Comparison of HDPE and ductile iron pipes for drinking water supply networks through eco-efficiency assessment

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1 INTRODUCTION

The construction procedure of drinking water distribution network involves a high expenditure and environmental impacts, so it is an important issue to be taken into account in the refurbishment of old quarters but specially in the construction of new areas. The present study aims to evaluate two alternative constructive solutions with different pipe materials, high density polyethylene (HDPE) and ductile iron, in order to determine which one is preferable from an eco-efficiency perspective. Figure 1 shows the diagram of the analysed system.

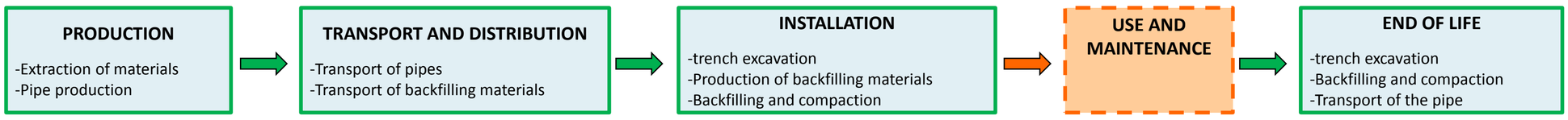

Figure 1 Life cycle system boundaries of drinking water distribution network. Green boxes are included in the assessment,, orange boxes have been analysed but are excluded from the present results.

2 METHODOLOGY

The functional unit considered for the comparison is 1 m of drinking water distribution network for the transport of water along 100 years considering the phases of production, transport, installation (including the trench, Figure 2) and end of life.

The LCA and LCC methodologies have been applied following the ISO 14040 [1] and the methodology described at Termes-Rifé et al. (2013) [2].

- Software: Simapro 7.3
- Calculation method: CML 2001 for global warming potential (GWP)
- Databases: Itec Metabase [3], Ecoinvent 2.2.

Regarding the life expectancy of the pipes, 100 years has been considered for ductile iron and 50 for HDPE [4]. The dimensions of the trench for the installation have been specified in Figure 2.

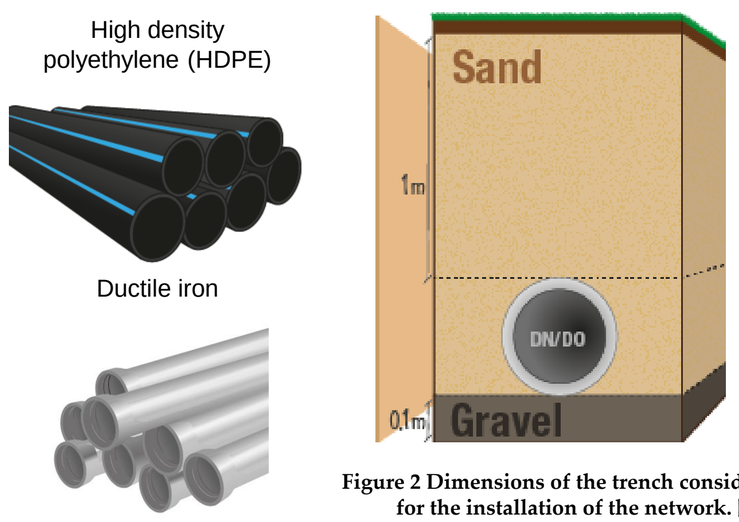

Figure 2 Dimensions of the trench considered for the installation of the network. [5]

3 RESULTS AND DISCUSSION

HDPE presents higher costs than ductile iron, especially for the 300 mm diameter constructive solution (2.4 times higher; Figure 3). In contrast, the impacts for GWP for HDPE are much lower than for ductile iron (between 55 and 80% lower). As a result, ductile iron scores much higher in the ecoefficiency indicator kg of $CO_{2\ eq.}$/€, which is between 3 and 11 times higher than for HDPE (Figure 4). As the pipe size increases, producing and placing a pipe has more impact, for this reason the differences between the two materials are greater.

