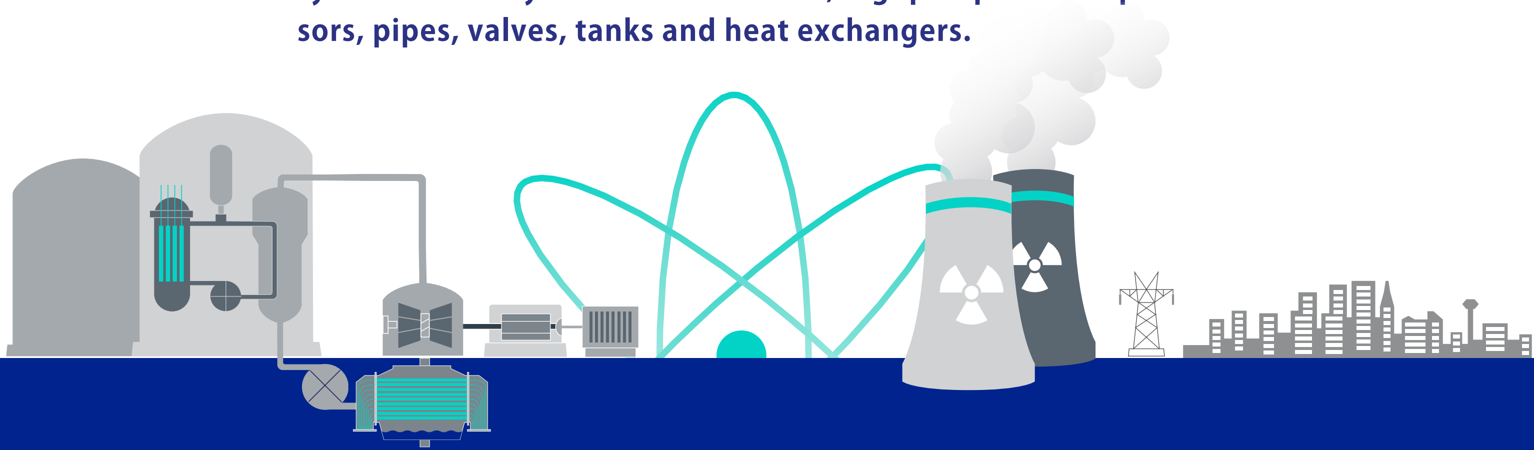
FLOWNEX® SIMULATION ENVIRONMENT SMR

SMALL MODULAR REACTOR

Flownex® SE determines pressure drop [flow] and heat transfer [temperature] for the connected components of a complete system in steady state and transient, e.g. pumps or compressors, pipes, valves, tanks and heat exchangers.



CYCLE SELECTION

Typical components:
- Reactor primary loop.
- Intermediate loops.
- Heat exchangers.
- Steam generators.
- Power generation cycle.

Flownex provides for various:
- Reactor fuel geometries.
- Reactor coolant types.
- Power cycle types.

CALCULATE OVERALL PLANT EFFICIENCY

Using a plant simulation model, determine the transient response of sensed parameters to changes in input parameters and based on that, set up appropriate pairings for control loops.

PASSIVE SAFETY SYSTEM DESIGN: NATURAL CIRCULATION

Calculate the plant-wide temperatures and pressures in response to various accident scenarios, taking into account decay heat generation, multiple natural circulation loops, transient energy storage and rejection to ambient conditions.

