Role of Carbon and Glass Surfacing Veils in Flue Gas Desulfurization Plants

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Abstract

New coal-fired power plants are facing increasingly lower emission level permitting requirements. Existing coal-fired power plants are being required to reduce their emission levels to these new standards. This situation has sparked a demand for better efficiency in sulfur dioxide scrubbing at these sites. As new plants come online and existing plants are revamped, the number of these units being built or retrofitted is projected to reach 160 by 2020.

This paper focuses on the role of a nonwoven glass or carbon surfacing veil in the manufacture of composite flue gas desulfurization stacks. Corrosion inhibition and electrostatic dissipation are discussed, as well as best practices for manufacturing with nonwoven veils.

Introduction

Environmental concerns have increased in recent years, with rising demands for the reduction of air, water, and solid wastes. Acid rain is one such concern that receives considerable public attention. Acid rain is generated in large part by sulfur dioxide and nitrogen oxides in the atmosphere — the notorious greenhouse gases. Sulfur dioxide and nitrogen oxides present are generated by industry, via fossil fuel burning. This is what must be controlled in the exiting flue gases from industrial plants and power generation plants, especially those burning coal and natural gas. Many programs are in place in countries around the world to ensure that a reduction in emitted sulfur and nitrogen-based air pollutants occurs.

Demands on new coal-fired power plants are some of the most stringent ever seen. In the 1970s, permitted emission levels were reduced twice for sulfur dioxide from 1.2 lb/MBtu in 1971 to as low as 0.3 lb/MBtu in 1979. Coal-fired power plants receiving permits in the 1990s had lower emissions levels. Figure 1 details the expected rate of capacity additions.

Engineering efforts to remove sulfur and nitrogen-based oxides have been quite successful, with designs ranging from 80% removal rates to new designs reaching 99.5% removal rates. These systems consist, in a generic description, of scrubbers and flue stacks, collectively referred to as flue gas desulfurization (FGD) unit operations. A generalized drawing of such a system is shown in Figure 2. Not all units in operation will be configured in this way. It is used here for example only.

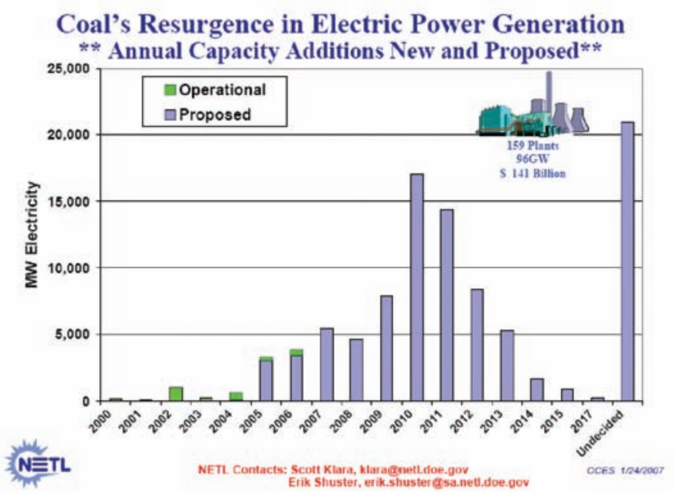
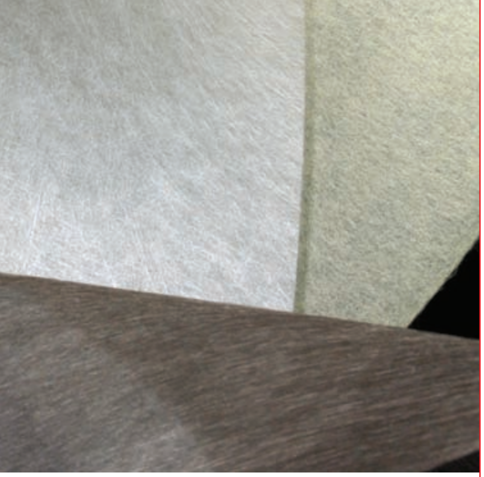


Figure 1.



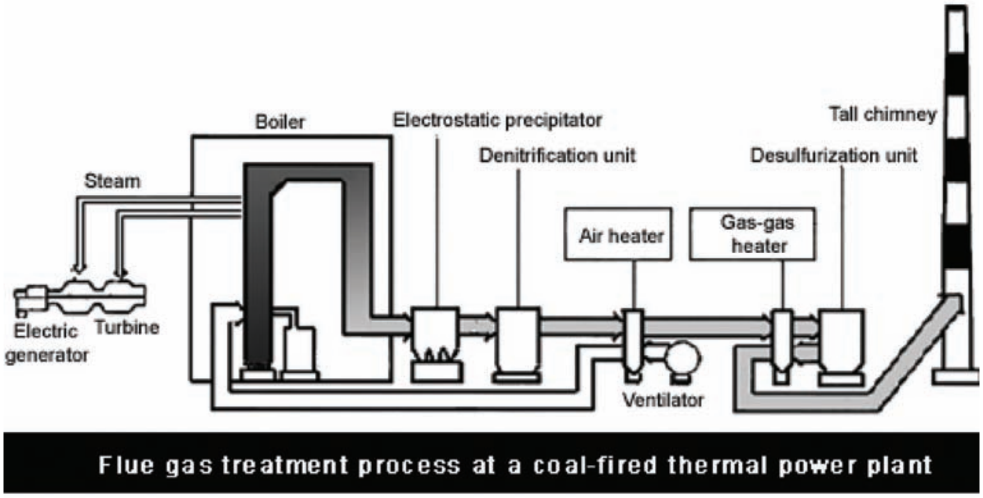


Figure 2.

