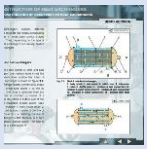


МУЛЬТИМЕДИЙНАЯ ТРЕНАЖЕРНАЯ ПРОГРАММА

МТП «СУДОВЫЕ ТЕПЛООБМЕННИКИ»

Версия 1.0

Назначение:

Мультимедийная тренажерная программа предназначена для практической подготовки специалистов машинного отделения по эксплуатации центральной системы охлаждения в соответствии с требованиями Конвенции ПДНВ и национальными требованиями.

В МТП включены:

- Интерактивный имитатор пульта управления центральной системой охлаждения.
- Интерактивные мнемосхемы систем охлаждения забортной и пресной водой.
- Описание теплообменников и центральной системы охлаждения с фотографиями и схемами.
- Задания для проверки знаний.

Целевая аудитория

Машинная команда – Управления

Машинная команда – Эксплуатации

Машинная команда - Вспомогательный

Тип судна

Все типы

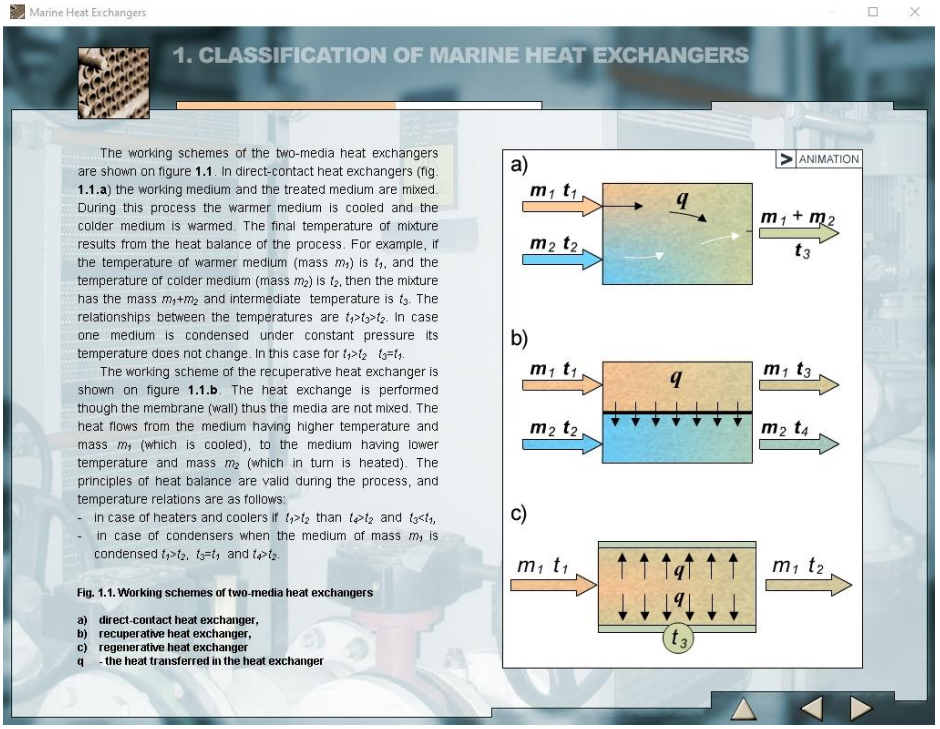
Нормативная база

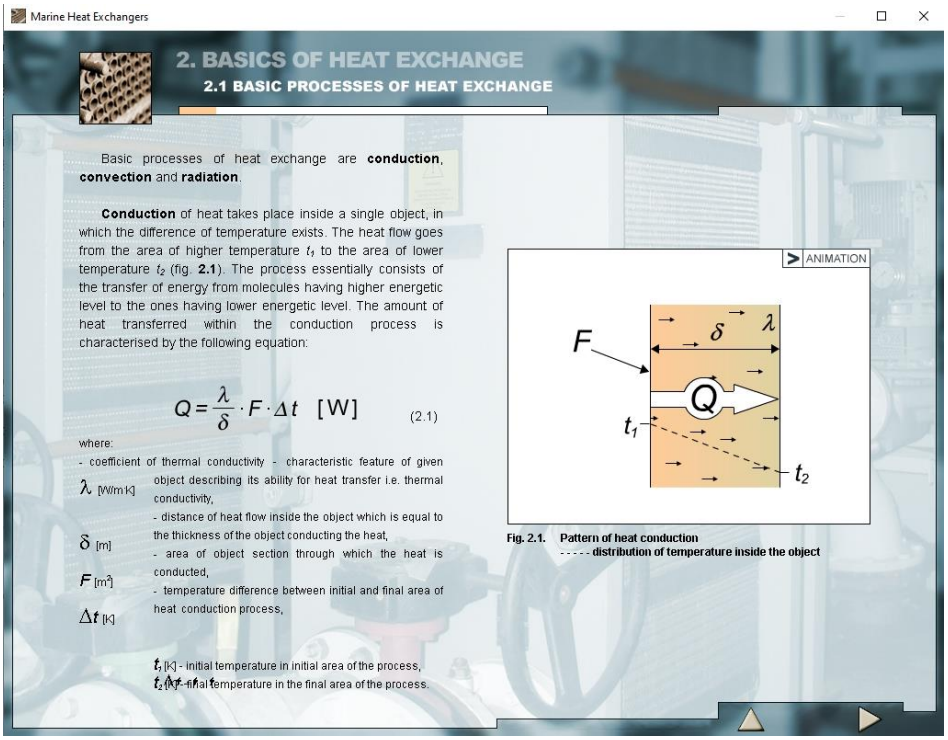
Конвенция ПДНВ:

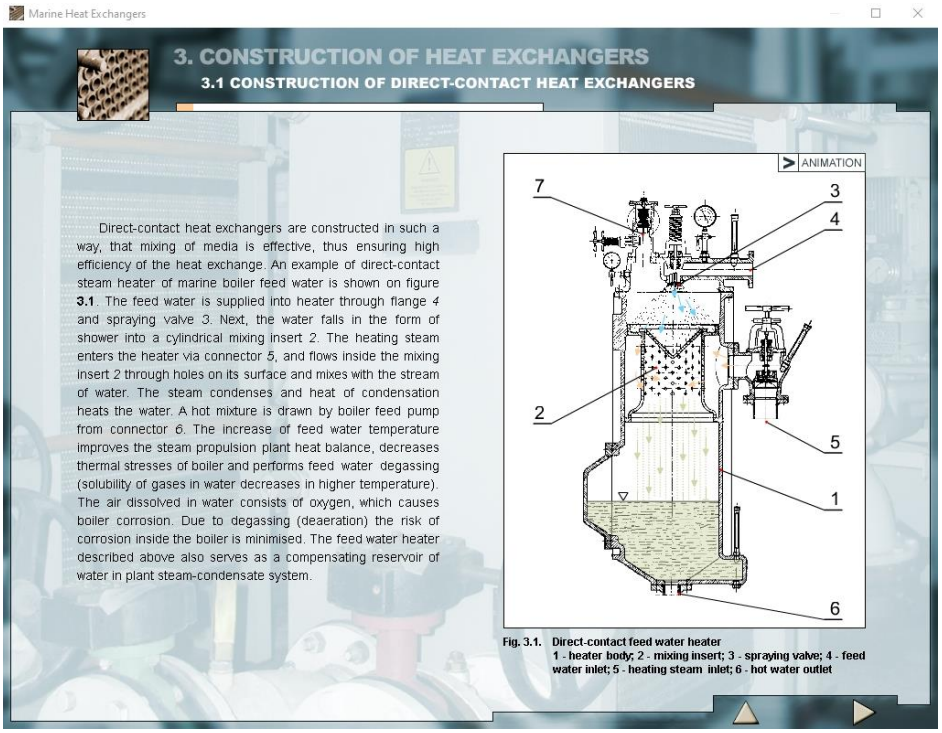
- Правила III/1, III/2, III/3, III/4, III/5.

