GENERAL START-UP AND SHUTDOWN INSTRUCTIONS FOR A SULFUR BURNING SULFURIC ACID PLANT CONVERTER CONTAINING MECS® CATALYST FOR SULFURIC ACID

GENERAL

These instructions should be considered general guidelines for starting up the converter in a sulfur burning sulfuric acid plant with MECS® Catalyst. Specific issues such as valve positions, tower acid flows, gas bypass options, safety interlocks, etc. are not included here. These instructions should be used in conjunction with the plant operating manual and any applicable manufacturers' specifications.

PLANT START-UP

DRY BLOW

1. During start-up, the initial heating of the converter should be carried out using dry air to minimize water condensation on the catalyst. MECS, Inc. (MECS) recommends a single dry blow, but some clients continue dry blows until all passes are between 100 and 170°C (212 and 340°F). Using only a single dry blow reduces the heat-up time by approximately 24 hours and reduces the number of labor-intensive blind changes required. The sulfur burner should be preheated to 870 - 900°C (1600 - 1650°F) using the start-up burner. After the sulfur burner has been held at this temperature for 3 to 4 hours, the procedure for heating the converter by "blowing through" heat from the sulfur burner to the converter can be started.

2. Acid must be circulating through all of the towers. With the acid circulating, the drying tower will dry the ambient air and the absorbing towers will absorb SO_3 that is formed during the converter heat-up. If the towers are not circulating acid, moisture from the air may damage the catalyst, and SO_3 not absorbed in the absorbing towers will cause a visible white plume in the stack.

3. Shut off the start-up burner. The main compressor is used to blow dry air through the converter until the sulfur burner outlet temperature drops to 400°C (750°F). Then the main compressor is stopped. When the process gas does not contain SO_2, such as in this dry blow, it is very important that the first pass inlet temperature does not exceed 530°C (985°F) to prevent desulfation of the catalyst.

   CAUTION: Note that the gas flows and gas temperatures to the converter passes should be adjusted as necessary to keep the temperatures within the manufacturer's specifications for mechanical integrity of the ductwork and converter, specifically the converter division plates. The manufacturer's specifications not only protect the structural integrity of the equipment, but also help maintain the gas-tight welds. For MECS-designed plants, the temperature in the converter inlet ducts should not exceed 600°C (1110°F) for stainless steel ducts and converters or 510°C (950°F) for carbon steel ducts and converters. The temperature differences across the division plates that separate the converter passes of MECS stainless steel converters should not exceed 120°C (250°F).

GAS FIRE

4. Continue to circulate acid over all of the towers. Restart the main compressor and light the start-up burner. Minimize firing rate, as practical, to keep a steady rise in the converter temperatures.

5. Hold the sulfur burner outlet temperature at 870 – 900°C (1600 – 1650°F). Continue putting combustion gases through the converter until all passes of the converter are as close to 400°C (750°F) as possible. The first and fourth (or fifth) pass exit temperatures should be over 400°C (750°F), and the second and third pass inlet temperatures should be at least 420°C (790°F) as a minimum before sulfur burning can begin. Note that passes containing cesium catalyst only need to be heated to 380°C (715°F) before sulfur burning can begin.

   CAUTION: Keep the ductwork temperatures and differential temperature across the converter division plates within the manufacturer's specifications.

6. If a superheater is present after the first pass, the outlet temperature of the pass should not exceed 510°C (950°F). This will prevent damage to the superheater in case there is no steam flow.

7. As the converter is heating, the vent gases in the start-up vents (typically at the economizers) may become cloudy as SO_3 gas is evolved from the catalyst when it reaches approximately 250 - 300°C (480 - 570°F). If these emissions are not acceptable, then the gases must be routed through the final tower and to the stack. This requires shutting down the start-up burner and main compressor to allow the duct blinds to be changed accordingly. Restart the main compressor and start-up burner to continue the heating process. When the vent gases are flowing through the absorbing towers, the acid becomes dilute due to absorption of the water of combustion from the gas. It is important to carefully monitor the acid strength when the vent gases are flowing through the towers to avoid circulating weak acid (<93 weight %). Weak acid must be pumped to storage and the volume replaced with strong acid (98%) to maintain acid strength above 93%. In some plants a start-up bypass duct is provided to bypass gas around the interpass tower to avoid cooling the gas as it passes through the tower and subsequent heat exchangers.

8. After the catalyst has reached the specified temperatures, the plant is ready to start with sulfur. Shut off the fuel supply, shut down the main compressor, and remove the start-up burner. Clean the sulfur burner sight glasses if they are dirty.

BURNING SULFUR

9. Reposition duct blinds and valves as necessary. Install the number of sulfur spraying assemblies that are recommended for start-up. Confirm that the cooling steam is flowing to all of the installed sulfur spraying assemblies. Verify that the stack gas oxygen and SO_2 analyzers are ready for service.

10. Start the main compressor and, as soon as practical, start the sulfur feed. Begin with sulfur feed to one or two sulfur spraying assemblies. Verify that there is a sulfur flame from each assembly.

11. Initiate SO_2 production at approximately 40 to 50% of full rate. It is recommended that this be done using approximately 7 to 9% SO_2 gas feed at a reduced blower rate. Maintaining the sulfur burner outlet temperature at about 790°C (1450°F) or a stack oxygen concentration of 11.5 to 8.5% O_2 will produce a 7 to 9% SO_2 feed, respectively. Note that in a plant with a single superheater after pass 1, the gas strength may need to be increased to near design gas strength more quickly in order to keep the steam temperature from going too high.

