Case Study

ANSYS + Aditya Birla Science and Technology Company

"Simulations using ANSYS helped us optimize the chlorine gas distribution inside our Stable Bleaching Powder (SBP) reactor. CFD studies revealed that solids lost from the reactor could be reduced by up to 70 percent. Simulations proved to be extremely valuable in understanding the gas flow distribution inside the reactor. These insights allowed us to evaluate a new chlorine gas manifold design for efficient control of the solid waste generated during the manufacturing process."

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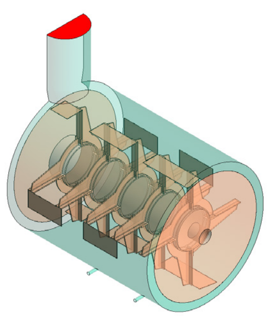
ANSYS

Case Study

Design Analysis and Process Improvement in Stable Bleaching Powder Reactor



SBP reactor domain (half-symmetric) for the base case with two nozzle inlets

Stable Bleaching Powder (SBP) is manufactured by chlorination of hydrated lime by aerating an SBP solids bed with chlorine gas. Valuable lighter particles at the top of the bed comprise products, reactants and intermediate compounds, which exit the reactor along with the gases. This solid–gas mixture is filtered to extract the useful material. Still, approximately 60 kg/batch of solids are lost. Reducing this loss would result in a major time and cost savings.

Challenges

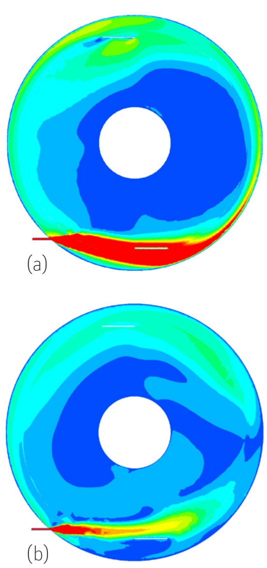
The goal was to minimize solids carryover without major modifications to the SBP plant. To identify process parameters that could be altered, it was important understand existing issues in the flow patterns. Being a closed loop system, onsite physical measurements were difficult. Therefore, we decided to use ANSYS CFD. Simulations were indispensable in determining the best solution from the interplay of the identified process parameters.

Technology Used

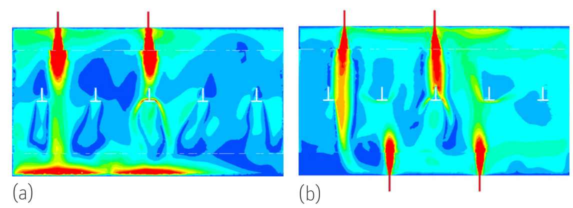
ANSYS CFX

Engineering Solution

- The aerated solids bed was modeled as a porous zone. Impeller rotation was captured using the frozen rotor approach, with the k-ε turbulence model.
- Simulations helped identify gas channeling and regions where flow velocities exceeded the terminal settling velocity of the average solids particle size.
- Gas injection nozzle diameters and the number of injection locations were identified as the design parameters.
- Simulations revealed that increasing the nozzle diameter 2.5 times reduced the outlet-velocity-to-terminal-velocity ratio to 0.57 with 92 percent more uniform flow distribution.
- Adding two injection locations further reduced the velocity ratio to 0.47, but some flow uniformity was lost.



Velocity distribution cross-section for (a) the base case with two nozzles, and (b) a modified setup with four nozzles



Flow pattern on a plane cutting across the injection nozzles for (a) base case with two nozzles (b) modified setup with four nozzles

Benefits

- The easy-to use-interface in ANSYS CFX helped to run rapid, robust simulations from pre-processing to solving to post-processing in ANSYS Workbench.
- Optimum design was achieved without incurring any physical testing costs and consequent plant downtimes.
- A more uniform chlorine gas distribution inside the reactor will reduce the SBP batch time.
- Increased process sustainability could reduce current EHS issues.
- Since chlorine gas tends to corrode metals, a more uniform distribution of chlorine within the reactor will reduce the excess chlorine required for reactions. This in turn will improve reactor lifetime.

Company Description

Aditya Birla Science and Technology Company Private Limited (ABSTCPL) is the corporate research and development centre for the Aditya Birla Group. Located in Taloja, just outside of Mumbai in India, ABSTCPL supports the broad diversity of the Group's businesses through multidisciplinary teams of expert scientists and engineers who lead fundamental and applied research projects. At ABSTCPL, research and development is based on two strong capabilities. The Process Engineering and Sciences Laboratory focuses on advanced processes and designs, process control and automation, and process engineering platforms and scale-up. The Science and Technology Platforms Laboratory provides expertise in metallurgy, fiber science and textiles, materials and surface sciences, and chemistry.

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