SELF PROPELLED FLOATING POWER PLANTS

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ABSTRACT

Engineering is a profession that tries hard to find solutions to the problems which is based on community's need. Engineers should be innovative, open-minded, and ethical to derive sensible solutions related to infrastructure. The naval architects deal with many kind of design and production problems for commercial use, defense, leisure and also social responsibilities. On the other hand producing and having energy when it is needed are some very important problems in a case of emergency or for developing centuries. Floating Power Plants (FPP) are a way out for this problem for developing countries. The idea of designing a FPP carry generators to produce electricity on a ship that can sail to any place near to a shore. A naval design office and an energy company became specialist manufacturing and operating such facilities. These are named NAVTEK and KARADENIZ.

1. Introduction

Floating Power Plant is a Ship having Electric Power generation capability. Usually, instead of building a brand new ship, an existing cargo ship is converted into a Floating Power Plant due to economic reasons and a shorter construction period. Jacona (Seen in Figure 1) was a very first floating power plant that was built in 1931 (Popular Mechanics, 1931). She was running along New England Coast to give support in any emergency case to cities or towns. During World War II some floating power plants were used that they were not self-propelled, with another words they were built on barges. In Figure 2, a modern barge power plant can be seen. This kind of plants were used by the USA during World War II. Also nuclear power plants have been designed and used. In this work, power plants different from nuclear ones.

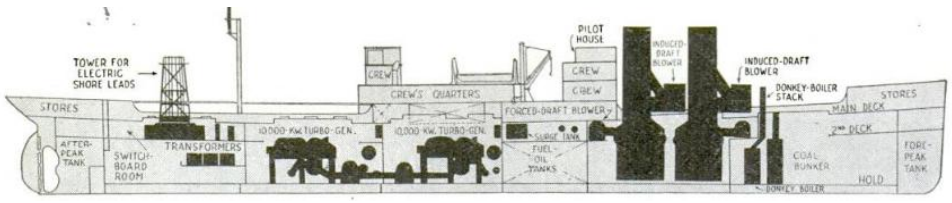

Figure 1. Jacona is a very early model of power plants (Popular Mechanics, 1931)

According to the platform ship's size, the Installed Power may vary from 50MWe to 540MWe. As prime movers, Gas Turbines, Steam Boilers & Turbines, Nuclear Reactors can be used as well as Reciprocating Engines. As the Floating Power Plants are self-propelled, they are always ready to go overseas and connect into the national grids where required. Today there are over 75 power barges deployed and operating around the world but they are mostly not self-propelled, they need to be wet or dry towage to the next destination (Navtek, 2017).

Figure 2. None propelled power plant

Karadeniz Energy Company and NAVTEK Design Office have been designing and operating power plants for 9years. The knowledge in this work is based on their plants and operations.

2. Facts about the Floating Power Plant

As the platform a ship or barge is chosen related to the decision if the plant is self-propelled or not. Usually the Ship can be easily found from the international second hand market. The size and the type of the Ship is specified regarding to the aimed installed power and hence prime movers' size and quantity.

The second hand platform is developed for the target. Main items for the renewal can be listed as follows:
– Auxiliary Systems of the prime movers,
– Pumps,
– Steel plates and profiles,
– Pipes,
– Valves,
– Transformers,
– Doors and Windows,
– Primary and Secondary High Voltage Equipment,
– Cables and cable ways,
– HVAC systems,
– Filters,
– SCADA (Plant Automation System),
– Fire Detection and Fighting Systems,

In concept stage modification of the ship/barge and required equipment can be listed, supplied and feasibility calculated. Following works to be done to convert the Platform Ship from a base ship/barge to a Floating Power Plant:
– Steel Works
– Pipe Works
– Engine & Machinery Installations
– InsulationWorks
– Paint Works
– Panelling Works
– EIC Works
– Furbishing Works

After completing the manufacturing work, tests and trails as well synchronization are performed in an order. The Floating Power Plant shall be ready to sail to the final destination. As per the Ship has all certificates allowing her to ocean-going voyages, the Floating Power Plant shall sail herself to the Site she will be running. After the Floating Power Plant has arrived the running site, she will be moored & anchored and Shore Grit Electric Connections shall be completed. A sample designed by NAVTEK and operated by KARADENIZ Company can be seen in Figure 3.

