2019

13th International Conference on Industrial Engineering and Industrial Management

XXIII Congreso de Ingeniería de Organización

Organizational Engineering in Industry 4.0

BOOK OF ABSTRACTS

Gijón, 11th-12th July 2019

Book of Abstracts

"13th International Conference on Industrial Engineering and Industrial Management" and "XXIII Congreso de Ingeniería de Organización (CIO2019)"

Book of Abstracts

"13th International Conference on Industrial Engineering and Industrial Management" and "XXIII Congreso de Ingeniería de Organización (CIO2019)"

COORDINADORES

DAVID DE LA FUENTE GARCÍA

RAÚL PINO DIEZ

PAOLO PRIORE

FCO. JAVIER PUENTE GARCÍA

ALBERTO GÓMEZ GÓMEZ

JOSÉ PARREÑO FERNANDEZ

ISABEL FERNÁNDEZ QUESADA

NAZARIO GARCÍA FERNÁNDEZ

RAFAEL ROSILLO CAMBLOR

BORJA PONTE BLANCO

Servicio de Publicaciones de la Universidad de Oviedo
Campus de Humanidades. Edificio de Servicios. 33011 Oviedo (Asturias)
Tel. 985 10 95 03 Fax 985 10 95 07
http: www.uniovi.es/publicaciones
servipub@uniovi.es

I.S.B.N.: 978-84-17445-38-6
DL AS 1875-2019

Imprime: Servicio de Publicaciones. Universidad de Oviedo

13th International Conference on Industrial Engineering and Industrial Management
XXIII Congreso de Ingeniería de Organización
Gijón, Spain, July 11-12, 2019

Optimal design of water supply networks using a tabu search algorithm

Robles-Velasco A[15], Cortés P[16], Muñuzuri J[17], Escudero-Santana A[4]

Keywords: Water supply network design; Tabu search; Metaheuristic; Optimization

1 Introduction

A water supply network is the infrastructure responsible for bringing drinking water to consumers. Currently, population is growing, specifically in urban areas. This causes new challenges regarding the construction and enlargement of this utility. The design and building of extensions of such water supply networks is a hard and expensive task. Therefore, an efficient planification may result in substantial cost reduction and increase in safety.

2 Objectives

The purpose of this study is the optimal design of water supply networks solving a model in which the demand of a set of consumer points must be covered with specific conditions of pressure and flow. The traditional model, which does not include penalty terms, is chosen and some requirements as minimum pressure in nodes are included as constraints The final objective of this selected model is to find the optimal diameters of each network pipe that minimize the total costs.

The intrinsic characteristics of the hydraulic systems and the discrete nature of some of their variables make this problem a non-linear mixed integer problem.

[15]Alicia Robles Velasco (e-mail: arobles2@us.es)*

[16]Pablo Cortés Achedad (✉e-mail: pca@us.es)*

[17]Jesús Muñuzuri Sanz (e-mail: munuzuri@us.es)*

[17]Alejandro Escudero Santana (e-mail: alejandroescudero@us.es)*

*Dpto. de Organización Industrial y Gestión de Empresas II. ETSI. Universidad de Sevilla. C/ Camino de los Descubrimientos S/N, 41092 Sevilla (Spain).

3 Methods

Metaheuristics are the most suited methodologies to solve this kind of complex problems. A tabu search algorithm, firstly introduced by (Glover, 1986), is designed and is implemented in the well-known Alperovits network (Alperovits and Shamir, 1977). The main characteristic that differences it from other metaheuristics is the use of short-term memory.

This specific problem requires two different evaluation functions. The first one performs the hydraulic simulation of the network and the second one evaluates the total cost of hydraulically valid solutions. The algorithm works with solutions in the form of lists where each element represents the diameter assigned to each arc. The neighbourhood structure is built through the decrease of one diameter unit to the next one in the commercial catalogue. It also includes an aspiration criterion and a hydraulic-non-valid solution detector.

4 Results

To simulate the network and to analyse if hydraulic requirements are reached, the WNTR library (Klise *et al.*, 2017) was employed. The use of this library has made possible to explore different solutions iteratively in short times.

The best attained solution for the Alperovits network has a cost of 420,000 m.u.. Despite being an optimized solution, it does not reach the results obtained using other metaheuristics. Genetic algorithms (Savic and Wlaters, 1997) seem to be more suited, but they need much greater computing times.

5 Conclusion

Comparing tabu search to the genetic approaches, it can be concluded that this metaheuristic seems to be less appropriate to solve the Alperovits network, although results are clearly in line. Future works may include the resolution of larger and more realistic networks in order to demonstrate the good performance of the designed methodology in these cases.

References

Alperovits, E. and Shamir, U. (1977) 'Design of optimal water distribution systems', Water Resour. Res., 13(6), p. 2637.

Glover, F. (1986) 'Future paths for integer programming and links to artficial intelligence', Computers and Operations Research, 13.(January), pp. 533–549.

Klise, K. A. et al. (2017) 'Water Network Tool for Resilience (WNTR) User Manual'. U.S. Environmental Protection Agency, p. EPA/600/R-17/264, 47.

Savic, D. A. and Wlaters, G. A. (1997) 'Genetic Algorithms for Least-Cost Design of Water', Journal of Water Resources Planning and Management, 123(2), pp. 67–77. doi: 10.1061/(ASCE)0733-9496(1997)123.