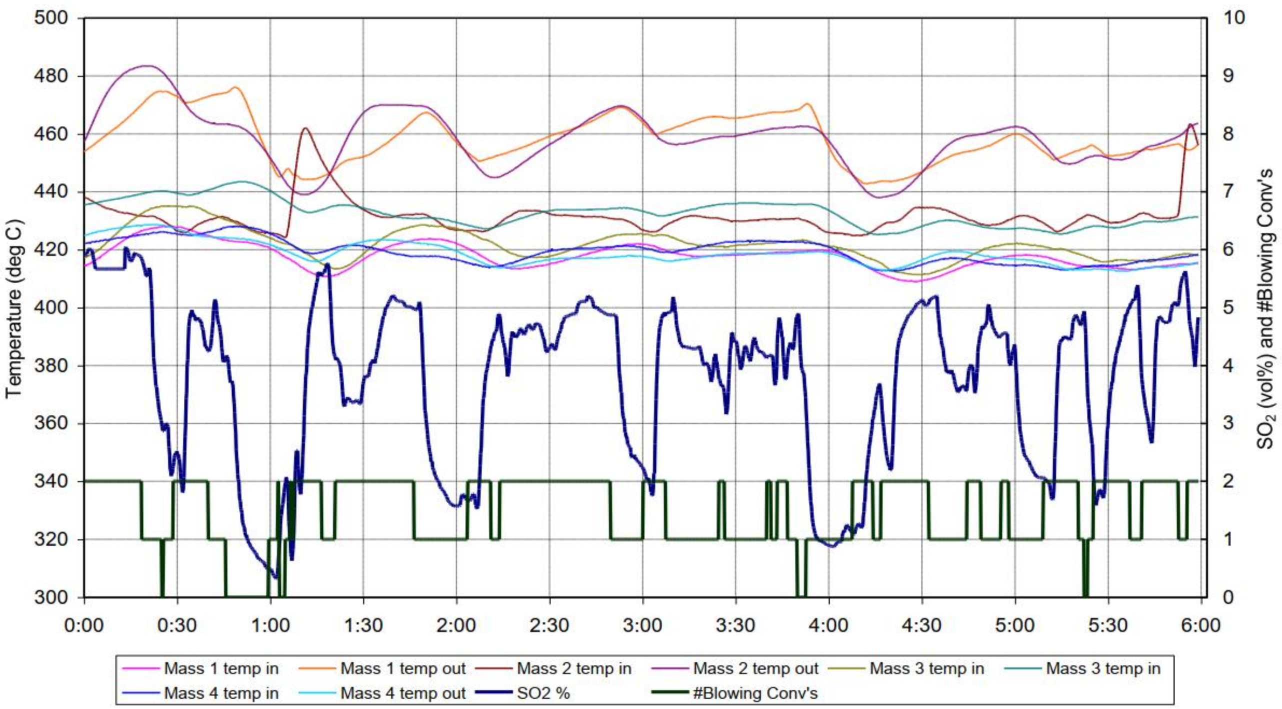
Acid Plant Inlet Profiles

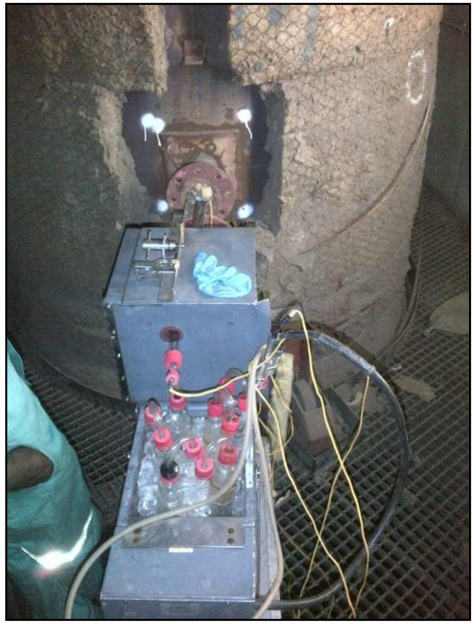
- The cyclical nature of the converter operation introduces further variability over shorter time periods



