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The Calculation and Study of Pipe Operation of Low-Pressure Circuit of Heat Recovery Steam Generators

Speacker:

Rodion

Maslov

National Research University “MPEI”

Authors:

Rodion Maslov

Konstantin Pleshanov

Kirill Sterkhov

Dmitry Khokhlov

National Research University “MPEI”

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Fig. 1 – Damaged evaporator pipe

Fig. 2 – Damaged low-pressure evaporator riser on welded seam of Kirishi state district power station

Fig. 3 – Damaged downcomer of low-pressure circuit

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Study of the reliable operation

- Input of initial data;
- joint thermal and hydraulic calculations;
- calculation of the circulation circuits characteristics and its elements;
- analysis of the obtained data and determination of the causes of damages;
- formulation of design recommendations.

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Boiler Designer

Used for thermal, hydraulic calculations, circulation research and dynamic processes study

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HRSG of Kirishi state district power station

High-pressurized HRSG for combined cycle gas turbine plant

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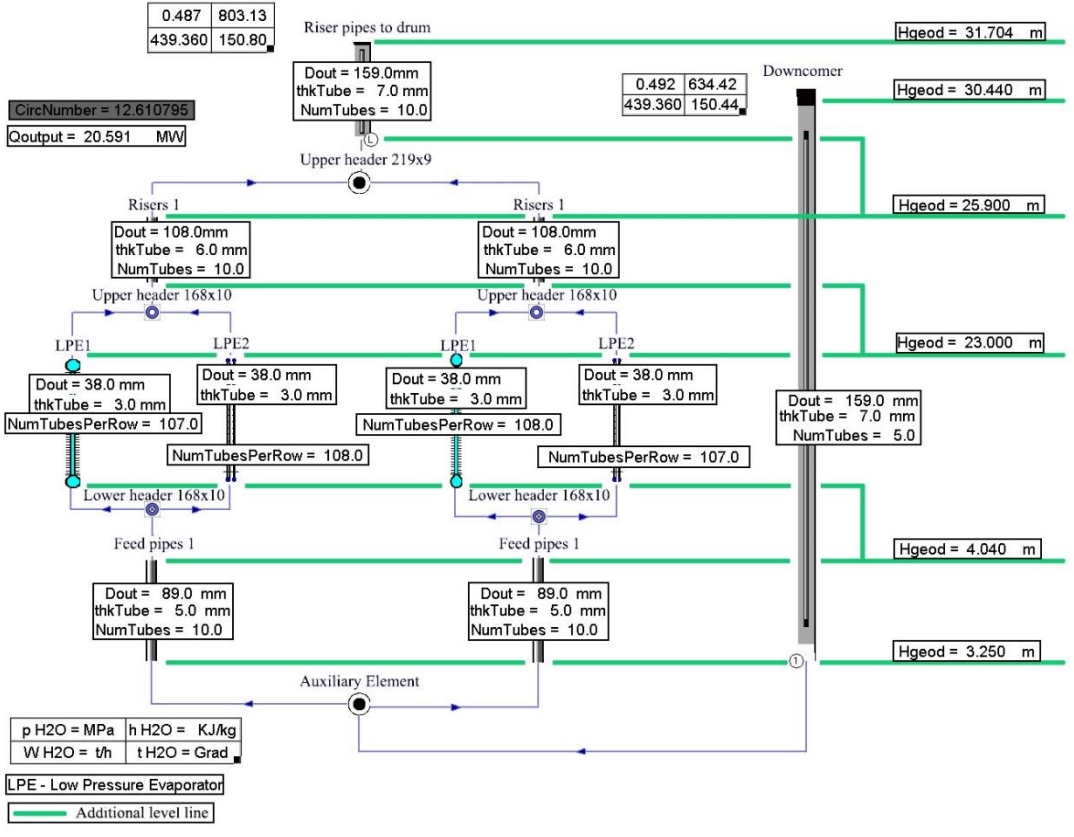
Fig.4 - Low-pressure circuit of HRSG P-132 of Kirishi state district power station



