IMPROVEMENT OF ENERGY AUDIT DATA AQUISITION FOR REAL-TIME EFFICIENT FUEL MONITORING OF TRAWL FISHING VESSELS

T. Suthipong, T. Thaweesak, **M. Khunthawat**
Southeast Asian Fisheries Development Center, Samutprakarn, Thailand

Abstract

Energy audit was proved as necessary activity to provide for fuel cost saving and decline environmental impact from carbon dioxide released from fishing vessels. Fuel consumption metering system is one important improvement for real-time monitoring on fishing vesseles. Fuel consumption data logger, CKPT-31, support all required parameters to operate fishing vessels at optimum conditions. And also to save fuel by reducing ship speed, this logger can show real-time accurate values of fuel consumption and GPS of fishing vessel that operator can use for making recent proper decision. The other than real-time fuel consumption data logger, water-in-fuel emulsion should be one of solution to decrease fuel cost and air pollution from diesel exhaust gas.

Keywords: Real-time energy audit for Thai trawl fishing vessels, Thai energy audit on trawl fishing vessels

Introduction

Two phases of energy audit project were performed by SEAFDEC/TD between 2013 to 2015 fund by FAO purposed for promoting green house gas emission reduction from Thai bottom trawl fishing vessels distributed in both Gulf of Thailand and Andaman Sea by extracting impact parameters of fuel consumption and finding suitable practical way to reach the purpose.

According to data results collected, in term of economic concerns, even expenditures of trawl fishing vessels composing fuel, labor, provision, ice, maintenance, etc. however fuel is almost main cost of all fishing trips. With this reason, all fishers and owners have to address and manage to get high incomes with less expenditures generated during doing fishing activities at sea.

Due to two different requirements among FAO and fishers/owners of trawlers, fishery engineering of SEAFDEC/TD attempts to find suitable way to implement on green house gas and fuel cost reduction through energy auditing project. This auditing need to extract fuel consumption profile of six representative bottom trawl fishing vessels by applying monitoring system including analog diesel fuel flow meter to measure fuel consumption via time and GPS navigator to track fishing path and ship speed during fishing operation. All measured parameters are displayed on screen of indicating devices and recorded manually onto log sheet that required some time for filling and calculation. These manual data collection and monitoring, it made fishers/owners inconvenience to use and understand real-time fuel consumption state. Not only fishers/owners made difficulty but also reporter need long time in extracting and processing raw data for analysis.

Energy audit development using a new energy monitoring system onboard fishing vessels for fuel consumption data logger should be a suitable solution to contribute user-friendly application and real-time fuel consumption monitoring for fishing vessel operator.

One of fuel consumption data logging system is called "CKPT-31" which support measuring and recording both analog and digital signals of sensors including pulse fuel flow sensor, GPS, analog fuel level sensor, and pulse engine revolution sensor. These signals sent to CKPT-31 logger were calculated and displayed on the screen. Fuel consumption analysis, these data in the logger will be load to PC. With display screen, fishers/owners are able to see

real-time fuel consumption rate of fishing vessel which they can monitor their suitable speed of fishing operation at optimum status.

Even though fishers/owners do not accept to invest on new real-time energy audit equipment but fishery engineering team recommend to use it and expect to save fuel about 10-15 % of their operational cost which breakeven should be not over one years.

MATERIALS AND METHODOLOGIES

Fuel performance indicators

In order to access energy performance of fishing vessels, simple indicator was defined and calculated. Fuel consumption rate for vessel speed in steaming and trawling phase were measured and calculated for evaluating and ranking the energy performance of fishing vessels. These measurements is useful for research purpose and to highlight possible suggestions to further investigate vessels.

Improvement of fuel auditing system

Manual data recording of fuel auditing system applied in the first and second phase of the project. All data values displayed on screen of fuel meter, engine revolution meter, gps navigator, and weather meter were recorded by CCTV system. All values recorded by CCTV were replayed to extract data and write onto log sheet that required for some time. Operators of fishing vessels were unable to understand recent fuel consumption condition because of uncalculated values on display of auditing devices.