Кодекс ПДНВ:

- Раздел A-III/1, Таблица A-III/1 «Спецификация минимального стандарта компетентности для вахтенных механиков судов с обслуживаемым или периодически необслуживаемым машинным отделением», сфера компетентности «Эксплуатация главных установок и вспомогательных механизмов и связанных с ними систем управления».
- Раздел A-III/2, Таблица A-III/2 «Спецификация минимального стандарта компетентности для старших механиков и вторых механиков с главной двигательной установкой мощностью 3 000 кВт или более», сфера компетентности «Эксплуатация, наблюдение, оценка работы и поддержание безопасности двигательной установки и вспомогательных механизмов».
- Раздел A-III/4, Таблица A-III/4 «Спецификация минимального стандарта компетентности для лиц рядового состава машинной вахты», сфера компетентности «Выполнение обычных обязанностей по вахте в машинном отделении, которые поручаются лицам рядового состава».
- Раздел A-III/5, Таблица A-III/5 «Спецификация минимального стандарта компетентности для лиц рядового состава в качестве квалифицированного моториста на судах с обслуживаемым или периодически необслуживаемым машинным отделением», сфера компетентности «Содействие наблюдению и управлению несением машинной вахты».

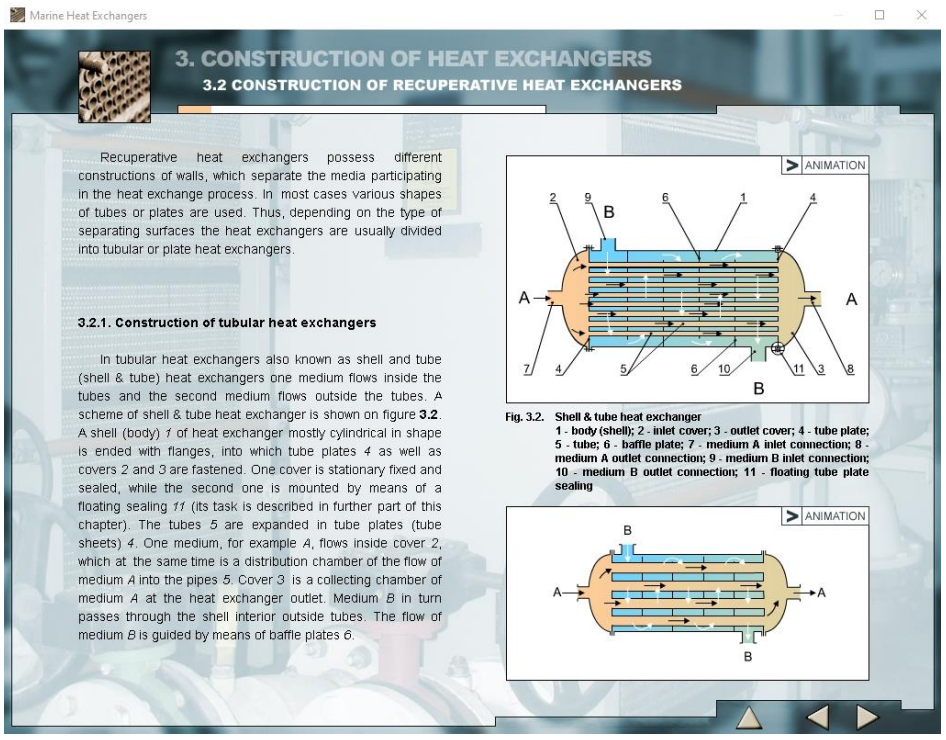

Marine Heat Exchangers
1. CLASSIFICATION OF MARINE HEAT EXCHANGERS
The working schemes of the two-media heat exchangers are shown on figure 1.1. In direct-contact heat exchangers (fig. 1.1.a) the working medium and the treated medium are mixed. During this process the warmer medium is cooled and the colder medium is warmed. The final temperature of mixture results from the heat balance of the process. For example, if the temperature of warmer medium (mass m_1) is t_1, and the temperature of colder medium (mass m_2) is t_2, then the mixture has the mass m_1+m_2 and intermediate temperature is t_3. The relationships between the temperatures are $t_1>t_3>t_2$. In case one medium is condensed under constant pressure its temperature does not change. In this case for $t_1>t_2$ $t_3=t_1$.
The working scheme of the recuperative heat exchanger is shown on figure 1.1.b. The heat exchange is performed though the membrane (wall) thus the media are not mixed. The heat flows from the medium having higher temperature and mass m_1 (which is cooled), to the medium having lower temperature and mass m_2 (which in turn is heated). The principles of heat balance are valid during the process, and temperature relations are as follows:
- in case of heaters and coolers if $t_1>t_2$ than $t_4>t_2$ and $t_3<t_1$,
- in case of condensers when the medium of mass m_1 is condensed $t_1>t_2$, $t_3=t_1$ and $t_4>t_2$.
Fig. 1.1. Working schemes of two-media heat exchangers
a) direct-contact heat exchanger,
b) recuperative heat exchanger,
