HFC 23 Abatement CDM at Jiangsu Meilan and Changshu 3F

By Thomas Grammig, GTZ Proklima in February 2006

General Production Structure

HFC 23 (trifluoromethane also called carbon trifluoride, fluoroform and R-23) is an inadvertant co-product of HCFC 22 production. HFC 23 is a colourless, low toxicity gas with a boiling point of -84°C. It has no ozone depleting potential but a very high global warming potential (GWP) rated at 11,700 and an atmospheric lifetime of 264 years. As HFC 23 has no commercial value, it was usually vented to the atmosphere. With the high GWP, HFC 23 has the lowest specific costs of all CDM projects in preparation and represents 25 % of all CERs generated so far.

The typical co-generation of HFC 23 is between 2 – 4 % by weight of HCFC 22. HCFC 22 is a good refrigerant and has played an important role in the phase-out of CFCs under the Montreal Protocol. Besides for refrigeration, it is only used as a feedstock for PTFE production. The Copenhagen Amendment to the Montreal Protocol calls for a freeze of HCFC 22 production in 1996 in developed countries, a 35 % reduction in 2004, 65 % in 2010 and 90 % in 2015. Developing countries will freeze HCFC consumption in 2015 and phase-out completely by 2040.

Consequently, Chinese HCFC 22 production has increased from 112 kt in 2000 to 340 kt in 2004. The Chinese government estimates that HCFC can rise to 500 kt in 2007 and decline from there as new refrigerators/AC equipment will convert to HFC or hydrocarbon based cooling systems. The number of HCFC 22 production sites in China will increase from 12 at present to 16. The largest plants are Shandong Dongyue, Zhejiang Juhua, China Yingpeng, Changshu 3F and Jiangsu Meilan. Outside China, only India has significant production at 4 sites but production costs are 40 % higher than in China and the level of production will remain stable.

CDM development

Two HFC 23 thermal destruction CDMs in India and in South Korea have been registered and for the latter a monitoring report for abatement during 2003 to 2005 is certified by DNV. These have established the AM0001 methodology, which specifies that HCFC 22 production eligible for CERs is limited “to the maximum historical annual production level at this plant during any of the last three years between beginning of the year 2000 and the end of year 2004”. They used the lowest historical co-generation of 2.89 and 2.9 % of HCFC 22. The thermal oxidation uses LNG with air and steam to reach 1200°C. The combustion products are absorbed and then neutralized with lime, yielding CaCl2 and CaF which is deposed. The technology is used in the INEOS plant in England. INEOS established local subsidiaries to operate the CDMs in both cases, and sold the CERs to Japanese companies.

Two HFC 23 CDMs in China have been submitted for validation at the Kyoto Secretariat, Zhejiang Juhua and Shandong Dongyue. Both are based on joint ventures between the plant owners and Japanese technology providers who receive the CERs generated. Juhua uses a superheated steam decomposition technology with an electric heater to maintain 800 to 1000 °C combustion temperature.

Shandong uses combustion with a Vortex high velocity burner for coal gas and diesel oil, originally developed for coke oven gas. In both cases combustion gases are absorbed and neutralized, leaving $CaCl_2$ and CaF_2 to be disposed in a landfill.

Both HFC 23 CDMs have been open for comments recently and their validation can be expected for summer 2006. All other Chinese HCFC plant operators have established Memorandums of Understanding with potential CERs buyers, but no decisions regarding abatement technology or CDM partners have been taken. The project documents for Juhua and Shandong were prepared by the Global Climate Change Institute of Tsinghua University in Bejing, which does not act as project participant.

CDM regulation in China

The Chinese government has established a Sustainable Development Fund to use the income from the sale of CERs. The government taxes 65 % of the revenues of CER sales for HFC 23 CDM. A CDM developer must submit project documents to the Chinese DNA, the National Development and Reform Commission (NDRC). The NDRC evaluates these project documents and suggests a decision to the National CDM Board, which comprises representatives of the relevant ministries. When approved by this Board, the NDRC issues the approval by the government, upon which the project developer submits the documents to the Kyoto Secretariat.

The NDRC also evaluates the Emission Reduction Purchase Agreements (ERPAs) of the CDM and has to approve these. In the past, the NDRC has preferred single buyers for all CERs of a CDM, privileging the highest buyer reliability, i.e. World Bank Carbon Funds. Informally, the NDRC expects a minimum CER price of 6.5 US$ at present. It sees a CDM which separates the technology transfer from the CER agreement as preferable to a combination of the two.