12. A gradual temperature rise will be observed in the first pass within a few minutes of catalyst being in contact with sulfur dioxide. For the initial start-up with new catalyst, this temperature rise (measured at the first pass outlet) should peak within forty five minutes at a maximum of 20 to 50°C (35 to 90°F) above the expected outlet operating temperatures for a given gas strength. This temperature maximum will begin to drop after approximately thirty minutes to eventually line out at the expected operating temperature for a given SO_2 strength gas stream.

13. Slowly increase the sulfur flow to increase the sulfur burner temperature outlet to 980 - 1050°C (1800 - 1920°F) or until the stack oxygen concentration is 7 to 6.2% O_2 which yields 10 to 10.5% SO_2, respectively. Hold this outlet temperature until the inlet temperatures to each pass of catalyst are near the design temperatures. The pass 1 outlet temperature should not exceed 650°C (1200°F) to prevent damage to the catalyst.

14. The plant should be stabilized before attempting to increase the plant rate. The plant rate can slowly be increased by adjusting the main compressor pressure and adjusting the sulfur feed rate to increase the sulfur burner temperature. The rate of feed adjustment should be dictated by the SO_2 emissions and the bed inlet temperatures. Raising the rate slowly minimizes process upsets and helps to keep everything under control. The feed rate increase will not generate a large temperature rise during the initial start-up with new catalyst since the catalyst is almost completely sulfated prior to operation.

GENERAL START-UP AND SHUTDOWN INSTRUCTIONS FOR A SULFUR BURNING SULFURIC ACID PLANT CONVERTER CONTAINING MECS® CATALYST FOR SULFURIC ACID

PLANT SHUTDOWN

Condensed moisture or acid may decrease the physical strength and/or cause a loss of vanadium or active salts in the catalyst, leading to high pressure drop and a possible permanent decrease in conversion efficiency. The catalyst is hygroscopic (attracts moisture), especially if SO_2 or SO_3 gas is in contact with the catalyst. Therefore, during a plant shutdown, moist air must be avoided and eliminated, to the maximum possible extent, from the catalyst and the converter / heat exchanger system. Before a shutdown SO_2 and SO_3 should be purged from the plant to reduce the sulfuric acid dew point temperature should any moisture enter the plant during the shutdown.

For any planned shutdown, especially if it is to be of such length that the catalyst temperatures will fall below the dew point of sulfuric acid (i.e. the point where moisture or acid would condense), the converter system should be purged with dry air to remove the SO_2 and SO_3 prior to shutdown.

For an unplanned shutdown, such as a plant shutdown due to an interlock, the plant should be purged with dry air to remove the SO_2 and SO_3 as soon as practical if the plant cannot be restarted quickly.

PLANNED, SHORT TERM SHUTDOWN

Prior to the shutdown, adjust waste heat boiler and heat exchanger bypasses to raise the temperatures in the converter by 10 °C (18 °F) in each pass and operate the plant at the higher temperatures for an hour or two to let the heat build in the catalyst beds. This will increase the length of time the plant may remain shut down without requiring the use of the start-up burner to start up. Note that if the catalyst bed temperatures fall below 400°C (750°F) for standard catalyst or 380°C (715°F) for cesium catalyst, the start-up burner will be needed to reheat the beds prior to burning sulfur again.

Reduce the plant rate to about 50% of design rate. Shut off the sulfur feed, but continue to operate the main compressor at approximately 50% volume.

Purge the converter / heat exchanger system with dry air until the SO_2 and SO_3 are purged from the catalyst passes (approximately 20 minutes for a purge prior to a short shutdown).

PLANNED, LONG TERM SHUTDOWN

Reduce the plant rate to about 50% of design rate. Shut off the sulfur feed, but continue to operate the main compressor at approximately 50% volume.

Purge the converter / heat exchanger system with dry air until all the equipment is cooled down and the SO_2 and SO_3 are purged from the catalyst passes (approximately 24 hours for a purge prior to a shutdown to cold conditions).

After purging the system, care should be taken to prevent moist air from reaching the catalyst. Natural draft will bring in moist air through the plant stack and the air inlet. The main valve in the discharge of the main compressor should be closed and all other valves that would otherwise allow ambient air to enter the plant should be shut and blanks installed to prevent moist air intrusion. If maintenance work is performed on the converter, the length of time that the manways are open should be minimized. Polyethylene sheeting secured with rope or wire should be used to cover the open converter manways when personnel are not inside the vessel. Polyethylene sheeting should also be used to cover other open manways within the gas system of the plant.

If the shutdown plans require the plant to be down for a long period, in excess of several months, sulfuric acid must be circulated through the towers on a regular basis (once or twice per week for an hour). Even with this precaution, it will be very difficult to maintain a dry environment for the catalyst. It is recommended that the catalyst is removed from the converter and stored in dry, closed waterproof bags or drums until the plant is ready to start up again. The drums or bags should be clearly labeled with the catalyst pass number and the catalyst location in the bed (top, middle, or bottom) so that the catalyst can be replaced in the same location later. Catalyst bags or drums should be stored indoors in a dry warehouse facility on wooden pallets to prevent exposure to free-standing water. If the catalyst needs to be stored outside of warehousing facilities, it must be stored in waterproof drums that are elevated on pallets to minimize exposure to free-standing water and must be covered with water-impermeable plastic to eliminate moisture exposure.

Catalyst should be reloaded in its previous location in the converter only a few days prior to the planned restart of the plant. Care should be taken so that moist air does not reach the catalyst between the time of catalyst loading and the plant restart.