Prince of Songkla University

Effect of Device Design on the Performance of a Dry Powder Inhaler Using CFD

Thailand

DRUG DELIVERY SYSTEM EXCELLENCE CENTER DDSE·C PRINCE OF SONGKLA UNIVERSITY

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Overview

Pulmonary drug delivery can directly deliver medication to the lungs, thus it can play an important role in the treatment of asthma and airways related diseases. In 1970s, the first dry powder inhalers was introduced. It offers a good portability and satisfy efficiency. However the performance of dry powder inhalers is still far from the ideal and most of the drugs are delivered only into the oral cavity. Thus, dry powder inhaler device needs more studies to optimize its performance.
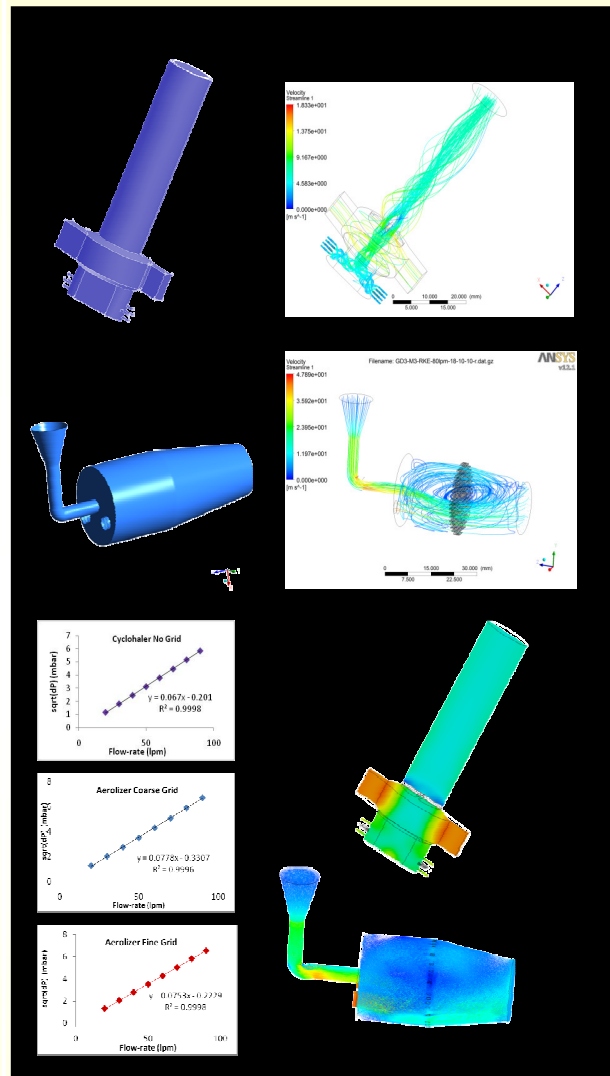
CFD has emerged in various fields of pharmaceutical research. ANSYS Fluent is one of advance CFD package that fulfills the gap in drug delivery research especially in pulmonary drug delivery system that the traditional experiment face many limitations such as one cannot investigate airflow characteristic. There by, we incorporate CFD to investigate dry powder inhalers aerodynamics behavior and performance.

Testimonial

Mouthpiece, grid and air inlet design were easily adjusted in Gambit. Velocity vector, pressure drop, Reynolds number, velocity streamline and particle trajectory of dry powder inhalers were observed and used to optimize the design of dry powder inhalers devices. The simulation data was well correlated with standard experimental data. ANSYS Fluent offers adaptability and convenience in the drug delivery system research.

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Cyclohaler No Grid
$y = 0.067x - 0.201$
$R^2 = 0.9998$

Aerolizer Coarse Grid
$y = 0.0778x - 0.3307$
$R^2 = 0.999$

Aerolizer Fine Grid
$y = 0.0743x - 0.2229$
$R^2 = 0.9998$

Challenges

• Study factors that influence the aerodynamics and particle dispersion in a dry powder inhaler device using computational fluid dynamics.
• Evaluate dry powder inhaler devices using computational fluid dynamics.
• To develop further high performance DPI devices.

Solution

• ANSYS Gambit is used to create the dry powder inhaler devices model and mesh.
• ANSYS Fluent is used to compute the solutions on PSU Grid.
• ANSYS CFD-Post; a power full post-processing tool is used to calculate the velocity vector, pressure drop, Reynolds number, velocity streamline and particle trajectory.

Benefits

• Enabled an investigation of airflow and particle disaggregation in the dry powder inhaler device.
• Flexible adjustment the device design.
• Allow adaptable validation with various experimental results

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