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## **Semi-analytical model for dynamical modeling thermal recycling in a doublet well of open-loop groundwater heat pump with variable heat extraction**

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The performance of a GroundWater Heat Pump (GWHP) is critically influenced by the thermal recycling between wells, i.e. the proportion of thermally affected injected water that is pumped back by the extraction well. The use of the complex potential theory, assuming a homogeneous aquifer and a uniform regional flow, to assess the evolution of the extraction temperature from a doublet is presented. One major limitation in the available models in the literature is that they assume a constant extraction flow rate and constant heat extraction. This is unrealistic since buildings energy loads vary naturally with time during the day, the month and the year. To overcome this, the present paper develops a semi-analytical model to dynamically determine the extraction temperature of a doublet GWHP taking into account a variable extraction heat flow. Results obtained are benchmarked to a finite-element Comsol Multiphysics numerical model under different conditions, which enlightens the limitations of the proposed model. The developed model can be easily used to assess the technical potential of a GWHP.