YUANPING CHEMICAL COMPANY LIMITED

COMPANY DESCRIPTION

Yuanping city Chemical Co. Ltd is a middle-sized chemical plant with 1679 staff, located in Yuanping city, Shanxi Province in China. It was established as a state-owned enterprise in 1970 and was in 1998 transformed into a company of limited liability as part of China's reform of state-owned enterprises. Its main products are oxalic acid (60,000 tons/year), sodium formate (80,000 tons/year), formic acid (10,000 tons/year) and other by-products. It is the largest oxalic acid producer in Asia and most of its products are exported to international market. The company management was keen to participate in the GERIAP project to reduce raw material and energy consumption through energy efficiency and cleaner production, and because they are an exporting company, the plant has to reduce environmental impact. In recent years, in order to cut production costs and raise operating efficiency, the company has collaborated with several institutes and academies to upgrade or remodel the production process and technology.

PROCESS DESCRIPTION

The major process steps for producing oxalic acid include:

- ***Gas making, washing and compressing:*** Fresh air is blown into furnace by blast blowers, where the air is heated and reacts with hot coke to form coal gas, which has as its main components carbon monoxide (CO), N_2, CO_2, dust and other waste gases. Next, the coal gas passes through a dust catcher and washing tower to remove off dust and CO_2, and then the purified gas (CO and N_2) is dried and compressed.
- ***Synthesis process:*** The compressed CO mixes with sodium hydroxide (NaOH) solution in Jacketed Preheater, where the mixed liquor is preheated by steam at 200°C and then synthesized into sodium formate (NaCOOH).
- ***Condensing and extracting of NaCOOH:*** The thin NaCOOH solution is evaporated, condensed by steam, and then solid NaCOOH is extracted. Some of the NaCOOH will be purified as the final product sodium formate, the remainder will continue through remaining processes to produce final oxalic acid.
- ***Dehydrogenation process***: Solid NaCOOH is poured into a dehydrogenating kettle on a fire. After heating for about 40~50 minutes, the dehydrogenation reaction occurs and NaCOOH turns into sodium oxalate ($Na_2C_2O_4$), which will then be sucked up by hose to plumbite treatment reservoir. This process is manually operated by mode of batch production.
- ***Plumbite treatment process***: Lead sulfate ($PbSO_4$) reacts with $Na_2C_2O_4$ to create sodium sulfate (Na_2SO_4) and insoluble lead oxalate (PbC_2O_4). Through water scrubbing Na_2SO_4 and PbC_2O_4 are separated and Na_2SO_4 is recovered as by product.
- ***Acidification process:*** In the acidification reservoir, PbC_2O_4 reacts with sulphuric acid to form oxalic acid ($H_2C_2O_4$) and insoluble $PbSO_4$. Then $PbSO_4$ is washed out and recycled and fed into the plumbite reservoir. The $H_2C_2O_4$ liquor will be neutralized by barium hydroxide to remove possible remaining sulphate in the liquor.
- ***Crystallization and drying of $H_2C_2O_4$***: The oxalic acid liquor is heated, evaporated and condensed to yield oxalic acid crystal. The crystal will further go through swing drying and heat drying, and finally gets packed as a final product.

The draft *Company Energy Efficiency Methodology* was used as a basis for the plant assessment to identify and implement options to reduce energy and other materials and wastes. Some of the interesting experiences are:

- ***Task 2d – Quantify inputs and outputs and costs to establish a baseline***

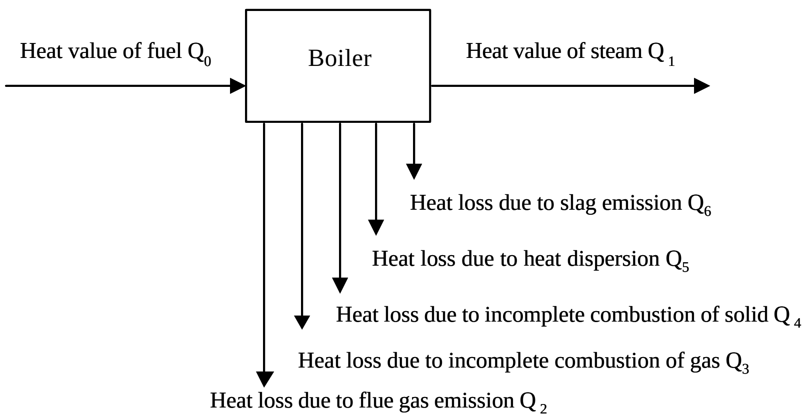
The company has very few meters to measure resource consumption and therefore only data on production, raw material consumption and energy use were available from invoices from the accounting department. Two industry experts participated in the assessment of this plant used their knowledge and experience to get some estimates of inputs and outputs, which allowed the Team to establish a minimum baseline.
<u>Lesson learnt: In the absence of meters to quantify inputs and outputs for focus areas, industry experts can assist with providing estimates.</u>

