Attachment 3B Operations Activities

Contents

Term/Abbreviation	Definition
APCr	Air Pollution Control residues
BA	Boiler Ash
CEMS	Continuous Emissions Monitoring System
FGTr	Flue Gas Treatment residues
HP	high pressure
IBA	Incinerator Bottom Ash
KWtE	Kwinana Waste to Energy
NOx	nitrogen oxides
SCR	selective catalytic reduction
SNCR	selective non-catalytic reduction

1. Waste Receiving

KWtE has contracts with its waste suppliers that specify the waste types the suppliers are permitted to deliver. Waste is only accepted from these contracted waste suppliers in accordance with their current collection schedules and directly from the collection vehicles or transfer station trucks. Upon arrival, the vehicles will be weighed on a weighbridge, screened for radioactive contamination, and allocated an unloading bay within an enclosed tipping hall, if no radiation is detected. It is anticipated that approximately 120 vehicles per day on a 7-day average arrive in the facility.

It is expected that waste will be delivered in rear dump trucks of the following main types:

- Refuse collection compactor truck (8.74m);
- Semi-trailer (19m);
- Pocket road train with 2 trailers – Category 3 RAV;
- B-double with 2 trailers (27.5m)

Vehicles will enter a tipping hall equipped with fast acting roller doors and unload into a bunker in a fully enclosed building. The bunker is sized to provide the storage capacity (five day volume at the normal operation conditions) required to allow the plant to operate continuously (24 hours a day, 7 days a week), including over weekends, and also to provide additional capacity to accommodate both planned and unplanned maintenance events.

This building operates under slightly negative air pressure because air is drawn from the tipping hall directly to the combustion chamber via the grate. This negative air pressure design helps to minimise odour. Furthermore, as the main plant and equipment are contained within a fully enclosed building, process noise is readily controlled.

The refuse bunker crane automatically mixes the waste received to assist in creating as homogenous waste composition as possible across the bunker. When required by the boiler control systems, the crane will collect waste in the grab and deposit it in the feed hopper. Any upfront pre-treatment or pre-sorting of the waste feedstock is not required due to the selected waste-to-energy technology.

2. Grate and Furnace

The furnace consists of five major parts with ancillary equipment:

- Feeding hopper
- Feeding chute
- Feeding grate
- Furnace with combustion grate
- Ash collection hoppers

The feeding hopper is a funnel to facilitate waste supply from the bunker to the furnace. The feeding chute is a narrow channel between feeding hopper and feeding grate, whose main functions are providing an air seal between furnace (operated at a small negative pressure) and environment as well as providing a limited storage capacity of waste. Under normal operating conditions the feeding chute is always filled with refuse, providing the air seal.

The feeding grate supplies waste from the feeding chute to the combustion grate by hydraulic feeders. The waste is then burned on the combustion grate.

KWtE plant has two grate lines operating independently and in parallel. Each grate line has a furnace designed with a moving grate technology to combust and mechanically handle the feedstock. At the transition zone between the furnace and the first empty pass of the boiler, there are two auxiliary burners permanently installed. The burners are used during commissioning and start-up, but their main function is to maintain incineration temperature in the incineration chamber such that minimum burning temperatures (850°C) and residence times (2 seconds) are maintained at all times during operations.

The waste material flows under gravity down through the furnace on an inclined moving grate (stoker). Ash remaining at the base of the grate after 60-70 minutes of combustion and mixing by the rows of grate bars, arranged in steps, is known as bottom ash.

Bottom ash is collected and cooled using a water quench within a water sealed ash discharger, which is integral to each grate/line. The ash discharger feeds the ash into a cement lined bottom ash bunker equipped with a front loader to load ash to vehicles to be taken off site for treatment.

3. Energy Recovery and Power Generation

Hot flue gases leaving the combustion chamber pass through a standard water wall boiler where superheated high pressure (HP) steam is generated through heat recovery. The boiler consists of three main parts:

- Economiser
- Evaporator and boiler drum
- Superheater

In the evaporator and in the boiler drum, the water is transformed to (saturated) steam. The boiler drum is used to separate the steam and water mixture, whereby saturated steam is sent towards the superheater.

In the superheater, the steam is further superheated. The HP steam is sent to a standard steam turbine generator, to generate the electricity required to operate the plant, with the balance available for export to the grid.

4. Flue Gas Cleaning Air Pollution Control (APC) system

The cooled flue gases leaving the boiler then pass through a series of scrubbing and cleaning processes, which comprise of the Air Pollution Control (APC) system. Both grate lines will have their own dedicated APC system. In order to lower water consumption and eliminate the need to discharge process waste water from the site, the KWtE plant is adopting a semi-dry APC system configuration.