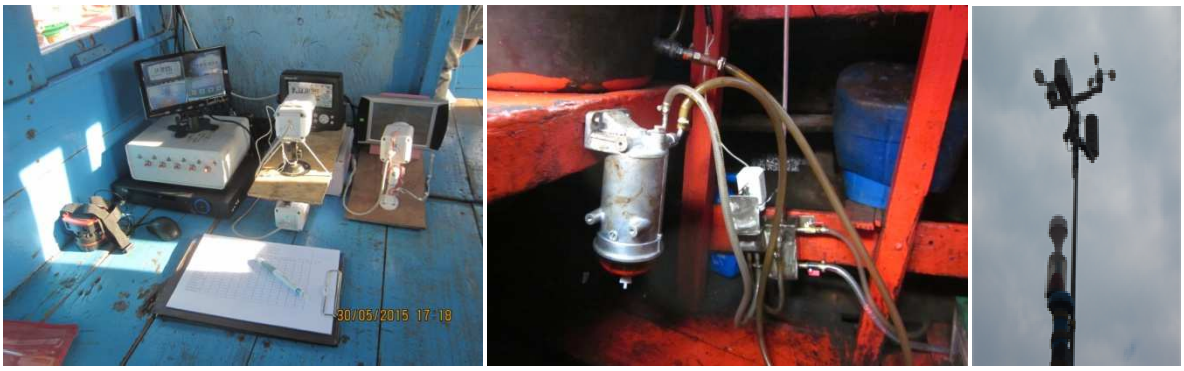


Figure 1 Manual fuel metering system

Fuel data logger receives several signals from GPS antenna for ship position, engine tachometer sensor for engine revolution, fuel flow sensor for fuel consumption of fishing vessel, and these measured values are acquired automatically and displayed real-time values on the screen and recorded into internal memory of CKPT31 shown in Fig. 2. At the end of recording test, these recorded data in CKPT 31 logger was loaded to personal computer through USB cable port for calculation by CKPT manager software that can record and evaluate fuel consumption rate, total fuel consumption, engine revolution, and ship position.

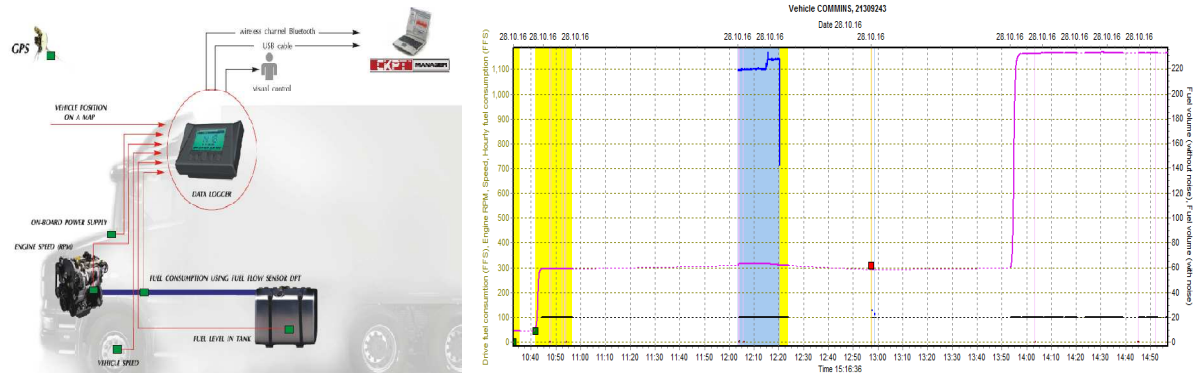
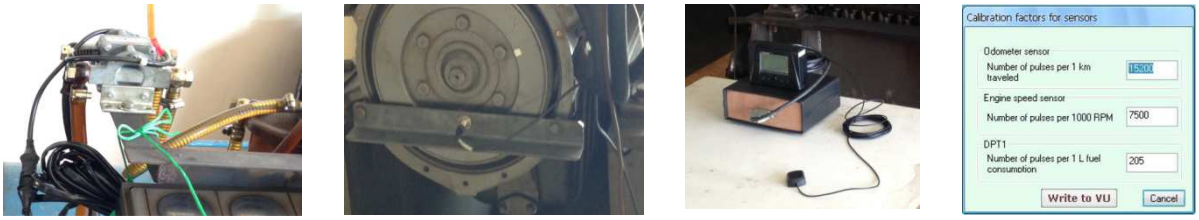