- ***Task 1c – Pre-assessment to collect general information***

A review of 2001, 2002 and 2003 data of the consumption of resources found that electricity and coal consumption have reduced significantly. But the specific consumption per kWh is still very high and therefore there is further scope for improvement.
<u>Lesson learnt: If energy consumption has reduced over the past years, then this does not necessarily mean that there is no further scope for improvement. To determine this the Team should also calculate specific consumption and where possible compare these with benchmark figures or equipment design parameters.</u>

- ***Task 2e – Quantify losses through a material balance***

Heat losses for the boiler were observed and upon analysis the Team found that heat was lost in several ways as illustrated below. Although the individual losses could not be quantified, this information was useful to be able to identify causes of these losses and options to reduce the losses.
<u>Lesson learnt: Even if quantification of losses is not possible, the identification of the type of losses is already helpful for identifying causes and options at a later stage.</u>



- ***Task 3a – Determine causes of losses***

This plant was visited by an energy expert and a Cleaner Production expert from the GERIAP project to train the plant's Team and the Chinese external facilitators on carrying out an energy assessment. The different perspectives from the two areas of expertise came to light when it was observed that a lot of heat was lost through the exit gas of the synthesis furnace. The energy expert suggested that the waste heat in the exit gas could be reused to preheat the inlet air (combustion air) of the synthesis furnace. The Cleaner Production expert looked at

this from a different angle and found out that the coal used for the furnace was of poor quality and that coal was fed into the furnace in sizes ranging from 80 – 200 mm. He suggested implementing strict quality control measures to regulate coke sizes to a maximum of 40 – 50mm, which would ensure more efficient and completing combustion and reduce the amount of waste heat in exit gas.
Lesson learnt: Cleaner Production and energy experts often can provide useful input from different perspectives. It is therefore recommended to include people in the Team from both backgrounds to maximize the output of the assessment.

- ***Task 4b – Ranking of feasible options***

Because this plant produces oxalic acid, staff are exposed on a daily basis to chemicals. Because of this staff health is an important consideration in the ranking of options for implementation. Even if the financial and environmental benefits for certain options are not as good as for other options, they should still receive a higher ranking if they result in a reduced staff exposure to chemicals.
Lesson learnt: Impacts on staff health and safety should be considered in ranking feasible options.

- ***Step 6 – Continuous improvement***

The company has a ISO 9000 certified quality management system and a ISO 14001 certified environmental management system and top management places importance on this because as an exporting company, clients often require ISO certified management systems. However, ISO certification does not always equal to good environmental performance. The company will therefore focus on improving its actual environmental performance rather than its procedures and systems, which are already in place. In addition, emphasis will be placed on linking environmental with health and safety performance because as a producer of oxalic acid, these two are closely related at this plant.
Lesson learnt: In addition to striving to have ISO certified management systems companies must also pay attention to improving actual environmental performance to ensure that real improvements in energy and resource efficiency are realized.

OPTIONS

A summary of options is as follows:

- The focus areas of the energy assessment included (1) Steam system (including boilers, steam distribution, and steam utilization, (2) Synthesis plant (including CO compressor and synthesis furnace), (3) Production process (in particular dehydrogenation process, plumbite process, acidification process)
- The Team identified a total of 19 energy and waste minimization options. At time of writing of this company case study, five options were implemented and one option was partially implemented. One option (steam turbine on boiler to generate electricity) was identified by the company prior to the GERIAP project and therefore not included in the overall calculations below. The most successful options implemented and investigated are summarized in table 1.
- The implementation of the five options required an investment of US$ 90566 and generated net annual savings of US$ 145769. The overall payback at Yuanping Chemical was therefore about 7.5 months. It is noted that for several options the financial and environmental benefits could not be quantified, otherwise the figures would have looked better
- For the five options implemented so far, the total (1) coal reductions were 5146 tons; (2) greenhouse gas (GHG) reductions were 12896 tons of CO_2 equivalent.
- At plant level, GHG emissions reduced by almost 6% compared to the total emissions of the plant in 2003 (226000 tons CO_2) at the start of the project. If the option identified by

the company would be included then GHG emission reductions are 7.5% compared to 2003.. An absolute comparison between 2003 and 2005 plant emissions could not be made, because the recovery of flash steam from blowdown option was only implemented in July 2005.

