Andrzej BANASZEK
Maritime Academy of Szczecin, Szczecin

**THE SHIP’S SIDE LOADING SYSTEM OF PAPER WITH HYDRAULIC DRIVE ON THE MODERN MULTIPURPOSE VESSELS**

**Key words**
Paper, transport, ship’s side loading system, hydraulics.

**Summary**
The paper presents a concept of a ship’s side loading system with hydraulic drive, used on board modern multipurpose vessels for the transport of paper by sea. The structure of the loading system is divided into functional parts. The relations between these parts are described. The hydraulic drive and control system is presented. Some examples from vessel B587-IV-class m/s ‘Stadiongracht’, built in Szczecin Shipyard, are given. Advantages and disadvantages are shown.

**Introduction**
The sea transport of the paper creates a technological problem in practice. Because a cargo of paper is acknowledged as especially sensitive, the subject of easy destruction or the damage during the transport and the transhipment in the harbour requires study. Therefore, for paper sea transport special ships are used called paper carriers. As a rule, modern vessels of this type are equipped with a specialised ship's side loading system. This one is characterised by the way the cargo is handled and carried during the transhipment operation. In this case, the
cargo route is horizontal with reference to the transport on line cargo hold – harbour quay.

In the traditional lo-lo type system, the cargo is introduced to the ship cargo area on vertical line using harbour or deck cranes. An example of the modern vessel with ship’s side loading system is the multipurpose ship m/s “Stadiongracht.” It was built by Szczecin Shipyard S.A., as the first of 8-ships, series B 587-IV- class, for the well-known Dutch ship owner Spliethoff’s Bevrachtingskantoor B.V. from Amsterdam. This ship owner is a world famous leader on the paper sea transport market. M/s ‘Stadiongracht’ is characterised by high loading elevator towers installed midship on the starboard side (see Fig. 1). Part

Fig. 1. General Arrangement of m/s ‘Stadiongracht’ [1]
of the ship's side loading system is specially designed for the paper transhipment on board. The loading system, except towers and loading columns, consist of the waterproof ship's side doors situated on side of loading towers, the waterproof top-hinged doors situated on longitudinal internal bulkhead, the waterproof side-hinged doors situated on the transverse bulkheads frame 154-164, and the system of protection devices as blockades of the palletizer car movement, barriers, splash covers etc. Each working part possesses a hydraulic drive. The whole system was designed in the Design Office of the Szczecin Shipyard S.A. in cooperation with TTS_Mongstad A.S. company of Norway. The subject of the present paper is the description of the ship's side loading system with a hydraulic drive as a trend in the building of modern paper-carriers.

1. The paper ship's side loading system on board the m/s ‘Stadiongracht’

The multipurpose vessel m/s ‘Stadiongracht’ was designed for the paper rolls transport at sea, mostly from harbours of Finland and Sweden to the Western European countries and the U.S.A. The a/m ship can also transport other kinds of cargoes, e.g. containers (on the ship deck and in cargo holds), cargoes on pallets and sacks.

Fig. 2. The schema of ship's side loading system on m/s ‘Stadiongracht’
M/s ‘Stadiongracht’ is the first multipurpose vessel B587-IV class built in the Szczecin Shipyard S.A. (and the Szczecin Nowa Shipyard Ltd.) for the Dutch shipowner Spliethoff’s Befrachtungskantoor from Amsterdam. The ship has a length $LOA = 172.60\ [m]$, breadth $Bc = 25.30\ [m]$, the draught (design) $Tc = 10.74\ [m]$, and it has a deadweight (at design draught) $21\ 400\ [DWT]$. This permits carrying $23\ 780\ [m^3]$ the paper rolls or 1134 containers TEU-size (see Fig. 1). The ship's side loading system on a paper carrier belongs to one of the most important systems, because it delimits paper cargo service, i.e. the ship’s basic function. A basic element of the system is the loading elevators of the platform type. The schema of their operation is shown in Fig. 2. On m/s ‘Stadiongracht’ are installed 5 such elevators (with numbers 1-5 counting from the bow), where the first was intended to the service of the fore hold area. Elevators No 2, 3 and 4, 5 were designed to service the stern hold (on both levels). Due to their large sizes, elevators numbers 1, 2, 3, 4 and 5 were grouped in separate tower- spaces. Every loading column contains a guiding column, which is used as the elevators are vertically moved to the loading platforms. The columns are rotationally mounted on special bearings and hinges. The platforms were arranged in this way to swing outboard. The inclination of the guiding column was effected by the remote controlled hydraulic cylinder. At the column montage, an exact installation was required in respect to the position tolerance with reference to the hinges, bearings and hydraulic cylinder. Therefore, for their correct positioning, a special laser kit for axial installation of the whole device was used. The vertical movement of the loading-platform was driven by another hydraulic cylinder (with the large nominal length and stroke) and using a block-and-tackle (see Fig. 2). To obtain the platform’s parallel position in relation to the ship's side (at the inclination of the guiding column in outboard position), electric motors were installed on the platform shoulders. The whole platform movement is controlled by the remote control devices installed in the control cabins. The control system, based on PLC technology, allows the programming of platform movement. The deck-officer, equipped with the managing computer system, can very easy supervise the loading and unloading operation in harbour in a more efficient way. It permits an increase in the platform speed and the reduction of time-consuming adjustment motions. As a result, such a system enables the reduction of the transhipment operation labour intensity. In this way, the 5 loading-elevators create separate and independent loading- channels. Each platform has a safe working load of 16 tonnes. Every loading tower has an exterior, hermetic ship's side door. This one can be hinged outboard to provide a rain shelter over the platform (see Fig. 2). For better protection of the cargo area, the bulkhead door system was created. It was very important with respect to ship’s safety. In case of a disaster at sea, ships of this type, equipped with very large cargo holds, can easy sinking. Therefore, 10 pieces of top hinged bulkhead doors between holds and elevators were installed on board and 4 side-hinged
bulkhead doors in transversal bulkheads fr. 154-164 (see Fig. 1). Ship was equipped with some electrically driven forklift trucks, each with capacity of 8 tonnes. These trucks are designed to transferring paper rolls between the loading platforms and its storage place in the holds. For better protection of these forklift trucks, every loading-channel was equipped with the barriers and wheel blockades. The detailed description of the loading system is presented in [3].