Fig. 2 Diagram of CKPT 31 connected with several sensors including GPS antenna, tachometer sensor, fuel flow DPT sensor. Values table and chart of recorded results were shown and suitable for characterization.

In order to check accuracy of software and hardware, calibration and accuracy of sensors are a process that all measurement devices must be done both before and after attaching different fuel flow and rpm sensors onto engine in Fig. 3, calibration is by varying constant values on CKPT software.



(a) (b) (c) (d)

Fig. 3 (a) different fuel flow sensor, (b) rpm sensor, (c) CKPT monitor with satellite antenna, and (d) calibration constant of sensors

New system of fuel consumption data logger uses different fuel flow sensor which will measure differential fuel consumption among inlet line before entering fuel pump and return line after diesel injector. This difference fuel flow sensor will accurately calculate fuel consumed during combustion. The other parameters that required to measure performance of fishing vessels is shaft rotational speed measured with an optical proximity sensor attached in front of diesel engine Fig. 3 (b). CKPT-31 logger with screen Fig. 3 (c) receives sensor signals and calculate with internal electronic module and show these measured values such total fuel consumption, fuel consumption per hour, GPS position and engine rpm. Operator is easy to observe real-time operation of ship and engine.

RESULTS

Discussion on new fuel data logger

From result measured in the previous phase, the below data extracted from GPS navigator one trip of Wor yingcharoen (Fig. 4), however, other data as fuel consumption, distance were recorded manually at some time. All most fuel consumption data are presented in term of total fuel consumption which is not continuous values, however, total fuel consumption was calculated and brought to estimated fuel consumption of each trawler (Fig. 5).

