FIELD MONITORING RESULTS OF AN ORC SYSTEM INTEGRATED IN A STEEL MILL

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INTRODUCTION

Global warming is a clear threat to life in our planet and European policies define a long-term strategy to reduce greenhouse gas emissions [1]. Industries, as large energy consumers, play a key role on this transition in which industrial waste heat recovery is a critical point to reduce fossil fuel consumption and therefore CO_2 emissions.
This work presents the experimental results of the annual performance of a 1,8MWe ORC system integrated in a steel mill. The waste heat recovered from the fumes of an Electric Arc Furnace (EAF) at ORI Martin is used to generate steam to deliver heat to a district heating (DH) grid during heating season and the rest of the year to run an ORC (Turboden). The results of one year of monitoring showed that a total of 45910 MWh of heat was recovered in a period of 4952 hours of plant operation. From the total heat generated 43% was delivered to the DH grid and 28% to the ORC, considering heat losses. The ORC overall efficiency resulted in 18% and generated 2631 MWh of electricity which corresponds to approximately 6% of the total energy recovered.
The hypothetical case of full ORC operation during a year was simulated and considering the plant´s losses the total electricity generated could reach approximately 8000MWh. This could result in annual carbon savings estimated on 2457 t CO2 based on a carbon footprint for Brescia of 0.353kg CO2 eq. per kWh. [2]

DEMO DESCRIPTION

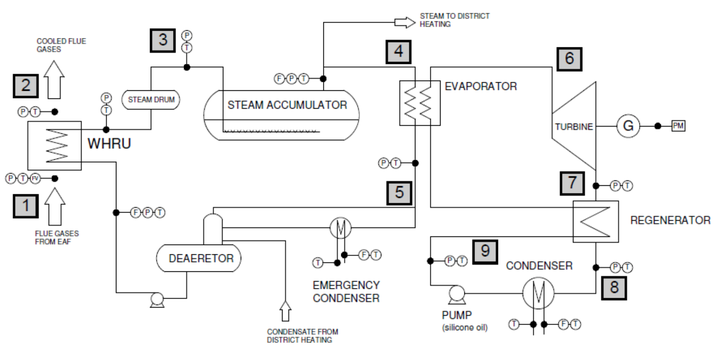

Figure 1. e-Recovery power plant flow diagram.

MODE OF OPERATION

Flue gases from the EAF pass through a Waste Heat Recovery Unit (WHRU). Heat is transferred to the boiler feed water (BFW) in the WHRU and saturated steam passes through a steam drum and then is driven to the steam accumulator. The steam accumulator is installed to overcome the discontinuity of the EAF production process. From the accumulator the steam is sent to the ORC unit and its flow is controlled to maintain a safe operating pressure and constant flow. The steady heat discharge to the ORC allows to provide a stable power output, [3].

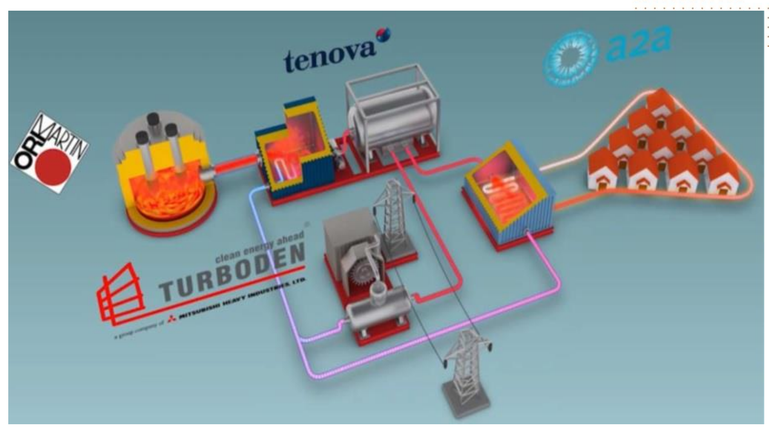

Figure 2. e-Recovery power plant scheme.

RESULTS

FIELD MONITORING RESULTS

- Flue gases inlet/outlet temperature: 504 / 195 °C
- Steam ORC inlet temperature: 204°C
- Cooling water inlet temperature: 32°C
- Total steam production: 45.910 MWh/yr
- Heat supplied to DH equipment: 23.137 MWh/yr
- Heat supplied to ORC: 13.890 MWh/yr
- Total plant heat losses: 11.920 MWh/yr
- Net electricity produced: 2.631 MWh/yr
- ORC average efficiency: 18%

