CASE STUDIES

AEROSPACE

CRITICAL ANALYSIS OF FAILURE CASES

Challenge: Perform critical analysis of failure cases during dynamic mid-air refueling of a Mirage F1 Fighter.

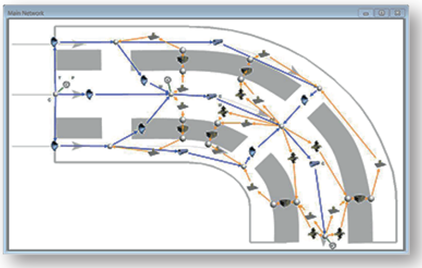
Flownex® allowed engineers to simulate flow rates and the refueling sequences of the system, track fuel distribution and investigate valve failure cases. The simulations ensured that, for any single failure case, the system would remain safe and maintain the center of gravity (cg) position of the aircraft.

Aerosud confirmed results predicted by Flownex® with ground test results. The simulation provided Aerosud with the confidence of delivering a final system design that is safe, reliable and conforms to customer requirements.

> Flownex enabled engineers to analyze the complete fuel system and its components in an efficient and accurate way, providing them with peace of mind that the final system design is safe, reliable and conforms to customer requirements.
>
> JACO GOUWS
> AEROSUD

TURBINES

GAS TURBINE ENGINE COMBUSTION CHAMBER



Challenge: Determine flow distribution in gas turbine combustion chambers at the preliminary design phase, taking into account various mechanisms of heat transfer.

By utilizing Flownex®'s swift execution ability, engineers could quickly and easily perform design modifications and parametric studies on the combustion chamber. Convection, conduction and radiation heat transfer was taken into account as well as the effect of fuel ratio on the combustion temperature. Studies performed in Flownex® allowed engineers to determine optimum boundary conditions for further detailed 3D CFD simulations.

MINING

MAXIMIZING OPERATIONAL EFFICIENCY

Today, mining engineers are at the forefront of applying system-level simulation to an industry that has predominantly relied on spreadsheets and hand calculations. The success achieved by our clients is abundantly clear in the case of AngloGold Ashanti, where one of their Simulation Engineers, **Jean Greyling, won an ETA (Energy Efficiency) Award using Flownex®**. Jean's compressor and pipe optimization project used Flownex® to do the first ever complete air-compressor system and network analysis of the mine. Flownex® allowed AngloGold to identify operational problems and opportunities to improve their operational efficiency. Implementation of the Flownex® solution led to significant energy and cost savings. The savings are estimated to be more than 2.5 MW with more savings expected as the system is further optimized with support from Flownex®. The cost of implementation of the project was minimal, thus giving AngloGold Ashanti an excellent return on investment.

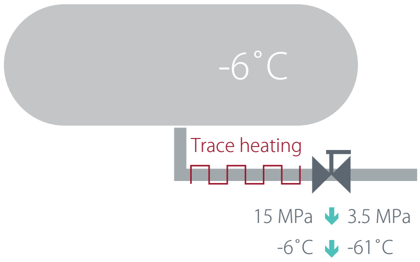
> Flownex® helped us to optimize the compressed air ring and to analyze the operating efficiency of the complete fleet. The simulations proved to be extremely valuable in understanding the operating capacity and in addition allowed us to implement a new efficient control philosophy.
>
> JEAN GREYLING
> PR. ENG
> ENERGY MANAGER
> ANGLOGOLD ASHANTI

GAS PROCESSING

GAS TURBINE START-UP

PRESSURE & EXPANSION CONTROL

CHALLENGE: Pressure regulators are to be employed at a gas-fired power station to reduce upstream gas pressures from a maximum of 15 MPa to approximately 3.5 MPa. Due to the Joule-Thomson effect, the resulting gas temperature drops could be in the region of 55°C. The dew-point temperature of the hydrocarbons (gas) flowing through is -15°C and the minimum ambient temperature of the area is -6°C. Thus the regulators could potentially be subjected to gas at -61°C at start-up. According to the valve manufacturer, temperatures as low as -20°C can be tolerated for some time, provided that condensation does not occur.