www.flownex.com   +27 18 297 0326/7   enquire1@flownex.com

PRIMARY CYCLE

REACTOR MODEL

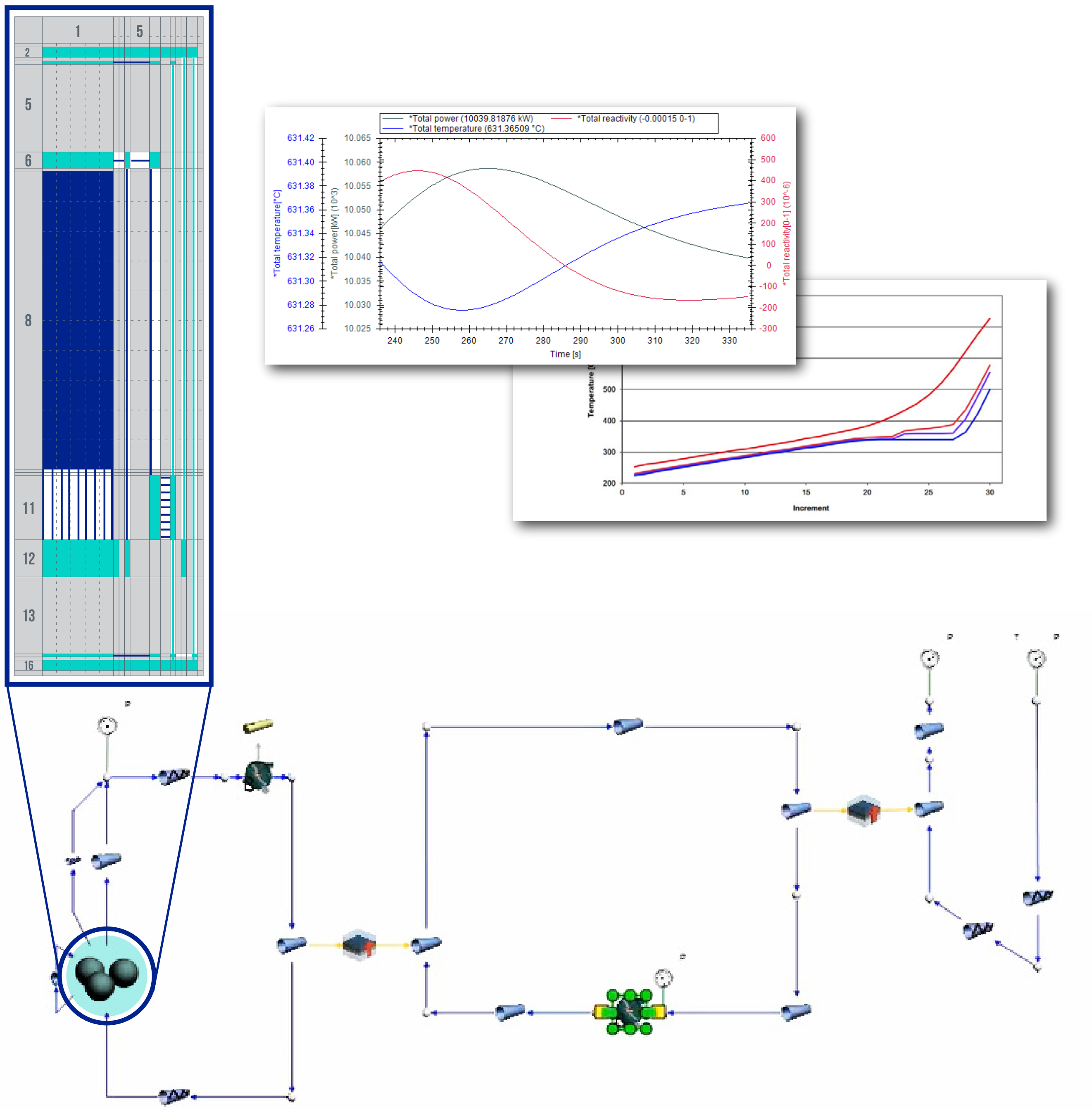
- Any fuel geometry or coolant type;
  - Molten salt, gas, water, and liquid metal.
- Neutronics/heat generation options;
  - Built-in point kinetics.
  - C# User-defined calculations.
  - External neutronic calculations with temperature and heat map exchange.

HEAT EXCHANGERS & STEAM GENERATORS

- Helical coil / once through steam generators
- Natural circulating boiler
- Compact heat exchanger
- User defined fluids, pressure drop, heat transfer correlations

FLOW CIRCULATION

- Pumps
- Gas circulators
- Natural circulation



CONTROL PHILOSOPHY DEVELOPMENT

- Integrated plant transient response.
- Built-in DCS library.
- C# user scripting.
- MatLab/Simulink coupling.
- OPC coupling.

SAFETY ANALYSES

- Relief valve sizing
- Passive heat removal analyses:
  - Natural circulation
  - Radiative heat transfer
  - Conjugate heat transfer

ACCIDENT ANALYSES

Calculate temperatures, leak rates, pressure waves (water hammer) and pipe support loads for:

- Loss of Cooling Accident (LOCA)
- Pump trip
- Tube break in Steam Generator

RESEARCH OR MATERIALS TEST REACTORS

- Calculation of core flow and temperature distribution.
- Calculation of irradiation loop cooling and flow requirements.

