Fishery Technology 57 (2020) : 200 - 205

Application of Hydraulics in Fishing Vessel Deck Equipment: Case Study of F.V. Sagar Harita

M. V. Baiju[1]*, V. Vipinkumar[1], Ashok Naik[2], Byeong Jang[3] and K. Sivaprasad[4]
[1]*ICAR-Central Institute of Fisheries Technology, P. O. Matsyapuri, Cochin - 682 029, India*
[2]*Goa Shipyard Limited, Vasco-Da-Gama, Goa - 403 802, India*
[3]*Jang Marine Exim Private Limited, Cochin - 682 020, India*
[4]*Cochin University of Science and Technology, Cochin - 682 022, India*

Abstract

The application of hydraulic power in operating deck machinery is a means of saving effort. A combination fishing vessel requires multiple winches onboard for setting and hauling different fishing gears. The commercial fishing vessels presently operating in India use mechanical winches driven directly by the main engine. When multiple gears are to be operated from a vessel, power transmission to all the winches from main engine will be made easy by hydraulic drive. This also reduces the maintenance of machinery and reduces the breakdown, especially during the peak fishing seasons. Compared to the mechanical system, hydraulic systems are compact and weigh less. The vibrations, wear and tear and sound are also less during operations compared to mechanical systems. This communication presents the application of hydraulics in deck machinery which was experimented and refined on F.V. Sagar Harita designed and developed by ICAR-Central Institute of Fisheries Technology.

Keywords: Fishing vessel, Hydraulic equipment, Combination fishing

Introduction

Mechanization of fishing vessels during the late 1970s was an important technological intervention in India that enabled fishers to expand the geographical spread of their fishing operation, thus enabling higher catch and profitability. Gear and fish handling equipment and steering system were the areas which were first mechanized. Mechanical systems were the de-facto systems which were available at that time, which eventually were adapted to all classes and types of fishing vessels. Though other systems of power transmissions systems were introduced later, mechanical transmission of power was widely used even in them. The aspects of the fishing vessel that were mechanized included fishing gear handling equipment on the main deck, steering system of the vessel and in some cases the bulk fish handling. The energy source for these marine power system was mechanical, electrical or hydraulic. In the beginning of mechanization there had not been much choice in power transmission other than mechanical. Hence it eventually became the accepted transmission method. Pneumatic, electrical and hydraulic systems were established later. Rigidity of mechanical systems imposes limitations and complexity in its field applications. Efficiency of the mechanical system decreases directly with the number of components, therefore step-less speed variation which requires more components will take down the bigger slice of the energy pie. No single component within a system is 100% efficient. Each component introduces its own inefficiency to the entire system. Each efficiency is multiplied together to obtain an overall efficiency for the system (Murray, 2010).

This case study presents design, installation and performance of a comprehensive hydraulic system onboard F.V. Sagar Harita, a 19.75 m Loa multipurpose fishing vessel. FAO had outlined engineering applications of hydraulic systems for small fishing trawlers, gillnetters seiners and long liners (Czekaj, 1989). The combination of gillnet and long line fishing onboard a vessel of this size operating with hydraulic system was a first. With significant reduction in the catch from the near shore areas, the

Received 06 March 2020; Revised 15 July 2020; Accepted 16 July 2020

**E-mail: vishnubaiju@yahoo.com*

stress of the government in the recent years has been to introduce vessels that could capture the oceanic resources in the EEZ and this vessel design tried to fill the void of the lack of a well-designed combination fishing vessel in our country.

Hydraulic systems possess advantages over mechanical, electrical and electro-mechanical systems. Besides being rugged and reliable, which are prerequisites for equipment in a fishing boat, hydraulic systems require very little maintenance and have fewer installation problems. The hydraulic system uses hoses and the pipes and these carrying the fluid can be installed in any convenient position, unlike the mechanical system requiring shafting, belting, etc. The mechanical systems essentially need straight lines and positioning them is difficult while the hydraulic systems are more flexible. However these were not so popular because of non-availability of suitable components and equipment, depriving the fast expanding Indian fishing fleet of the benefit of hydraulic system (Velu, 1973). Hydraulics allow energy to be sent via liquid medium over long distances and these driving force is generally produced by a motor which turns a pump. The pump moves oil in a circuit which in turn moves a hydraulic motor or cylinder (Czekaj, 1989). For all practical purposes liquids are considered incompressible. Hydraulics is widely used for trawl winch, long line winch and gill net haulers. Deck equipment comprises of gear handling equipment, such as winch and drums which are used to pay out and haul the fishing gear (Fyson, 1986; Benyami, 1994, FAO; 2009). The main engine driven hydraulic pump is used as the power source. Every winch will have a separate motor for its operation.

