by Ernesto Vera-Castañeda,
DuPont Clean Technologies

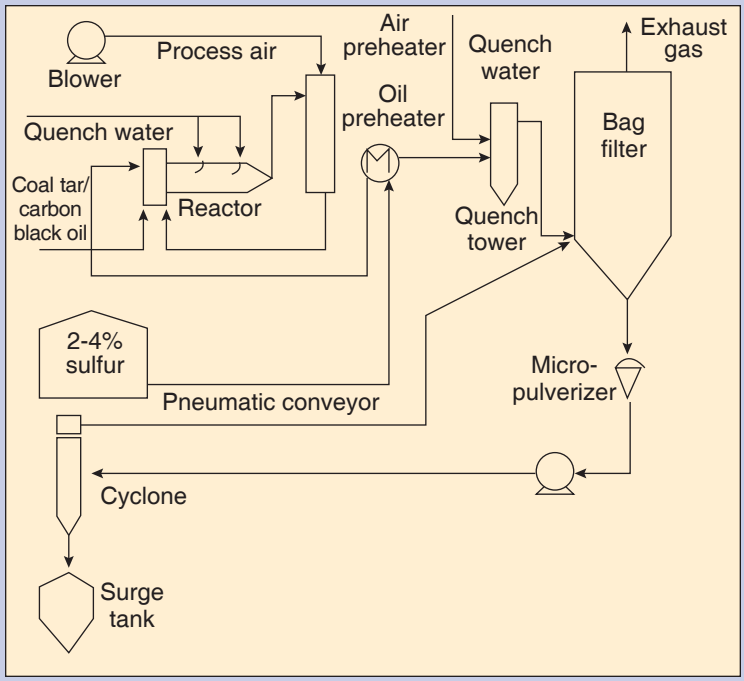
Emissions control solutions for carbon black production exhaust gas

Across the globe, governments and communities are focused on reducing pollutants that have adverse environmental and health effects. Particulate, sulfur dioxide and nitrogen oxides are of specific concern. Carbon black production has been recognized as an industry that needs to address stack emissions by many countries, communities and operators. By the nature of the feedstocks used, which are derivatives of coal, natural gas and oil, sulfur dioxide (SO_2) is present in the off gas. The formation of nitrogen oxides (NO_x) is also expected in the reactor based on process temperatures. To curb emissions of SO_x and NO_x, many carbon black producers have incorporated low sulfur fuels, low NO_x burners and heat recovery into their process. However, there is a direct relationship between carbon black production plant size and exhaust gas volume. Thus, with recent industry consolidation and construction of larger plants, exhaust gas volumes have increased. With environmental regulations continually tightening, producers may need to consider new, more robust exhaust gas emissions control options to further drive down emissions.

Current exhaust gas emissions control measures typically consist of a bag house for filtering particulate (figure 1) and a stream of unit operations (figure 2) to remove the various components in the off-gas stream: wet electrostatic precipitators to remove fine particulate; a furnace for combustion of carbon monoxide (CO), hydrocarbons and sulfur components like hydrogen sulfide (H_2S); selective catalyst reduction for nitrogen oxide treatment; and wet scrubbing for sulfur oxide removal. In the case of wet scrubbing, the sulfur dioxide is reacted with a base such as caustic (sodium hydroxide), lime (calcium oxide) or limestone (calcium carbonate), and then oxidized with air, forming the corresponding sulfate which leads to a secondary effluent that must be removed from the production site. The sulfate formed is sold as gypsum or disposed in a landfill. Depending on the sulfate effluent composition, hazardous material disposal may be required. The costs for the reagent, transportation and landfill must all be considered in the lifetime costs of using wet scrubbing as a solution.

