Manganese Processing Plant Variables

Section 1: Core Processing Plant Variables

This section describes the variables for the initial manganese processing plant simulation, covering ore feed, crushing, separation, equipment health, and energy tracking.

Core Plant Parameters

Variable	Purpose
plant_capacity	Defines daily throughput of the plant (Tonnes/day).
operating_hours	Daily operating hours. Affects equipment usage, energy, and throughput calculations.
ore_params	Dictionary containing ore chemistry and property ranges.
equipment_params	Dictionary with equipment efficiency values and crusher capacity.

Ore Feed Variables

Variable	Purpose
mn_grade_pct	Manganese content percentage of the ore feed.
fe_content_pct	Iron content percentage, affects separation behavior.
siO2_content_pct	Silica content percentage, impacts slag and separation.
al2O3_content_pct	Alumina content percentage, affects ore behavior.
p_content_pct	Phosphorus content percentage for quality control.
moisture_pct	Moisture content percentage, affects flowability and crushing.
p80_mm	Particle size at 80% passing, determines crushing needs.
work_index_kwh_t	Ore hardness measured in kWh/tonne.
specific_gravity	Ore density, essential for gravity separation.
ore_type	Categorical type of ore: oxide, carbonate, or silicate.
timestamp	Time dimension for time-series tracking.

Blended Ore Variables

Variable	Purpose
high_grade	High manganese grade ore feed portion.
low_grade	Low manganese grade ore feed portion.
blend_ratio	Proportion of high-grade ore mixed with

	low-grade ore.
blended_feed	Final blended ore dataset for downstream processing.

Crushing Circuit Variables

Variable	Purpose
feed_rate_tph	Crusher throughput in tonnes per hour.
crusher_gap_mm	Crusher setting affecting product size distribution.
power_draw_kw	Crusher power draw in kilowatts.
product_p80_mm	Output particle size at 80% passing after crushing.
liner_wear_pct	Wear percentage of crusher liners.
vibration_rms_mm_s	Vibration levels, indicates equipment health.
ore_hardness_wi	Ore hardness from feed data.
feed_moisture_pct	Feed moisture percentage impacting crushing efficiency.
timestamp	Time-series tracking variable.

Separation Circuit Variables

Variable	Purpose
spiral_speed_rpm	Spiral concentrator speed, affects separation efficiency.
wash_water_m3h	Wash water flow rate in cubic meters per hour.
feed_density_pct_solids	Solids percentage in feed slurry.
spiral_concentrate_grade_pct	Mn grade in spiral concentrate.
spiral_tailings_grade_pct	Mn grade in spiral tailings (losses).
spiral_recovery	Fraction of Mn recovered via spiral separation.
magnetic_intensity_t	Magnetic field intensity in Tesla.
belt_speed_ms	Belt speed of magnetic separator in meters per second.
final_concentrate_grade_pct	Mn grade of final concentrate after magnetic separation.
overall_recovery	Combined recovery rate of Mn from all separations.
ore_type	Ore type influences magnetic separation efficiency.
timestamp	Time-series tracking variable.

Equipment Health Variables

Variable	Purpose
equipment_id	Unique ID for each equipment unit.
equipment_type	Type of equipment (crusher, pump, etc.).
operating_hours	Total runtime hours of the equipment.
health_score	Overall health score (0-100).

vibration_rms	Vibration reading for condition monitoring.
temperature_c	Equipment operating temperature in Celsius.
power_factor	Electrical power efficiency of equipment.
wear_rate_pct	Wear rate percentage of key components.
failure_probability	Probability of equipment failure.
rul_days	Remaining useful life in days.
maintenance_priority	Rank (1-5) for maintenance urgency.
timestamp	Time tracking variable.

