

## ***HOW THE MIDWEST CHEMICAL CONVERSION TECHNOLOGY IS SUPERIOR TO THERMAL OXIDATION FOR ELIMINATING HFC-23 PRODUCED DURING HCFC-22 MANUFACTURE***

### **Overview:**

- HFC-23 (Trifluoromethane-CHF<sub>3</sub>) is a by-product generated from the production of HCFC-22 (Chlorodifluoromethane-CHClF<sub>2</sub>). The Global Warming Potential of HFC-23 was upgraded to 14,800 in 2007.
- While the production of HCFC-22 for comfort cooling and foam-blowing will be phased out by developing countries in 2020, production will continue for an indefinite period after that, because HCFC-22 is used as a feedstock for the manufacture of polymers.
- At the end of the production process, the HFC-22 is packaged for sale. Smaller quantities of other production by-products are usually rerouted for further processing, and the HFC-23, produced at an average of 3% of the HCFC-22 production total, is either vented or incinerated by a thermal oxidizer.
- Thermal oxidation is an expense for the producer, so atmospheric venting of the HFC-23 is sometimes used as the cheapest method of elimination.

### **How is the Midwest conversion process different than thermal oxidation?**

- The HFC-23, which is waste to a thermal oxidizer, is feedstock to create value for the Midwest technology. The HFC-23, and/or the balance of the HCFC-22 manufacturing waste stream, is reacted with hydrogen (H<sub>2</sub>) and carbon dioxide (CO<sub>2</sub>), which the Midwest unit generates from water. The process breaks the mix down to molecular level.
- These molecules are then re-assembled to form anhydrous hydrogen fluoride, with small amounts of anhydrous hydrogen chloride. These outputs are of far higher purity (99.99%+), with trace-metals in parts per billion, and can either be returned to the production cycle or possibly sold for greater value for electronics and semi-conductor manufacturing.
- By adding the hydrogen (H<sub>2</sub>) and carbon dioxide (CO<sub>2</sub>) for conversion, a third output, either technical grade carbon monoxide (CO) or carbon dioxide (CO<sub>2</sub>) is produced. These are additional saleable outputs. For every 1.0 pound of input, the Midwest technology delivers about 1.6 pounds of output, creating even more value.

### **The cost comparison:**

The operating cost of a Midwest unit is less than a thermal oxidizer. The thermal oxidizer produces no value. The Midwest process produces dollars per pound of value for every input pound, with no waste stream. A small excess of hydrogen is re-used.

### **A cost example:**

If an HCFC-22 manufacturing plant produces 30,000MT annually, it will generate approximately three-percent (900 MT) of HFC-23.

Incinerating 900 MT by thermal oxidation is a production expense and creates no value.

From the conversion of the 900 MT of HFC-23, the Midwest technology produces 772 MT of anhydrous hydrogen fluoride (AHF), a small amount of anhydrous hydrogen chloride (AHCl), and 720 MT of technical grade either carbon monoxide (CO) (or carbon dioxide (CO<sub>2</sub>)). The recovered 772 MT of AHF saves the mining of about 1500 MT of fluorspar. The value created by these outputs is in the millions of dollars.

The capital cost for a Midwest conversion unit would be slightly more than a thermal oxidizer to process 900 MT annually. However, the value created by the Midwest unit would eliminate that disadvantage within a short time and make conversion a profit center for the producer for however long the HCFC-22 is in production.

### **The Midwest Technology Profile:**

- In November 2011, the Midwest technology was approved by the Montreal Protocol members as the “Conversion by Chemical Reaction with Hydrogen and Carbon Dioxide”. To date, it is the only conversion technology ready for commercial use.
- There are no stack emissions and no waste stream, the only Montreal Protocol methodology that can make this claim.
- Because chemical conversion is not incineration, it is considered part of the chemical manufacturing process and not subject to hazardous waste rules.
- Patents have been granted in the U.S., China, Hong Kong, Macau, Korea, Japan, Australia, Canada, Russian Federation, the EU, Mexico, and South Africa. India is pending.