Chronology of Operational Challenges

Item	Challenges	Root Cause	Reference
1	<u>Furnace no draft</u> • Combustion chamber is kept constantly underpressure to avoid explosion or leakage of flame to outside of the chamber. • This underpressure is created by a large suction fan mounted. before the chimney. Between the combustion chamber and suction fan are thermal oil coils and dust collectors where the hot gases produced from the combustion chamber would to pass through. • The combustion chamber draft is monitored real time by a pressure sensor. The plant stops whenever combustion chamber's pressure goes to positive (no vacuum). • We experienced frequently furnace no draft situation that resulted in stoppage of the plant.	<u>Low ash melting point of EFB fibers</u> • The inherent property of low ash melting point of EFB fibers resulted in formation of 'soft' and 'sticky' ashes. • These soft and sticky ashes formed adhere to the thermal oil coils, hot water economisors and dust collector blocking the travel path hot gases. • Therefore pressure of the combustion chamber increases.	1. Faxes from Hartalega to Vyncke, reference a. H.A.-Vync-KML-43 b. H.A.-Vync-KML-44 c. H.A.-Vync-KML-46 d. H.A.-Vync-KML-51 2. Faxes from Vyncke to Hartalega, reference a. 1.2549 dated 20.08.2003 b. 1.2549 dated 02.09.2003 3. Figures 1, 2, 3, and 4
2	<u>Excessive clinker formation</u> • Excessive clinkers were formed on the furnace (combustion chamber side wall), furnace floor (step grate) and at the furnace ceiling. <u>Damaged furnace refractory wall</u> • Accumulation of clinker resulted in	<u>Low ash melting point of EFB fibers</u> • A softened / melted ash due to the low melting point property of empty fruit bunches and its high potassium content resulted in formation of hard silica like clinker on the mentioned surfaces.	1. Faxes from Hartalega to Vyncke, reference a. H.A.-Vync-KML-43 b. H.A.-Vync-KML-44 c. H.A.-Vync-KML-46 d. H.A.-Vync-KML-49 e. H.A.-Vync-KML-51

	collapse of refractory lining of furnace side wall and furnace ceiling.		2. Fax from Vyncke to Hartalega, reference 1.2549 dated 02.09.2003 3. Purchase order no. to replace (overhaul) old refractory with new a. 041999 b. 040225 c. 042141 d. 042127 e. 042129 f. 042473 g. 042309 4. Figures 5, 6, 7 and 8
3	<u>High furnace temperature</u> • Frequent occurrence of high furnace temperature. • A temperature sensor senses the furnace temperature continually. Once temperature reaches the limit, the system will cut off to prevent over-temperature situation. • Over temperature may results in melt down of the furnace and greatly shortens the lifespan of the plant. Hence the necessity of the safety cut off to prevent over-temperature.	<u>Low calorific value of EFB fibers</u> • Owing to this characteristic, equipment in the plant such as thermal oil coil and combustion chamber are undersized • To compensate for the reduced surface area of these equipment (due to undersizing), the operating temperature has to be higher in order to attain the required capacity • Operating in higher temperature also resulted in other problems mentioned earlier such as clinker formation due to melting ashes and blockage of pathway of hot gases.	1. Fax from Hartalega to Vyncke, reference H.A.-Vync-KML-51
4	<u>Over estimation of fuel density</u> • Owing to the fact that EFB fibers are	<u>Low density of EFB fibers</u> • EFB fibers were assumed to have	1. Faxes from Hartalega to Vyncke, reference