Treatment configurations include processes based on the neutralising reaction between lime injected into the system and the acidic components in the flue gas. Quicklime (CaO) is used as a reagent in the flue gas cleaning system to remove acid gases (HCl, SOx and HF). It is dosed by a dosing screw and is pneumatically transported to the hydrator. The dosage rate is controlled independently for each line. In the hydrator the quick lime is slaked to hydrated lime, and then mixed with the recirculated residue in the mixer.

Powdered Activated Carbon (PAC) is injected into the flue gas as an adsorbent for dioxins/furans and heavy metals. For the two incineration lines, there is one common system for the storage of PAC. The PAC is dosed by a dosing feeder and transported to the APC system by pneumatic conveying system.

The lime reaction products, the activated carbon and any residual particulate material (Air Pollution Control residue, APCr) are collected in a baghouse filter. The bag filter will minimise the particulate matter emissions below the required emission limits and captures activated carbon and lime for the purposes of treating flue gas emissions.

The Selective Non-Catalytic Reduction (SNCR) process is used for post-combustion NOx reduction. The chosen method reduces NOx to nitrogen (N_2) through the controlled injection of a 40% urea solution into the flue gas flow of the firing system. The NOx reducing reaction is strongly temperature sensitive and thus, the reagent needs to be distributed within this optimum temperature zone to obtain the best performance. An AGAM system (acoustic temperature measurement) is installed in the first empty pass of the boiler to ensure the optimum conditions for SNCR performance.

5. Flue Gas Stack and Continuous Emissions Monitoring System (CEMS)

The facility will be equipped with a multi-flue stack, with a separate flue provided for each of the two grate lines operating in parallel. The cleaned flue gases are drawn by an induced draft (ID) fan and released into the atmosphere through an appropriately sized flue within the multi-flue stack.

Each grate line is equipped with a dedicated Continuous Emissions Monitoring System (CEMS). In addition, a redundant CEMS is installed as a common back-up for both lines. The CEMS facilitates continuous on-line monitoring of flue gas properties and composition, thus allowing the control system to track those pollutants which can be feasibly measured on-line, in order to make automatic adjustments to the combustion system and the injection rates for the APC system reagents.

Furthermore, the stack is provided with spare flanges for non-continuous emission measurements, to perform calibration and official measurements.

For those pollutants for which online measurement is not currently feasible or sufficiently accurate, a sampling and testing regime will be established as part of the plant standard operating procedures, to ensure that the plant is constantly in compliance with its environmental obligations and to confirm the performance of the CEMS.

6. Metal Recovery

The ash residue remaining after combustion typically represents less than 20% by volume of the feedstock. Bottom ash leaving the ash dischargers is held securely in a bottom ash bunker before being conveyed to a metals recovery area, which consists of a drum magnet, for ferrous metal recovery and an eddy current separator with vibrating screens, for non-ferrous metals recovery.

The ferrous metals are directed towards the ferrous metal storage area by means of a belt conveyor. The non-ferrous material is separated in three fractions. The finest fraction goes straight to the bottom ash storage area. The two larger fractions are transported in their respective systems to Eddy current separators where the non-ferrous metals are separated. The non-ferrous materials are directed to a container. The other fraction falls down into the bottom ash storage area.

It is possible to by-pass the bottom ash segregation system in the event of malfunction and thereby ensure Incinerator Bottom Ash (IBA) offtake and hence maintain facility operation. In bypass operation the diverter directs the ash onto another system of vibrating conveyors and conveyor belts which transport the material to the bypass storage area.

7. Ash Management

The ash content of the waste (ash is all the incombustible/inorganic matter in the waste) leaves the incinerator/boiler as IBA and fly ash. The IBA is what remains on the grate when the waste is burned. The IBA is transported continuously by the grate to the IBA extractor, where it is cooled by water. The water seal in the ash discharger facilitates removal of the bottom ash from the grate system, whilst maintaining the negative air pressure under which the combustion chamber operates. From the extractor IBA is discharged via diverter gate onto a series of conveyors and ends up in metal recovery as described above (section 6).

The fly ash is the ash that is transported by the flue gas through the boiler. Roughly half of the fly ash quantity deposits on the boiler tubes and it is taken out as boiler ash (BA). The remaining fly ash is transported as suspended solids with the flue gas to the flue gas cleaning system.

The Air Pollution Control residue (APCr) taken out of the bag house filter consists of fly ash, hydrated lime, activated carbon and reaction products from adsorption/absorption of pollutants. Some residue is recirculated to the reactor to improve lime usage efficiency and thereby minimise the consumption of lime and the generation of APCr.

The BA and APCr are generated and collected separately on-site but are managed (on and off-site) together.

Ash generation and handling is described more in detail in plant's *Ash Management Plan*.