As an alternative to the wet scrubbing process, DuPont Clean Technologies offers a concentration/conversion solution resulting in a salable byproduct, high strength (98.5%) sulfuric acid (figure 3). This process combines MECS SolvR technology with the sulfuric acid production contact process. The MECS SolvR system employs an environmentally friendly absorption solvent, and is capable of removing sulfur dioxide from gas feed concentrations of 300 ppmv to 50 vol% in the inlet gas. Typically, the system will reduce emissions below 20 ppmv. If lower emissions are required, stripping steam can be increased incrementally and emissions can be lowered to below 10 ppmv. While this technology in combination with the sulfuric acid production contact process requires a higher initial capital investment than wet scrubbing, it significantly reduces the secondary sulfate effluent associated with wet scrubbing that is becoming increasingly problematic in many world areas. The MECS concentration/conversion solution offers reduced equipment sizes due to the higher concentration of SO_2 in the gas stream before conversion to sulfuric acid. As such, lower capital costs are incurred when compared to other sulfuric acid technologies currently available to the carbon black industry.

Figure 1 - furnace black process flow diagram



Feedstock flexibility

A further benefit to the MECS concentration/conversion solution is the flexibility to consider high sulfur feedstock for carbon black production. As an example, recent changes in the shipping industry have resulted in falling prices for fluid catalytic cracking (FCC) or bunker fuel oil. Bunker fuel oil has a higher sulfur content than coal tar, which is predominately used in Asian markets as a feedstock. The MECS

Figure 2 - emissions control flow scheme using a wet scrubber as final treatment step

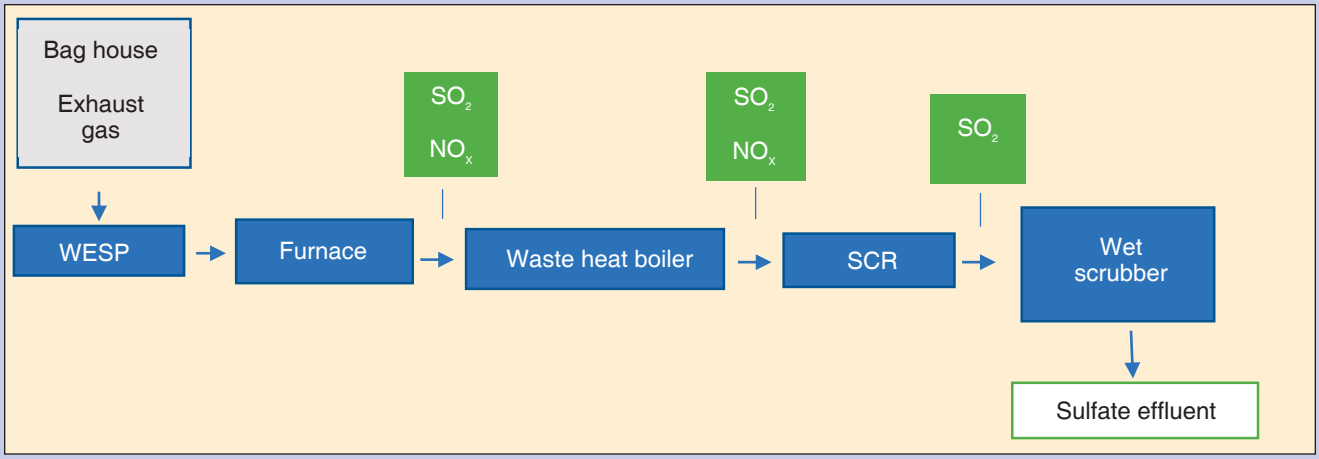
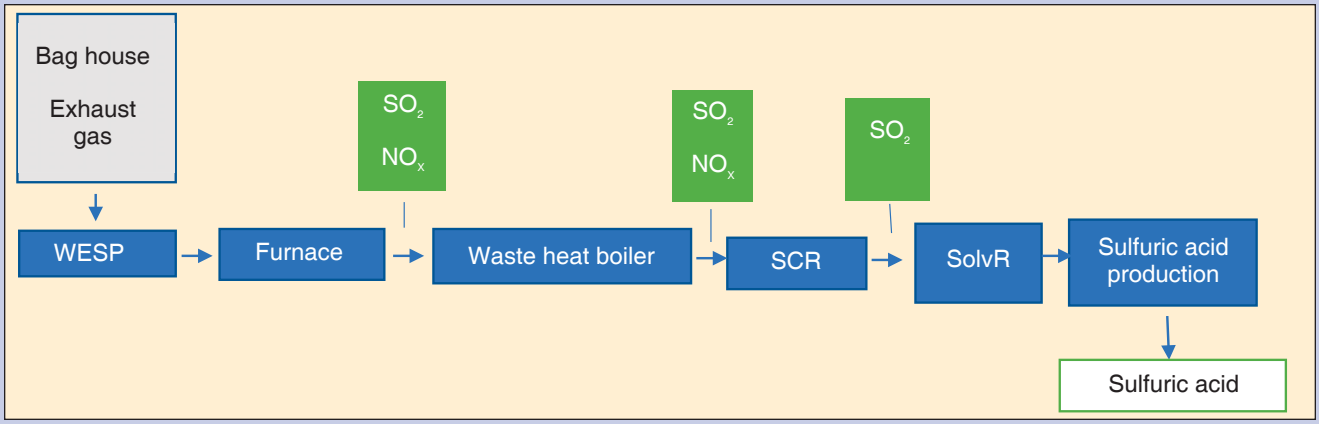