c) regenerative heat exchanger
q - the heat transferred in the heat exchanger
ANIMATION
a)
m_1 t_1
m_2 t_2
q
$m_1 + m_2$
t_3
b)
m_1 t_1
m_2 t_2
q
m_1 t_3
m_2 t_4
c)
m_1 t_1
q
q
m_1 t_2
t_3


Marine Heat Exchangers
2. BASICS OF HEAT EXCHANGE
2.1 BASIC PROCESSES OF HEAT EXCHANGE
Basic processes of heat exchange are conduction, convection and radiation.
Conduction of heat takes place inside a single object, in which the difference of temperature exists. The heat flow goes from the area of higher temperature t_1 to the area of lower temperature t_2 (fig. 2.1). The process essentially consists of the transfer of energy from molecules having higher energetic level to the ones having lower energetic level. The amount of heat transferred within the conduction process is characterised by the following equation:
$$Q = \frac{\lambda}{\delta} \cdot F \cdot \Delta t \quad [W] \qquad (2.1)$$
where:
- coefficient of thermal conductivity - characteristic feature of given object describing its ability for heat transfer i.e. thermal conductivity,
λ [W/m·K]
- distance of heat flow inside the object which is equal to the thickness of the object conducting the heat,
δ [m]
- area of object section through which the heat is conducted,
F [m²]
- temperature difference between initial and final area of heat conduction process,
Δt [K]
t_1 [K] - initial temperature in initial area of the process,
t_2 [K] - final temperature in the final area of the process.
ANIMATION
F
δ
λ
Q
t_1
t_2
Fig. 2.1. Pattern of heat conduction
- - - - - distribution of temperature inside the object



Direct-contact heat exchangers are constructed in such a way, that mixing of media is effective, thus ensuring high efficiency of the heat exchange. An example of direct-contact steam heater of marine boiler feed water is shown on figure **3.1**. The feed water is supplied into heater through flange *4* and spraying valve *3*. Next, the water falls in the form of shower into a cylindrical mixing insert *2*. The heating steam enters the heater via connector *5*, and flows inside the mixing insert *2* through holes on its surface and mixes with the stream of water. The steam condenses and heat of condensation heats the water. A hot mixture is drawn by boiler feed pump from connector *6*. The increase of feed water temperature improves the steam propulsion plant heat balance, decreases thermal stresses of boiler and performs feed water degassing (solubility of gases in water decreases in higher temperature). The air dissolved in water consists of oxygen, which causes boiler corrosion. Due to degassing (deaeration) the risk of corrosion inside the boiler is minimised. The feed water heater described above also serves as a compensating reservoir of water in plant steam-condensate system.

