



THE INTERACTION BETWEEN GAS AND PARTICLES

In this case study the endless possibilities within FlowNex are highlighted by the application of user coding and the versatility it adds to the tool.

In a pneumatic conveying system, the interaction between the gas and the particles being conveyed is very important for control and performance prediction. This is also the case for the Fuel Handling System of the Pebble Bed Modular Reactor where the fuel (in the form of 60mm graphite spheres) is pneumatically conveyed with Helium ($\pm 11\text{m}$ vertically). The Helium accelerates the pebbles in the feed line and then pneumatically brakes the pebbles before they are deposited back into the bed or storage container. The challenge is to model/predict the sphere kinematics, and to determine the interaction of the sphere on the flow velocities/distribution in the system.

NUCLEAR & SMR

CUSTOMER PROFILE:

As a diversified engineering solution business IST has extensive experience in the nuclear, energy, telecommunications and defense industries. In addition to being a niche supplier to South African industries, IST applies its technologies across a range of markets in Africa and internationally.

IST successfully uses Flownex as an engineering tool in their day to day business and as seen in this case study they were able to incorporate sphere kinematics through the powerful equation element within Flownex.

CHALLENGE:

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BENEFITS:

In this case study the endless possibilities within Flownex are highlighted by the application of user coding and the versatility it adds to the tool.

SOLUTION:

Being able to introduce user coding to the transient simulation, the sphere kinematics (interaction between sphere and gas flow) can be incorporated in the simulation to predict the exact overall system behavior. The maximum pebble velocity being conveyed (a critical design restriction) can be predicted and designed for.

"The equation element is a vast improvement of Flownex, and almost eliminates the need for external software. The capabilities are endless and all users of Flownex should explore ways to use this new element in their analyses."

Dr. Wim Fuls (PhD. Eng)
Senior Design Engineer
IST Nuclear (2007)

INTRODUCTION

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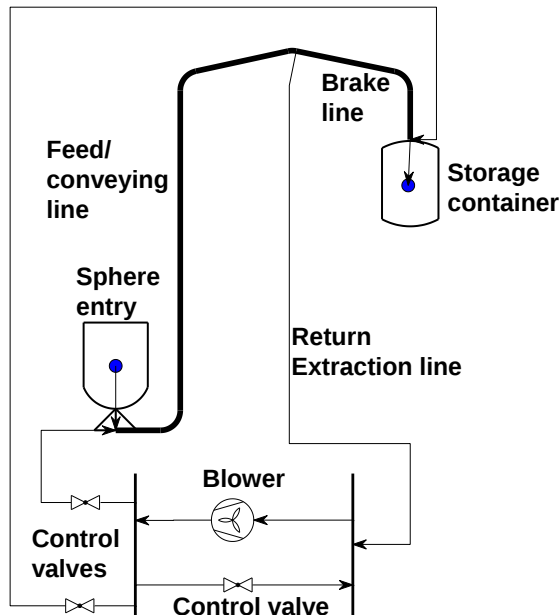
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SOLUTION

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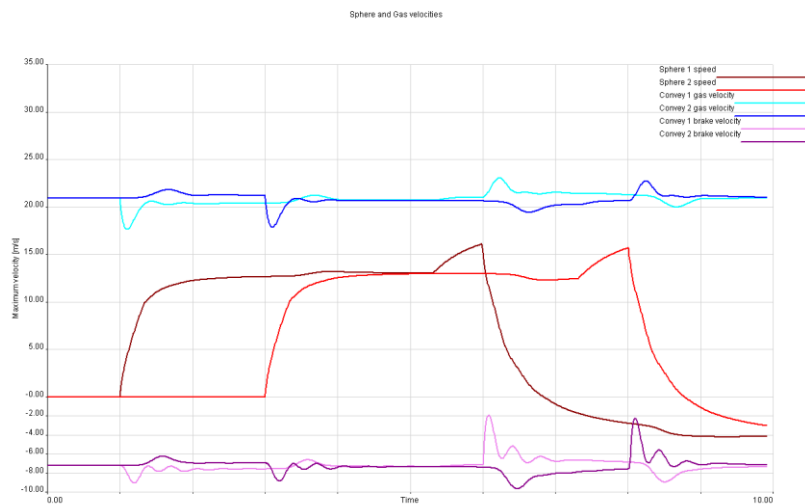
RESULTS

With the sphere kinematics incorporated with the compressible gas and solid gas heat transfer models in Flownex, it is very easy to see the interaction of the sphere on the gas flow velocities, temperatures and sphere velocities at the feed and brake lines. One can clearly see the pressure pulses caused by a sudden introduction of a sphere in the conveying stream, as well as bypass and leak flow changes due to the additional flow loss caused by the sphere. Flownex can model the pressure pulses in the conveying stream due to its ideal gas and compressible gas models. By designing the valve positions with the designer functionality, one can make sure that the sphere stays below its maximum allowable velocity throughout the conveying route. The design philosophy of controlling the mass flow distributions through the different pneumatic lines in the system can also be investigated.

Heat transfer from the pebbles to the pneumatic gas simulated in Flownex can be used to determine at which temperature the pebbles are deposited in the storage container. The sphere cooling rate to the pneumatic gas is used to determine if there are any thermal stresses on the pebble.

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It is also possible to see the effect of a second sphere introduced a few seconds after the first, and determine if they would catch each other on route. This knowledge can then be used to determine the maximum possible transfer rate of the pebbles without damage. The maximum transfer rate is essential in determining the amount of pebbles that can be moved through the fuel handling system, analyzed, sorted and stored within any given day. With this knowledge from Flownex it can be evaluated whether the pebble analyzer or the pebble pneumatic transport is the limiting factor in the sphere transport system.



Damaging the pebbles due to excessive speed, collision of pebbles or congestion in the transport of the pebbles is critical design parameters with unwanted results if these parameters were exceeded. Being able to simulate the transport of the pebbles in an integrated fashion allows the system as a whole (transport, control, valve sizing, blower sizing, insulation, operating temperatures, etc.) to be designed, analyzed and optimized for performance, safety and durability.

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