The NDRC is concerned with the technological level of the HFC 23 CDMs proposed in China. Both HFC 23 CDMs submitted do not recover fluorine and chlorine and the combustion technology is not the most advanced. Other Japanese technology involves using the CaF_2 to recover fluorine. Furthermore, the NDRC is not satisfied with the overall CDM terms the Chinese plant operators have obtained from the technology providers, Mitsubishi and Marubeni of Japan.

HFC 23 abatement technology in Germany

In Germany only one unit for HFC 23 incineration is in operation. This is a historic result of the market dominance of Solvay and Hoechst. Solvay stopped CFC production in 1994 and had to provide capacity to treat returned CFCs. The incineration uses a high temperature flame at 2000 °C with hydrogen and oxygen mixed with the HFC 23 in the burner. A graphite reactor uses an absorption heat exchanger with circulating hydrofluoric acid to recover 100 % of the fluorine and a second absorption stage to recover 100 % of the chlorine, both as technical grade acid for sale. The resulting exhaust gas consists of CO_2, O_2 and water vapour. The design variable of the reactor is a fuel stream of 80 Nm^3/h of hydrogen.

Besides HFC 23 from the Hoechst Industrial Park area, Solvay treats HFC from other sites in Germany and in Tarragona, Spain, with transport by road. Solvay operates three combustion reactors each with a capacity of 100 kg/hr HFC 23. The reactors

are produced by SGL Carbon and the plant engineering is from SGL Acotec GmbH, based on jointly held patents. Solvay estimates costs at 14 UScts/kg, not including the value of the recovered acids.

Solvay has sold two identical combustion reactors to SRF Ltd. in Rajasthan India, the second Indian HCF 23 CDM. There 2.94 % of HCFC 22 is the HFC 23 abated, resulting in 3,834,000 CERs per year. Solvay provided the reactor equipment, instrumentation and license against a fee. Recently, SRF Ltd sold the CERs separately with PriceWaterhouseCooper India as its agents.
CDM preparation at Jiangsu Meilan and Changshu 3F

The Chinese Ministry of the Environment (SEPA) has led a delegation of 6 to visit CDM technology providers in Germany during 31 October to 7 November 2005. SEPA favours the environmental and technological features of the Solvay abatement technology. Solvay opened its plant and readily discussed all technical details, sure of its patents and know-how. However, Solvay does not provide information on the commercial side, neither of its operation in Germany nor the HFC 23 CDM in India. Furthermore, Solvay has not considered different options of CDM participation and did not indicate to the Chinese delegation which contractual CDM configuration Solvay prefers. The delegation also expressed its interest in the Solvay technology regarding the abatement of CTC, a pressing problem for the SEPA when it guides Chinese companies in the production of Chloroform. Solvay appears to make no effort to pursue this technology other than by selling the reactor in the configuration used in Frankfurt.

Following the visit to Solvay in Frankfurt, Jiangsu Meilan and Changshu 3F have asked Solvay for a preliminary offer for a HFC 23 stream of 150 kg/hr with fluorine recovery as 50 % aqueous solution. These parameters are similar to those in operation at Solvay. Both Jiangsu Meilan and Changshu 3F have recently increased their HCFC 22 production from 40 kt to 60 kt/yr. The offers invited correspond to the 40 kt production which could indicate that Jiangsu Meilan and Changshu 3F wish to evaluate these offers for the CDM under the current methodology AM0001.

The next Kyoto negotiation round at the Meeting of Parties (MOP1) in December 2005 will consider the eligibility of HFC 23 CDMs (see FCCC/SBSTA/2005/INF.8). It is possible that the eligibility criteria of AM0001 will be modified to create a suitable overlap between Kyoto and Montreal Protocols. If AM0001 remains in force unchanged and Jiangsu Meilan and Changshu 3F operated their plants at full capacity with similar HFC 23 co-generation as the CDM already submitted (2.37% at Shandong), the CDMs have a maximum CER volume of 11 mio per year each.

This volume exceeds the CER buying interest of Solvay, whose EU ETS obligation in Germany amounts to 4.8 mio EUA. If Solvay wishes to retain some CERs for its 2007 ETS obligation, this could correspond only to 100 – 200,000 CER. Likewise this volume exceeds the possible interest of the KfW Carbon Fund.