Figure 3 - emissions control flow scheme using MECS SolvR technology coupled with MECS sulfuric acid production technology as final treatment step



concentration/conversion solution can easily manage the resultant higher SO_2, leading to more sulfuric acid production. In contrast, an increased SO_2 load to traditional wet scrubbing processes would result in higher reagent and disposal costs.

While high strength (98.5%) sulfuric acid is a valued commodity in most parts of the world, some local markets may need other options. The MECS concentration/conversion solution can produce other products, such as oleum or high purity gaseous SO_2 in multiple combinations to allow carbon black producers to customize the product line for their local markets.

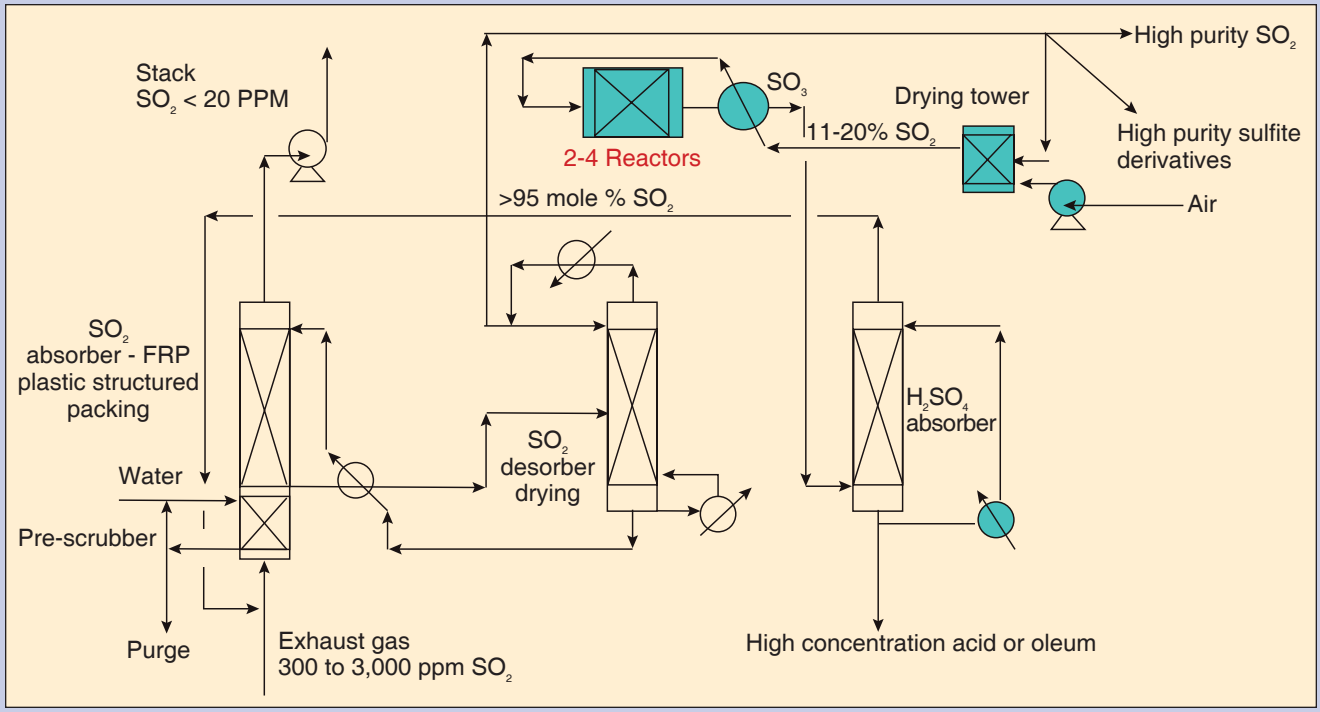
Process flow

The MECS concentration/conversion solution uses the simple to operate MECS SolvR technology to concentrate the SO_2, then convert it to salable high strength (98.5%) sulfuric acid. This solution can be summarized as follows: The exhaust gas enters the SolvR absorber where solvent absorbs the sulfur dioxide, producing a clean exhaust gas stream (SO_2 emissions below 20 ppm). Clean gas exits the absorber at the top, and the rich solvent is pumped to a stripping tower which removes SO_2. The clean solvent is pumped back to the top of the absorbing tower.

The concentrated sulfur dioxide stream (greater than 95 mole % SO_2) exits the stripping tower and is ready for conversion using the MECS sulfuric acid process. In the first step of this conversion, the concentrated stream enters an absorbing tower where it is diluted with air and dried. It then passes through a catalytic reactor to convert the sulfur dioxide to sulfur trioxide. The reactor uses an MECS catalyst specifically designed for this application. Heat is removed between the reactor passes in this equilibrium reaction.

The heat removed is redistributed for process control. The concentrated sulfuric trioxide is then sent to another absorbing

Figure 4 - MECS concentration/conversion solution for carbon black exhaust gas emissions control



tower where it enriches circulating acid to the desired sulfuric acid product strength. The tail gas exiting this second absorbing tower is sent back to the SolvR system for further processing. The small amount of effluent from the SolvR system is an aqueous sodium sulfate solution that can either be sent to battery limits or concentrated to produce higher grades of sodium salt (figure 4).

