



CONTROL OF FLOWNEX NETWORK USING SIMULINK

This case study demonstrates how Flownex and Simulink are integrated to perform different parts of a simulation.

Integration of Flownex with Simulink is a powerful tool that is regularly used for the design of advanced control systems. It is also frequently used to simulate electrical systems that interact with thermal flow systems.

GENERAL INDUSTRIES

CHALLENGE:

The objective of the simulation is to show the use of two PID controllers in Simulink in the start-up and operation of a two shaft Brayton cycle. One of the PID controllers is used to control the generator power during the start-up. The second PID controller is used to control the reactor outlet temperature by adjusting the control rod depths when the start-up is complete.

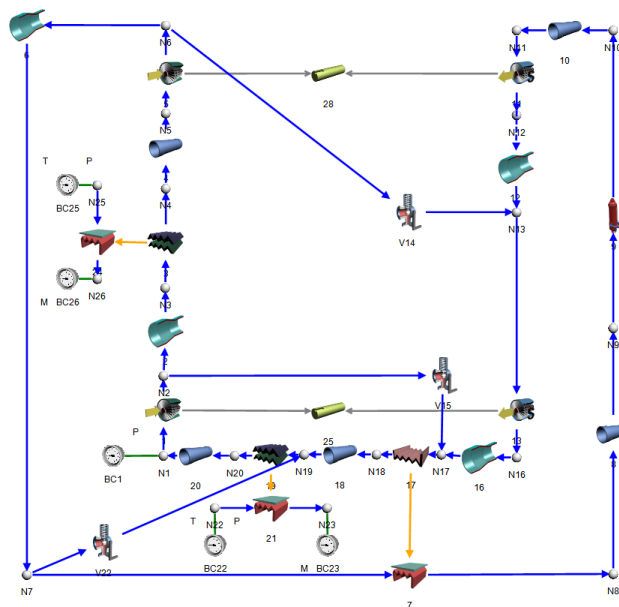
BENEFITS:

This case study demonstrates how Flownex and Simulink are integrated to perform different parts of a simulation.

Integration of Flownex with Simulink is a powerful tool that is regularly used for the design of advanced control systems. It is also frequently used to simulate electrical systems that interact with thermal flow systems.

SOLUTION:

Flownex provides easy integration with Simulink. The combination provides an easy to use and powerful tool for advanced applications of Flownex in control system design and simulation of integrated systems.



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INTRODUCTION

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SYSTEM DESCRIPTION

The system that is used for this demonstration is the same system that is described in the case study "Start-up of Two-shaft High-Temperature Gas-Cooled Reactor Nuclear Power Plant". For a detailed system description, please refer to that case study.

OBJECTIVE OF SIMULATION

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FLOWNEX MODEL SETUP

The data that will be exchanged with Simulink is defined in the External Control Set Editor.

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External Control Specification Dialog

Identity

Set Name

External Control Set 1

Wait Time

600

Plant Input Variables

No	Plant Input	Variable Type	Status
0	Turbine (13)	Generating Power	Active
1	Pebble Bed Reactor (9)	Control Fraction	Active

Add

Delete

Edit

Copy

Move Up

Move Down

Plant Output Variables

No	Plant Output	Variable Type
0	Compressor (1)	Rotation Speed
1	Pebble Bed Reactor (9) Downstream Node	Temperature

Add

Delete

Edit

Copy

Move Up

Move Down

OK

Figure 1: External control set editor.

The Flownex model of the system is shown in Figure 2.