	a relatively new biomass fuel, therefore its properties are not well established. • The density of EFB fibers were wrongly estimated by Vyncke, resulting in undersizing of the feeding systems • Therefore feeding conveyors speeds were increased to accommodate the undersize condition, resulting in much higher wear and tear.	density of 250 kg/m^3 • Actual density was found to be around 105 kg/m^3	a. H.A.-Vync-KML-46 b. H.A.-Vync-KML-49 2. Faxes from Vyncke to Hartalega, reference a. 1.2549 dated 20.08.2003 b. 1.2549 dated 02.09.2003 c. 1.2549 dated 09.09.2003 3. Figures 9, 10, 11, and 12
5	<u>Damaged moving floor (ESB)</u> • Moving floor is a fuel feeding system that installed at floor level. • This system consists of 3 to 4 ladders, each ladder moving back and forth in a horizontal direction parallel to the floor • Its function is to discharge biomass materials into feeding screws to convey fuel to the combustion chamber. • Moving floor (ESB) for EFB fibers encountered extremely high wear and tear and was also unable to function well • A new moving floor was purchased after only running the plant for 18 months	<u>Abrasive property of EFB fibers</u> • Owing to the highly abrasive property of the EFB fibers, the welding joints of the moving floor that were in direct contact with the EFB fibers were 'grinded' of, resulting in breakages. <u>Entanglement of EFB fibers</u> • EFB fibers tend to entangle, making this material difficult to convey by the moving floor. • Some modifications were carried out but were unsuccessful, instead lead to further damages to the moving floor.	1. Faxes from Hartalega to Vyncke, referece a. H.A.-Vync-KML-49 b. H.A.-Vync-KML-51 2. Faxes from Vyncke to Hartalega, referece a. 1.2549 dated 09.09.2003 b. 1.2549 dated 13.10.2003 3. Figures 11 and 12 4. Purchase order no. 037770 to purchase new moving floor
6	<u>Over current of screw conveyors</u> • Motors of screw conveyors conveying EFB fibers frequently	<u>Abrasive property of EFB fibers</u> • Owing to the highly abrasive property of the EFB fibers, screw	1. Faxes from Hartalega to Vyncke, referece a. H.A.-Vync-KML-57

	experienced over current. <u>Breakage of screw conveyors</u> • Screw conveyors broke not long after plant started operation <u>Breakage of silo mixer</u> • Mixer is installed at the intermediate silo	conveyors experience high wear and tear <u>Entanglement of EFB fibers</u> • EFB fibers tend to entangle, making this material difficult to convey by the screw conveyors. • When EFB fibers are entangled, forces resisting the screw conveyors are much increased resulting in over current and breakages. • Due also to entanglement, silo mixer experience high forces that results in high wear and tear and short fatigue cycle	b. H.A.-Vync-KML-58 2. Figures 9 and 10 3. Purchase order no. for repair of screw conveyor a. 030048 b. 041288 c. 041499 d. 040998 4. Purchase order no.030076 to replace silo mixer
7	<u>Damaged impeller of flue gas fan</u> • Flue gas fan impeller welding joints cracked • Flue gas fan impellers were noticeably thinner within less than 12 months in operations	<u>Impermeability of EFB fibers</u> • Due to impermeability of the EFB fibers, primary and secondary air flows were increased to provide more air for combustion. • Increase in primary and secondary air flows have to be compensated by increasing the speed of the flue gas fan (suction fan installed before the chimney) to maintain a negative pressure inside the combustion chamber. <u>Highly abrasive property of EFB fibers</u> • Due to high ash and potassium content of EFB fibers, the flue gas fan impeller where the air flow	1. Fax from Hartalega to Vyncke, referece H.A.-Vync-KML-60 2. Figures 13 and 14 3. Purchase order no. for purchase of new flue gas fan impeller a. 031117 b. 040699 c. 041781

		speed is the highest experienced high wear and tear <u>High operating temperature</u> • Due to the plant being undersized because of unanticipated problems associated with EFB fibers as biomass fuel, the thermal oil heaters were forced to run at higher temperature in order to achieve its design capacity. • This has resulted in accelerated deterioration of parts	
8	<u>Biomass boilers 1&2 unable to deliver up to the design capacity</u> • All the above has resulted in the boilers 1 and 2 unable to deliver heat energy up to the design capacity • Designed capacity 15Gcal/hr	<u>Furnace no draft</u> • Flue gas fan impeller speed has to be increased to increase the furnace underpressure to compensate for the increase in primary and secondary air flows due to impermeability of the EFB fibers. • This has resulted in reduced retention time of hot gases within the system, therefore reducing the time of heat transfer to the thermal oil <u>Excessive clinker formation</u> • Excessive clinkers were formed due to the low ash softening point of EFB fibers. • Its furnace design temperature of 1,000ºC is not sustainable as excessive clinker will form	1. Faxes from Hartalega to Vyncke, reference a. H.A.-Vync-KML-51 b. H.A.-Vync-KML-54 2. Email from Vyncke to Hartalega From Jef Mestdagh to Kuan Mun Leong dated 24.12.2003 3. Contract signed between Vyncke and Hartalega