Acid Plant Inlet Profiles

- Characterisation of the furnace and converter off-gas is essential at the start of the project as input into the Process Design Basis
- Isokinetic sampling is necessary if continuous measurements are not available





Technology Selection

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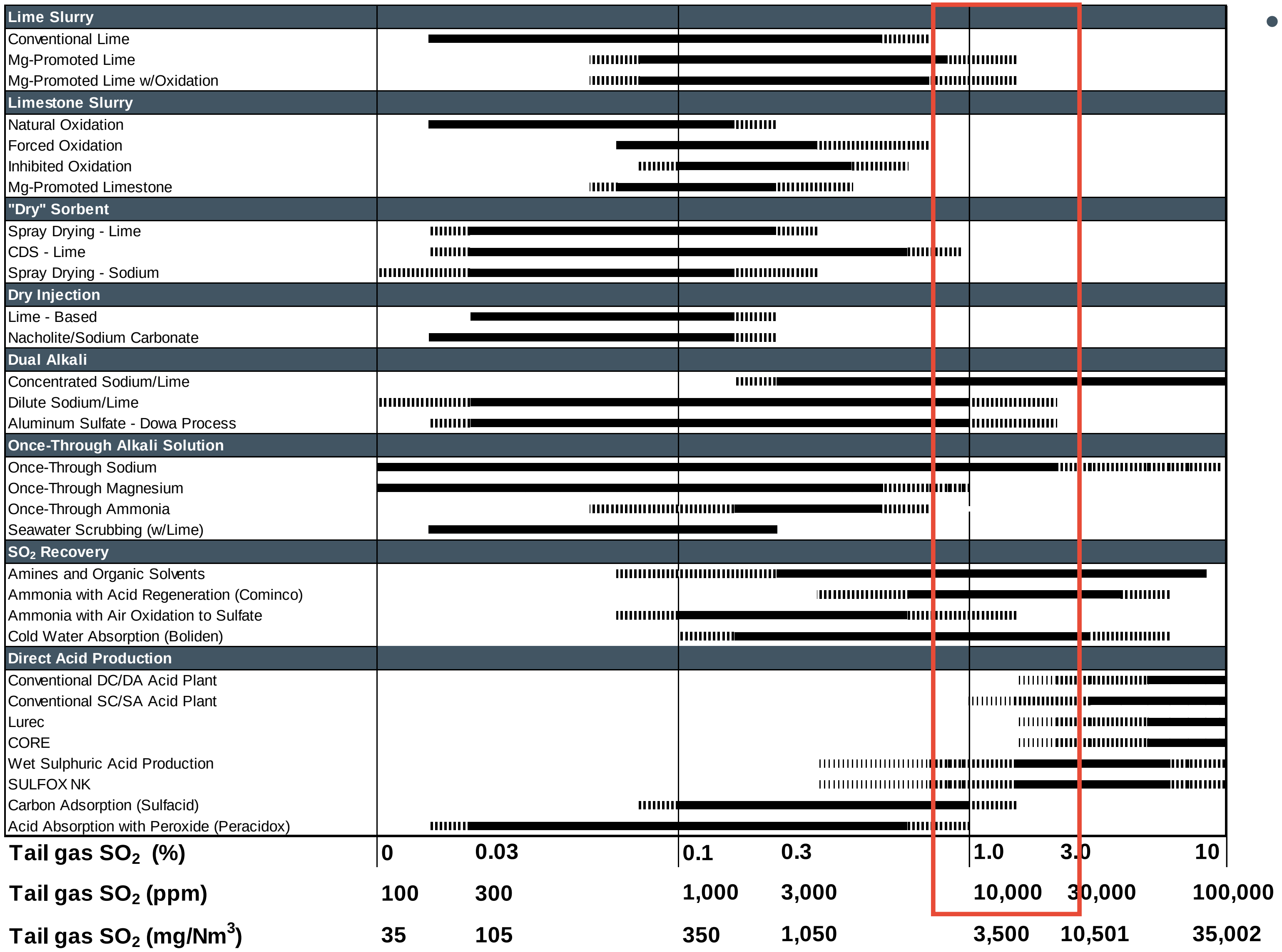