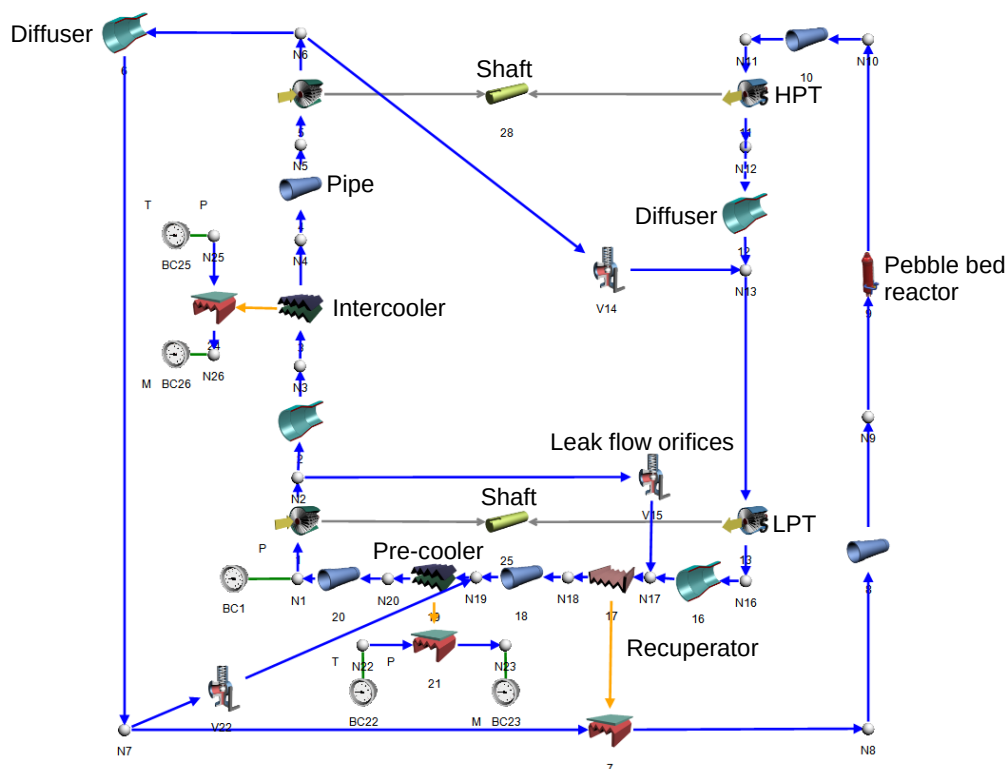


Figure 2: Flownex network of the direct two-shaft closed inter-cooled recuperated Brayton cycle PBMR power plant.

SIMULINK MODEL SETUP

The next two figures show how the inputs and outputs are defined and the model is set up in Simulink.

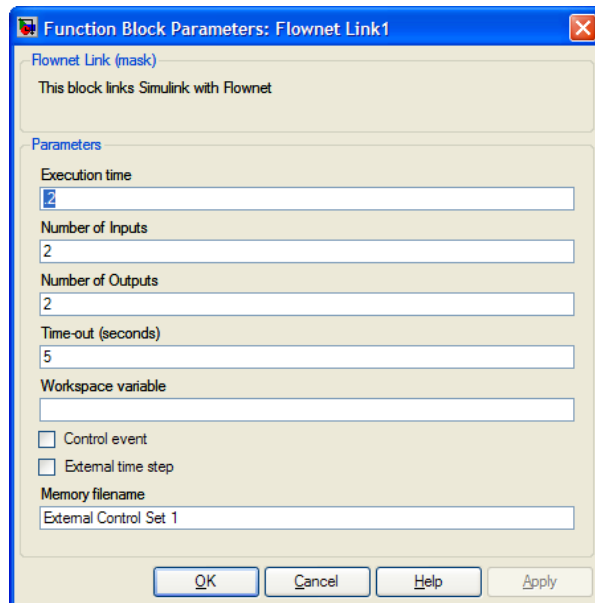


Figure 3: Input and output definition.

The speed of compressor 1 (low pressure compressor) is sensed and the generating power of turbine 13 (power turbine) is controlled by one PID controller in Simulink.

