INNOVATIVE DANUBE VESSEL

Executive Summary

Introduction

In order to reduce the environmental impact and to improve the economic performance of Danube navigation, it is necessary to stimulate the modernisation of the Danube fleet. To gather the necessary knowledge for this attempt, a specific research and development project, the "Innovative Danube Vessel", was launched within the frame of Priority Area 1a -To improve mobility and multimodality: Inland waterways - of the EU Danube Region Strategy.

Objective of the project

The objective of the project "Innovative Danube Vessel" (IDV) was to give recommendations for modernising the Danube fleet, considering

- Requirements of the transport market in the Danube region,
- Specific fairway and navigation conditions of the Danube river,
- The state of the art in inland waterway vessel technology,
- Innovative technical solutions derived from published research projects.

For the project, "innovation" is not an end in itself, but understood to be "better than the existing fleet", in terms of energy efficiency, cost efficiency and environmental impact. As the modernisation rate of the Danube fleet is low due to long amortisation periods of investments, the aim was to identify both designs for newly built vessels as well as solutions that can be applied to existing ships.

Research questions

The inland waterway transport industry on the Danube is confronted with particular challenges due to geographical and market-related restrictions. Within this framework, technical aspects of ship design had to be analysed:

- How can the energy and cost performance of inland vessels be improved by innovative solutions?
- What are appropriate vessel concepts and dimensions for the particular situation on the Danube waterway?
- Which innovative devices can be applied to improve the performance of existing ships?

Main results

The IDV project confirms that, under good waterway conditions, transportation carried out with Danube vessels can reach **excellent cost and energy efficiency**. Innovative devices and optimised ship designs would further improve this situation.

As far as **new constructions** are concerned, the IDV project identifies three most promising options leading to energy and cost savings and reduced environmental impact: **two new types of Danube pushers** as well as an **innovative version of a self-propelled vessel**. **Quick wins** can be realised by installing real-time **voyage speed optimisation tools** on existing Danube vessels.

Additionally, results demonstrated that **energy and cost efficiency** of Danube vessels is **largely dependent on waterway conditions**, especially on the available water depth. Proper fairway maintenance on the Danube therefore is an important prerequisite for energy and cost-efficient inland waterway transport operations. This applies to both existing and innovative vessel types.

Most promising vessel concepts for the Danube

In the course of the IDV project, detailed concepts were elaborated for the three most promising ship types. One concept focuses on improved design of a classic push boat. The remaining two concepts integrate innovative LNG solutions (liquefied natural gas) on a push boat and an improved self-propelled vessel.

The strength of the classic pusher concept is that it could be implemented immediately. The LNG concepts are not available off-the-shelf, but would presumably offer greater cost savings. This is due to the fact that LNG fuel costs are expected to reduce operation costs significantly, even when taking into account the expected higher costs for crew (as more skills are required) and depreciation of investments. Also environmental advantages of LNG are significant. Nevertheless, precise cost calculations will remain subject to uncertainties, which depend for instance on the further development of LNG market prices and land-side supply infrastructure.

A. Classic pusher operated with gasoil

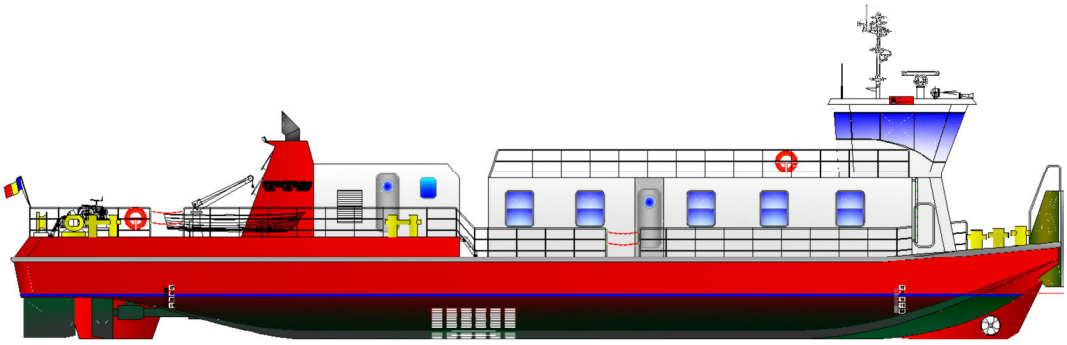

Figure 1: Classic pusher (source: SDG)

This concept offers the basic advantages of convoy transport: flexibility and high bulk capacity resulting in low transport costs. Whereas fuel consumption, fuel cost and transport performance remain unchanged compared to existing pushers, the main advantage of the new concept is the low pusher draught due to improvements in constructive elements. This improves operational performance in shallow waters and therefore increases reliability of transport. Furthermore, the concept would be more or less ready for market introduction.

B. LNG pusher

Figure 2: LNG pusher (source: SDG)

The main innovation of this concept combines advantages of LNG fuel (low costs, low emissions) with the advantages of convoy transport (economies of scale, logistical flexibility). The propulsive efficiency of the vessel is not influenced by the new design.