- Screening of available and proven technologies is done early with typically three options identified for further study

Technology Selection

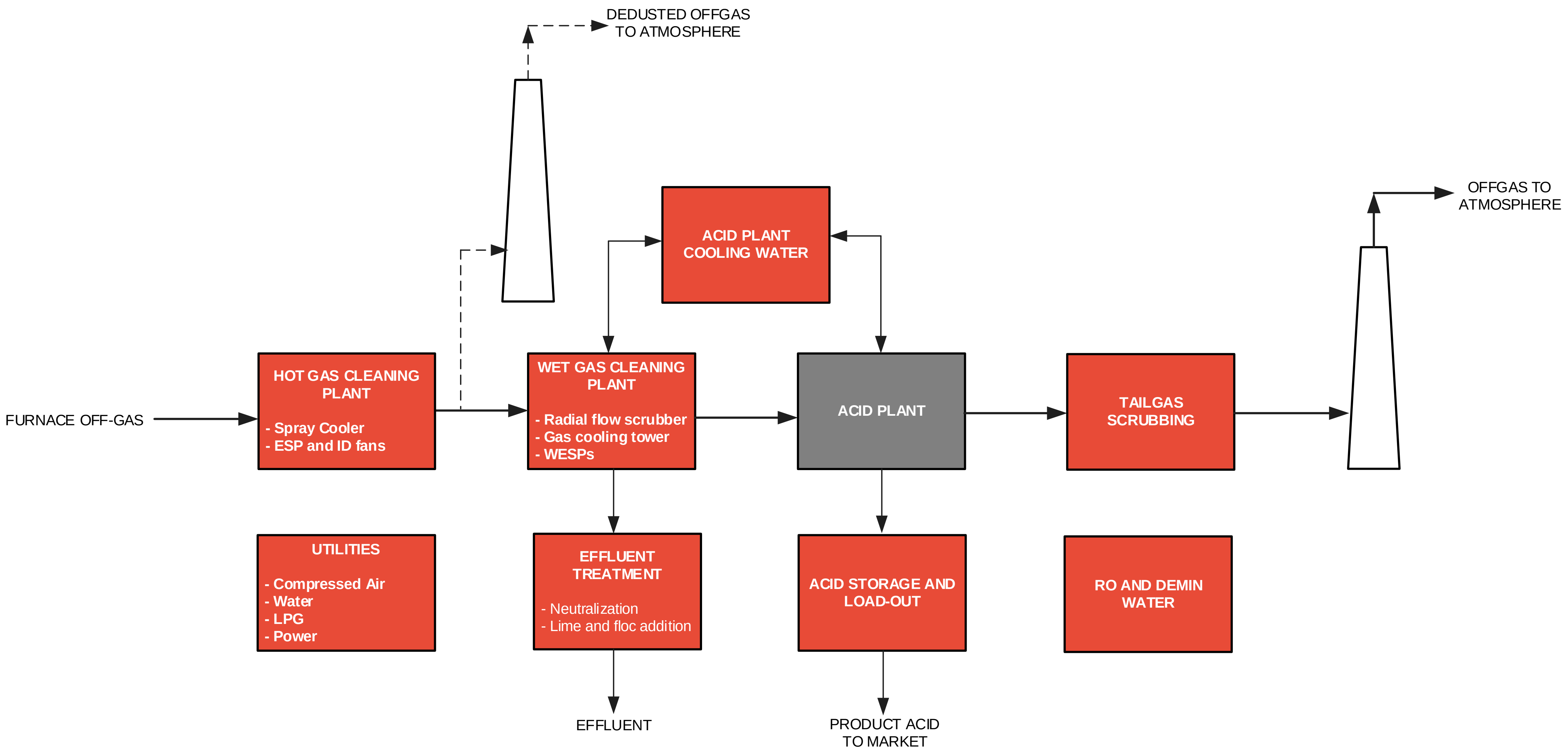
Ranking:	3 - Superior
	2 - No differentiation
	1 - Inferior