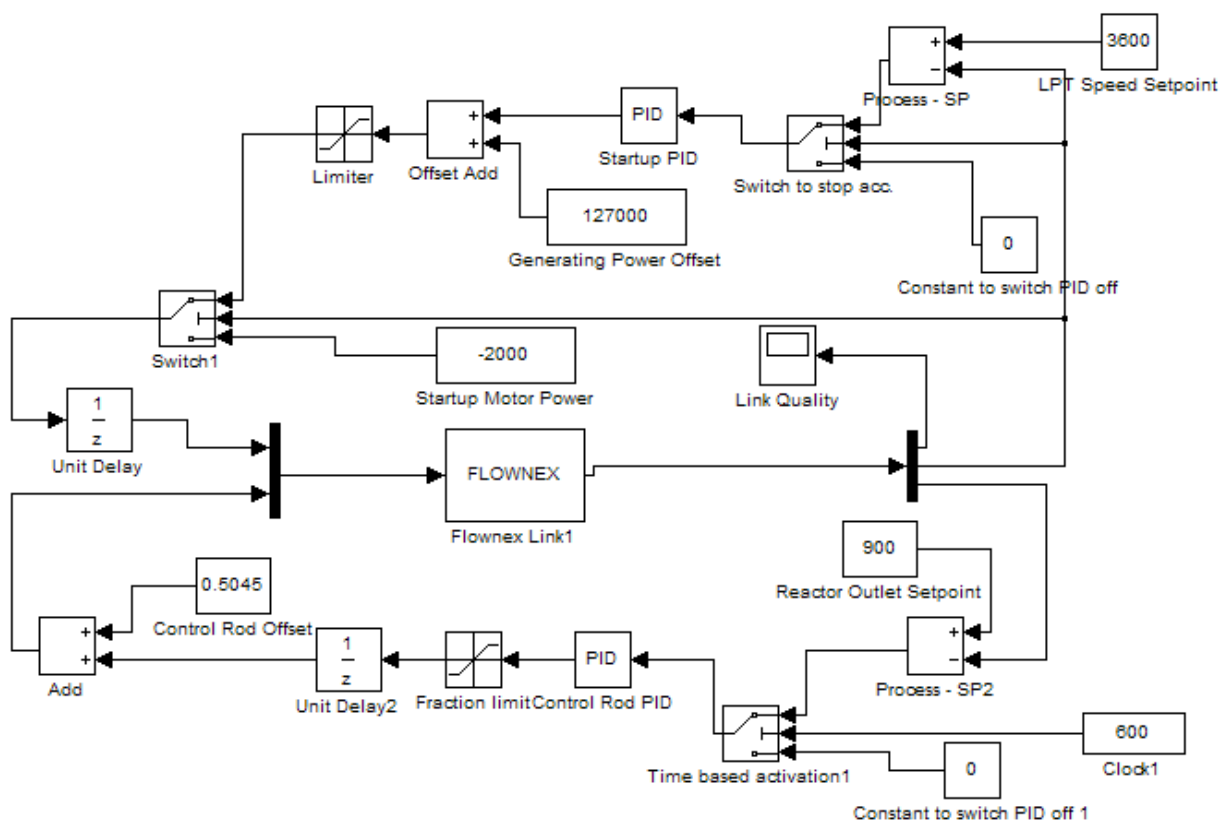


Figure 4: Simulink model.

DESCRIPTION OF SIMULATION

The speed of compressor 1 (low pressure compressor) is sensed and the generating power of turbine 13 (power turbine) is controlled by one PID controller in Simulink. At first when the compressor shaft speed is low the generator power is set to -2 MW and the generator acts as a motor. The PID controller is switched on and the generator then switches over to generating mode when the compressor shaft speed approaches its design point. The PID controller in Simulink that controls the reactor outlet temperature is only activated after the start-up is complete. This controller controls the reactor control rod depth to maintain a constant reactor outlet temperature of 900°C. The temperature of Node 10 at the reactor outlet is sensed and the control rod depth of the reactor, element 9 is controlled.

The first results graph show how the power is kept at -2 MW during the first phase of start-up for the generator to act as a motor.

RESULTS

The first results graph show how the power is kept at -2 MW during the first phase of start-up for the generator to act as a motor. When the turbo machine speed is close enough to the design point, the PID controller takes over and starts to increase the generator power until it is at full load.