Materials and Methods

F.V. Sagar Harita is a 19.75 m multi-purpose fishing vessel equipped with multiple fishing gears like gillnet, trawl and long line for the economic and efficient utilization of the vessel. The vessel was built under the Classification regulations of Indian Register of Shipping and registered under fishing vessel criteria. F.V. Sagar Harita requires wide range of power transmission for its deck equipment since different fishing operations like trawl fishing operation, which has rigorous power requirement on one hand and apparently lesser energy intensive operations such as long line and gillnet on the other hand. The output power requirement is dynamic as the use of passive fishing gears onboard may lead the winches to start from full load in many occasions. The hydraulic system minimizes the periodic repair and maintenance of winch system onboard this vessel. The hydraulic deck equipment is meant for multi gear operation in the combination fishing vessel. The deck equipment required for trawling is a winch for hauling as well as setting the trawl gear system. For long lining, setting the lines is done by a line setter and hauling by a winch. In case of gill netter the net is dropped manually and hauled up after fishing using net drum. All these systems in the vessel were driven from the hydraulic pump attached to the main engine. Two different fishing methods of varying cruising speed, different load requirement to meet and limited deck space of the vessel of its class demanded compact power transmission system for F.V. Sagar Harita.

The deck equipment required for trawling is a winch for hauling as well as setting the trawl gear system. For long lining, setting the lines is done by a line setter and hauling by a winch separately. In the case of a gill netter the net is dropped manually and hauled up after fishing using a net drum. The prime mover of the hydraulic system is the main engine, auxiliary engine or electric motor which drives hydraulic pumps. The power is calculated as follows.

The hydraulic power supplied by a pump (100% efficient), N (kW) = (P x Q)/(600)

Where, Q= flow rate (L/min); P=pressure (bars)

Different parts of pump are made of cast iron, gun metal, mild steel and AISI 304 grade steel alloy. Experimental gillnetting and long lining was conducted from F.V. Sagar Harita and the performance of the complete hydraulic system were observed. Feedback from crew onboard was collected using a scale from 1-10 on operational parameters like operational easiness, time saving in operation, savings in man power, repair and maintenance, sound and vibrations, durability, deck space utilization, labour for winch, frequency of breakdown and overall rating of hydraulic system compared to other mechanical winches, to assess their response to the system.

Results and Discussion

The normal cruising speed range of commercial fishing vessels in our country is in the range of 7 to 10 kn. The speed during fishing operations varies

depending on the type of fishing. For passive fishing like gillnetting and long lining, the speed is not a criterion in catching fish. So, only free running speed is important here. Since majority of the commercial long liners and gill netters operate at 8–9 kn speed range and commercial trawlers operate at 9–10 kn (Baiju et al., 2019).

Typical hydraulic motor driven by the main engine using a clutch is shown in Fig. 1. This hydraulic motor can run a winch. Arrangements to drive two winch from the main engine is shown in Fig. 2.

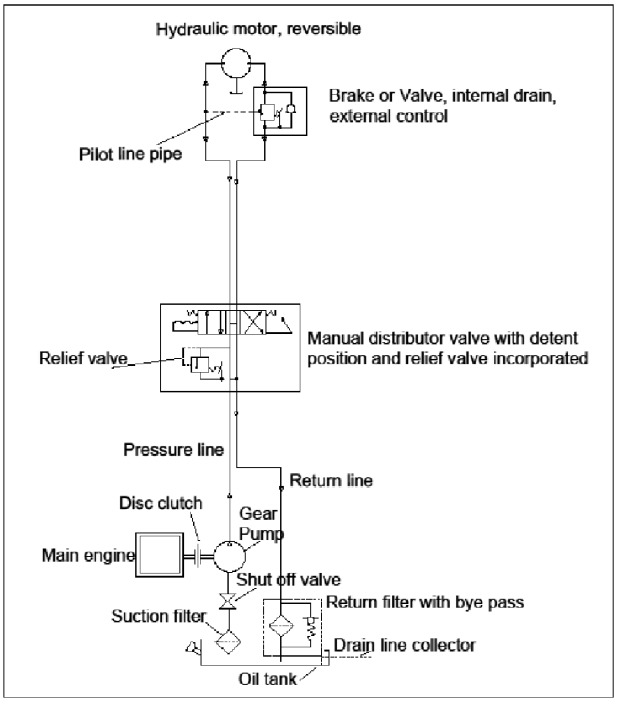

Fig. 1. Line diagram of a main engine driven winch system.