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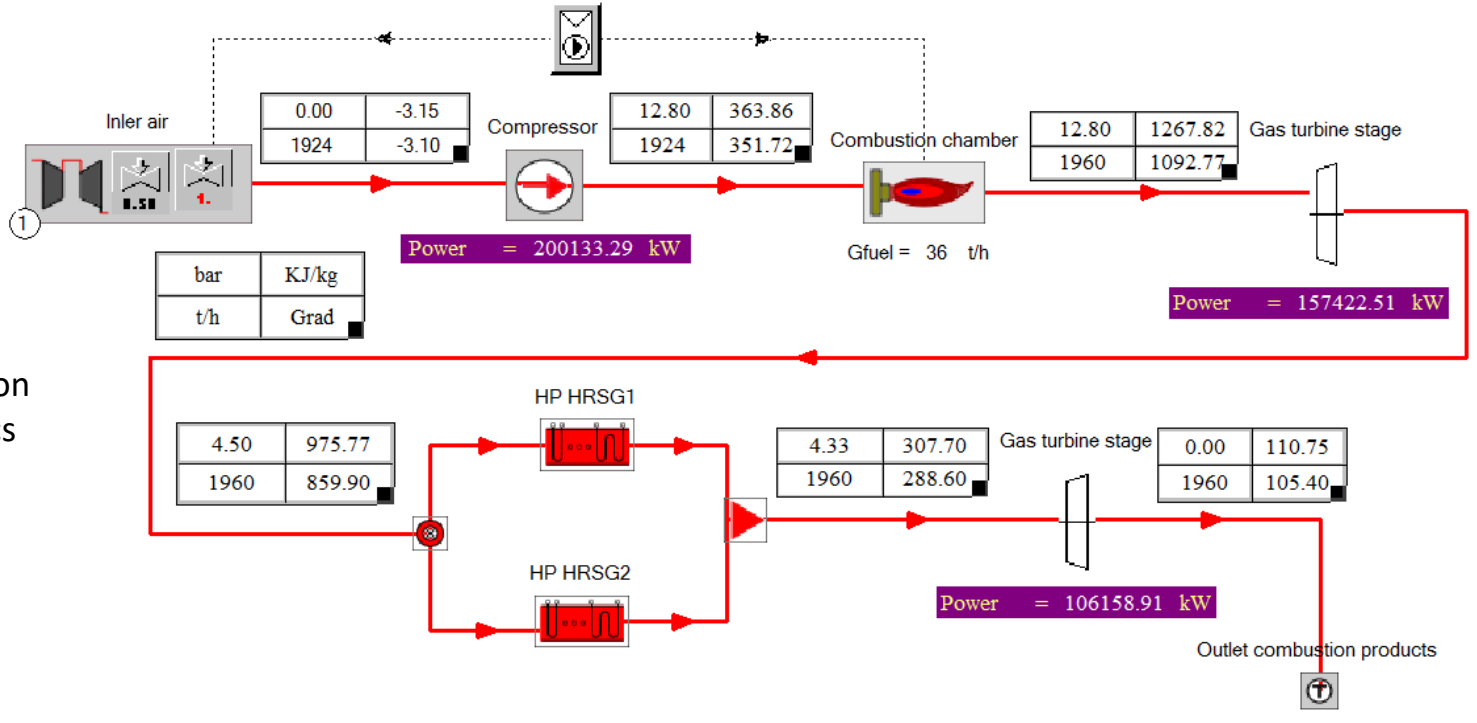

Fig. 5 - Main combustion products characteristics calculated by Boiler Designer software of HPHRSG

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Table 1 – Main characteristics of different energy units

Characteristic	Power unit			
	CCGT with High-Pressurized HRSG (GTE-160 and T-100)	Kirishi State District Power Station, Low Pressure Circuit	Kirishi State District Power Station, Intermediate Pressure Circuit	Kirishi State District Power Station, High Pressure Circuit
Superheater				
Heat-transfer coefficient, W/(m²·K)	325	12	21	38
Temperature drop, °C	330	34	42	80
Average combustion products speed, m/s	16	10	11	14
Evaporator				
Heat-transfer coefficient, W/(m²·K)	99	38	48	46
Temperature drop, °C	164	55 – 36	50 – 21	89 – 17
Average combustion products speed, m/s	13	9	10	12
Average heat flux to inner surface, kW/m²	223	26	18	33

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Problems are:

- high velocity inside some pipes;
- increased heat absorption ;
- presence of gas shunts;
- inequality heat absorption across the width of the boiler unit.

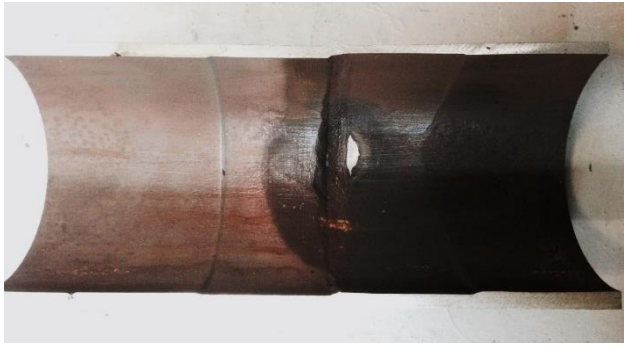

Fig. 6 – Misalignment and damage of low-pressure riser of Kirishi state district power station

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Solutions:

- increase pipes cross-section;
- decrease medium velocity;
- use 12H1MF steel;
- use straight pipes without bends.

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Conclusion

1. The nature of damage of P-132 HRSG has signs of erosion.
2. Increased wear of pipes in P-132 HRSG is caused by a combination of factors:

- *high medium velocity (over 10 m/s in evaporator pipes, over 20 m/s in risers);*
- *presence of pipe bends;*
- *unsatisfactory quality of alignment of pipes in a place of welding and performance of welded seams in risers;*
- *presence of gas shunts in heating surfaces, which increasing medium velocity.*

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Thank you for your attention!

Speacker's contacts:

Rodion Maslov

National Research University "MPEI"

maslovrs@mpei.ru

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