Corrosion in FGD systems

Flue gas desulfurization (FGD) units generally employ one or more of three processes: wet scrubbing, dry scrubbing, and sorbent injection. Other units have been designed by other means, but are typically quite site-specific and cannot be considered the industry norm. Flue gases are chemically acidic in nature, with pH values from 2 to 3 and absorbed water at roughly 10%, and can be introduced to the FGD systems at temperatures around 50°C. These conditions create an environment ripe for corrosion.

Wet scrubbing is by far the most prevalent FGD control mechanism in place today around the world. This process relies on limestone slurry to cool and saturate the hot flue gas as it enters the scrubber. Additional mechanical means are taken to promote the gas-liquid contact for the most complete reaction, and, therefore, removal of sulfur dioxide from the flue gas. These systems can have efficiencies as high as 96-98% when additional, and often expensive, additives are used. Along with the removal of sulfur dioxide, these units are now also used to produce gypsum as a by-product for resale. Gases exiting the unit can contain sulfuric acid mists and solid particulate matter. These gases are introduced to the stack for dispersion.

Dry scrubbing, or semi-wet scrubbing, employs a modification of standard spray-drying technology. A slurry of lime is forced through atomizers, yielding tiny droplets that contact the flue gas. These droplets, and the lime they contain, absorb the sulfur dioxide and sulfates as the water carrying the lime evaporates. Again, this reaction forms gypsum as a by-product. The dry gypsum and other particulates are collected in a bag-house or electrostatic precipitator for resale or disposal.

Sorbent injection is a modification of standard dry scrubbing. In this process, limestone is injected into a furnace and converted to calcined lime. It is this calcined lime that is used for dry scrubbing.

In each case for flue gas desulfurization, the opportunities for both corrosion and static electricity buildup are plentiful. Mechanical and chemical corrosion are taking place, creating a cycle for hastened failures. With the flow of a liquid slurry over the walls of the structure, water and acid-laden flue gas exiting the stack and counter-current flow present in many of these units generate prime conditions for static electricity buildup.

Static buildup

Static electricity is the accumulation of excess electrical charge in a material with poor electrical conductivity. This excess electrical charge will find a conductor and follow that path to ground in order to neutralize the charge buildup, resulting in a spark or arc. In the case of industrial applications, this static buildup can lead to catastrophic events.

The triboelectric mechanism for the generation of static electricity is such that two materials only need to come into contact and then separate from each other for some electron exchange — charge polarity and thus static charge buildup — to occur. As a liquid flows through a closed pipe system, there is significant contact between the liquid and pipe wall. The resulting rubbing and friction lead to large amounts of static.

This is a topic of great importance for industrial plant designers, both for reasons of safety and for damage to infrastructure and goods. There are many recorded instances of harm to people and damage to equipment when this static charge is allowed to arc in the presence of flammable fluids, such as petroleum distillates. In order to control this phenomenon, countermeasures are designed into process equipment through which liquids flow.

Carbon fiber-based nonwovens are commonly used as surfacing veils in such applications. These veils serve multiple purposes. The first advantage to inclusion of a surfacing veil is to enhance the corrosion resistance of the part for the application. The veil will hold up a resin-rich layer at the point of contact with the corrosive environment. The second advantage to inclusion of a carbon fiber-based surfacing veil is the conductive nature of the material. Carbon fiber is inherently conductive; it also provides electrostatic dissipation, or grounding of the composite part against static arcs.

Section of composite flue stack with Hollingsworth & Vose carbon fiber-based surfacing veil visible. Photo courtesy of Ershigs, Inc.

The function of nonwoven veils

Nonwoven veils (also known as mats or tissues) are often used for making corrosion barriers in composite tanks, pipes, ducts, flue stacks, fittings, and pump/valve housings. Nonwoven veils inhibit the generation of microcracks in composite surfaces, protecting the manufactured part from further attack. For highly corrosive environments, these veils are usually made from glass or carbon fiber. Veils play a key role in forming the corrosion barrier's inner liner by acting as the carrier and stabilizer for the resin. This resin-rich surface must be designed for contact with the specific chemical environment in which the corrosion barrier will be utilized. It is important to point out that a veil will not alter the performance of the resin; however, it will produce a surface composed entirely of the appropriate resin. The corrosion barrier's innermost liner should consist of at least 90% resin and should be reinforced by multiple layers of glass or carbon veil reaching the total thickness specified.