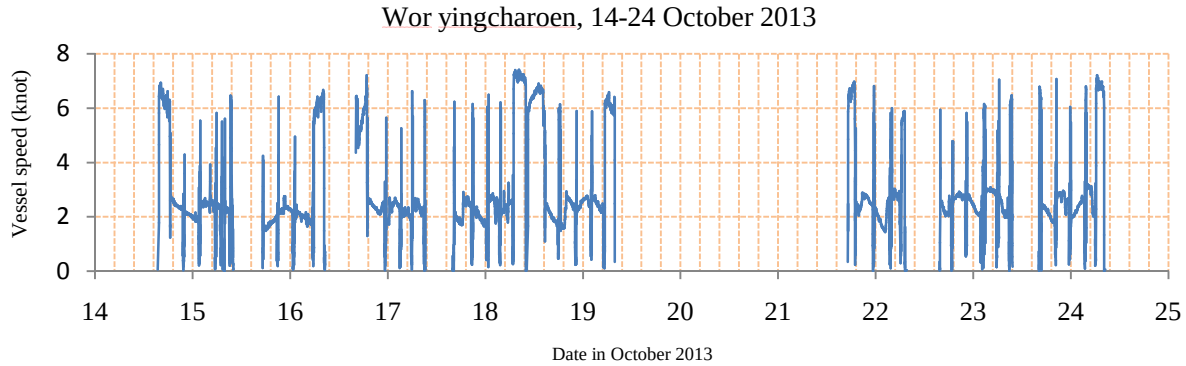


Fig. 4 Shipspeed profiel of Wor yingcharoen having fishing ground in Chaonburi

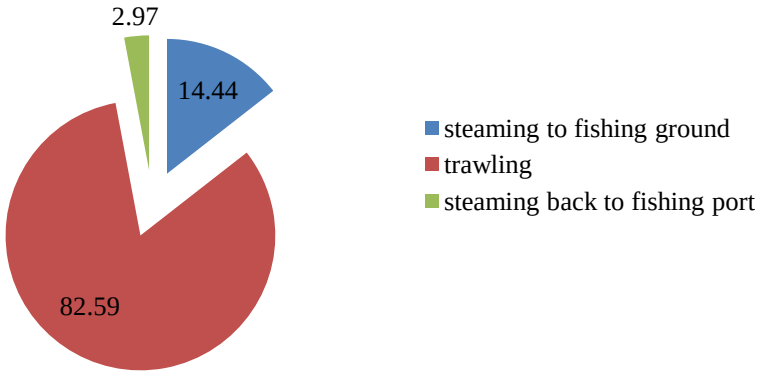


Fig. 5 One trip total fuel consumption percentage of Chokpanthawee small bottom trawl fishing vessel

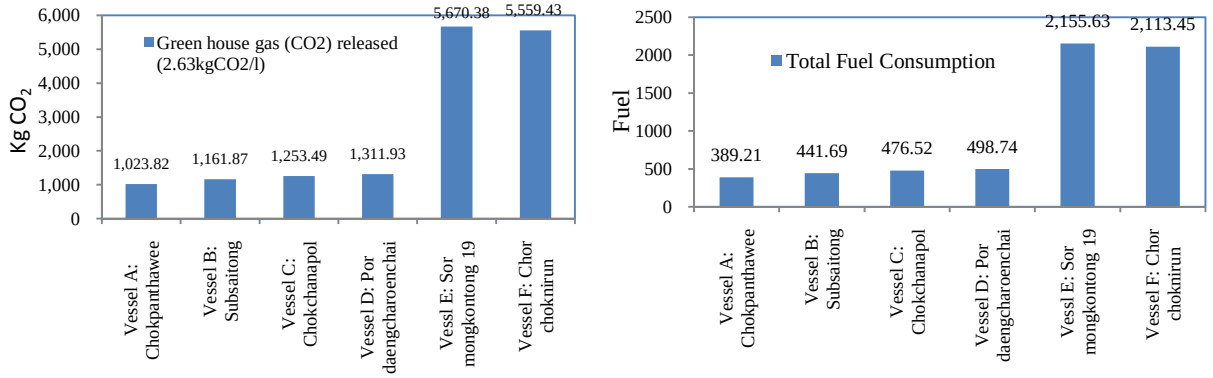
Practical test on engine test base at fishery engineering workshop, the electronic recording system can measure and collect values of fuel consumption rate, total fuel consumption, GPS position and speed, and these results will be displayed on CKPT-31 monitor. These recorded value data can be downloaded from the data logger and transferred to pc through USB cable. With supporting function of CKPT-31, fishers can see real-time fuel consumption condition and ship speed of fishing vessel at recent operation. This function of real-time measurement is possible to contribute fisher/skipper to manipulate optimum speed of fishing vessel at proper condition following specific fuel consumption profile of each fishing vessel which is achieved under standard sea trail test. It is one technique to minimize fuel cost of doing business of the owner and to reduce carbon dioxide emission from combusting diesel fuel.

Discussion on impact parameters to fuel consumption of trawlers [1]

According to auditing fuel consumption of Thai bottom trawler in the first and second phase, each Thai bottom trawl has their specific fuel consumption due to distinguish of ship and engine characteristics, and location of fishing grounds. Almost fuel consumption of Thai bottom trawlers is in trawling period because water resistance and drag force resistance occurring on trawl net are main impact parameters during trawling period. One case study of Wor yingcharoen, high fuel consumption observed from reducing of ship speed on speed-time chart (Fig. 4). But the average trawling speed of Wor yingcharoen is about 2.3 knots. Sometime ship speed in trawling period is surged up. It is possible because of obstruction of trawl net with an object on sea surface. Sea surface property is one of impact parameter to fuel consumption that should be considered as well.