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Table: EXAMPLES OF OPTIONS IMPLEMENTED AND INVESTIGATED

FOCUS AREA/ OPTION	CP TECHNIQUE	FINANCIAL FEASIBILITY	ENVIRONMENTAL BENEFITS	COMMENTS
Steam system/ Install steam turbine to existing boiler to generate electricity from superheated steam *(see case study)*	New technology /equipment	▪ Investment: US$ 1.43 million ▪ Cost savings: US$ 0.61 million /yr ▪ Payback period: 2.3 yrs	▪ Electricity savings: 20196 MWh/yr ▪ Coal savings: 1700 t/yr ▪ GHG emission reduction: 4260 tCO_2/yr	Implemented. The Company had also identified this option before GERIAP
Steam system/ Recover flash steam from blow down to heat the boiler feed water *(see case study)*	New technology /equipment	▪ Investment: US$ 82829 ▪ Cost savings: US$ 131259/ yr ▪ Payback period: 8 months	▪ Coal savings: 5146 t/yr ▪ GHG emission reduction: 12896 tCO_2/yr ▪ Water savings 71280 t/yr	Implemented
Steam system / Install steam traps at air heating coils in the oxalic bagging line *(see case study)*	New technology / equipment	▪ Investment: U$ 483 ▪ Cost savings: not quantified ▪ Payback period: almost immediate	▪ Coal savings: not provided ▪ GHG emission reductions: not provided	Implemented Eight float steam traps were needed
Steam system/ Install 12 steam traps at main steam pipes and 10 self-made water seals at other branch pipes	Good housekeeping	▪ Investment: US$ 4836. ▪ Cost savings: not provided ▪ Payback period: not provided	▪ Energy savings: estimated 20% by manager (but not measured because there are no meters on the steam system)	Implemented. One more boiler is on standby than before, and there is still enough steam to meet the steam demand in process heating.
Steam system / Install lagging and repair of broken lagging at steam pipelines	Good housekeeping	▪ Not provided	▪ Not provided	Not fully implemented Newly installed pipelines are lagged with rock wool Old pipelines will be lagged gradually due to high investment costs for huge piping network
Synthesis plant/ Weld	New technology /equipment	▪ Investment: very small	▪ Coal savings: not provided	Implemented Downtime and

FOCUS AREA/ OPTION	CP TECHNIQUE	FINANCIAL FEASIBILITY	ENVIRONMENTAL BENEFITS	COMMENTS
"Impingement Plates" for each steam inlet point at the jacketed heater to avoid heat loss *(see case study)*		▪ Cost savings: Not provided ▪ Payback period: immediate	▪ GHG emission reductions: not provided	maintenance cost could be reduced by 40-50% Production rates could increase significantly
Synthesis plant/ Install capacitor bank to raise the power factor from 0.75 to 0.85	New technology / equipment	▪ Investment: US$ 2418 ▪ Cost savings: US$ 14510/yr ▪ Payback period: 2 months	Savings by electricity supplier (not by Yuanping): ▪ Coal savings: 475 t/yr ▪ GHG emission reduction: 1173 t	Implemented. Cost savings are 5000 RMB per month in penalties due to low power factor
Synthesis plant / Convert air gas-making process into oxygen enrichment gas-making process *(see case study)*	Process / equipment modification	▪ Investment: US$ 360000 ▪ Cost savings: not provided	▪ Coke savings potential: 20%	Not implemented due to technical and financial barriers
Synthesis plant / Strict control of coal size (80 – 200 mm to 40 – 50 mm) to increase furnace efficiency	Good housekeeping	▪ Not determineed	▪ Coke savings through more efficient combustion	Not implemented because coke supply is limited, so little choice in suppliers. Staff are assigned to crush and screen coke
Production process / Improved recovery of lead sulphate and sodium sulphate (glauber salt) in plumbite process and acidification process *(see case study)*	Onsite reuse / recovery	▪ Investment: up to US$ 1.5 million ▪ Cost savings: not determined	▪ Water savings: 65% ▪ Lead sulphate and sodium sulphate in wastewater	Not implemented. Two alternatives were investigated but high investment costs is the main barrier

FOR MORE INFORMATION

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