3. Steam Turbine and Boiler

3.1 Steam turbine

3.1.1 Main turbine

In 2012, Kawasaki Heavy Industries, Ltd. (“KHI”) delivered 1 unit of URA type main turbine for LNG carrier to their own shipyard, Sakaide Shipyard. In respect of the order acquisition, KHI received the order of 1 unit of URA type main turbine for LNG carrier. As the actual operation result, there was 1 unit for Hudong-Zhonghau Shipbuilding (Group) Co., Ltd.

In 2012, Mitsubishi Heavy Industries, Ltd. (“MHI”) delivered to their Nagasaki Shipyard 3 units of MR-II main turbine for LNG carrier which were the first marine reheat turbine produced by MHI. The number of unit that went into actual operation was zero. As for the order acquisition, MHI received the orders of 3 units of reheat type MR-II main engine turbine. Further, with respect to the prospect of order acquisition, since the demand of LNG has been increasing with the recovery of global economy and the influence of the mega earthquake etc., the market of LNG carrier has been becoming active, and therefore, the order of LNG carrier is expected to increase in near future. As the propulsion main engine, the electric propulsion system by diesel engine has been so far widely adopted. Since the adoption of electric propulsion system has resulted in high maintenance cost and the environmental rules of IMO have to be taken into consideration, there have been the movements shifting to the diesel propulsion with gas injection or returning to the steam plant. It is needless to say that the future’s operation result of highly efficient reheat main engine turbine (Fig.3.1, Fig3.2) may largely influence on the trends.

Fig.3.1  Sectional drawing of reheat turbine.

3.1.2 Turbine for auxiliary machinery

As the actual production and delivery results of the turbine for auxiliary machinery, Shinko Ind. Ltd. (“Shinko”) forwarded at their factory 260 units (cargo pump turbine, generator turbine), and Mitsubishi Heavy Industries, Ltd. (“MHI”) forwarded at their factory 14 units (all generator turbines). As the topics of order acquisition, it can be mentioned that the number of production of cargo pump turbine by Shinko has decreased due to the influence of the decrease of construction of crude oil tankers. As for MHI, the order of waste heat recovery system (MERS) has decreased with the influence of the slow speed operation of container ship.

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The rise of fuel price, the energy-saving tasks like reduction of CO₂ etc. and the various environmental problems have been still enumerated as the recent driving environmental factors surrounding society, and further, the demand of waste heat recovery turbine has been increasing in consideration of the slow steaming. It is expected that the enforcement of EEDI (Energy Efficiency Design Index) may also contribute to the increase of demand of energy saving turbine. Both of Shinko and MHI have continuously concentrated on the system development including the turbine enabling the maximum recovery of exhaust heat. Although MHI has already delivered the waste heat recovery system combined with the power turbine for reefer container carrier consuming the large volume of electric power and they had a number of actual operation results on the sea, they have been further carrying out the development of the marine ORC (Organic Rankine Cycle) system, taking into consideration the present slow steaming (Fig.3.3). Also, in response to the strong demand of LNG as stated above, the plan of the floating facility (Floating-LNG), which carries out the production, storage and unloading of LNG on the ocean, has been becoming enhanced. On this F-LNG, the gas turbine plant is installed in some case and in other case the steam turbine plant is installed, and therefore, the trend from now on should be watched with keen interest.

Fig.3.2 Test trial operation of reheat turbine.

Fig.3.3 ORC system outline.

(Written by Seiji Utoh)
3.2 Boiler

3.2.1 General

The followings are the topics in 2012 of 8 marine boiler makers (Mitsubishi Heavy Industries, Ltd., Kawasaki Heavy Industries, Ltd., Alfa Laval Aalborg K.K., Osaka Boiler MFG. Co., Ltd., Tortoise Engineering Co., Ltd., Miura Co., Ltd., IMEX Co., Ltd., Sasebo Heavy Industries Co., Ltd.), which have been gathered from questionnaires.

1. Mitsubishi Heavy Industries, Ltd. and Kawasaki Heavy Industries, Ltd. have produced the reheat boilers for reheating and regenerative turbine plants for LNG carriers, and both of them have also produced boilers of FPSO (Floating Production, Storage and Offloading System).
2. Alfa Laval Aalborg K.K. has developed the exhaust gas economizer for generator engine.
3. Tortoise Engineering Co., Ltd. has developed the energy saving type boiler and exhaust gas economizer by making use of the exhaust heat of generator.
4. Miura Co., Ltd. has developed the exhaust heat recovery merchandise.