		<u>High furnace temperature</u> • To deliver the designed capacity, the boilers need to be forced to run at extremely high temperature (furnace temperature above 1,100ºC. • At such high temperature, the risk of the system cutting off is high as the cut off limit is 1,200ºC. <u>Over-estimation of fuel density</u> • Due to over estimation of density of EFB fibers, all feeding systems are under-sized. • Tuning up their operating speed will increase wear and tear, not a good engineering practice. <u>Sticky ashes</u> • Build up of soot and sticky ashes around thermal oil coils, creating an insulating layer and therefore reducing heat exchanging surface. • Plant has to be stopped frequently to clean of the soot	
9	<u>Damaged Soot Blowers</u> • Soot blowers are installed to use compress air to blow away soot formed on the outer surface of the thermal oil coils. • These soot blowers experienced high wear and tear	<u>Abrasive nature of EFB fibers</u> • Owing to the abrasive nature of EFB fiber and its high ash content, the soot blowers have higher wear and tear rate.	1. Figures 15 and 16

10	<u>Damaged multicyclones</u> • A dust collector installed between the thermal oil coil and flue gas fan to collect dust / soot before discharging out through the chimney • Within the dust collector, there are multi-cyclones, these cyclones experienced high wear and tear	<u>Abrasive nature of EFB fibers</u> Owing to the abrasive nature of EFB fiber and its high ash content, the dedustor and cyclones have higher wear and tear rate.	1. Purchase order no. 039586 for replacement of cyclones 2. Purchase order no. 040792 to repair dedustor

