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Energy Procedia 105 (2017) 2239 – 2244

Energy Procedia

The 8th International Conference on Applied Energy – ICAE2016

System development for eco-industrial parks using ontological innovation

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Abstract

Engineering design and system operating comprise highly innovative and knowledge-intensive tasks in the design of an eco-industrial park. Efficient information exchange and communication among distributed parties are very important for a business to succeed. Building a well-structured framework for data/information streamlining and processing is an urgent task in order to achieve further process simulation and optimization in the eco-industrial parks. This paper presents a study of ontological representation for an eco-industrial system, and its deployment on a knowledge-based software platform. The contributions of this work include: Firstly, an ontology model for the relevant chemical process is built relying on the ontological framework provided by OntoCAPE. Secondly, a surrogate modeling method is adopted and implemented for the industrial system. Finally, a Graphical User Interface (GUI), acting as an operating platform, is developed based on the proposed software architectural design. A case study is carried out to demonstrate the chemical process simulation and information query on this platform.

Peer-review under responsibility of the scientific committee of the 8th International Conference on Applied Energy.

Keywords: Eco-industrial system, Ontology, Chemical process simulation, Information query

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doi:10.1016/j.egypro.2017.03.637

1. Introduction

Over the past decades, study of eco-industrial parks (EIP) has gained wide popularity in the scientific community. An EIP is defined as a community of neighboring businesses collaborating with each other, seeking enhanced environmental, economic and social performance [1]. An EIP system is a large-scale complex system, comprised of a great number of components from different operation levels, including units, processes, plants and networks [2]. Efficient collaboration between different sectors is the key to EIP success, which requires storing, sharing and processing a large amount of heterogeneous and dispersed data and information. In this scenario, traditional information technology may no longer be able to provide satisfying support. It requires a novel knowledge-based software system, which has two basic components: 1) a knowledge base containing generic domain knowledge and concrete facts specific to the considered case; 2) and an inference engine to process the knowledge and facts stored in the knowledge base, and to generate solutions for the cases at hand. It's obvious that building a valid knowledge base is crucial to the development of an EIP software system. Ontologies are emerging as a useful infrastructure for knowledge representation and sharing. During the past decades, the number of available ontology frameworks has increased rapidly, in particular for the engineering domain. At the earliest stage, *EngMath* was presented for mathematical modelling in engineering [3], *YMIR* was reported for representation of engineering design knowledge [4], and *PhysSys* was developed for modelling generic physical system [5]. Subsequently, ontologies for a wider domain, such as chemical process engineering [6-7], pharmaceutical engineering [8], were proposed and applied. Amongst the reported ontologies, OntoCAPE [9] is the most prominent and well-accepted framework for process engineering. Several of its extensions and applications have been reported [10-12]. Although many ontological frameworks are reported for certain engineering domains and applications, the ontology-based representation and simulation of a large-scale industrial park system have never been achieved. This paper presents an efficient approach for developing a Computer Aided Process Engineering (CAPE) software system for an EIP. OntoCAPE is adopted for knowledge base construction. An efficient surrogate modelling method is developed to describe the performance of complex industrial systems. A software architecture is designed, and a Graphical User Interface (GUI) is developed in order to perform process simulation and information query in the EIP.

2. An ontology-based repository for chemical processes in an EIP

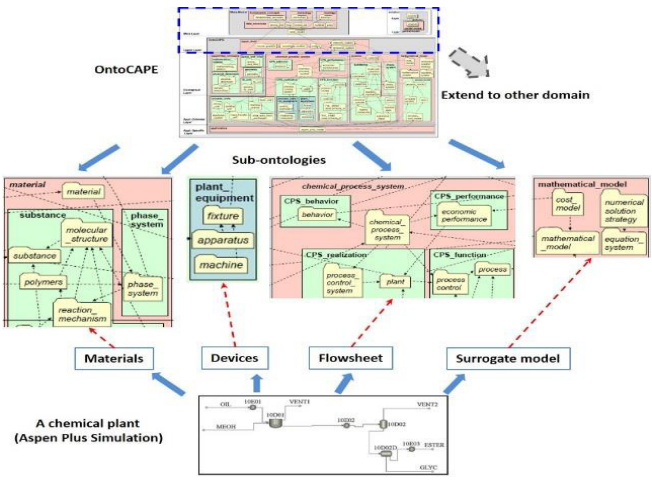

Fig. 1 Representing a chemical process using OntoCAPE.