Discussion on evaluation of carbon emission from previous energy audit results:

Carbon dioxide emission from these trawlers was calculated from fuel consumption through complete combustion of diesel fuel. A constant of 2.63 kg CO_2 per liter of diesel oil is for converting diesel oil consumption to kilogram carbon dioxide released. Total fuel consumptions of fishing vessels are varied depending on engine house power, efficiency of engine, service displacement, fishing operation trip, sea condition, fishing ground, and etc. It is impossible to compare among a group of fishing vessel because of distinguish of ship and equipment characteristics even doing the same fishing condition.

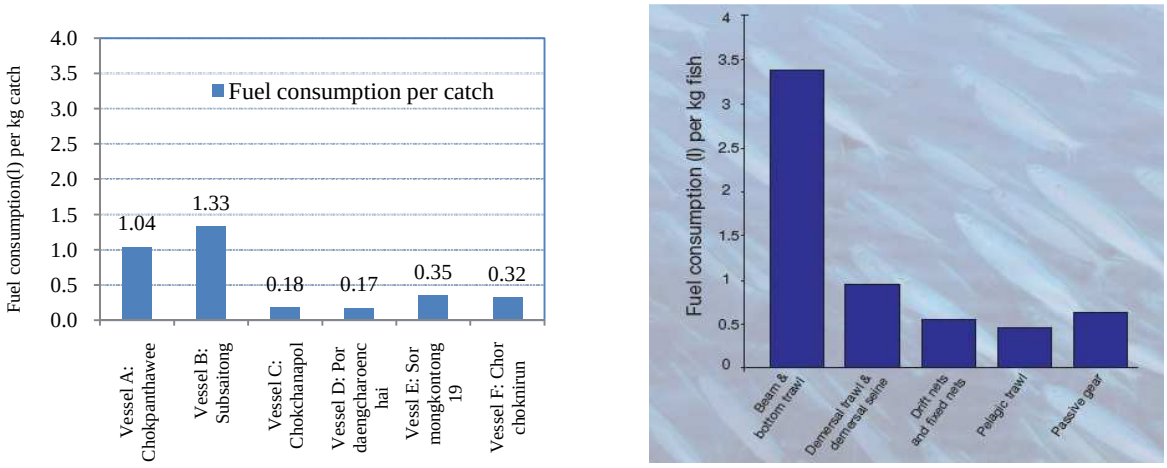


(a) kg CO_2 emission (b) total fuel consumption, liter

Fig. 6 Kilogram CO_2 emission calculated through complete burning of fossil fuel

Discussion on average fuel consumption per kilo catch for difference fishing vessels

One indicator to present current situation of carbon dioxide emission of Thai trawl fishing vessels is average fuel consumption per kilogram of catch. One report from North sea foundation presented in Fig. 7 (b), Beam and bottom trawl in EU produce about 3.4 liter fuel per kg fish which is about nearly three time of Chokpanthawee that generate 1.04 liter diesel per kg catch.



(a) (b) Source: North sea foundation

Fig. 7 Average fuel consumption per kilo catch for difference fishing vessels (a) in Thailand (b) in EU

From previous discussion of carbon dioxide emission, a fishing vessel has more fuel consumption more carbon dioxide released. Thus, based on this criteria, Thai bottom trawl emit less carbon emission than EU bottom trawl.

Discussion on fuel saving by reducing ship speed [2]

Several modifications and readjustments should be considered for fuel optimization. Ship speed reduction is a simple way that various fuel saving document introduce to do because of without any investment cost. After sea trial test to identify fuel consumption profile of investigated trawlers, blow two charts present (Fig. 8) the results of Chokpanthawee and Chokchanapol trawlers. During trawling with trawl net in water, reducing one ship speed one knot contribute to drop fuel consumption 44 % and 55 % or Chokpanthawee and Chokchanpol, respectively.