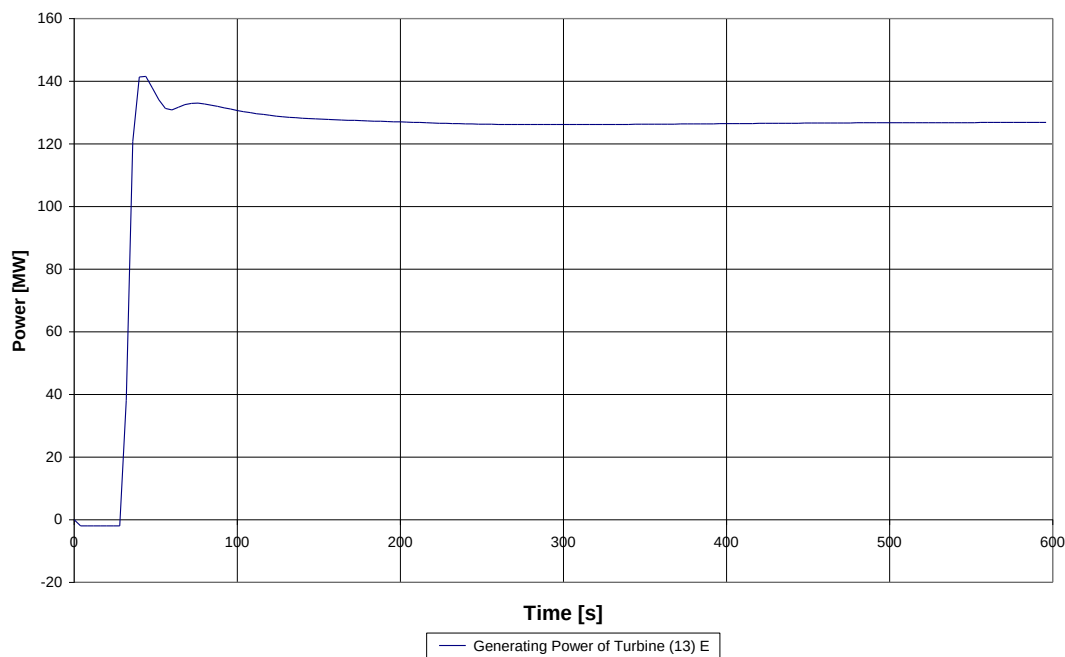


Figure 5: Generating power.

The next figure shows how the low pressure compressor speed is controlled to be at the design point of 3600 rpm.

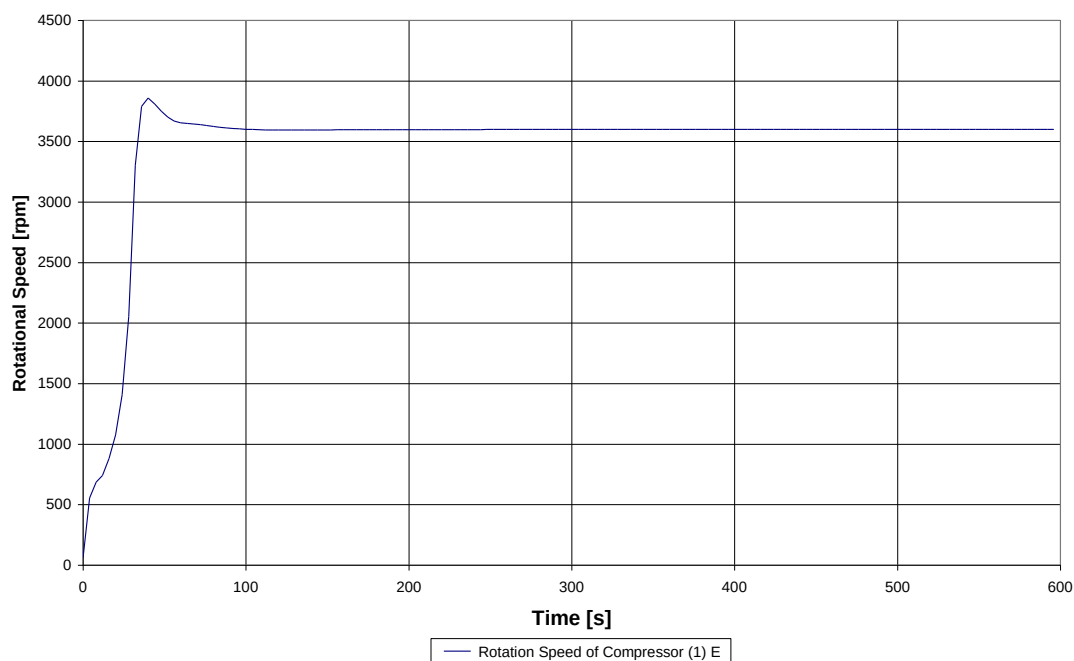


Figure 6: Low pressure compressor rotating speed.

After 200 seconds in the simulation the PID controller that controls the control rod depth is turned on. The next figure shows the controller action.