Figure 3 Irem Sultan designed by NAVTEK and operated by KARADENIZ Company

3. Technical Specification of the system

Prime Movers are located into the cargo holds of the Platform Ship. The arrangement may vary regarding to the tye of the Platform ship: 5-Holder Bulk Carrier, 7-Holder Bulk Carrier, Bo Hold Type Container Ship and so on.

Auxiliary Systems are located on or in the Platforms and Rooms constructed in the cargo spaces.

All pipe and cable connections are made according to the shipbuilding practice to provide adequate safety.

As the Generating Sets' output level is Medium Voltage, and the National Interconnected Systems to be fed are in High Voltage level, the Floating Power Plant has following electrical systems:
-High Voltage (from 35000 Volts to 380000 Volts, according to the Shore connection/National Grit Voltage Level)
-Medium Voltage (from 1000 Volts to 35000 Volts, according to the Generating Sets)
-Low Voltage (up to 1000 Volts, according to the consumers in the Plant, generally 380V)

Also an automation system controls all generating sets and the auxiliary systems to produce continuous electric power according to the power demand.

Sea Water is the main coolant for the cooling down of the Prime Movers and also used to generate fresh water for the Plant's needs through evoparating or reverse osmosis techniques.

The fuel for the Plant is supplied through the Shore or a storage tanker ship next to the Floating Power Plant. Besides, The Floating Power Plants are designed to have enough fuel storage

capacity to allow the plant runs continuously for 3 days to 1 week without fuel supply for the emergency cases.
The following systems are used to maintain the Floating Power Plant's negative influence minimum:
-Cooling System for the Cooling Sea Water discharge (to keep the temperature difference in an acceptable value in between the intake sea water and the discharged sea water.)
-DeNOx System (to reduce the Nitrogen Oxides in the exhaust gas)
-DeSOx System (to reduce the Sulphure Oxides in the exhaust gas)

4. Operation of the System

After the platform is moved the area where she is going to work the main concern is how to anchor or fasten her on the port. Quite complicated calculations should be carried out to keep the platform safely fixed on a port. The second important issue is to do the connection of electricity from shore to the land.

For the operating of the platform the followings should be supplied:

Fuel: The Plant can consume Heavy Fuel Oil or Natural Gas. The Engines can be switched either to the fuel oil or natural gas. Tank capacities of consumptions should be calculated correctly to find out supply periods.

Consumables: Following consumables to be provided during the operation:
– Lubrication Oil
– Fresh Water
– Chemicals (For water treatment, cleaning, engines etc.)

Personnel: Main target is to employ local people to work. At the beginning of the operation ex-pats shall may be employed but the plan is to decrease ex-pat/local workers ratio in time.
Health & Safety: Additionally there shall be an H&S team working according to the Local Rules and Regulations.

Sewage & Sludge Disposal: There shall be arrangement to dispose the sewage and sludge according to the National & International Rules and Regulations.

Spares: A Planned Maintenance system shall be applied and regular an non-regular spare parts for prime mover reciprocating engines and all auxiliary machineries shall be needed.

Surveys: During operation , regular and non-regular surveys shall be performed onboard of the Floating Power plant like:
– Classification Society Surveys to keep the Ship marine certified and ready to sail.
– Insurance Company inspections related to the policies.
– Equipment Manufacturers' supervisors' inspections regular basis and/or due to some failure or problems.
– Local Authorities' surveys like flag administration or Port Authority.

5. Conclusions

Designing a Floating Power Plant (FPP) is a complex problem but also it is very creative solution to requirement for energy of some countries or some areas. It is complex because of locating many generators in to a ship, solving construction, mooring and anchoring, noise and vibration problems as well as setting enough tank volumes. On the other hand it is very beneficial to have a mobile generator unit with high capacity. Some areas in the world is still unsafe to keep some sources such as power stations. In this case it is easy to move the source of energy from the area under risk to a safe heaven. If you have mobile power sources it is easy to fill the gaps of power requirement easily.

References:

Popular Mechanics, 1931, "A Floating Power Plant", February, pages 217 and 218.

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