

# AFT Fathom™ Heat Transfer Capability Used in Power Plant HVAC System

CASE STUDY

Hot Water System for HVAC  
Power Industry



## Energoprojekt Katowice Katowice, Silesia, Poland Platinum Pipe Award Honorable Mention - Software Features and Model Creativity

The task of a newly designed heat exchanger plant is to provide hot water flow with parameters that meet the demands for the buildings of a new power plant. Parameters include: amount of water (hot water mass flow), operational pressure, and temperature (which varies in relation to temporary heat demand).

Agnieszka Markwica, engineer at Energoprojekt Katowice, created an AFT Fathom model using piping system data including technical documentation of all relevant fittings and instruments. First, she used the input data to determine the pump operating point. Next, she selected two control valves for the extensive range of prospective water mass flows (between 20 - 241 metric tons/hour (m-ton/hr), (22-265 ton/hr)).

“Obtaining results in a short time gives the possibility for checking other than typical solutions - a very important aspect in the design process.”

Three different case types were studied in this analysis:

### **Normal operation mode:**

During normal operation, only control valve 1 works, and its basic task is to control the flow, set to 241 m-ton/hr (265 ton/hr). Water is heated in both heat exchangers and all HVAC systems connected to the heating network are working. Control valve 2 is closed.

### **Emergency cases:**

- One of the external heat consumers is closed. In this situation, water demand is reduced from 241 to 174 m-ton/hr (265 to 191 ton/hr) or 67 m-ton/hr (74 ton/hr) depending on which heat consumer is closed. Control valve 1 modulates flow to match one of the above levels. Control valve 2 is closed. There is an emergency rise of the temperature in the return pipeline in one of the heat consumers where a temperature-sensitive element gives a signal to open the shut-off valve. If set boundary

values of the temperature are exceeded, this flow is directed back to the heat consumer supply by control valve 2 instead of being heated in the heat exchangers.

- All external heat consumers are closed. In this situation, water circulates in the system and both of the control valves work together (see Figure 1). Control valve 1 sets the flow to 241 m-ton/hr (265 ton/hr) and control valve 2 provides pressure reduction equal to the pressure drop in the external heat consumers - about 3 bar (44 psid).

### **HVAC station preheating - circulation:**

A small flow (20 m-ton/hr (22 ton/hr)) is dedicated for pipe and device preheating within the HVAC heat exchanger station. All heat consumers are closed and the control valves work as previously described. In this case, the pump by-pass must be opened for the minimum flow of 46 m<sup>3</sup>/h (202 gpm).

The AFT Fathom model was used to determine the diameter of the orifices. Orifice 1 is used during minimal flow (20 m-ton/hr (22 ton/hr)). Orifices 2 and 3 are used during maintenance operations and must generate the same pressure loss as the heat exchangers during normal operation mode.

“AFT software makes it possible to build quite complicated models and calculate them within a few seconds or minutes, saving a lot of time, Markwica said.”

“My model has evolved with the engineering design, and from time to time it was necessary to change piping geometry or include new information about devices. I could quickly enter new data and upgrade results in a short time.

“Some model elements could be set directly on the pipeline - this provides greater clarity of the model schema and gives more readability. The ability to manipulate the appearance of the model (for example, color of the pipelines) is also of great importance for our clients.”

*Energoprojekt Katowice is a leading engineering firm providing design services for conventional power plants, thermal power plants and heating plants.*

### Other software features used in this case:

- Flow Coefficient (Cv) for the control valves, which allowed Markwica to check the valve loading in every possible case.
- Use of the GSC module to determine the diameter of the orifices which caused the drop of pressure demanded in the by-pass pipes (see Figures 2 & 3).
- Circulation pump selection was based on hydraulic loss of pressure.
- The Heat Transfer with Energy Balance option was used for water heated in heat exchangers.
- Scenario Manager was used for every operational case to compare and choose the optimal system solution.
- An external Pipe Material Database was imported for steel pipes with nominal diameter.