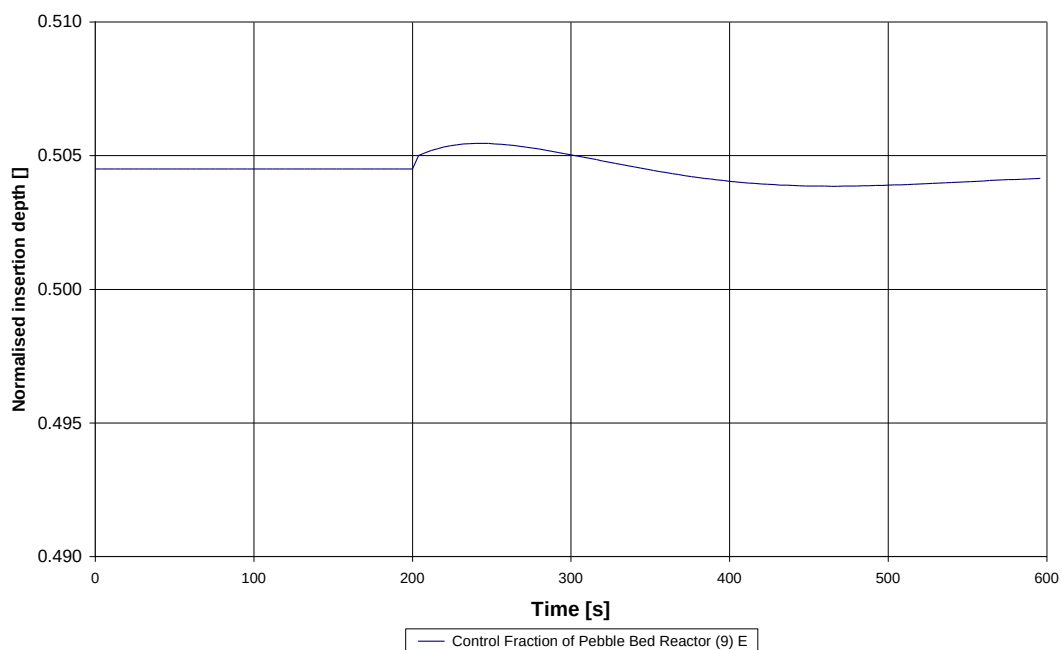


Figure 7: Control rod depth.

The last figure shows the reactor outlet temperature being controlled to 900°C.

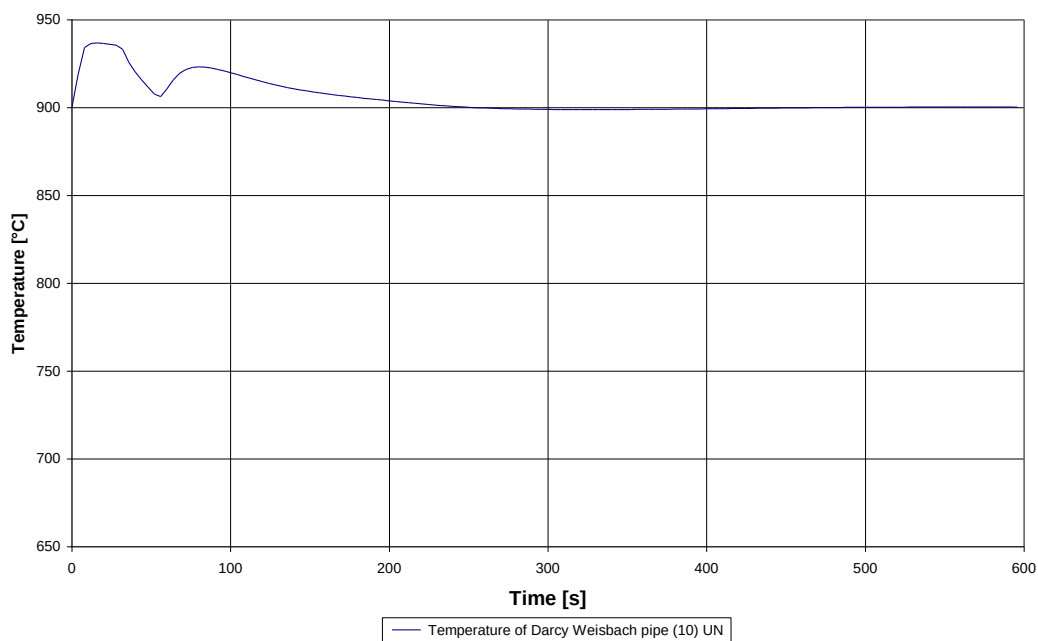


Figure 8: Reactor outlet temperature.

CONCLUSION

Flownex provides easy integration with Simulink. The combination provides an easy to use and powerful tool for advanced applications of Flownex in control system design and simulation of integrated systems.