The hydraulic system established onboard F.V. Sagar Harita was tested for operation of gill nets and long lines which is presented in this communication. The prime mover of the hydraulic system is the main engine, auxiliary engine or electric motor which drives hydraulic pumps.

Since the intended hydraulic application involves multiple fishing gear operations, the hydraulic power calculation was done to meet all the types of gear hauling. Gillnet hauling speed range is 20 to 41.5 m/min and the load is 1 ton. Hence this requires 12 kW motor. The long line hauler requirement is

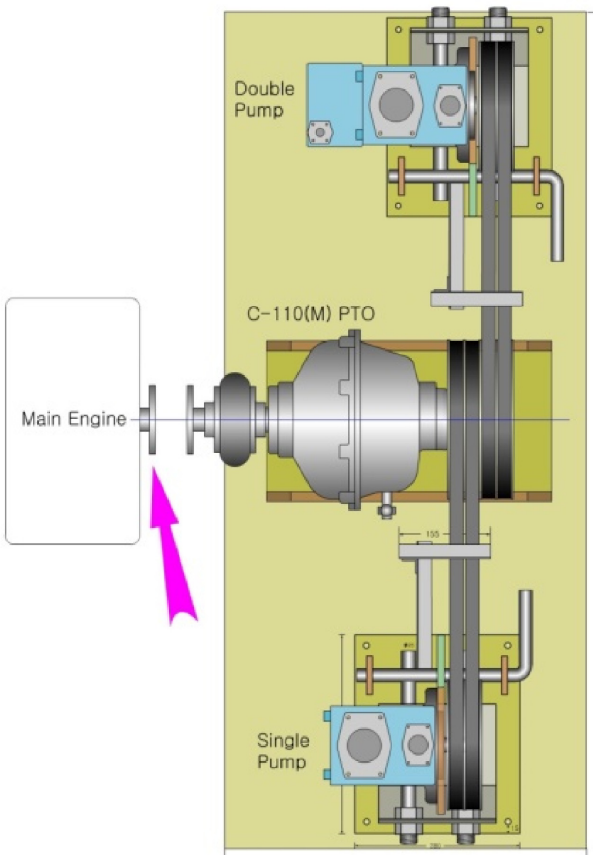

Fig. 2. Main engine driven hydraulic pumps through PTO in Sagar Harita

to pull 0.5 ton at 120 to 240 m/min. For this 9 kW motor is required. Control box is equipped to control all the gear operations independently. Capacity of hydraulic pump is estimated with gillnet hauler, long line hauler and long line setter operating one at a particular time.

The deck lay out of F.V. Sagar Harita was developed as per the guidelines of Indian Register of Shipping (IRCLASS, 1997) and has been approved. As seen in Fig. 3, the deck is laid out with a view to provide sufficient space on the main deck to facilitate multipurpose fishing operations. The main engine has a power of 400 hp. A belt driven pulley system is used for power transmission here and the power -take off from the main engine to drive the different pumps of the winches in the hydraulic system in such a way to arrange the redundancy and independence in operation at varying load conditions at sea. The hydraulic pipes are laid underneath the main deck as shown in Fig. 2.