Relative to glass, carbon fiber veils provide the added benefit of also being electrically conductive. Typical carbon veils produced by Hollingsworth & Vose Company display properties of surface resistivity in the range of 5 ohms/square. Carbon veils are used in composite structures for grounding in order to minimize the buildup of static electricity. Static dissipation is particularly important in composite tanks and pipes that handle explosive or flammable liquids and gases.

Electrostatic dissipation rates can be tailored to meet the specific needs of the application. Blends of conductive and nonconductive, corrosion-resistant ECR glass can be produced to provide the best balance of corrosion resistance, static dissipation, and cost. Hollingsworth & Vose produces such veils; a partial listing is shown in Table 1.

Nonwoven veils are designed to be compatible with a variety of resins, such as epoxy, vinyl ester, and polyester. However, nonwoven veils are specifically formulated for different applications. Not all veils are the same; Hollingsworth & Vose can design veil characteristics such as conformability, resin solubility, and conductivity into the product. Veils are widely used in corrosion barriers in hand lay-up, filament winding, and pultrusion fabrication processes. In general, carbon veils are cut and applied like other mats, roving, and woven materials. Where possible, veils should be applied wet on wet, maximizing bond strength.

References

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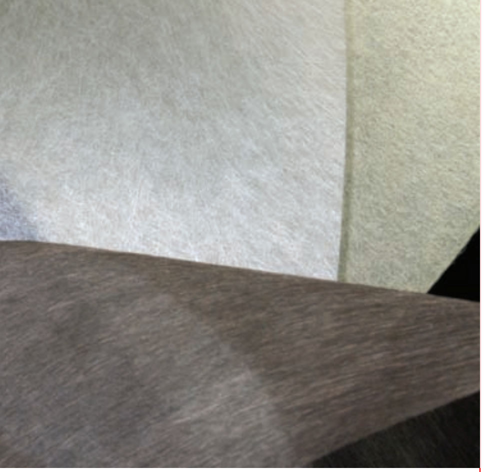

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Carbon and glass nonwoven veils are produced by Hollingsworth & Vose in the United States and are available for commercial sale. To obtain further information, please contact a Hollingsworth & Vose representative listed at left.

Technical data for AFN® veils and mats

CARBON

					Average tensile			
	Basis weight		Thickness		(lb/in)		(kN/m)	
Grade #	oz/yd^2	g/m^2	mils	mm	MD	CD	MD	CD
8000015	0.20	6.8	2.1	0.05	3.0	3.0	0.5	0.5
8000018	0.30	10.0	2.5	0.06	5.2	3.0	0.9	0.5
8000020	0.50	17.0	5.0	0.13	7.0	7.0	1.2	1.2
8000028	0.50	17.0	5.0	0.13	7.0	7.0	1.2	1.2
8000029	0.59	20.0	6.0	0.15	8.5	8.5	1.5	1.5
8000030	1.00	34.0	11.0	0.28	10.0	10.0	1.8	1.8
8000033	1.00	34.0	9.8	0.25	21.0	21.0	3.9	3.9
8000036	1.00	34.0	9.8	0.25	14.0	14.0	2.4	2.4
8000044	1.47	50.0	15.7	0.40	21.0	21.0	3.6	3.6
8000039	2.00	68.0	21.5	0.55	8.0	8.0	1.4	1.4
8000040	2.00	68.0	21.0	0.53	25.0	25.0	4.3	4.3
8000047	3.00	102.0	33.0	0.84	18.0	18.0	3.2	3.2

Table 1.

ECR GLASS

					Average tensile			
	Basis weight		Thickness		(lb/in)		(kN/m)	
Grade #	oz/yd^2	g/m^2	mils	mm	MD	CD	MD	CD
8000130	0.30	10.2	3.0	0.08	1.0	1.0	0.2	0.2
8000110	0.50	17.0	4.6	0.11	4.5	4.5	0.8	0.8
8000190	0.75	25.4	7.0	0.18	5.5	5.5	1.0	1.0
8000107	1.00	34.0	7.5	0.19	23.0	13.0	4.0	2.3
8000191	1.00	33.9	9.9	0.23	8.0	8.0	1.4	1.4
8000192	1.50	50.8	13.0	0.34	12.0	12.0	2.2	2.2
8000118	1.75	59.5	16.0	0.41	16.0	19.0	2.8	3.3
8000195	3.11	105.0	25.0	0.64	13.0	13.0	2.3	2.3
8000115	4.80	163.0	45.0	1.14	18.0	18.0	3.2	3.2
8000116	6.24	211.6	57.0	1.40	24.0	24.0	4.2	4.2
8000117	10.5	356.7	60.0	1.52	30.0	30.0	5.2	5.2

Table 2.

About H&V

Established in 1843, Hollingsworth & Vose Company is a global leader in developing, manufacturing, and supplying technically advanced engine, high efficiency, and liquid filtration media; battery materials; and industrial nonwovens. H&V adds value to customers' products by inventing next-generation materials with superior performance. H&V's expertise and process capabilities include wet-laid, dry-laid, meltblown, nanofiber, and composite technologies. The company operates manufacturing sites and research centers in the Americas, Europe, and Asia.

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