Grouping	Subgroup	Category	Weight	A		B	
				Rank	Value	Rank	Value
Fatal Flaws	Fatal	Saleable Product	Fatal	Yes	OK	Yes	OK
		Meeting Legislation requirements	Fatal	Yes	OK	Yes	OK
Critical	Risk and SHE	Safety and hazards concerns in operations (# of)	5	1	13	3	10
		Complexity (number of rotating equipment)	5	2	9	2	7
		Commercial installations - total	10	1	13	3	133
		Commercial installations - metallurgical	10	1	1	3	14
		Commercial Installations - proposed flowsheet	5	2	1	2	2
	Cost	Capital expenditure - Future Case ($ million)	10	2	26.0	2	23.9
		Operating expenditure - Future Case ($million/year)	15	3	1.4	1	1.7
	Technical	Expandability	10	2	-	2	-
		Workshop feedback	50	2	-	3	-
		Footprint (m x m)	5	2	50 x 42	2	50 x 40
Important	Resources	Process energy / additional energy requirements	5	2	-	2	-
		Electrical energy required (MWh/d)	5	3	55	1	65
		Water consumption (m^3/d)	5	3	0	1	56
		Waste production (gypsum, molten salt, catalyst)	5	3	-	1	-
	Operability	Plant availability (%), maintenance, redundancy	10	2	-	3	-
		Turn down ratio	5	2	-	2	-
	Commercial	Commercial Aspects	15	1		3	
		Score (weight x rank)		340	81%	420	100%
		Preference		2		1	

- SO_2 abatement options are narrowed down to one technology during the Pre-Feasibility Study
- A screening and ranking exercise helps to identify important differentiators other than cost

Flowsheet Development

Gas Cleaning and Balance Of Plant



Gas Cleaning and Balance Of Plant

Dry Gas Cleaning

- Optimised duct routing
- Interconnecting systems to enable emergency bypassing
- Insulation and materials of construction essential to manage corrosion

Wet Gas Cleaning Plant

- WGCP vendor selection
- Inlet and outlet process design criteria development for optimum catalyst screening intervals, acid plant equipment protection and acid quality