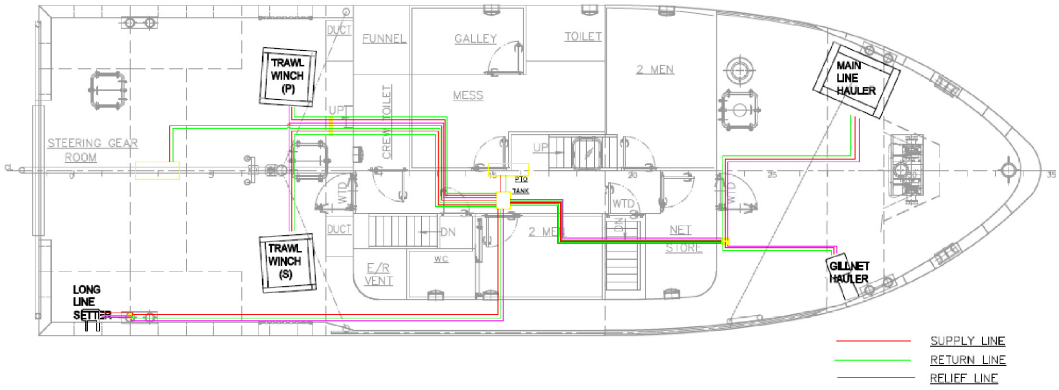

Fig. 3. The deck layout showing the position of all winch on F.V. Sagar Harita

An improvised design of three stage single drum gillnet hauler ensure with minimal damage to the fish and hassle free operation. A fully stainless steel gillnet drum with inner rubber layer made the fishing operation easier with gear engaging and operation. The entanglement of gill net happens when the sea conditions become rough due to wind, the hydraulic hauler help the gill net operation in a better way during such adverse conditions. For the gillnet operation hydraulic gillnet hauler provides very high pulling power and efficient control of the gill net while hauling.

Gill net of length of 2000 m and depth of 140 m and mesh size 140 mm were operated from F.V. Sagar Harita. The gill net drum fitted on starboard side forward of wheel house is shown in Fig. 4. Twenty-nine experimental fishing operations in the deep sea off Cochin were carried out. Twenty seven field trials of experimental gill net (twine specification 210×9×3 and three hanging coefficient 0.4, 0.5 and 0.6 with mesh size 140 mm were conducted (Jha, 2017; Chinnadurai, 2018). The total catch was 276.8 kg, catch per trip 10.32 kg, catch per area of net employed 9.59 kg 1000 m) and catch per soaking time 2.76 kg h^{-1}.

For the long line winch, the hydraulic pump is driven by the main engine through a clutch and the power is transmitted to the hydraulic motors at the line setter and hauler (Czekaj, 1989). For the long lining operations in the vessel, the branch line setter is provided with many rollers so that when the main line is shot into sea it will not undergo high tension, since the rollers will share the load in the line and reduce the chances of breaking of line especially in rough sea conditions. The hauling is done at low speeds only using a hauler having dimensions of 1080 (Frame L) x 750(W) x 750(H) mm. The structural frame of the long line spooler/ hauler winch is made from steel and the warp guide made of stainless steel shaft is seen in Fig. 5 (a). The line setter shown in Fig. 5 (b) is made of steel with rubber bush on steel rollers. The important machinery for long line operations in the sea are the main line spooler and line setter. The spooler is the part of the fishing equipment where the main line is retrieved. The diameter and length of the spool are variable and its capacity ranges from approximately 30 to 250 km of line, depending on the spool's diameter and the reel. The line setter or line shooter is synchronized with the reel by the hydraulic system and enables the launch of the main line at a speed independent of the vessel speed (Domingo et al., 2014).

The long line gear system in the commercial vessels consists of a very long main line having length from

Fig. 4. Main line spooler and three stage gill net hauler on the forward deck of F.V. Sagar Harita