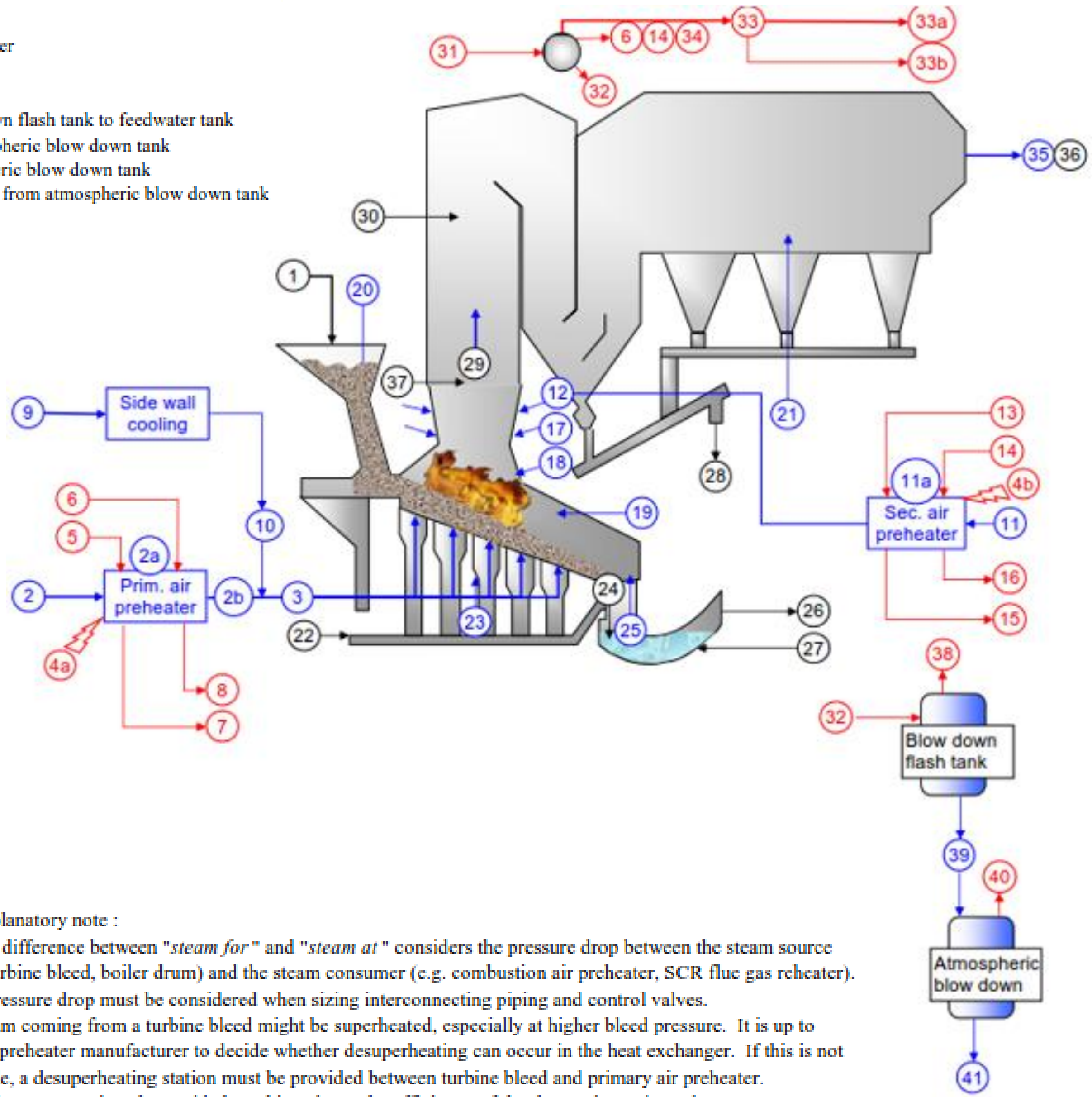
8. Potable, Harvested Rainwater and Process Wastewater

Rainwater will be harvested from roofs of buildings and sealed areas. This rainwater will be directed to storage tanks, from which process make-up water can be drawn for re-use on site. Rainwater in excess of process requirements and storage capacity will be filtered and dissipated in an infiltration basin, in accordance with City of Kwinana stormwater system design standards for the Kwinana Industrial Area.

The facility's water and wastewater systems are designed to provide suitable quality water for each process use. Harvested rainwater and water from the existing Water Corporation scheme (potable) water connection will be the primary sources of water supply for the boiler makeup water system, fire protection system and other potable and non-potable process uses.