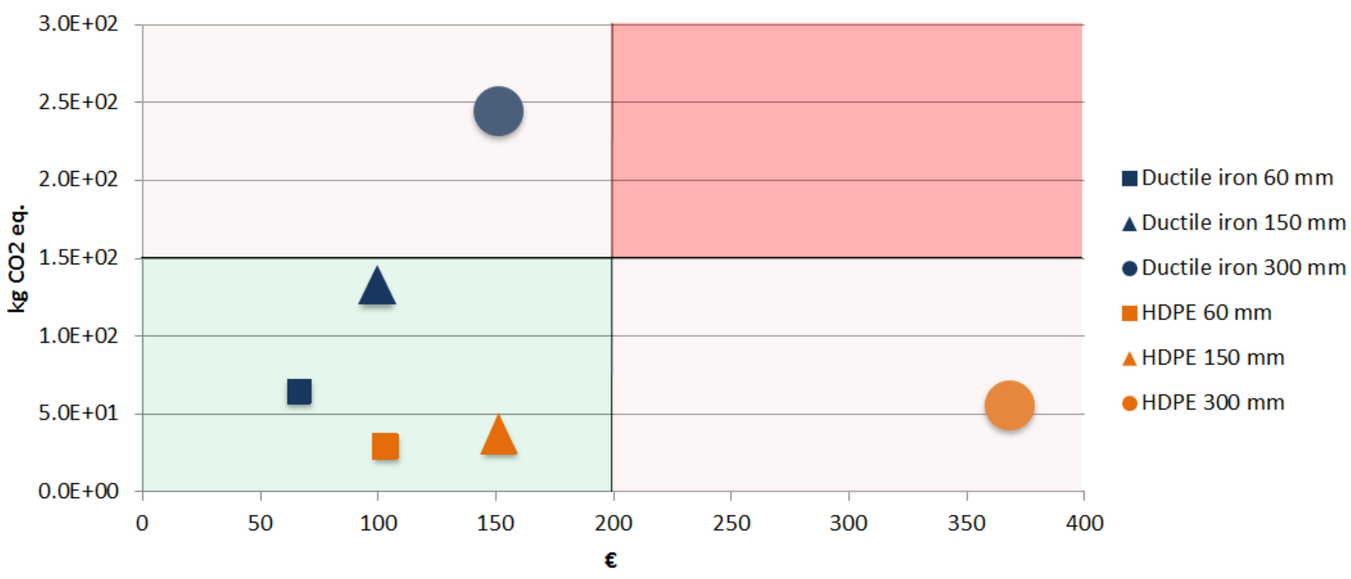

Figure 3. Graphical representation of eco-efficiency results for HDPE and ductile iron pipes constructive solutions of 60, 150 and 300 mm pipe sizes

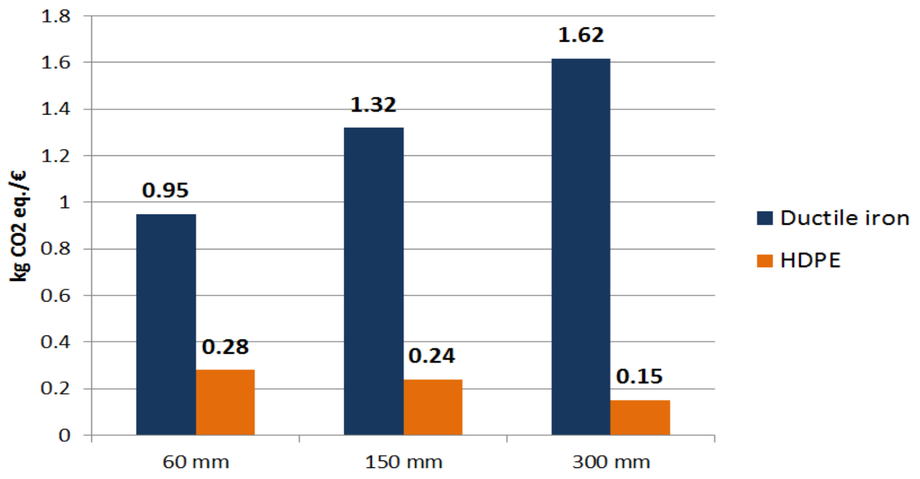

Figure 4. Representation of the indicator kg of CO_2 per € for different pipe sizes.

Although 1 m of ductile iron pipe is more expensive than HDPE, the HDPE constructive solution requires more accessories and working hours during its installation. Besides, its shorter lifespan implies accounting twice the impacts and costs. The selection of the material will rely on the decision-making flexibility of the project due to technical issues.

4 CONCLUSIONS

In this assessment, environmental and economic issues have shown to be confronted. Whereas HDPE allows reducing the greenhouse gas emissions of the network construction (between 55 and 80% lower), ductile iron enables reducing significally its costs (between 35 to 60% cheaper). Increasing the lifespan of HDPE might make it the best option from both the economic and the environmental perspective. Finally, the selection of one or another pipe will depend on the priorities of the project.

References and aknowledgements:

[1] ISO, 14040:2006 (E), Environmental management - Life cycle assessment - Principles and Framework. International Organization of Standardization, Geneva, Switzerland, 2006.
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