Pollution control: a core technology

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The existing and planned aluminium plants in the Middle East demonstrate the progress that is being made in emission monitoring and emission control effectiveness.

Today's large, high performance aluminium smelters require extremely effective pollution control systems to be able to operate in harmony with the environment. As advancements have been made in power efficiency, process stability and plant productivity, similar progress has been made in pollution control.

Larger cells, higher amperage, reduced anode effects, higher quality metal, longer potlife, increased automation, improved sensors and control programmes and reduced process variations all contribute to the success of the aluminium industry in the 21st century. Improvements in emission controls also play a role.

The strong focus on environmental excellence by the aluminium plants in the Middle East begins with electric power production. On-site gas-fired power plants produce much of the electric power for the smelters. Although a relatively clean fuel, natural gas combustion can produce significant levels of oxides of nitrogen. However, by taking advantage of the advances that have been made in low NOx burners, the power plants used by these smelters are among the lowest emitters of oxides of nitrogen in the world. Some of these plants also use waste heat from the power plants to produce high quality hot water for use by the local communities.

Photo: Fives Solios

The fume treatment centre at the Sohar smelter, designed and installed by Fives Solios.

Improved hooding systems and advanced pot-tending machines that minimise the length of time cells are open for routine process work play a large role in reducing the pollutants that escape from the cells into the potrooms. The Qatalum smelter will use the next generation of the pot-tending machine that has successfully been used at Hydro's smelter expansion in Sunndal, Norway. That new potline is considered one of the most environmentally friendly in the world. The use of such highly automated machines also increases productivity. Opening the cells for a shorter period reduces the exposure of workers to potentially harmful pollutants and minimises the concentration of fluorides, particulates and sulphur dioxide in the ventilation air that flows from the potrooms. Capture efficiencies of 98% or more are now possible in modern potrooms.

Dry scrubber systems that use re-circulated alumina and improved bag filters are capable of removing more than 99.5% of the fluorides and particulates collected from the electrolytic cells. The Sohar smelter uses some of the most efficient scrubbing equipment in the industry. Such systems make it possible for very large plants to operate without

impacting vegetation or wildlife, even in areas adjacent to, and sometimes within, the smelting plant complex. The Alba plant is establishing an eight-hectare "oasis" in the centre of its smelting complex to demonstrate that the plant can operate without harm to the environment.

Alumina flow management within the scrubber systems and after the reacted material is ready for use in the smelter has improved the systems' capabilities and the quality of the metal produced.

WET SCRUBBERS

Sulphur dioxide, a pollutant of growing concern within the industry, has traditionally been released from the plant via discharge stacks that allow dispersion to reduce the concentrations before the plumes reach the ground. In a number of larger plants, sulphur dioxide is being removed through the use of wet scrubber systems. In some cases seawater is used effectively owing to its natural magnesium content. In other cases freshwater is used for scrubbing with alkalinity added to increase the sulphur removal rate. Wastewater treatment may be required to address pollutants such as fluorides that are removed along with the sulphur. Sulphur dioxide scrubbing is planned for the Qatalum plant, based on proven Hydro technology.

Carbon anode paste mixing and anode forming can be sources of organic gas emissions. These emissions are controlled in some cases by incinerators and in others by dry or wet scrubbing systems. At least one company uses anode coke as the scrubbing medium for removing the organic gases, while others use lime or alumina as bag pre-coat and scrubbing media. Temperature control is important in the process for the effective removal of organic emissions.

The carbon baking furnace emissions present a challenge since in most cases the gases must be cooled before they can be treated effectively. Most modern plants use water cooling systems and alumina-based dry scrubbers to remove fluorides and particulates from carbon baking furnace off-gases. The alumina is then sent to the potrooms for use since the collected fluoride has significant value. These systems are so effective that less than 5% of the fluoride emissions for a smelter come from the baking furnaces, and there are no visible emissions. The Dubal plant has one of the most efficient carbon bake furnace emission control systems, ranking second in a recent survey of plants based on fluoride emissions.

Photo: Fives Solios

Four 80-tonne tilting holding furnaces at Sohar Aluminium's cast house were supplied by Fives Solios, along with a water treatment plant

PFCS ADDRESSED

Finally, emissions of per-fluorinated compounds (PFCs) have been addressed effectively in modern plants. Improved sensors, effective computer control systems and software that anticipates and prevents or quickly corrects process upsets, precise measuring and feeding systems and greater focus on stable pot operation have resulted in dramatic reductions in the increased voltage situations in cells that allow PFCs to be produced. As a result, PFC emissions have been reduced in modern cells by over 90% without the need for pollution control equipment. It is expected that additional reductions can be achieved as further improvements in process control are made in future cell designs and control systems.

Advances in continuous real-time monitoring of emissions and of ambient concentrations provide additional information that assists in optimum performance of the process equipment and the pollution control equipment. The Sohar smelter as well as other Middle East aluminium producers make extensive use of this type of equipment and use them to help achieve continuous improvements.

The ongoing evolution of aluminium smelting technology has been accompanied by a similar evolution in emission control equipment and emission management techniques. The technologies are interdependent. Progress in one area allows for increased flexibility in the other and increased capability for the entire system. This unique integration of pollution control and process operation has served the industry well, and will continue to allow improvements in productivity, energy efficiency and plant output, while protecting the workers, the communities and the environment. ■

Pat Atkins has over 35 years of industry experience and provides consulting support for IAI