

Digital and intelligent Semi-submersible Heavy Transport Vessel

As the major ocean transport tool of large intact cargo, the semi-submersible heavy transport vessel (SSHTV) has become more and more valued with the rapid advance of ocean engineering, polar exploration and global trade.

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Simultaneously, higher safety, reliability, efficiency and performance requirements for SSHTV are needed in order to guarantee owner and operator profit. The Digital SSHTV concept presented here is based on development and maturity of intelligent sensor technology, information technology, data technology and IoT technology, all aimed at satisfying these demanding requirements. The concept combines onboard equipment and energy management, vessel and fleet operation, and onshore planning and service based on a uniform platform. It embodies efficient the integration of people, things and service, in keeping with current development trends. It also supports China Classification Society's rules for intelligent ships, effective March 1st 2016.

Preface

Semi-submersible heavy transport vessels (SSHTV) are specialised in the transportation of large-size cargo, which is overlong, overweight and intact.

Compared to other large cargo transport tools, SSHTV has advantages such as high transport speed, long duration sailing, loading/unloading by roll-on/roll-off, and supporting semi-submersion, dynamic positioning and double-vessel combination operation.

Due to such operational features as:

- Large hull size and power requirement
- Multiple working requirement
- Preferred unlimited navigation area
- Difficult and dangerous working process
- Heavy, big and expensive cargo

SSHTV owners and operators have some key concerns, such as:

- Saving on fuel, manual labour and maintenance costs
- Environment friendly, e.g. lower emissions, low noise, etc.
- Good performance on sailing, manoeuvrability and positioning
- Flexible and friendly operation to adapt to schedules and multiple working requirements
- Safe, reliable, long life and comfortable
- Information timely accessibility to both ashore and aboard
- Continual improvement of operation performance and working efficiency

ABB Marine is the largest and most experienced power and electric propulsion system supplier in the SSHTV global market. ABB Marine China has gained around a 65 per cent global market share of SSHTV since 2008. As an important component of ABB Ability, which represents ABB's complete portfolio of digital solutions, the digital SSHTV



Dockwise Vanguard

(D-SSHTV) is ABB Marine China's new solution, based on ABB's IoTSP (Internet of Things, Services, and People) proposition, to satisfy owner and operator requirements, and also to maintain the lead in SSHTV application and advancement.

D-SSHTV

Definition of the digital ship

In concept of the digital SSHTV, the digital ship is defined as to the use of sensors, communication, the Internet of Things, edge computing, cloud

computing, and other technical means to automatically collect and process information on the ship itself, from the marine environment, and on logistics, ports and other marine data. Based on computer technology, automatic control technology and large data processing and analysis technology, the system is able to realise intelligent operation in ship navigation, management, maintenance, cargo transport and other aspects, making the ship more secure, more environmentally friendly, more economical and more reliable.

The concept has six aspects independent of concrete equipment and location:

- Autonomous information sensing and acquisition
- Autonomous data processing and storage
- Autonomous data mining, calculation, analysis, knowledge extraction and decision and advisory, based on real-time and historical data
- Autonomous control and management execution
- Autonomous self-diagnosis and improvement
- Autonomous interconnection, communication and cooperation

Application depth and degree of integration of the six aspects determine a vessel's level of intelligence.

D-SSHTV goals

To help customers enhance the value of both economy and society, based on market development, customer position, and working autonomously, cooperatively and flexibly to integrate multi-level information processing and communication, fleet, vessel, equipment, energy management, strategic and advisory information.

Solution

Intellectualised and digital objects of SSHTV can be divided into eight classes:

- Navigation
- Equipment
- Energy
- Motion & hull
- Cargo
- Communication
- Operation
- Service

Automatic cooperative work between all intelligent objects is the primary concept of smart SSHTV.

Each dimension of SSHTV intelligence is rooted in imitating interaction between human intelligence and objects. Comprehensive D-SSHTV will integrate onshore planning and analytics and on board autonomous control and management through a unified communication platform. This includes planning and management from owner and operator, advanced analytics and monitoring from ABB, automatic navigation, equipment and energy control, and status management from the vessel.

Increasingly, ABB offers many qualified products and solutions, with a uniform name of ABB Ability, satisfying the core requirements of complete intelligence, some of which have been deployed widely. ABB Ability™ Marine Advisory System – OCTOPUS, for example, has been installed and applied on more than 80 per cent of SSHTV globally, and has had success in helping vessels to transport large and costly cargoes to their destination safely, economically and quickly.

Case Illustration

ABB is a leader in marine power and propulsion equipment and solution supply. Therefore, intelligence in engine room machines plays a significant role in their D-SSHTV solution.

Engine/machine room

After decades of continuous research, development, application and improvement, ABB offers a complete engine room solution portfolio. Some advanced solutions significantly enhance SSHTV digital implementation.