This concentration/conversion process best fits the larger carbon black applications based on equipment economies. In addition to the MECS concentration/conversion solution, DuPont Clean Technologies is well suited to handle the gas cleaning process (WESP, furnace, waste heat boiler and SCR) that is often upstream of the concentration/conversion process. Many versions of this part of the process may already be installed or may need upgrading to address further regulations for particulate and NO_x, as well heat recovery. In a grass roots plant application, they can be custom engineered as a continuous, integrated treatment process.

Conclusion

The carbon black industry has a range of emission control solutions at its disposal to control air pollutants from exhaust gases. Producers can tailor their preferred option to specific operating conditions, feedstocks and desired byproducts. By factoring initial capital expenditures, and reagent, transportation and landfill lifetime costs, as well as the financial benefits derived from sulfuric acid sales, producers can customize solutions. They find a balance that best meets their needs, while complying with and even exceeding environmental requirements.

The world leading MECS sulfuric acid technology offered by DuPont Clean Technologies has been implemented at over 650 customized plants worldwide in the phosphate fertilizer, non-ferrous metals (leaching and smelting), oil refining and general chemical industries.

MECS technologies feature breakthrough solutions, many of which have revolutionized the performance, quality and cost-effectiveness of customer operations. They include MECS heat recovery systems (HRS), MECS SolvR regenerative SO_2 scrubbing and MECS MAX3 sulfuric acid production technology.

Integrated into these MECS technologies are proven specialty products such as catalysts, Brink mist eliminators, DynaWave scrubbers, ZeCor corrosion resistant alloy products, and acid coolers, all of which are specifically designed for the most demanding operating environments.

With over 90 years of expertise, the MECS team is said to provide best-in-class sulfuric acid, energy recovery and environmental technologies, engineering, integrated specialty products and services to a wide range of industries.

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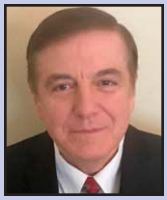

Ernesto Vera-Castañeda is a senior technology fellow and acid research and development manager at DuPont Clean Technologies. He has B.S. and M.S. degrees in chemical engineering from the National Polytechnic Institute in Mexico City and a Ph.D. in chemical engineering from Texas A&M University.