



**FACULTEIT ECONOMIE  
EN BEDRIJFSKUNDE**

**TWEEKERKENSTRAAT 2  
B-9000 GENT**  
Tel. : 32 - (0)9 - 264.34.61  
Fax. : 32 - (0)9 - 264.35.92

## **WORKING PAPER**

# **Tank allocation for liquid bulk vessels using a hybrid constraint programming approach**

**Rowan Van Schaeren<sup>\*</sup>, Wout Dullaert<sup>†</sup>, Birger Raa<sup>‡</sup>**

**Pierre Schaus, Pascal Van Hentenryck<sup>§</sup>**

August 2010

2010/664

---

<sup>\*</sup> Antwerp Maritime Academy  
Noordkasteel Oost 6, 2030 Antwerpen, Belgium  
[rowan.van.schaeren@hzs.be](mailto:rowan.van.schaeren@hzs.be)

<sup>†</sup> Institute of Transport and Maritime Management Antwerp (ITMMA), University of Antwerp  
Keizerstraat 64, 2000 Antwerpen, Belgium  
[wout.dullaert@ua.ac.be](mailto:wout.dullaert@ua.ac.be)

<sup>‡</sup> Department of Management Information and Operations Management, Ghent University  
Tweakerkenstraat 2, 9000 Gent, Belgium  
[birger.raa@ugent.be](mailto:birger.raa@ugent.be)

<sup>§</sup> Dynadec  
Place de l'Université 16, 1348 Louvain-La-Neuve, Belgium  
[pschaus@dynadec.com](mailto:pschaus@dynadec.com)  
[pvanhentenryck@dynadec.com](mailto:pvanhentenryck@dynadec.com)

## ABSTRACT

This paper considers the allocation of cargoes to tanks for the specific case of chemical liquid bulk vessels. No articles in the literature and no commercial software packages are available that can handle the multitude of side constraints that need to be considered. These constraints include segregation constraints for the chemicals on the one hand, to prevent chemicals from being loaded into certain types of tanks or next to other chemicals in adjacent tanks. On the other hand, the constraints include vessel stability considerations, which limit the volumes with which the tanks are loaded. A hybrid CP-LP model is presented in this paper, in which constraint programming (CP) is used to determine possible cargo-to-tank allocations, after which linear programming (LP) is used to generate actual loading plans that optimize the vessel stability. The validity and practical usefulness of this model are shown by solving real-life instances.

**KEYWORDS:** Tank allocation problem, Constraint programming, Chemical tankers, Load planning.