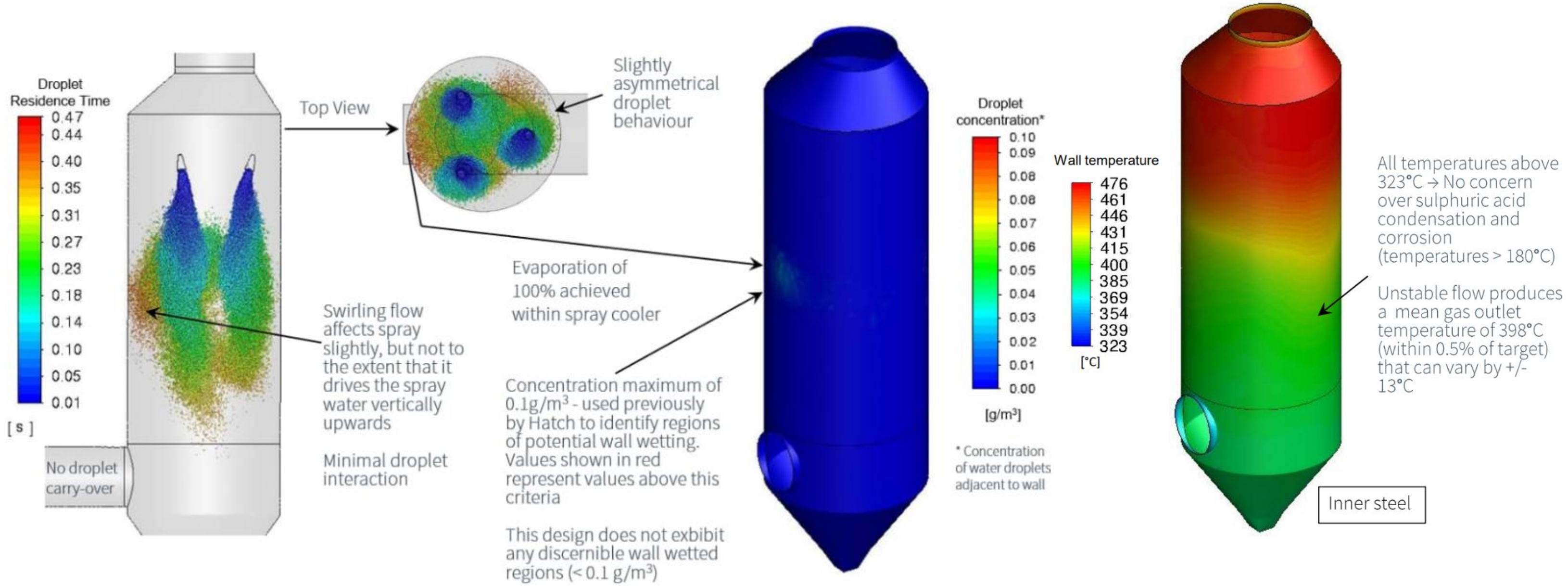
Cooling Water Plant

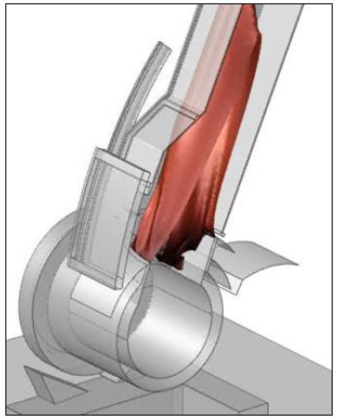
- Integrated cooling water network with SO_2 plant and/or smelter
- Optimum configuration to minimise footprint and water losses

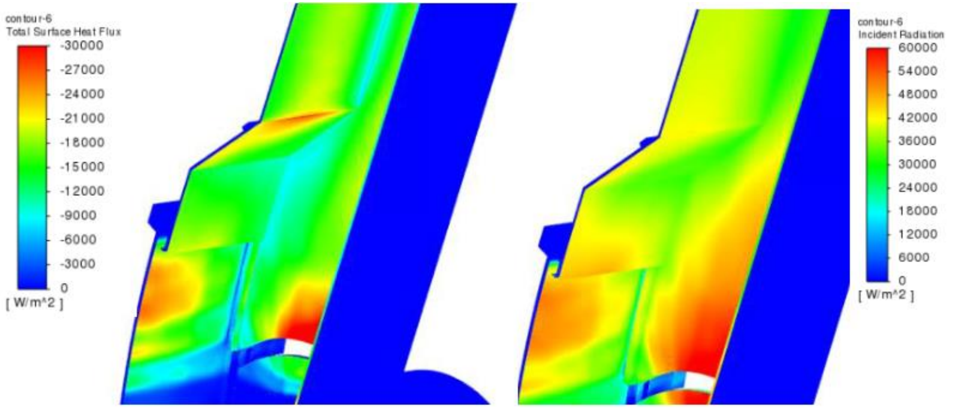
Engineering Design Consideration

Advanced Engineering Design

- Advanced engineering tools were used for design the converter spray coolers and primary hoods







Minimising Corrosion

- Selecting the correct materials of construction essential to ensure plant availability and minimise maintenance but with cost in mind
- Several materials were used in the plant : CS, SS, HDPE, FRP, C267
- Covering only the essential sections of the plant to minimise corrosion potential and conserve heat

Enclosed building only for high risk corrosion and heat preservation area

Transport, Layout and Erection

- Large equipment designed to minimise site assembly but with logistical constraints in mind
- Constructability essential in the layout design to ensure adequate crane access to all equipment for erection but also maintenance
- Side assembly prior to installation to optimise construction schedule

Sufficient crane space and assembly pad

Concluding Remarks

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- A smelter SO_2 abatement plant must have a well defined operating window and engineered agility to prevent it from affecting upstream operations
- Ensure the right technology is selected
- Don’t forget the importance of the balance of plant, especially if it needs to share services with the smelter
- Custom design where it is needed to ensure it will work
- Equipment selection and equipment requires forward thinking such as how it will be installed, transported and maintained