PHOTOGRAPHS

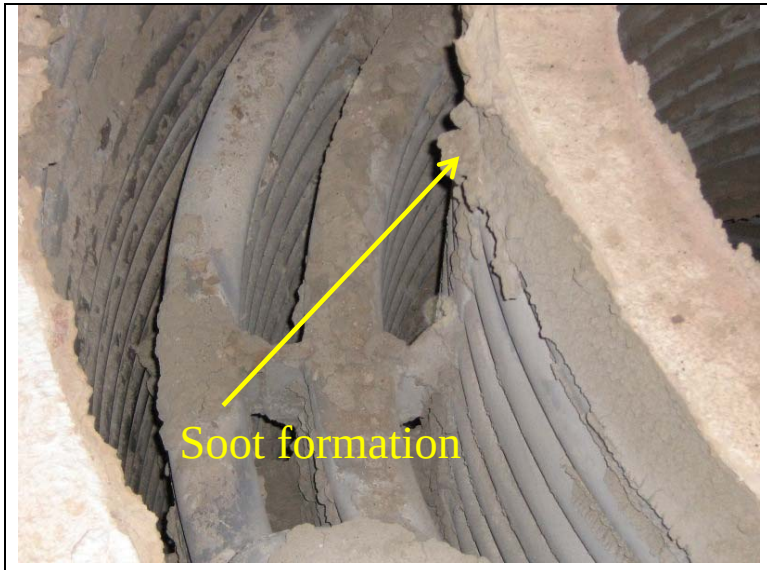

Figure 1: Softened ashes sticking to the thermal oil coils

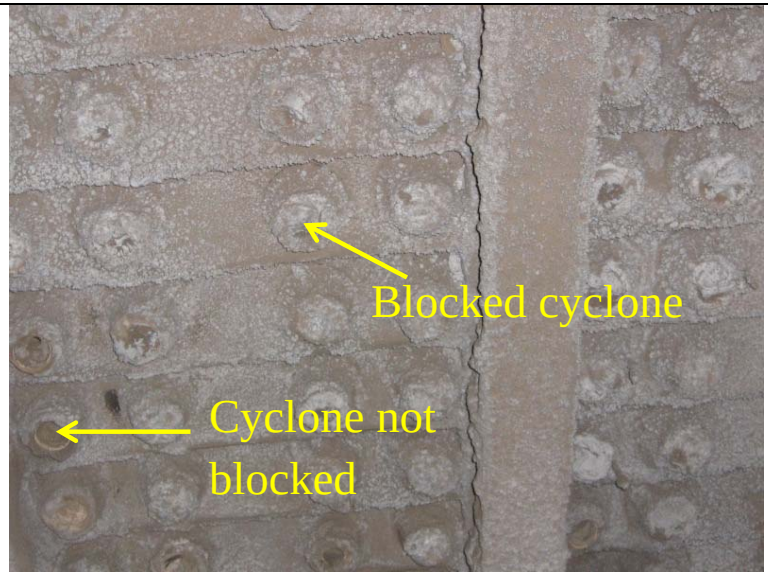

Figure 2: Blocked cyclones in dust collector

Figure 3: Cyclones cleaned - unblocked

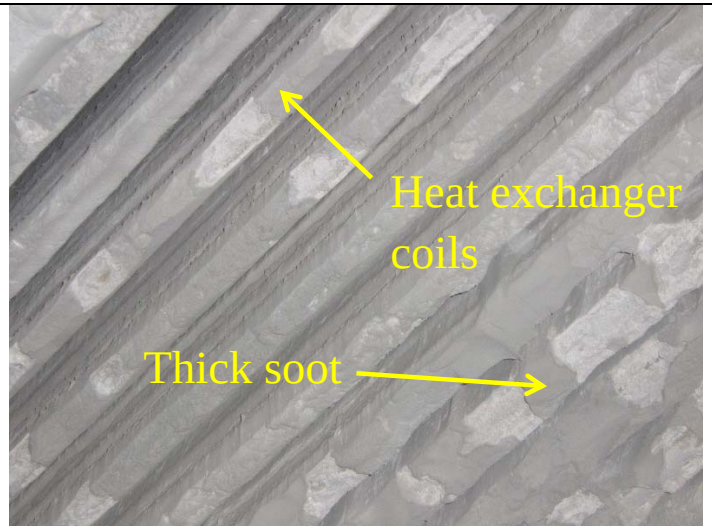

Figure 4: Blocked economisor heat exchanger coils

Figure 5: Excessive clinker formation on furnace floor (step

Figure 6: Without clinker, steps of the furnace floor is clearly

grate)	visible
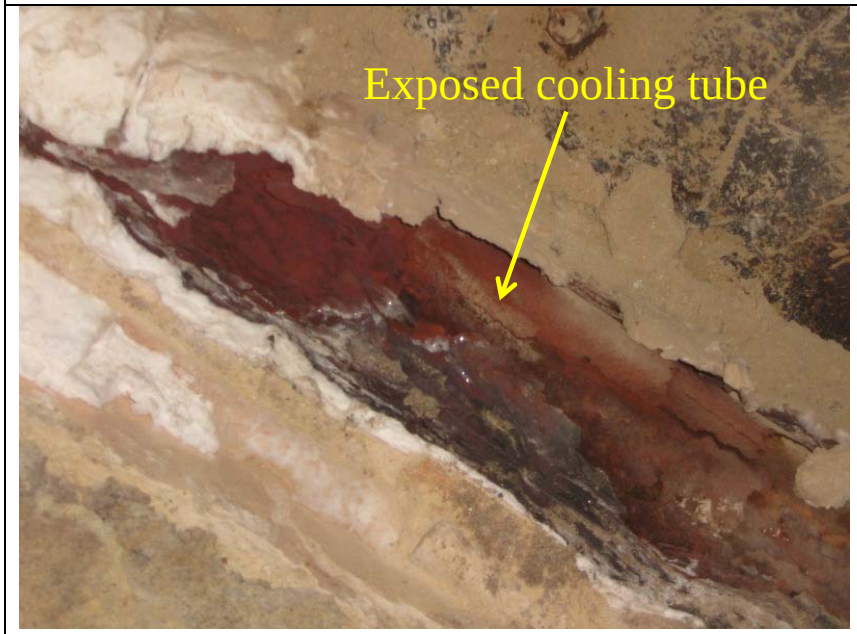	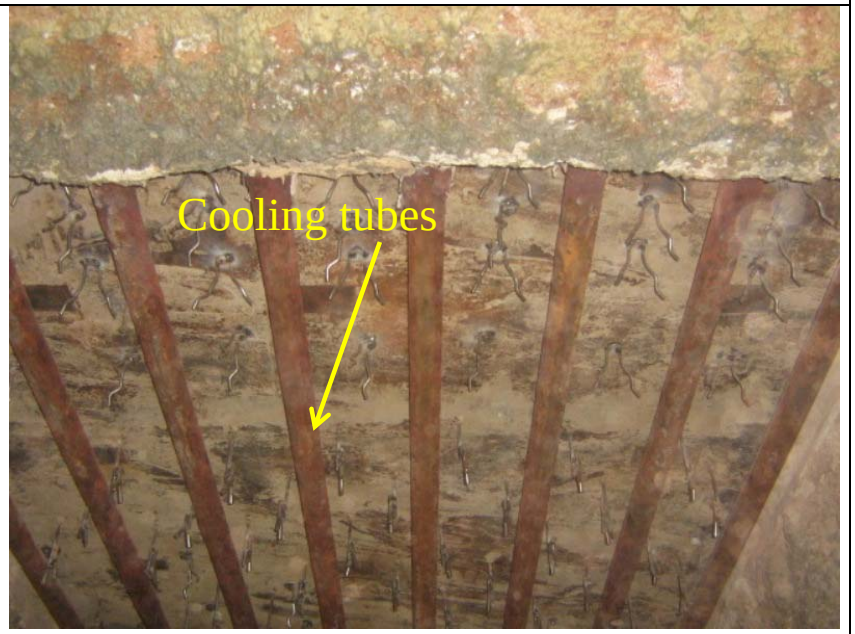
Figure 7: Damaged refractory at furnace ceiling, exposing cooling pipe. Exposed pipes experience high corrosion	Figure 8: Repair underway for damaged furnace ceiling. Water cooled coils are exposed when refractory is damaged causing excessive corrosion of water coils to take place