Fig. 3.1. **Direct-contact feed water heater**
1 - heater body; 2 - mixing insert; 3 - spraying valve; 4 - feed water inlet; 5 - heating steam inlet; 6 - hot water outlet

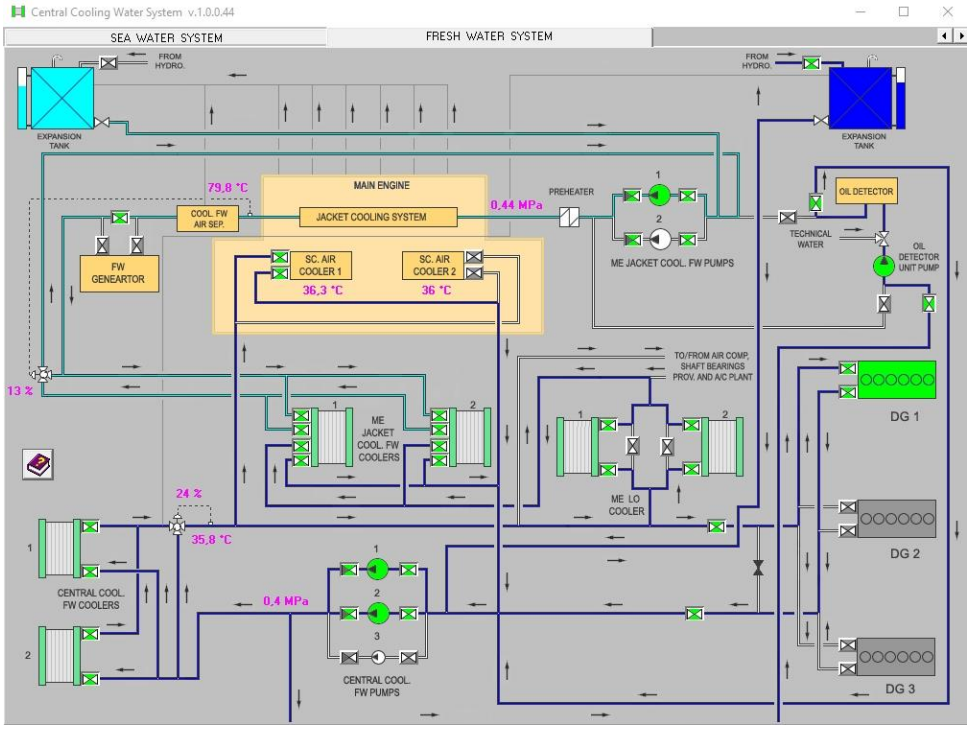


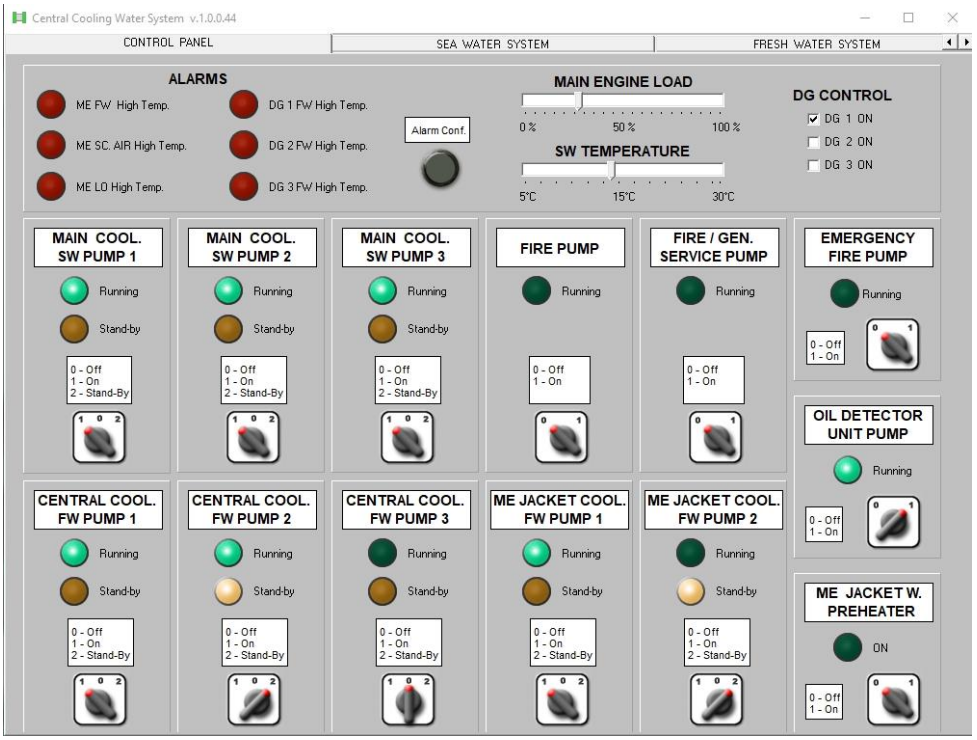
Recuperative heat exchangers possess different constructions of walls, which separate the media participating in the heat exchange process. In most cases various shapes of tubes or plates are used. Thus, depending on the type of separating surfaces the heat exchangers are usually divided into tubular or plate heat exchangers.