Energy Variables

Variable	Purpose
total_power_kw	Total power consumption of the plant.
crushing_power_kw	Power consumption of the crushing circuit.
separation_power_kw	Power used by the separation circuit.
auxiliary_power_kw	Power used by auxiliary systems like pumps.
base_load_kw	Base load consumption of the plant.
energy_cost_kwh	Cost of energy per kilowatt-hour.
operational_factor	Adjustment for day/night operations.
maintenance_mode	Boolean flag indicating maintenance downtime.
timestamp	Time-series tracking variable.

Section 2: Enhanced Manganese Modules

This section adds advanced beneficiation stages including Froth Flotation, Dense Media Separation, Jigging, and Dewatering, along with direct links to equipment health for integrated optimization.

Equipment Metadata

Variable	Purpose
equipment_id	Unique identifier for each equipment unit.
equipment_type	E.g., flotation cell, pump, cyclone, jig, filter.

Equipment Health Variables

Variable	Purpose
health_score	Overall health of the equipment (0-100).
wear_rate_pct	Wear percentage of key parts.
failure_probability	Probability of failure occurring.
rul_days	Remaining useful life of the equipment in days.

Froth Flotation Variables

Variable	Purpose
feed_grade_pct	Mn grade of flotation feed.
collector_dosage_gt	Collector dosing rate in grams per tonne.
frother_dosage_gt	Frother dosing rate in grams per tonne.
actual_collector_consumed_gt	Actual collector used, affected by pump wear.
actual_frother_consumed_gt	Actual frother used, affected by pump wear.
ph_value	pH level of flotation pulp.
pulp_density_pct_solids	Solids concentration percentage in slurry.
air_flow_m3_min	Air supply to flotation cells in cubic meters per minute.
residence_time_min	Retention time of material in flotation cells.
flotation_recovery	Recovery of Mn from flotation process.
concentrate_grade_pct	Mn grade in flotation concentrate.
tailings_grade_pct	Mn grade in tailings.
froth_stability_index	Stability index of froth.
froth_grade_pct	Mn grade of froth overflow product.

Dense Media Separation (DMS) Variables

Variable	Purpose
feed_grade_pct	Mn grade in DMS feed.
feed_size_mm	Feed particle size in millimeters.
media_density_sg	Specific gravity of dense media liquid.
cyclone_pressure_kpa	Operating pressure of DMS cyclone.
media_consumption_kg_t	Heavy media consumption per tonne of ore.
media_recovery_pct	Percentage of media recovered for reuse.
sink_grade_pct	Mn grade of heavy fraction (product).
float_grade_pct	Mn grade of light fraction (waste).

sink_yield_pct	Percentage of material reporting to heavy fraction.
dms_recovery	Recovery of Mn through DMS process.
separation_efficiency	Overall efficiency of dense media separation.

Jigging Circuit Variables

Variable	Purpose
stroke_length_mm	Stroke length of the jig.
stroke_frequency_spm	Stroke frequency in strokes per minute.
water_flow_m3h_m2	Water flow rate per square meter.
bed_height_mm	Height of jigging bed material.
hutch_water_m3h	Water flow beneath the jig bed.
concentrate_grade_pct	Mn grade of jig product.
tailings_grade_pct	Mn grade of jig waste.
jig_recovery	Recovery rate of Mn using jigging.
separation_efficiency	Overall efficiency of the jigging process.

Dewatering Circuit Variables

Variable	Purpose
feed_solids_pct	Solids percentage in slurry feed to thickener.
flocculant_dosage_gt	Flocculant dosing in grams per tonne.
retention_time_hr	Residence time in thickener in hours.
underflow_solids_pct	Solids percentage in thickener underflow.
overflow_clarity_ntu	Clarity of overflow water in NTU.
thickening_efficiency	Performance of the thickener unit.
filter_pressure_kpa	Pressure applied during filtration.
cycle_time_min	Cycle time per filtration run.
cake_moisture_pct	Moisture percentage of filter cake.
water_recovery_pct	Percentage of water reclaimed.
solid_recovery_pct	Percentage of solids retained in product.