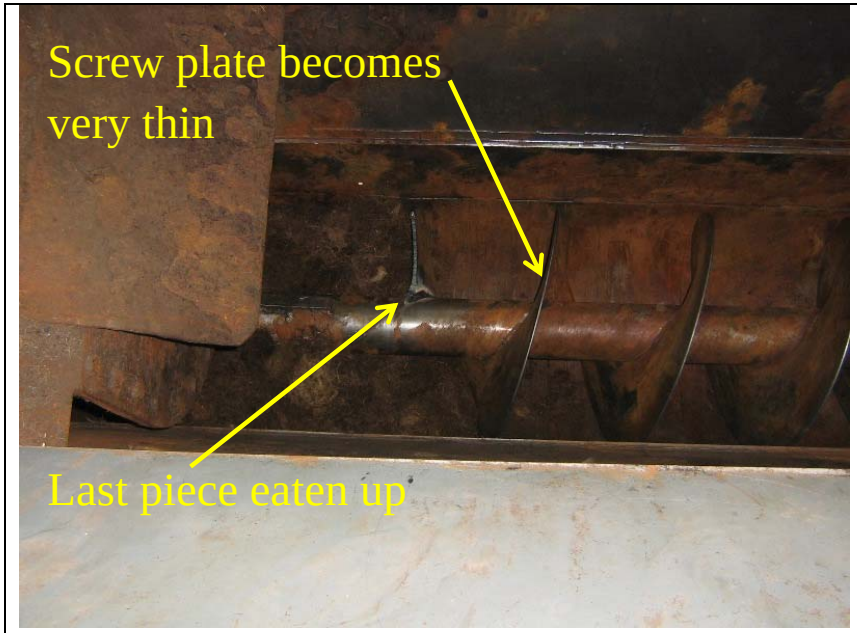

Figure 9: Feeding becomes thin due to excessive wear and tear. Last piece of screw totally eaten up.

Figure 10: Repair of one of the components of feeding system (screw conveyor)