INTEGRATED SYSTEM SIMULATION

- Control philosophy testing.
- Power ramp rate calculations.

HTR COMPONENT MODELING

- Pebble bed or prismatic block reactor core calculation: coolant, moderator and fuel temperatures, neutronic feedback from built-in point kinetics or external software.
- Once-through steam generator: calculation of boiling rates, dry out position, metal temperatures; sizing of flow distribution orifices for boiling stability.
- Passive heat removal design: calculation of natural circulation in liquids, gases and two phase fluids.

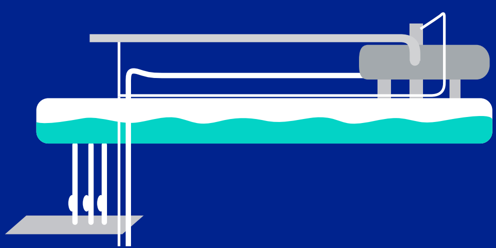
RANKINE SECONDARY CYCLE

STEAM TURBINE & SUPPORTING SYSTEMS

- Start-up, shut-down and load following operation.
- Turbine trip control.
- Gland steam systems.
- Lubrication systems.

CONDENSERS

- Wet and dry condenser heat exchange.
- Condenser level following.
- Air leak detection.



FEED WATER SYSTEMS

- Pipeline, valve and pump sizing.
- Cavitation, flashing and condensing detection.
- Pump performance and NPSH.
- Feed water heater performance and tube leaks.
- Flash tank behavior.
- De-aerator.

COOLING WATER CIRCUITS

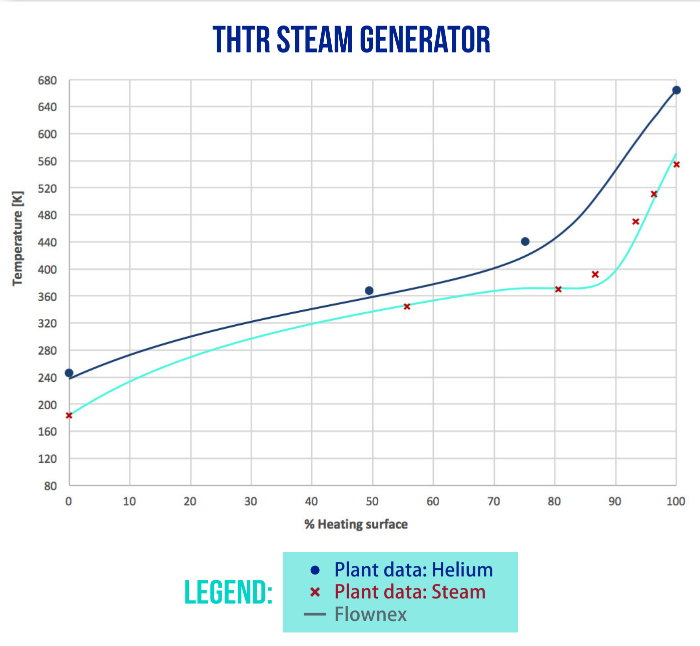
- Pipeline, valve and pump sizing.
- Water hammer.
- Cooling tower response.
- Heat exchanger sizing.
- Water reticulation flow balancing & energy efficiency.

> 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 modeling 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

CASE STUDY

FLOWNEX HIGH TEMPERATURE REACTOR APPLICATIONS



The Thorium High Temperature Reactor (THTR) was built in Germany in the early 1980`s and very well instrumented for commissioning. Using the data from one of its steam generators, the capability of Flownex to calculate the temperatures is demonstrated by the graph on the left.

The steam generator model is discretised and as such, it offers the following:

- User-specified heat transfer correlations.
- Boiling-regime dependent friction factor/heat transfer coefficient.
- Detection of Critical Heat Flux (CHF) conditions.
- Any combination of primary-to-secondary fluid types (liquid metal/molten salt/gas/two-phase water).
- Steam generator integrated with the rest of the plant.
- Transient response.

BRINGING NUCLEAR QUALITY AND STANDARDS TO SYSTEM SIMULATION

Flownex® is developed in an ISO 9001:2008 quality assurance system and NQA1 supplier approved environment.

FLOWNEX®