3.2.1. Construction of tubular heat exchangers

In tubular heat exchangers also known as shell and tube (shell & tube) heat exchangers one medium flows inside the tubes and the second medium flows outside the tubes. A scheme of shell & tube heat exchanger is shown on figure **3.2**. A shell (body) *1* of heat exchanger mostly cylindrical in shape is ended with flanges, into which tube plates *4* as well as covers *2* and *3* are fastened. One cover is stationary fixed and sealed, while the second one is mounted by means of a floating sealing *11* (its task is described in further part of this chapter). The tubes *5* are expanded in tube plates (tube sheets) *4*. One medium, for example *A*, flows inside cover *2*, which at the same time is a distribution chamber of the flow of medium *A* into the pipes *5*. Cover *3* is a collecting chamber of medium *A* at the heat exchanger outlet. Medium *B* in turn passes through the shell interior outside tubes. The flow of medium *B* is guided by means of baffle plates *6*.

Fig. 3.2. **Shell & tube heat exchanger**
1 - body (shell); 2 - inlet cover; 3 - outlet cover; 4 - tube plate; 5 - tube; 6 - baffle plate; 7 - medium A inlet connection; 8 - medium A outlet connection; 9 - medium B inlet connection; 10 - medium B outlet connection; 11 - floating tube plate sealing


Central Cooling Water System v.1.0.0.44
SEA WATER SYSTEM
FRESH WATER SYSTEM
FROM HYDRO.
EXPANSION TANK
79,8 °C
COOL. FW AIR SEP.
MAIN ENGINE
JACKET COOLING SYSTEM
0,44 MPa
PREHEATER
ME JACKET COOL. FW PUMPS
OIL DETECTOR
TECHNICAL WATER
OIL DETECTOR UNIT PUMP
FW GENEARTOR
SC. AIR COOLER 1
36,3 °C
SC. AIR COOLER 2
36 °C
13 %
TO/FROM AIR COMP. SHAFT BEARINGS PROV. AND A/C PLANT
ME JACKET COOL. FW COOLERS
ME LO COOLER
DG 1
DG 2
DG 3
24 %
35,8 °C
CENTRAL COOL. FW COOLERS
0,4 MPa
CENTRAL COOL. FW PUMPS


Central Cooling Water System v.1.0.0.44
CONTROL PANEL
SEA WATER SYSTEM
FRESH WATER SYSTEM
ALARMS
ME FW High Temp.
ME SC. AIR High Temp.
ME LO High Temp.
DG 1 FW High Temp.
DG 2 FW High Temp.
DG 3 FW High Temp.
Alarm Conf.
MAIN ENGINE LOAD
0 %
50 %
100 %
SW TEMPERATURE
5°C
15°C
30°C
DG CONTROL
DG 1 ON
DG 2 ON
DG 3 ON
MAIN COOL. SW PUMP 1
MAIN COOL. SW PUMP 2
MAIN COOL. SW PUMP 3
FIRE PUMP
FIRE / GEN. SERVICE PUMP
EMERGENCY FIRE PUMP
Running
Stand-by
0 - Off
1 - On
2 - Stand-By
OIL DETECTOR UNIT PUMP
CENTRAL COOL. FW PUMP 1
CENTRAL COOL. FW PUMP 2
CENTRAL COOL. FW PUMP 3
ME JACKET COOL. FW PUMP 1
ME JACKET COOL. FW PUMP 2
ME JACKET W. PREHEATER
ON