Unheated, no pipe wall mass: | **-61˚C < -20˚C** Valve range exceeded

Heated, with pipe wall mass: | **-10˚C > -20˚C** Within valve range

SOLUTION: Operation of the pressure regulators during the start-up of the turbines at a gas-fired power station was studied and simulated in Flownex®. The major advantage of using Flownex® is that the capacitance of the pipe material and the full Joule-Thomson effect could be simulated. The simulations established that the regulator internals would be exposed to extremely cold gas for an extended period. The model was also able to determine if the proposed trace heating and insulation system would be sufficient to prevent the valve internals from cooling below their minimum temperature limit of -20 °C, with a reasonable safety factor taken into account.

"

I am not aware of any other tool with which I could have obtained the required results in such a short time span. Part of the success must undoubtedly be attributed to the prompt and high level support provided by Flownex® International almost daily in answering all my questions and offering suggestions throughout this very technically challenging simulation. The support fee has been paid for with this one project!

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HANNES VAN DER WALT
SENIOR THERMAL & PROCESS ENGINEER
GASCO

GASCO

OIL & PETROCHEMICAL

BOILER FUEL OIL DISTRIBUTION

CHALLENGE: Uniform fuel distribution, and acceptable performance at low temperature due to oil viscosity. Therefore, in order to force the flow to be similar in each branch, the resistance path for each branch should be similar. With the pump in the incorrect position and many high primary resistances in the line (due to long pipe runs), this resulted in increased pressure drop, triggering larger pumping power which is required to balance flow at the branches further away from the pump.

SOLUTION: Using Flownex® ensured that Steinmüller could set up an accurate model of an existing fuel oil distribution network. It was discovered that due to the large diameter ratio of the supply manifold and fuel oil spray nozzle, a high enough back pressure was created to pressurize the whole manifold.

Heat loss from the pipes to ambient conditions was also taken into account, for the viscosity of oil changes drastically with temperature, especially in the low-temperature range. The heat transfer properties of the pipe and insulation layers were taken into account, and appropriate free convection heat transfer correlations were implemented to predict the temperature distribution accurately throughout the system.

Steinmüller
engineering services

POWER GENERATION // FOSSIL FUEL

BOILER TUBE FAILURE THERMO HYDRAULIC ANALYSIS

Flownex® Interoperability and Investigative Analysis of Failures:

Challenge: Using Flownex®, carry out investigative analysis of tube failure issues on a boiler, to test various hypotheses, which were considered to be the cause of tube failures. This case study also shows the versatility of Flownex® to work in an interactive communicative manner with other modeling software in this case ANSYS structural analysis.

Flownex® was successfully employed in the investigation of boiler tube failures in a power plant setting. Having built a representative model of the boiler wall section in Flownex® by importing geometric data from ANSYS it was possible to test all assumptions regarding the cause of the tube failures, related to the thermodynamic effects of operation in Flownex®. Then the temperature distribution data from Flownex® was fed back into ANSYS to analyze the structural effects on the boiler tube wall owing to the Flownex® obtained temperature distribution data.

The results from the model corresponded very well with the measured data from the plant, meaning that the Flownex® model was an accurate simulation of the existing plant performance. This enabled the model to be used for further data analysis for various other future plant operating scenarios.

POWER GENERATION // NUCLEAR

THERMAL-HYDRAULIC SIMULATION OF A NUCLEAR STEAM GENERATOR USING FLOWNEX® AND RELAP5

Master graduate: Charl Cilliers (M.Eng in Nuclear Engineering)