C. LNG self-propelled vessel with flexible tunnel

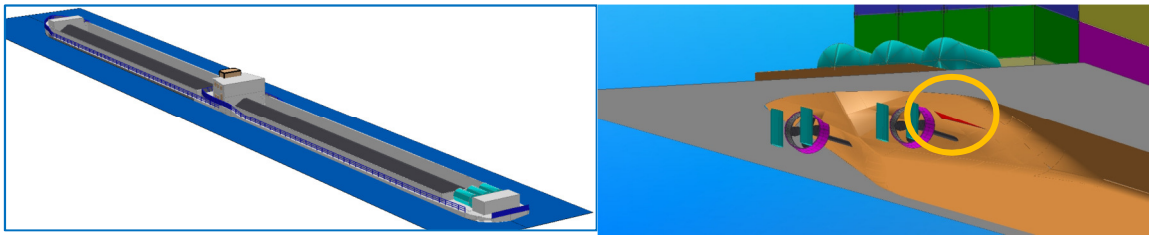

Figure 3: LNG self-propelled vessel (source: DST)

In this concept, propulsive efficiency is improved for upstream voyages, which require the highest amounts of energy. The foldable tunnel (circled yellow) allows the captain to adapt to changing water levels and therefore enables more efficient use of propulsion energy. In addition to this technical adaptation, this concept exploits the advantages of LNG. In general, self-propelled vessels are less flexible than convoy formations, but can reach higher speeds when going upstream. This makes self-propelled vessels suitable for transport of higher value commodities and thereby enables higher revenue.

Recommendations

Based on the results achieved, the following recommendations can be given to European policy-makers and the R&D community in order to bring innovative Danube vessels forward. A considerable part of the findings could also be extended to other rivers in a next step.

1. Develop real-time voyage speed optimisation tools

Especially on the river Danube, energy and cost efficiency of the vessels significantly depend on ship speed due to the interdependence of water levels and energy consumption. Economic voyage planning (i.e. speed and route planning) can be supported by a real-time decision support tool, taking the specific Danube conditions into account. It could easily be installed on existing vessels, which enables quick wins. As a next step, the tool could be extended to other European inland waterways.

2. Use RIS data for voyage planning

River Information Services (RIS) enable improved forecasts of fairway conditions, especially related to water depths in different sections. Exploiting the full potential of RIS data for voyage planning will enable operators to determine more efficient loading of ships and therefore contribute to competitiveness of Danube navigation.

3. Adapt motor vessels to the specific navigation conditions of the Danube

Existing motor vessel concepts should be further elaborated in order to meet the specific requirements of the Danube. This relates mostly to optimised ship dimensions and optimised design draught. Furthermore, new engines compliant with stricter emission standards or engines using LNG should be used in order to reduce emissions.

4. Develop an LNG pusher for the Danube

In the Danube region, bulk goods have a large share of the transport volume. Pushed convoys offer great bulk capacity, which as a consequence makes them very attractive for being used on the Danube. Furthermore, they offer the possibility to adapt to changing waterway conditions by adding or removing lighters flexibly. Installing high performance propulsion on pushers would allow the operation of larger convoys, which is especially attractive on the Lower Danube. Using LNG fuel on pushers will also have a significant impact on the emissions of inland waterway transport in the region.

5. Optimize lighters

In case of new lighters, optimised convoy dimensions making full use of available lock sizes should be implemented. Further savings can be realised through hydrodynamic improvements. In addition, the steel structure of the lighters should be redesigned for lower weight at reduced building and maintenance cost.

6. Improve energy efficiency benchmarking of vessels

The project revealed the complexity of energy efficiency benchmarking of inland vessels. Further research including both model testing and full scale measurements is needed to optimise benchmarking methods. This will enable a deeper understanding of the parameters influencing the energy efficiency, leading to improved results for the design and operation of inland waterway vessels.

7. Assure proper fairway conditions

Proper fairway conditions as agreed by the AGN (European Agreement on Main Inland Waterways of International Importance) should be provided. Better maintenance of the Danube waterway will facilitate better energy and cost efficiency of Danube waterway transport. The analysis of the study revealed that – under the current circumstances – improved or innovative ship designs are unlikely to compensate for insufficient waterway maintenance. Sufficient water depths remain a main prerequisite for efficient waterway transport. This relates to both new and existing vessels.

Project Consortium

The IDV project was funded by the European Union (DG REGIO) within the framework of the European Union Strategy for the Danube Region and supervised by via donau – Österreichische Wasserstraßen-Gesellschaft mbH. The project partners were:

- DST - Development Centre for Ship Technology and Transport Systems, Duisburg, Germany (project coordinator)
- ÖIR - Austrian Institute for Regional Studies and Spatial Planning, Vienna, Austria
- UB - University Belgrade, Department of Naval Architecture, Belgrade, Serbia
- SVA - Vienna Model Basin, Vienna, Austria
- SDG - Ship Design Group, Galati, Romania
- PDI - Pro Danube International, Vienna, Austria (sub-contractor to the consortium)