The demand of efficient utilization of the onboard exhaust heat has become strong. Also, the investigation has been carried out on the change of quantity and temperature of exhaust gas from main engine originated from the recent controls of NOx by IMO and the influence of energy saving operation of ship, and further the study has been made on the maintenance and the situation of additional burning of auxiliary boiler due to the drop of evaporation quantity of exhaust gas economizer.

3.2.2 The number of production unit

In Fig. 3.4 and Fig. 3.5, the statistical values published by the Shipbuilding and Ship Machinery Division of the Ministry of Land, Infrastructure, Transport and Tourism are used and the transits of the actual production results of marine boilers during the past 15 years (January to December) since 1997 are respectively shown by the number of production and the weight of production. Both the number of production and the weight of production suddenly decreased in 2010 after they had hit the peak in 2009, and then, the slight recovery was observed in 2011. The annual statistics in 2012 has not been published yet.

![Fig.3.4  Boiler Production by Annual Report of Marine Industrial Statics.](image_url)
3.2.3 The main trends

The Energy System Research Committee of The Japan Institution of Marine Engineering has investigated the production and order acquisition results of main and auxiliary boilers of the marine boiler makers in Japan. From the data of 2012, the trends of the main and auxiliary boilers installed in the various kinds of ships can be summarized as follows.

(1) Main boiler:
The production and order acquisition results of main boilers in 2012 are shown in Fig. 3.6. The production result of main boiler for LNG carrier of Mitsubishi Heavy Industries, Ltd. (“MHI”) was 2 units of 45t/h class (reheat boiler 10MPa, 565℃), and their order acquisition result was 4 units of 45t/h class.
The production result of Kawasaki Heavy Industries, Ltd. (“KHI”) was 2 units of 55t/h class (Reheat boiler 12MPa, 565℃), and their order acquisition result was 4 units of 50t/h class. Besides, the production result of main boiler for LNG carrier in 2011 was 6 units in total.
As regards the boiler for F-LNG(FPSO), MHI produced 2 units of 71t/h class and 2 units of 40t/h class, and KHI produced 7 units of 220t/h.

(2) Auxiliary boiler:
Fig.3.7 shows the production and order acquisition results of auxiliary boiler (oil burning boiler) in 2012 by the boiler capacity standard. The production results of 8 marine boiler makers in 2012 were 121 units
in total, and their order acquisition results were 80 units which was less 20% compared with 151 units of the previous year’s result. However, the production of boilers of large capacity (26t/h~100t/h) has increased in MHI in comparison with the result of the previous year.

Fig.3.8 shows the production and order acquisition results of composite boiler in 2012. Similarly to the trend of the previous year, many composite boilers have been produced in the range of calorific value between 1.6~3.0t/h. The actual production result in 2012 was 399 units, and the order acquisition result of same year was 384 units. Since the production result in 2011 was 423 units, the result in 2012 has decreased about 6%.

![Fig.3.7 Production and Orders received of Auxiliary Boiler in 2012.](image)

![Fig.3.8 Production and Orders received of Composite Boiler in 2012.](image)

(3) Exhaust gas economizer:
The Fig.3.9 shows the production and order acquisition results of exhaust gas economizer in 2012. Comparing with 122 units of the production result in 2011 units (among which 20 units were the large exhaust gas economizers for T/G), the production result in 2012 was 74 units (among which 15 units were the large exhaust gas economizer for T/G). The production result of exhaust gas economizer has been sharply decreasing, since the production result in 2010 had been 175 units.
(4) Heat-medium boiler:
The actual production result in 2012 was 52 units, among which 5 units were the boilers of comparatively large capacity of heat output 2,400~3,500kW. The big majority of the boilers have been produced by Miura Co., Ltd. Since the numbers of production were 13 units in 2010 and 37 units in 2011, the production of heat-medium boilers has been rapidly increasing.

3.2.4 The trend prediction of marine boiler:
In reference to the boiler, the onboard exhaust heat recovery and the investigation of the existing state/the measures about the additional burning of boiler during slow speed operation of main engine will become to be demanded.

The trend prediction in 2013 obtained from marine boiler makers are enumerated as follows. However, it is anticipated that this year will also become the year of fierce cost completion similarly to the previous year.

(1) The more fierce completion of price and order acquisition due to the sluggish marine market.
(2) The decrease of order and production for the new ships built in the domestic shipyards.
(3) The research and development of the onboard exhaust heat recovery merchandise.

(Written by Yoshiharu Itami)