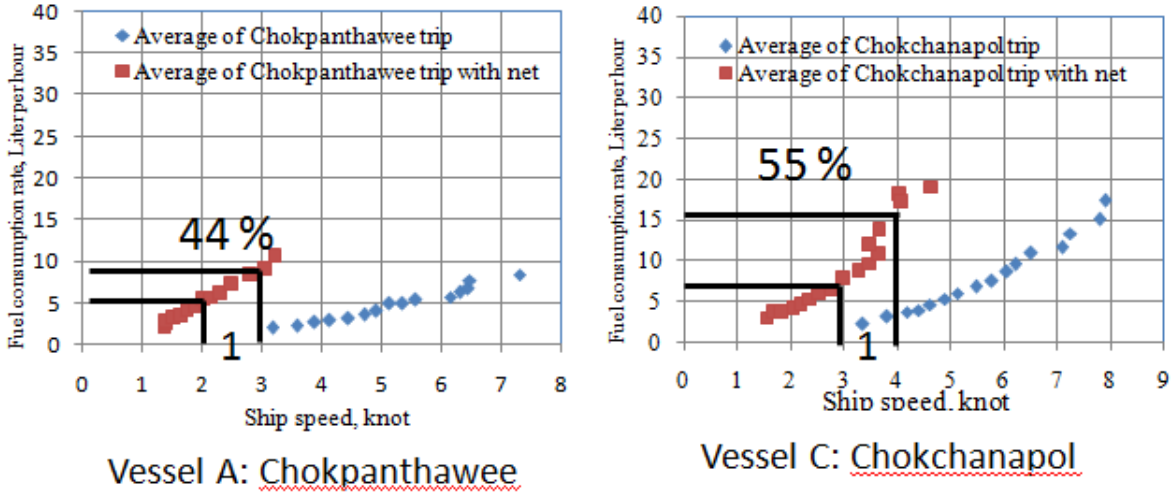


Fig. 8 fuel consumption via ship speed of two trawlers

However, ship speed reduction should be under operator consideration based on practical condition of fishing gear such as forming shape and floating of trawl net. During trawling net, fuel consumption rate of both trawler is sharp raise up because of water resistance force increase power two of net speed. In order to minimize net resistance force, suitable net speed should be tested. Using optimum net speed can drop high rate of fuel consumption rate.

Discussion on using diesel-water micro emulsion to drop both fuel consumption and carbon emission from diesel engine

A new technology of water-in-fuel emulsion, some work call green emulsion fuel [3] or Sosei Water Fuel [4], purpose for saving fuel cost by 40 % and reducing CO_2 and NO_x emission by 50-80% released from diesel engine . This technology can be found in marine cargo industry which should be suitable adapted system for Southeast Asian fishing fleet industry. One practical application on Malaysian fishing vessel in Khuantan, Pahan was done by running SWF for ten day without any engine troublesome and decreased 40 % diesel fuel consumption [4]. The other several works reported that they can mix water 5 to 30 % with fuel with maintaining diesel engine efficiency and drop pollutant of emission.

CONCLUSION

Development of energy audit for Thai bottom trawls for fuel saving and carbon emission reduction must be introduced to local fishers to understand. New improvement of fuel data logger has main purpose for user-friendly and real-time monitoring by fishers/skippers to enhance optimum fuel use of trawl fishing vessels. Utilizing real-time ship and engine monitoring system with energy audit process will save fuel consumption which drop carbon dioxide as well. Not only fuel consumption data logger is interested in, but also water-in-fuel emulsion is one technology to enhance engine efficiency, reduce both fuel cost

and carbon dioxide emission. Some document address this emulsion help to drop 40% fuel cost and 50-80 % of CO_2 and NO_x. This emulsion should be a parallel application technology in energy audit topic for trawl fishing vessel to raise up awareness of fishers to their life and environment.

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