SIMPLIFIED PROCESS FLOW CHART - INCINERATION

1 waste mixture
2 cold primary air (before preheating)
2a primary air between first and second preheating stage
2b primary air after second preheating stage
3 preheated primary air
4a heat from grate cooling to primary air
5 LP steam for prim air preheater (*)
LP steam at prim air preheater (*)
6 Drum steam for prim air preheater (*)
Drum steam at prim air preheater (*)
7 LP Condensate from prim air preheater
8 Drum condensate from prim air preheater
9 Side wall cooling air
10 Side wall cooling air - heated
11 cold secondary air (before preheating)
11a secondary air between first and second preheating stage
12 preheated secondary air
4b heat from grate cooling to secondary air
13 LP steam for sec air preheater (*)
LP steam at sec air preheater (*)
14 Drum steam for sec air preheater (*)
Drum steam at sec air preheater (*)
15 LP Condensate from sec air preheater
16 Drum condensate from sec air preheater
17 flue gas recirculation
18 other gas flows
19 sweeping air
20 leakage air furnace
21 leakage air boiler
22 siftings quench water
23 siftings quench vapour
24 dry bottom ash
25 bottom ash quench vapour
26 wet bottom ash + wet siftings
27 bottom ash quench water
28 boiler ash
29 flue gas to boiler
30a SNCR ureum solution
30b SNCR water
30c SNCR steam
30d SNCR air
31 boiler feedwater inlet economiser
32 blowdown
33 gross steam (superheated) outlet final superheater
33a net steam (superheated) outlet final superheater
33b sootblowing steam consumption (daily average)
sootblowing steam consumption (instantaneous)
34 drum steam for external user (*)
drum steam at external user (*)
35 flue gas exit boiler
36 fly ash
37a flue gas from support burner
37b fuel to support burner
37c air to support burner
38 flash steam from blow down flash tank to feedwater tank
39 flash condensate to atmospheric blow down tank
40 flash steam from atmospheric blow down tank
41 uncooled flash condensate from atmospheric blow down tank
(to be cooled by others)

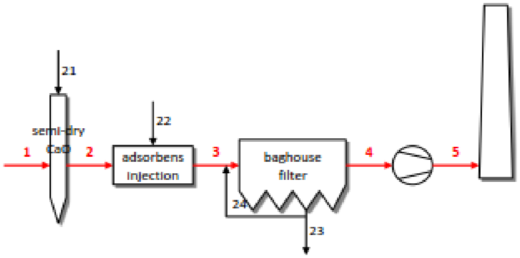


(*) explanatory note :
1) The difference between "*steam for*" and "*steam at*" considers the pressure drop between the steam source (e.g. turbine bleed, boiler drum) and the steam consumer (e.g. combustion air preheater, SCR flue gas reheater). This pressure drop must be considered when sizing interconnecting piping and control valves.
2) Steam coming from a turbine bleed might be superheated, especially at higher bleed pressure. It is up to the air preheater manufacturer to decide whether desuperheating can occur in the heat exchanger. If this is not possible, a desuperheating station must be provided between turbine bleed and primary air preheater. Reducing pressure is to be avoided, as this reduces the efficiency of the thermodynamic cycle.

SIMPLIFIED PROCESS FLOW CHART – FLUE GAS CLEANING[1]

Flue Gas Cleaning
C model - Point NOP - 700 mg HCl 300 mg SO2
Flowsheet

version : 3.0



	Flow	Temp	Composition					Pollutants											Density
			CO_2	H_2O	O_2	N_2	Ar	HCl	SO_2	SO_3	HF	NOx	dust	Cd, Tl	Hg	As, …	dioxin		
	Nm³/h	°C			vol%						mg/Nm³, dry 11% O2						ng		kg/Nm³
1	143 304	160	8,73%	17,29%	7,41%	65,72%	0,78%	700	300	0	10,0	180	1967	0,47	0,38	50	5		1,25
2	143 304	160	8,73%	17,29%	7,41%	65,72%	0,78%	700	300	0	10,0	180	1967	0,47	0,38	50	5		1,25
3	146 339	135	8,55%	18,49%	7,38%	64,80%	0,77%	9	45	0	0,9	180	97075	0,38	0,01	40	5		1,25
4	147 334	134	8,50%	18,37%	7,47%	64,88%	0,77%	9	45	0	0,9	180	2	0,04	0,01	0	0		1,25
5	147 334	136	8,50%	18,37%	7,47%	64,88%	0,77%	9	45	0	0,9	180	2	0,04	0,01	0	0		1,25

Nr	Flow description	Solid flow [kg/h]	Liquid flow [kg/h]	Water [kg/h]	Gas flow [Nm³/h]	Temperature [°C]	Remarks
21	*water and CaO*	255*		2011			**CaO @ 86% purity*
22	*activated carbon*	9,0					
23	*residue*	807					
24	*recirculation*	13 118					

[1] Keppel Seghers. KW2E-05-PE-CA-KEP-0112 Heat & Mass Balance – Flue gas Cleaning Point NOP – 700 mg HCl 300 mg SO2.