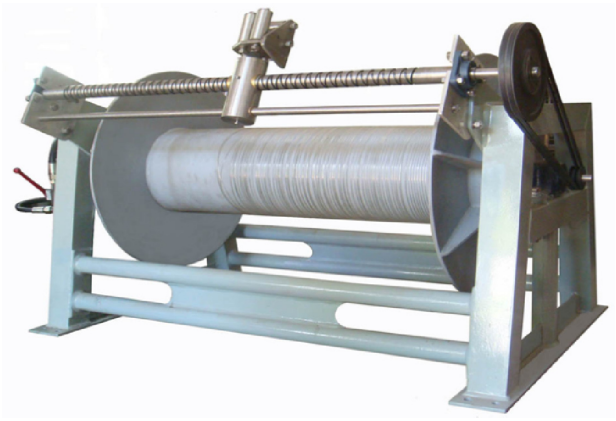

Fig. 5 (a). Main line spooler/ hauler

Fig. 5 (b). Digital branch line setter in F.V. Sagar Harita

2000-2700 m. The diameter of the main line ranges from 2-4 mm and that of the branch line from 1.5-2.5 mm. The total number of hooks used per vessel ranges from 300-700 and the commonly used hooks are 'J' type of size ranging from 3 to 5 (Edwin et al., 2014). The main line of the long line gear system is stored on the line hauler also called main line spooler which will be released to the line setter while shooting. Shooting a long line gear with more than 300 hooks is a laborious task which will take nearly 4 to 5 h continuously. Handling the main line having a diameter of 2.5 mm and a length of 2700 m length can cause injuries to the fishermen. This hydraulic winch eases manual drudgery of operation and considerably reduces the time for shooting as well as hauling the gear by 3-4 h compared to manual operation. The long line hauler is fitted on the port side of the vessel F.V. Sagar Harita. In the experimental long line operations conducted from this vessel using 110 hooks achieved a maximum hooking rate of 10% while comparing the fishing performance of J-hook and circle hook and the effect of different hook shapes on the species caught (Renjith et al., 2017)

Feedback on onboard experience of the crew collected on the merits and demerits of the system vis-a-vis the traditional long line and gill net winch, showed that this system was preferred over the existing systems. The rating for hydraulic system was 90.6 compared to 80.7 of mechanical system during 2 years of operations.

The dimension and the power of the hydraulic system developed seems to suit the overall requirement of the gill net and long line fishing industry which was also observed from rating given by experienced fishermen and skippers. The designs with hydraulic power will have significant impact on the fishing industry which may be willing to shift to these systems as they it will also have positive impacts on the economics of operation, especially as deep sea resources are being targeted.

Acknowledgements

Authors express thanks to the Director, ICAR-Central Institute of Fisheries Technology, Cochin for the facilities and encouragement. The authors are also indebted to Dr. Leela Edwin, Dr. Nikita Gopal and Dr. V.R. Madhu for the valuable advice. The help rendered by the skipper and crew members of F. V. Sagar Harita is gratefully acknowledged.

References

Ben-Yami, M. (1994) Purse seining Manual, FAO Fishing Manual, Fishing News Books Ltd., Farnham. 416p

Chinndurai, S., Paras Nath Jha, R. K. Renjith, M. P. Remesan, Saly N Thomas and M.V.Baiju, (2018) Depredation in gillnets operated along the south-west coast of India Indian J. Fish., 65(4): 154-156, 2018 154 DOI: 10.21077/ijf.2018.65.4.80126-19, Note

Czekaj, D. (1989) Hydraulics for Small Fishing Vessels, Engineering applications, FAO Fisheries Technical Paper (Vol-3) Volume 296 179 pp

Domingo, A., Rodrigo Forselledo, Philip Miller, Sebastian Jimenes and Federico Mas Maite Pons, (2014) ICCAT Manual, ICCAT publications, 15

Edwin, L., Pravin, P., Madhu, V. R., Saly N.Thomas, Remesan, M. P., Baiju, m. V., Renju Ravi, Dhiju Das, P. H., Boopendranath M. R. and B. Meenakumari (2014) Mechanised Marine Fishing Systems:India, Central Institute of Fisheries Technology, 277p

FAO (2009) Fisheries Topics: Technology Fishing Vessels. In: FAO Fisheries and Aquaculture Department, Rome

Fyson, J. F. (1986) Design of Small Fishing Vessels, FAO, Fishing News Books Ltd., Farnham. 320p http://www.fao.org/fishery/topic/1616/en

IRCLASS (1997) Indian Register Of Shipping Indian Register of Shipping Part 1 Regulations 205

Jha, P.N., Saly N. Thomas, Renjith, R.K., Chinnadurai, S. and Baiju, M.V. (2017) Effect of mesh lumen area on girth of fishes and catch in deep sea gill nets operated off Cochin. In: Fostering Innovations in Fisheries and Aquaculture: Focus on Sustainability and Safety (Thomas, S.N., Rao, B.M., Madhu, V. R., Asha, K. K., Binsi, P. K., Sajesh V.K. and Jha, P.N., Eds.) - Book of Abstracts, 11th IFAF, ICAR-CIFT, Kochi and Asian Fisheries society, Indian Branch, 21-24 November, 2017, Kochi, India. 116p

Murray, M. (2010) System efficiency, Power transmission engineering. pp 6-23

Renjith, R.K, Paras Nath Jha, S.Chinnadurai, M.P.Remesan, Saly.N.Thomas and M.V.Baiju (2017) Performance of J-hook and circle hook in long lining fishing off Cochin, India, 11th IFAF

Velu, M. (1973) Hydraulic equipment for fishing boats. Seafood Export Journal. pp 21-25