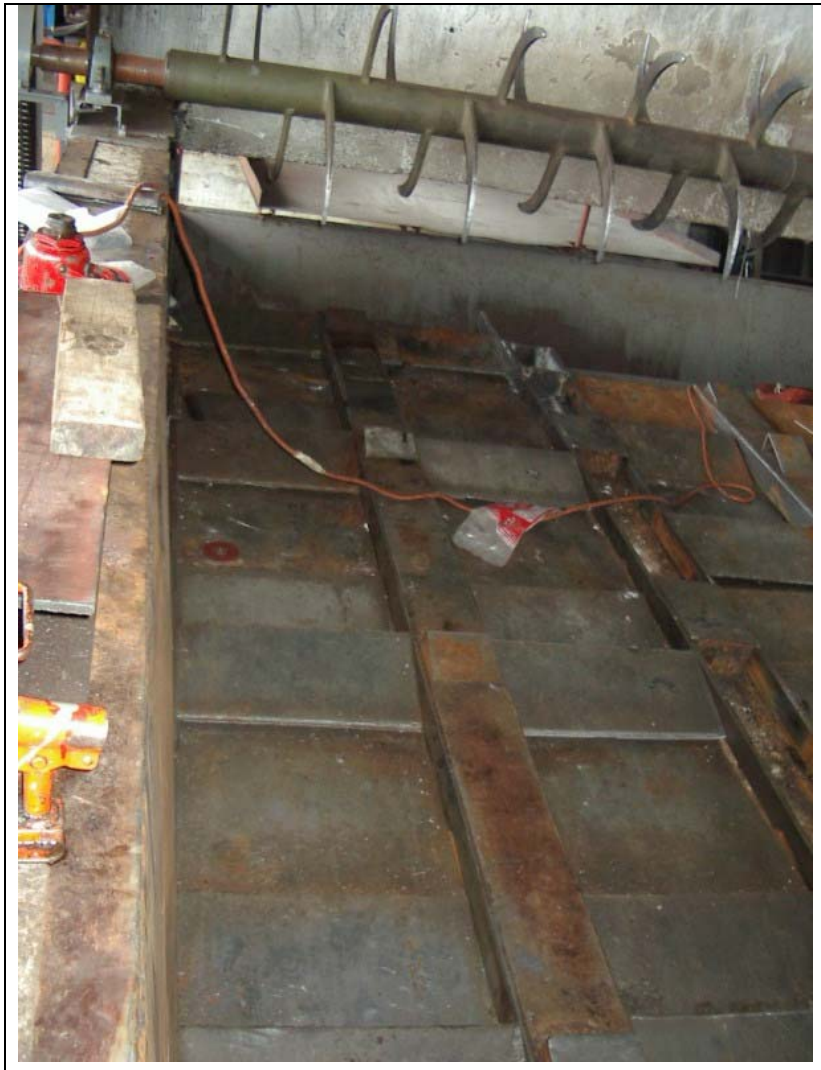

Figure 11: Moving floor damaged due to wrong design and excessive wear and tear – repair works being carried out

Figure 12: Replacement of new moving due to old one worn out beyond repair

Figure 13: Damaged impeller of flue gas fan

Figure 14: Impeller becomes paper thin due to excessive wear and tear

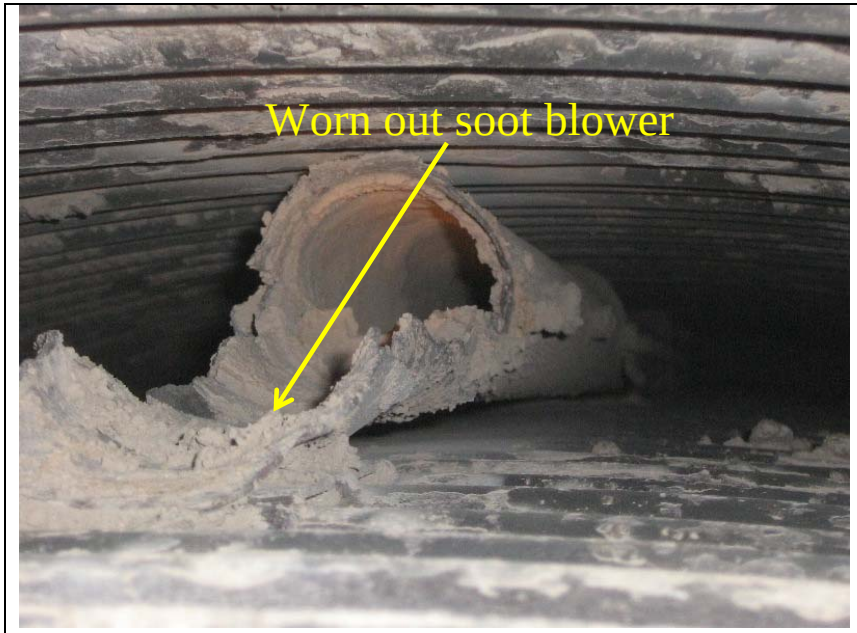

Figure 15: Damaged soot blower


Figure 16: Soot blower repaired