

CASE STUDY

GAS TURBINES

FLOWNEX[®]
SIMULATION ENVIRONMENT

FUEL FLEXIBLE COMBUSTION SYSTEM MODELLING WITH ZERO CARBON FUEL

CHALLENGE

In the modern era, comprehending air and fuel flow splits, pressure drops, velocities, and combustion within combustion systems is a major challenge. Costly and time-consuming 3D CFD simulations and experiments are often required, especially for hydrogen fuels, to accurately predict system pressure drop.

SOLUTION

Flownex SE offers rapid 1D flow modelling, streamlining the design process with easy modifications and quick results. Engineers can explore the impact of geometrical changes and verify system performance for a broad range of operating conditions, all while reducing computational time and costs.

BENEFITS

1D flow modelling using Flownex SE will give the results very fast compared to the numerical simulation and experiments, significantly cutting computational and experimental expenses. Flownex SE unlocks valuable insights into flow splitting, pressure drop, combustion, and heat transfer in combustion systems. 1-D modelling in Flownex SE is the first step in the design and development of combustion systems.



**Sustainable Business &
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Flownex is a very useful tool to perform flow path analysis of different configurations and media. In our specific example, we are using Flownex for air-fuel path layouts. It gives the air/fuel flow split at different locations, pressure, temperatures and velocity in the flow



SUSTAINABLE BUSINESS & ENGINEERING SOLUTIONS

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INTRODUCTION

Zero carbon fuels are used to reduce the CO₂ emissions in the atmosphere and move towards green technology. A suitable candidate for zero-carbon fuel is Hydrogen. Hydrogen combustion engines are a valuable substitution for internal combustion engines, with the potential to significantly reduce greenhouse gas emissions and reliance on fossil fuels. However, the combustion properties of hydrogen often result in high combustion temperatures, producing harmful emissions such as NO_x emissions.

Modelling the hydrogen combustion system is crucial during the design stage. Several methods, such as 3D CFD modelling, exist in the industry and can be used to model the hydrogen combustion system. However, one of the major fallbacks of the 3D CFD modelling is that it is very time-consuming and costly; hence 1D flow modelling was taken into consideration for the simulation of the hydrogen combustion system.

The primary aim of the demonstration is to characterise the pressure drop, a key parameter for energy saving, over the burner in the combustion system. The combustion test rig and the 1-D network modelling of the combustion system are shown in Figure 1 and Figure 2, respectively.



Figure 1: Combustion test rig

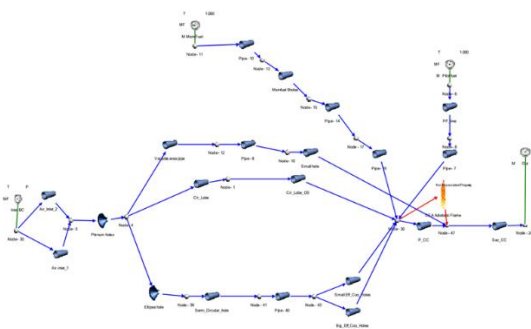


Figure 2: Combustion test rig Flow Network Model

METHODOLOGY

Detailed design information was leveraged to model a comprehensive 1D network, efficiently simulating the entire combustion system. Experimental data, including variations in mass flow rates, allowed us to obtain pressure drop results in the burner. These results were then validated against 1D Flownex SE modelling and 3D CFD simulations, along with comparisons for adiabatic flame temperature and emissions products.

RESULTS

The pressure drop in the burner showed a strong correlation with 1D Flownex[®] modelling, verifying its accuracy. Additional parameters, such as adiabatic flame temperature, NO_x, and CO₂ emissions, also closely aligned with experimental results.

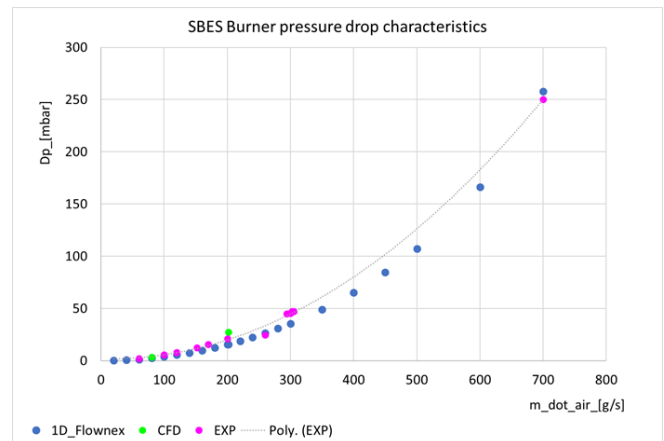


Figure 3: Pressure drop in the burner

CONCLUSION

SBES technologies successfully leveraged Flownex SE's 1D flow modelling for an entire hydrogen combustion system, achieving results that strongly aligned with 3D CFD simulations and experimental data. The adoption of Flownex SE significantly reduced computational costs and accelerated the design process, allowing for quick evaluation and verification of system performance under diverse conditions.