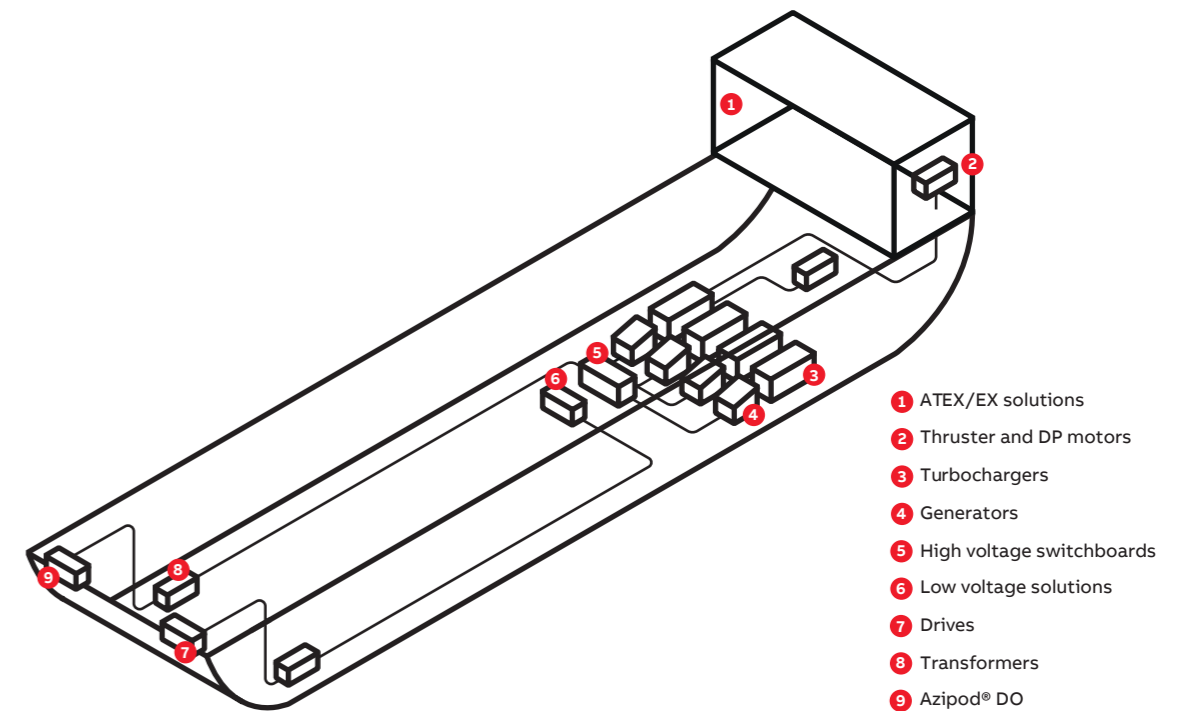
Working from forecasts on the intelligence megatrend, ABB began several years ago to focus on increasing the intelligence of the main engine room equipment. Most ABB main equipment can be merged into digital and intelligent solutions, as both functionality and data are sourced through integrated monitoring sensors and communication.

For example, compared with a traditional switchboard, the digital switchboard (D-Switchboard), in addition to fulfilling normal power distribution function, is able to acquire, collect, display and send multi-dimension data by installing additional real time sensors and function units inside the switchboard. Depending on these input data, RDS can also conduct health condition assessments to implement status monitoring, fault diagnoses and health assessment and prognostics to the switchboard.

Digital Engine room operation analysis

In SSHTV shipping operations, after loading, the vessel management centre (VMC) will break down the shipping plan, and according to a self-correcting schedule, route and optimisation targets, allocate tasks to all engine room equipment controllers. Autonomous propulsion controllers will

SSHTV 3D view



follow the command and requirement to operate propulsion equipment to provide sufficient push force and side force, so that the vessel may safely sail to its destination with optimal course, speed and fuel consumption, within the specified time.

Meanwhile power and energy controllers will follow the command and requirements to optimally configure supply and effectively control generation equipment in order to guarantee energy supply.

Throughout the entire shipping process, various intelligent sensors covering electric status, temperature, vibration, stress, voice, light, etc., both integrated in equipment and independently installed, will continuously monitor the status of main engine room machines. The real time monitoring data will be sent to the Remote Diagnostics Centre, RDS, using certain rules to support fault forecast and diagnosis, status analysis and assessment, settlement advisory and the Conditioned Based Maintenance, or CBM plan. Looking closer at CBM, if a potential generator bearing fault fails to activate a traditional fault response, but is detected by RDS because the bearing's temperature and vibration are beyond

normal range, RDS will present possible causes and come up with a handling solution based on the status level, such as communicating with Power Management System (PMS) to advise a generator changeover and preventive maintenance to the faulty generator. Fault escalation and performance decline can be avoided, and effects and maintenance costs can be minimised.

In the near future, ABB's maintenance robots and automatic spare parts warehouses might make engine room component auto-replacement a reality.

Summary

Requirements for SSHTV continue to increase and diversify. D-SSHTV is a promising and growing concept to compliment owners' and operators' eagerness and ambition. It uses a friendly, efficient, developing and autonomous method to handle SSHTV issues, including safety, cost, efficiency, functionality, environmental care, availability and optimisation. Foreseeably, with progress in related technologies, product portfolio extension and the maturity of the intelligence environment, D-SSHTV will continue to grow in strength and scope.