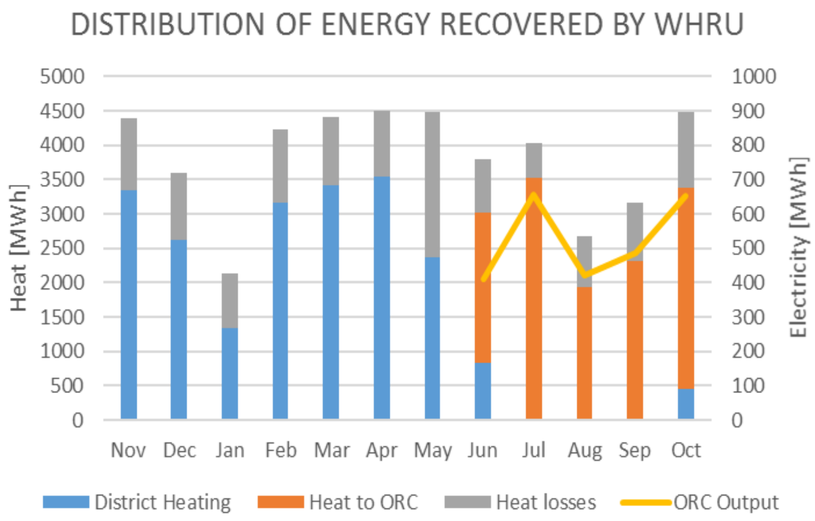

Figure 3. Global energy production recovered by WHRU.

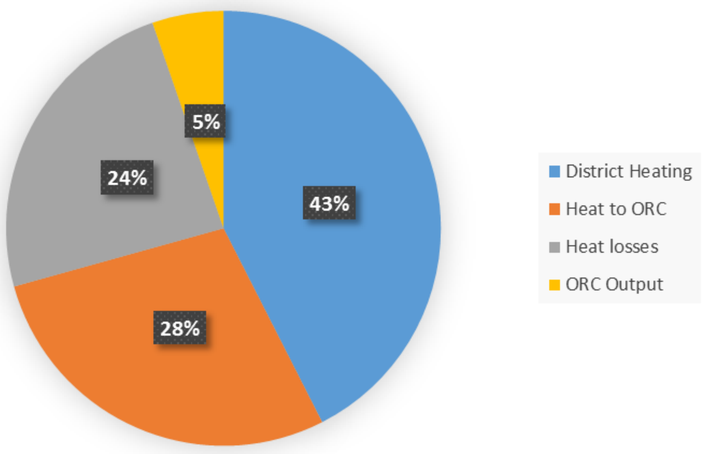

Figure 4. Distribution of waste heat recovered.

SIMULATED ORC FULL OPERATION

- Heat supplied to ORC: 45.910 MWh/yr
- Heat losses: 5.797 MWh/yr
- Net electricity produced: 8.071 MWh/yr
- ORC average efficiency: 17,5%.
- Annual carbon savings: 2457 t CO2.

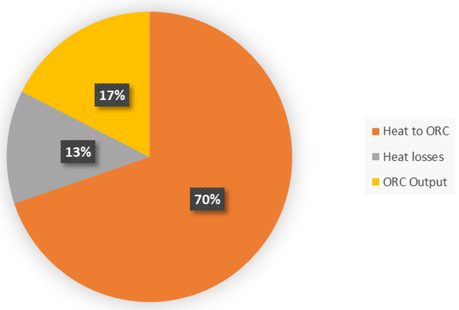

Figure 5. Heat balance simulated distribution.

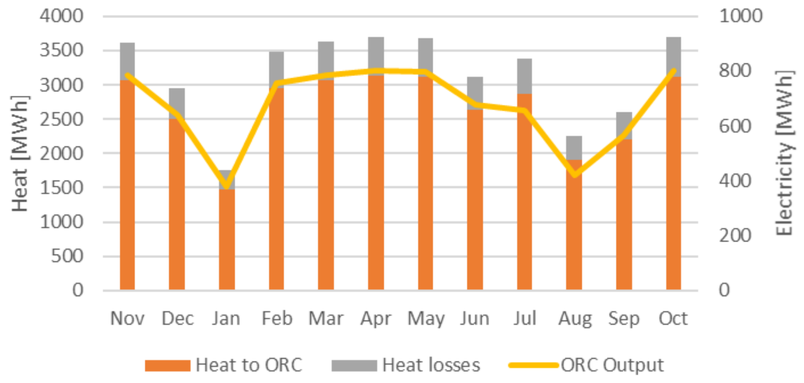

Figure 6. Simulation of electricity production during one year.

CONCLUSIONS

The results show that the ORC unit operated with an average efficiency of 18% during approximately 1800h. From the heat recovered by the WHRU 43% was transferred to the district heating and 28% to the ORC. The annual carbon savings during the ORC operation is 928 t CO_2 based on carbon footprint 0.353kg CO_2 eq. per kWh [2]. In the case scenario of fully ORC operation the annual carbon savings could reach 2457 t CO_2.
During the monitoring period actions were performed for maintenance and to improve the operation of the plant which resulted in lower performance during these specific periods. These issues have been solved and the performance will present further improvements.

REFERENCES

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