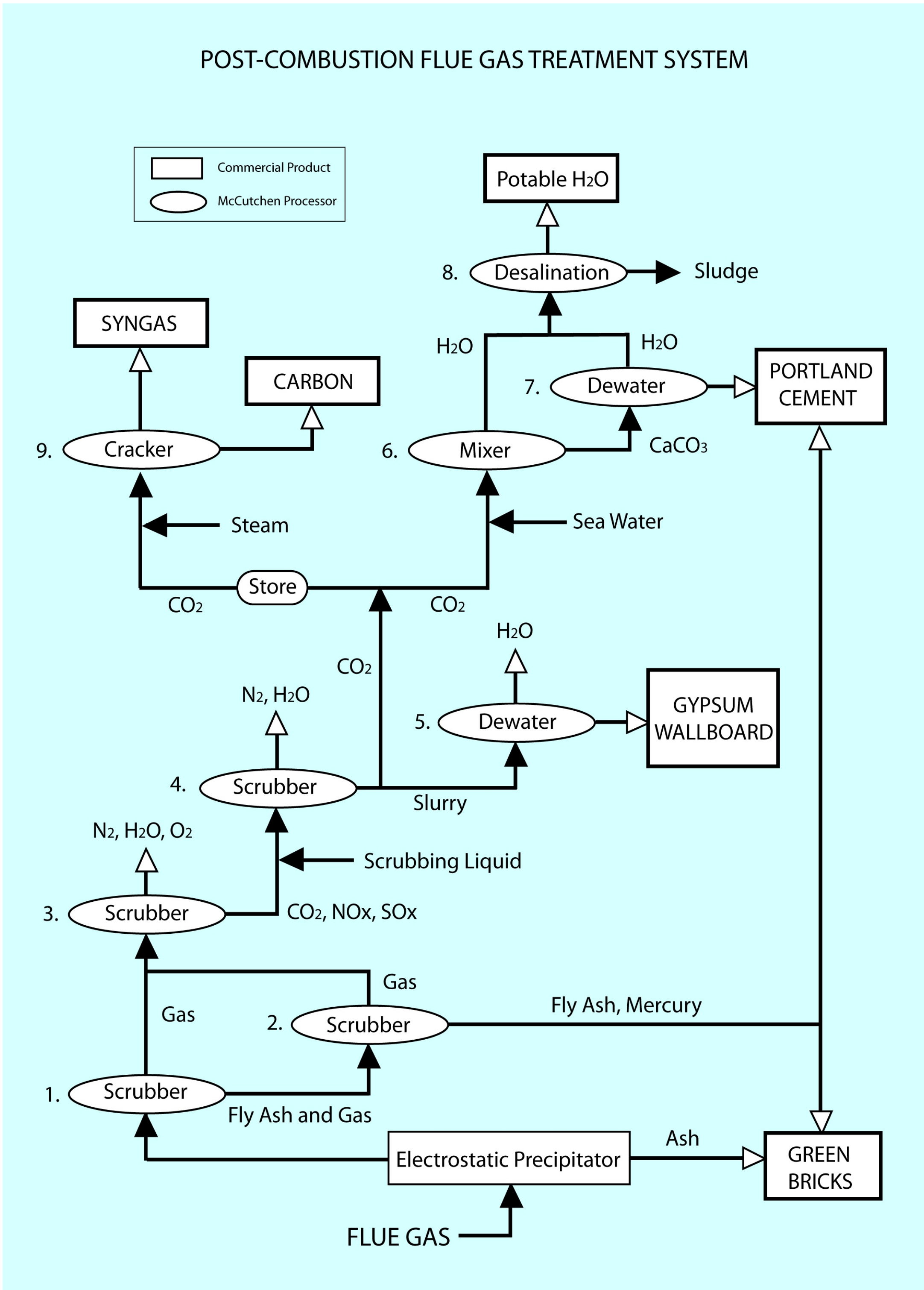
Post-Combustion Flue Gas Treatment System

Remediation of pollution from flue gas involves both gas and water treatment. Solutions must be found for fly ash, NOx and SOx, as well as capturing and neutralizing the CO_2 emissions. The new radial counterflow McCutchen Processors from Vorsana offer variants to take care of all of these, as part of a comprehensive approach that actually turns the pollution into valuable products.



The flue gas first goes to an electrostatic precipitator, which removes the major particulates. The gas then goes to two McCutchen Scrubbers which centrifugally separates the heavier fly ash component, including the mercury, from the lighter gas, preferably in a dual cascade (1. and 2.). Each of these Scrubbers use twin counter-rotating disk impellers producing a branching structure of vortex turbulence between them with extreme centrifugal separation effects. The separated components are pulled in opposite directions according to their weight, in a continuous radial counterflow, where the heavier pollution elements exit the periphery and the lighter gases are sucked from the axis. The result of this stage is the axial extraction of the gases, including all of the gaseous pollutants, from the fly ash particulates. This fly ash, including the heavier particles from the ESP stage, are then pressed into "Green Bricks", which are a new product that is commercially valuable in its own right.

Another McCutchen Scrubber (3.) separates the lighter components from the heavier components of the gas stream, again using radial counterflow vortices. The lighter gases, nitrogen (N_2), oxygen (O_2), and water vapor (H_2O) can be safely vented to the atmosphere, while the heavier gases, including CO_2, SOx (SO_2 and SO_3), and lesser amounts of NOx (NO and NO_2), move on to the next stage.

Here another McCutchen Scrubber (4.) mixes injected limestone scrubbing liquid ($CaCO_3$, H_2O) into the turbulent vortices in the workspace between the counter-rotating disks. The lighter gases remaining, chiefly N_2 and H_2O, are axially vented into the atmosphere while the remaining gaseous CO_2 and the scrubbing slurry exit the periphery. The CO_2, now a concentrated stream, is easily separated for further treatment. The slurry contains gypsum created by the reaction of the sulfur dioxide and trioxide with the scrubbing liquid. This slurry is then dewatered by another McCutchen Dewatering processor (5.), which separates the slurry between the counter-rotating disks, extracting the water axially while extruding a gypsum paste at the periphery. This "synthetic" gypsum ($CaSO_4 \cdot 2H_2O$) has a growing market as an additive for Portland Cement and also for making gypsum wallboard.

The carbon dioxide stream remaining would be a dangerous greenhouse gas if it were allowed to simply be vented into the atmosphere. Instead, it too can be turned into valuable products with new technology and other models of the McCutchen Processor. There are two main approaches which can both handle the large volumes of CO_2 involved.

The first approach involves turning the CO_2 into marine cement, using a process such as the new cement production method from Calera. Seawater is mixed with a hot CO_2 stream from flue gas, and the reaction of the calcium and magnesium in the seawater with the CO_2 produces cement. In this system the mixture takes place in a McCutchen Processor mixer (6.), and the product is passed to a McCutchen Dewatering processor (7.), resulting in the cement product. The extracted water from the process is fed to a McCutchen Desalinator (8.), which blocks the flow of the remaining salts using an inductive field, resulting in valuable potable water.

The second approach cracks the carbon dioxide through electrolysis, resulting in valuable products. The CO_2 can be stored for when inexpensive or non-polluting power is available, such as during off-peak hours, or when intermittent sources such as wind or solar power are available. A McCutchen Cracker processor (9.) uses a powerful corona discharge field between charged counter-rotating disks, which act as disk dynamos, to simultaneously electrolyze CO_2 and steam into valuable syngas (CO and H_2) which can be burned or turned into vehicle fuel, plus O_2, while also producing some pure carbon (C_2), which is also a valuable product.

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