Fig. 3. The outside movement put out idea of the loading-platform

2. The hydraulic drive system

The described, ship’s side, loading system is installed in a quite small area. Therefore, hydraulics where used for the drive systems. All hydraulic energy receivers are supplied from the central loading system, which is a collector type. The individual drive of every device is not economical. From technical side, simultaneous work of all hydraulic receivers at the same time is not required. In the Hydraulic Room are installed two Power Packs powering the whole hydraulic central loading system. First device is a “Fore Power Pack” equipped with 4-aggregate set (see Fig. 5) supply the loading elevators No. 1, 2 and 3 together with the side-hinged bulkhead doors Fr. 154-164 (on both levels). Next is the “Stern Power Pack,” which contains 3-hydraulic aggregates and serves loading-
elevators No 4 and 5. The block diagram of the hydraulic driving system is presented in Fig. 4. Below, in Tab. 1, is the primary technical data of the described power packs.

Fig. 4. The block diagram of hydraulic central loading system on board m/s ‘Stadiongracht’

Table 1. Technical data of hydraulic power packs

<table>
<thead>
<tr>
<th></th>
<th>Fore Power Pack</th>
<th>Stern Power Pack</th>
</tr>
</thead>
<tbody>
<tr>
<td>The nominal flow:</td>
<td>4x300 [l/min]</td>
<td>3x300 [l/min]</td>
</tr>
<tr>
<td>The max. working pressure:</td>
<td>250 [bar]</td>
<td>250 [bar]</td>
</tr>
<tr>
<td>The nominal power:</td>
<td>4x150 [kW]</td>
<td>3x150 [kW]</td>
</tr>
<tr>
<td>Nominal rotational speed of motors</td>
<td>n = 1750 [rpm]</td>
<td>n = 1750 [rpm]</td>
</tr>
<tr>
<td>The electric supply:</td>
<td>3x440 [V]-60 [Hz]</td>
<td>3x440 [V]-60 [Hz]</td>
</tr>
</tbody>
</table>

In both hydraulic power packs, the axial-piston (with variable displacement) pumps A11VLO190 type, produced by the Bosch/ Rexroth /Germany [6] are installed. These are equipped with the regulators p = const  EP2D type (see Fig. 6). This made possible the remote adjustment of the pump displacement and remote pressure control in the hydraulic collector system by means of an electronic signal. For the remote control of all moving parts of the loading system,
Fig. 5. View on the hydraulic Fore Power Pack

Fig. 6. Hydraulic diagram of EP2D type regulator [6]

electromagnetic distributors in the hydraulic block assembly are mounted. For local control, in case of a remote control system damage or for technological purposes, the emergency control blocks in every hydraulic energy receiver are
installed. The deck-officer, who is responsible for the loading operation on board, can remotely adjust the speed of each loading elevator from the control computer or control panels. Master panels are mounted in each control cabin, where the deck-officer can make remotely start hydraulic power and control of all hydraulic devices. For all bulkhead doors and side doors, the local, manual, control panels (for local opening and closing) are installed. The correctness of the closing and locking door execution is checked by the electronic transmitters. The confirmation signals are transmitted to the control cabins and to the Navigation Bridge.

Conclusions

The ship's side loading system with the hydraulic drive is an important development in paper cargo, transhipment technology. The described system has the following main advantages:

1. The acceleration of the paper cargo transhipment operation;
2. The more easy cargo distribution to and from the ship holds;
3. Good paper cargo protection during the transhipment operation in case of rain or snow;
4. The ease of the automation of the transshipping operation through the use of the hydraulic system and electric PLC system.

Disadvantages of the system are as follows:

1. The comparatively high cost of the system;
2. The unprofitable influence of the loading system on the ship centre of gravity.

References

6. Bosch-Rexroth, Hydraulic Pumps Catalogue, Lohr a/Main RD 10002/04.03.

Recenzenci:
Jerzy KUBICKI,
Zygmunt PASZOTA

Okrętowy system burtowego załadunku papieru z napędem hydraulicznym na współczesnych statkach wielozadaniowych

Słowa kluczowe
Papier, transport, system załadunku burtowego statku, hydraulika.

Streszczenie
W artykule przedstawiono koncepcję okrętowego systemu załadunku burtowego, stosowanego na pokładach wielozadaniowych statków do transportu papieru drogą morską. Opisano poszczególne części systemu załadowczego oraz zależności między nimi. Zaprezentowano system napędu i sterowania hydraulicznego. Pokazano kilka przykładowych rozwiązań ze statku typu B587-IV- m/s „Stadiongracht”, zbudowanego w Stoczni Szczecińskiej S.A. Przedstawiono zalety i wady systemu.