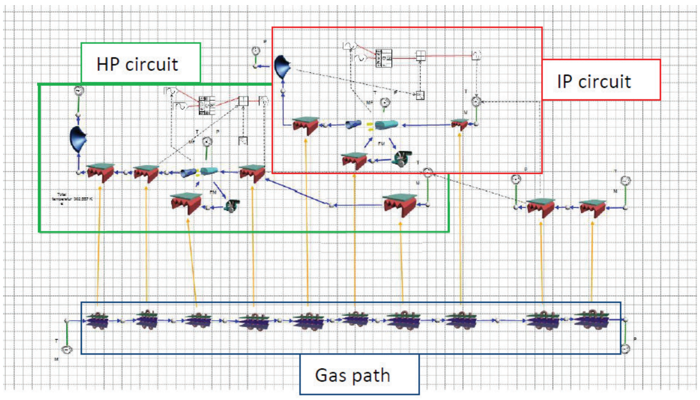
The aim of the project was to compare the results of Flownex®, which uses homogeneous equations for two-phase flow, with RELAP5, which uses two-fluid equations for two-phase flow, with application to the U-Tube steam generator from a pressurized water nuclear reactor. Flownex® affords an intuitive, visual network design interface. Components may be easily added and removed from the network, and input parameters may be optimized for certain constraints. This makes it much easier to develop and perform analysis on antiquated codes. This was realized in the project by a quick turnover time for the development of the model, and more time to assign to analysis. The results showed that it is important to consider the restrictions applicable to the homogeneous model for two-phase flow. Flownex® performed extremely favorable compared to the more advanced code. It performed especially well in the high heat-transfer regions, where boiling flow is turbulent and chaotic. The ill-defined flow fields in these areas often make it impractical and inefficient to use such a complex code. Flownex® deviated from RELAP5 by only 5% for the overall heat transfer and less for the pressure solution. The major differences arose from the different heat transfer correlations used by the two models, which may easily be corrected by employing a user-defined script in Flownex®. Flownex® is an invaluable tool with a multitude of useful features that makes the researcher's life a hundredfold easier, without sacrificing a hundredfold in accuracy.

> Engineering productivity for the design and analysis of complex thermofluid systems such as those found in large coal fired power plants is vastly improved by modelling in Flownex®. In addition, the system knowledge and understanding gained by the modeler is invaluable in subsequent activities.
>
> **GARY DE KLERK, PR. ENG**
> **CHIEF ENGINEER, PLANT ENGINEER**
> **TURBINE PROCESS GROUP TECHNOLOGY**
> **ESKOM**

HEAT RECOVERY STEAM GENERATOR

THERMOECONOMIC ANALYSIS FOR POWER PLANTS UNDER FLEXIBLE OPERATION

As start-ups, shutdowns and frequent load changes are common procedures for combined cycle power plants, knowledge of the behavior of components during transients and/or part loads, is vital for plants that are facing continuous load fluctuations. A complete dynamic model is therefore an extremely helpful tool for modeling systems under flexible operation.



Flownex® proved to be an excellent tool for the modeling of start-up and shutdown procedures as well as modeling load changes of a Heat Recovery Steam Generator (HRSG).

> "Flownex® proved to perform well for simulations of start-ups (or shutdowns), making it a valuable tool for studying and optimizing such procedures."

CARLO FAVALLI
POLITECNICO DI MILANO
MS THESIS - ENG.

ACADEMIC & RESEARCH

> "Flownex® is an ideal process modeling tool from an academic perspective. It solves the fundamental equations to the full degree – no short-cuts. This allows us to model real physical phenomena and understand the fundamental behavior. Furthermore, the documentation is of exceptional quality, showing each and every model used with proper references. It is certainly not a "black-box" tool like so many other process modeling software on the market."

Dr. Wim Fuls,
Senior lecturer
Energy Efficiency,
University of Cape Town

HVAC

BALANCING OF AIR CONDITIONING DISTRIBUTION SYSTEM

A well balanced air distribution system can very easily be designed in Flownex® SE. The correct flow damper openings or flow orifice diameters for any required flow at various positions in an HVAC system can be calculated simultaneously in Flownex® during a steady state solving process. This case study presents the case where a central air conditioning distribution system was balanced instantaneously in order to produce a mass flow of 0.02 kg/s to each room. The built-in orifice sizing capability used in this study assisted powerfully to produce the required balancing of the flow distribution in a very short time.