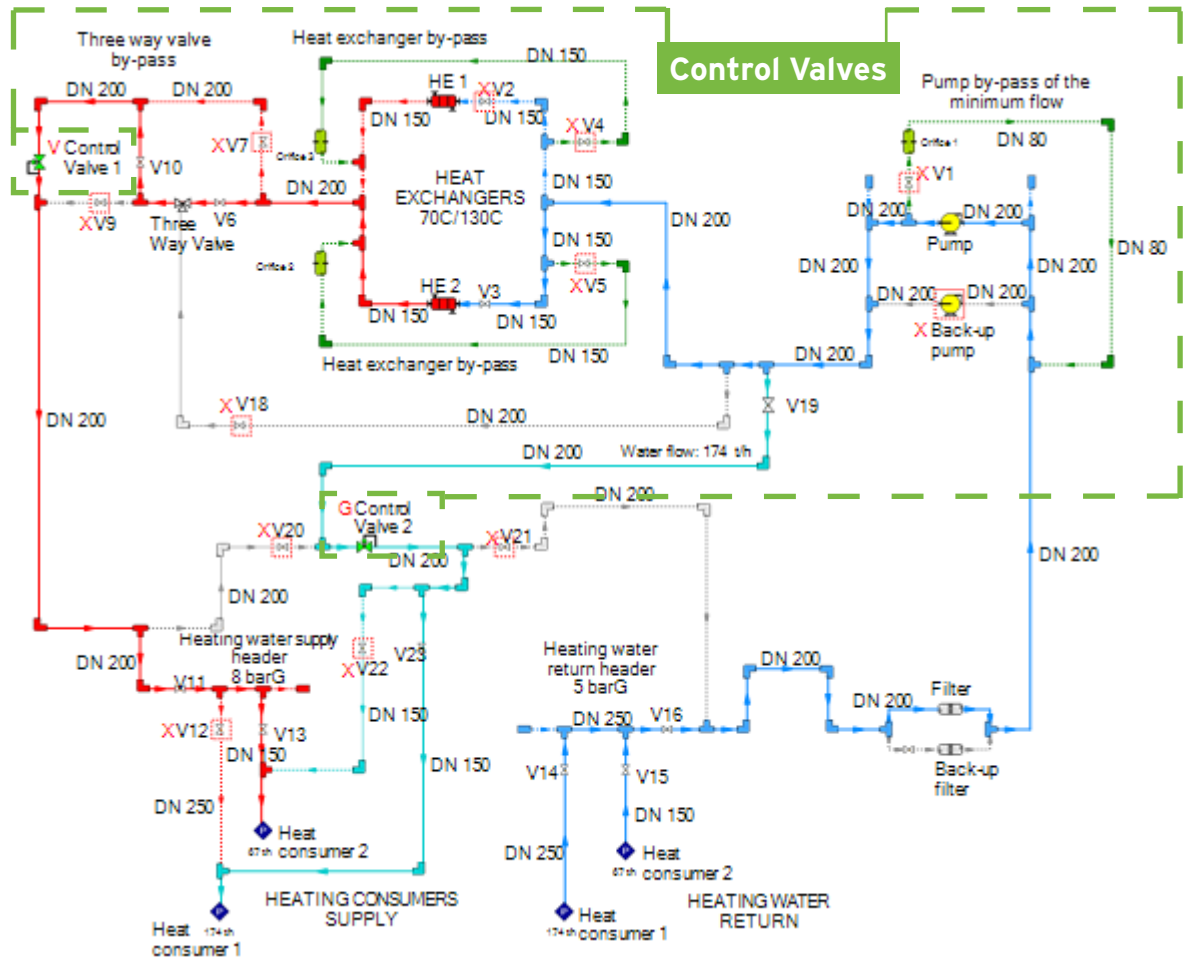


Figure 1 - AFT Fathom model for Emergency Case 2

Variables										
Goals										
Numerical Control										
New Goal		Duplicate Goal		Delete Goal		Delete All Goals		Desired goals in Output		
Apply	Goal Type	Object Type	Goal Parameter	Criteria	Goal Value	Goal Units	Object ID	Object Location		
<input checked="" type="checkbox"/>	Point	Control Valve	Open Percentage	=	90	Percent	J119 (Control Valve 2)	NA		
<input checked="" type="checkbox"/>	Point	Pipe	Volumetric Flow Rate	=	45.78	m <sup>3</sup> /hr	P152 (Pipe)	NA		
<input checked="" type="checkbox"/>	Point	Pipe	Mass Flow Rate	=	120.5	m-ton/hr	P161 (Pipe)	NA		

Figure 2 - AFT Fathom GSC Module - Goals used for Emergency Case 2

Variables										
Goals										
Numerical Control										
New Variable		Duplicate Variable		Delete Variable		Delete All Variables		Parameters to vary in order to reach goals		
Apply	Object Type	Junction Type	Object Number and Name	Variable Parameter	Link To	Lower Bound (Optional)	Upper Bound (Optional)			
<input checked="" type="checkbox"/>	Junction	Control Valve	J98 (Control Valve 1)	Control Setpoint	(None)					
<input checked="" type="checkbox"/>	Junction	Orifice	J163 (Orifice)	Diameter/Area	(None)	0				
<input checked="" type="checkbox"/>	Junction	Orifice	J169 (Orifice)	Diameter/Area	(None)	0				

Figure 3 - AFT Fathom GSC Module - Variables used for Emergency Case 2